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(12) (19) (CA) **Demande-Application**

(21) (A1) **2,303,465**
(22) 2000/03/29
(43) 2000/09/30

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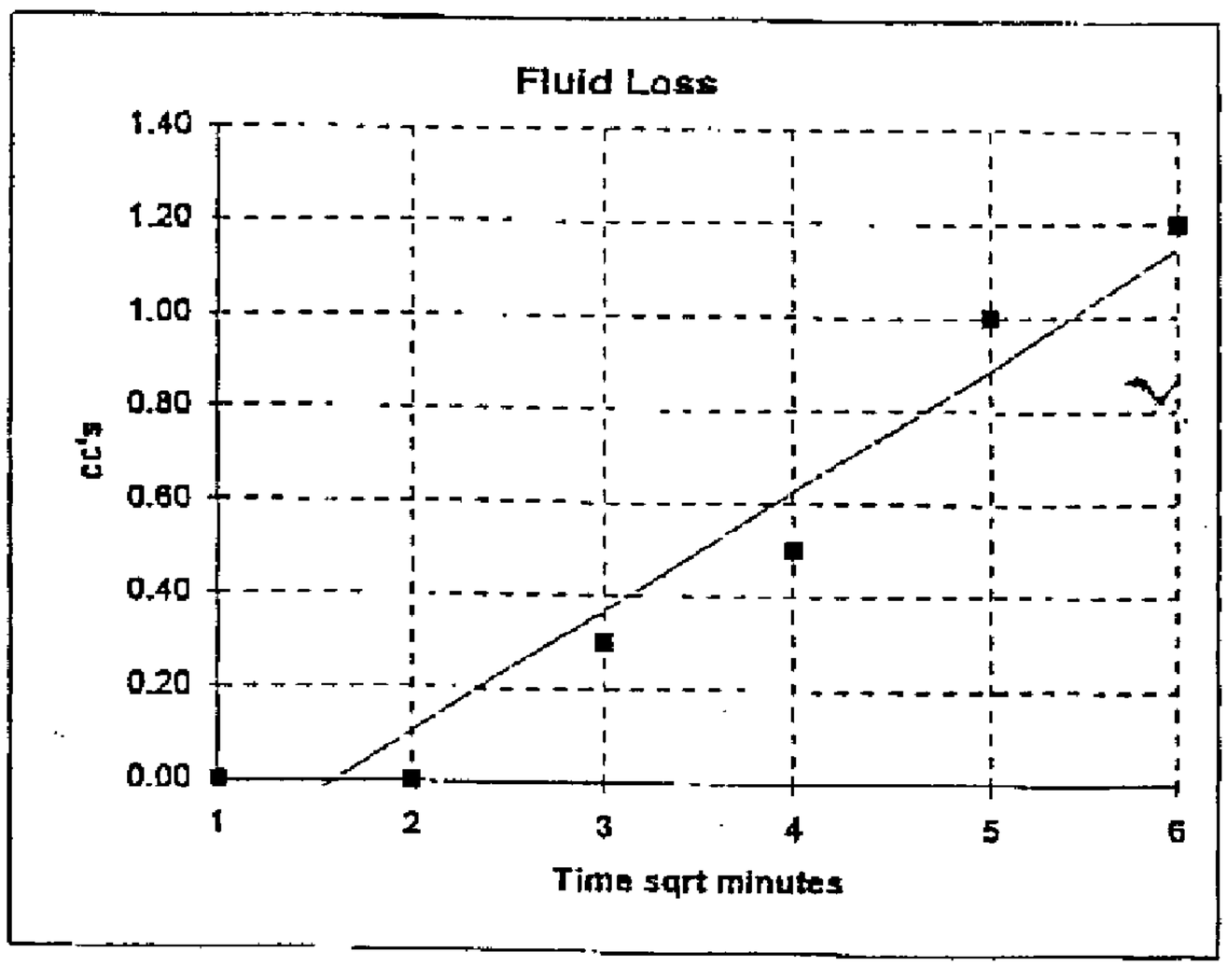
(51) Int.Cl.[7] C07F 5/06, C07C 309/58, C07C 51/41, C07C 57/38, E21B 43/267, B01J 13/00, C07C 53/00, C07C 53/126, C08F 222/10, C08F 222/08, C07F 15/02
(30) 1999/03/30 (60/127,298) US
(30) 1999/04/05 (60/129,770) US
(30) 1999/08/11 (60/148,274) US

(54) **COMPOSITIONS D'HYDROCARBURES GELIFIEES ET METHODE POUR LES UTILISER**

(54) **GELLED HYDROCARBON COMPOSITIONS AND METHODS FOR USE THEREOF**



(57) Gelled organic compositions and methods for using same. The gelled compositions may be liquid organic fluids, such as gelled liquid hydrocarbons, formed from a mixture of an organic-base fluid, a carboxylic acid, and one or more metal source compounds, such as a metal salt of carboxylic acid. The gelled compositions may be used in variety of applications including, but not limited to, oil field, pipeline and processing facility applications.

ABSTRACT

Gelled organic compositions and methods for using same. The gelled compositions may be liquid organic fluids, such as gelled liquid hydrocarbons, formed from a mixture of an organic-base fluid, a carboxylic acid, and one or more metal source compounds, such as a metal salt of carboxylic acid. The gelled compositions may be used in variety of applications including, but not limited to, oil field, pipeline and processing facility applications.

GELLED HYDROCARBON COMPOSITIONS AND METHODS FOR USE THEREOF

by Joseph E. Thompson and Joel L. Boles

BACKGROUND OF THE INVENTION

1. Field of the Invention

This invention relates generally to gelled organic compositions and methods for using the same. In particular, this invention relates to gelled liquid organic fluids, such as gelled liquid hydrocarbons formed from a mixture of an organic-based fluid, a carboxylic acid and/or other hydroxyl-containing compound, and a metal source compound.

2. Description of Related Art

Gelled organic fluids, such as gelled hydrocarbon liquids, may be employed for a variety of different purposes including, but not limited to, applications in the petroleum, refining, chemical and pipeline industries. In one common application, liquid hydrocarbon gels are employed as fluids for stimulation treatment of subterranean formations. Such stimulation treatments include, but are not limited to, hydraulic fracturing treatments with or without proppants, such as sand. In any event, it may be desirable to utilize liquid hydrocarbon gels for the stimulation of subterranean formations which are sensitive or adversely affected by introduction of aqueous-based fluids.

In the past, hydrocarbon liquids have been gelled in a number of different ways. For example, phosphate ester-based hydrocarbon gels are commonly employed in the formulation of hydrocarbon-based well treatment fluids. However, concerns have arisen regarding residual phosphates which may remain in refined petroleum products which have been exposed to, or processed using, phosphate-based hydrocarbon gels (such as through the use of phosphate-containing well treatment fluids, anti-foulants, scale inhibitors, *etc.*).

Non-phosphate-based hydrocarbon liquid gels have been developed. One conventional non-phosphate method of gelling liquid hydrocarbons involves the saponification of tall oil fatty acids ("TOFAs") with caustic. However, methods employing this and similar chemistries typically suffer from limited temperature stability, losing effectiveness at temperatures above about 130°F to about 140°F.

Another conventional method of gelling liquid hydrocarbons involves mixing aluminum salts of long chain fatty acids with liquid hydrocarbons. However, gelation rates of such mixtures is typically very slow at temperatures below about 80°F, requiring heating to obtain satisfactory gelation times.

SUMMARY OF THE INVENTION

Disclosed are non-phosphate methods and compositions related to gelled organic liquids. These methods and compositions may be used in any application in which, for example, gelled hydrocarbon liquids are employed including, but not limited to, stimulation fluids for subterranean formations, drilling and workover fluids, treatment fluids for oil field production equipment and pipelines, treatment fluids for refinery and chemical processing facilities, *etc.*

The disclosed compositions may include select mixtures or formulations of linear and/or branched chain fatty acids, fatty acid salts, and other metal salts or metal alkoxides, blended to obtain desired gelled organic fluid properties. Surfactants and other additives may also be employed to further vary fluid properties. Exemplary compositions include, for example, mixtures of fatty acids, metal alkoxides, and fatty acid salts in hydrocarbon-base fluids, such as diesel.

Also disclosed are compositions which are reaction products of fatty acid salts with linear or branched chain fatty acids. Such a reaction product may advantageously be further processed, for example, dried and ground to a desired particle size. In this further processed state, the dried material may be dispersed or blended into an organic fluid, ultimately resulting in viscosity

development. Advantageously, such a dried particulate reaction product allows components to be pre-reacted to form a product that may be conveniently stored and then added to an organic-based fluid at a later time to form a gelled organic liquid, without the need for reaction equipment or the performance of reaction procedures at the work site, for example, at a well site or chemical processing facility. Further advantageously, by varying particle size of solid reaction product particulate, amount of shear to which the combined materials exposed, and/or mixing dynamics (*e.g.*, duration and/or amount of shear), viscosity development over time may be controlled to suit individual applications, such as those in which an initial relatively lower viscosity followed by development of later relatively higher viscosity are desired.

Also disclosed are non-phosphate compositions, and methods for using the same, which may include partial monoesters of styrene maleic anhydride copolymers and fatty alcohols ("MSMA's") for greatly enhanced rheology performance (*e.g.,* viscosity, *etc.*) fluid compatibility and shelf life. As used herein, "MSMA-based compounds" include MSMA's as well as derivatives of MSMA's (such as sodium salts of sulfonated MSMA's). One or more MSMA-based compounds may be combined with one or more metal source compounds and one or more of other compounds described elsewhere herein, for example in mixtures or formulations comprising linear and/or branched chain fatty acids, fatty acid salts, and other metal salts or metal alkoxides. Alternatively, one or more MSMA-based compounds may be combined with one or more metal sources in the absence of other types of hydroxyl-containing compounds, such as fatty acids.

Many of such MSMA-based compounds are available in solid resin form and may be first dissolved in an organic solvent (*e.g.,* xylene, toluene, or any solvent capable of dissolution of the MSMA-based compound) in any suitable amount (*e.g.,* from about 1% to about 50%) MSMA-based compound by weight of organic solvent solution. The MSMA-based compound/solvent solution may then be combined in any suitable manner with other components. For example, a metal source, such as aluminum isopropoxide may be directly combined with the MSMA-based compound/solvent solution and heated (if necessary) to form a gelled fluid. Alternatively the MSMA-based compound/solvent solution may be combined with at least one fatty acid and at least one metal source, and heated (if necessary) to form a gelled fluid. Additional metal source

may be "back added" following initial combination of ingredients, if so desired. This is represented in Table 69 in which additional isopropyl alcohol ("IPA") and aluminum isopropoxide were added at the end of the synthesis process.

Also disclosed are methods and compositions related to phosphate ester-containing gelled organic liquids. For example, MSMA-based compounds may be advantageously combined in an organic base fluid with phosphate ester compounds (such as EG-1 from Ethox Chemicals, Inc., Greenville S. Carolina; RHODAFAC LO-11A from Rhone-Poulenc, Cranbury, New Jersey; ASP-160 or ASP-162 from Nalco-Exxon, Sugarland, Texas; or HGA-70 from Clearwater, Inc., Pittsburgh, Pennsylvania) and gelled with, for example, aluminum or iron metal source compounds such as aluminum isopropoxide, iron sulfate or an iron chelate solution, *etc.* For example, MSMA-based compound may be dissolved in an organic solvent such as toluene, xylene, *etc.* Separate liquid process streams containing MSMA/solvent, phosphate ester and metal source compound (*e.g.,* aluminum isopropoxide, iron salt, *etc.*) may then be combined as part of a continuous mix process to form a gelled fluid. Examples of phosphate ester materials and methods of using the same may be found in United States Patents No. 5,514,645; 5,417,287; 4,153,649; 3,505,374; 4,003,393; 4,200,540; 4,316,810; 5,271,464; and 4,622,155 which are incorporated herein by reference.

Advantageously, MSMA-based compounds may be used to obtain gelled organic liquids having increased stability, and in a wide variety of organic fluids, including organic fluids described elsewhere herein and containing components (*e.g.,* asphaltenes) that may hamper stability and/or shelf-life of similar gels that lack MSMA-based compounds. Furthermore, such gelled organic liquids may be formulated with MSMA-based compounds to have relatively high viscosity (*e.g.*, from about 2000 cp to about 1000 cp) at relatively low rates of shear (*e.g.,* from about 40 to about 100 sec-1). Thus shear stress of such fluids may advantageously increase with decreasing shear rates, forming a gelled organic fluids capable of carrying relatively large concentrations of proppants, and offering reduced friction characteristics in flow regimes such as present in tubing. In one exemplary embodiment, at 100C fluid viscosity may be about 1000 at 100 reciprocal seconds, while being about 2000 at 40 reciprocal seconds. Furthermore, viscosity

of the disclosed gelled organic fluids may advantageously increase with increasing temperature, *e.g.*, as a well treatment fluid is displaced downhole.

For example, in one embodiment MSMA-based compounds may be combined with asphaltene-containing crude oils and other components to form gelled organic liquids possessing more consistent and/or increased gel stability relative to comparable non-phosphate or phosphate-containing gelled fluids formulated without MSMA-based compound. Such increased stability may include increased shelf life as well as viscosity (*e.g.*, up to about 1000 or 1200 centipoise) consistently in the presence of asphaltenes. Thus, when formulated and used as described herein, MSMA-based compounds allow gelled fluids to be formulated from crude oils containing impurities such as asphaltenes, therefore increasing the versatility of the system. In one embodiment, a gelled liquid may be formulated from a crude oil containing up to about 1% - 5% asphaltenes by weight, although greater amounts of asphaltenes may be present as well.

MSMA-based compounds may be employed in any amount suitable for reaction and/or gellation of organic fluids using components and methods described elsewhere herein. In one embodiment, MSMA-based compound is present in a gelled an amount of from about 1% to about 10% alternatively from about 2% to about 6% and further alternatively from about 2.5% to about 4% by volume.

In one exemplary embodiment, gelled organic fluids may be formulated as described elsewhere herein, with the exception that MSMA-based compounds may be combined with (or substituted for) a portion of fatty acid materials. In this regard, virtually any ratio of fatty acid to MSMA-based compound may be employed. In one embodiment, a ratio of fatty acid to MSMA-based compound may be from about 1:1 to about 10:1, alternatively from about 3:1 to about 7:1, further alternatively from about 3:1 to about 5:1. Examples of formulations falling within these ranges may be found in Tables 61-69.

Further viscosity enhancement may advantageously be achieved in any of the embodiments described herein with the incorporation of high rosin fatty acid/s in place of, or in addition to, fatty acids described elsewhere herein. Rosin content of tall oil fatty acids typically range from less than about 1% to about 40% by weight rosin. By "high rosin" it is meant that a

fatty acid contains from about 20% to about 80% by weight rosin. Examples include, but are not limited to, "UNITOL-S" and "UNITOL AR-40" (the latter containing about 38% rosin), available from Arizona Chemical Company, Panama City, Florida; and International Paper Company, Chemical Division. Other examples of specific fatty acids and high rosin fatty acids include, but are not limited to "UNITOL" products available from Arizona Chemical and International Paper, such as "PDT" distilled tall oil, "AR-40" specialty tall oil, "DPX", *etc.* Solid high rosin fatty acids may be prepared for use by dilution with a solvent, such as an aromatic solvent like toluene, xylene, "AROMATIC 150" from Amoco Chemical, *etc.*

When present, additional viscosity may be imparted to a gelled organic fluid by high rosin fatty acids, and when introduced to an organic fluid at a temperature of, for example, about 25C to about 27C, considerable viscosity development may be achieved. Further increased viscosity may be achieved with increasing temperatures. In such a way, gel time (or vortex closure time as described in the examples) may be shortened (for example, from about 180 seconds to about 30 seconds, alternatively to about 30 seconds) and/or controlled, for example using temperature. In one embodiment, high rosin fatty acid is employed in a gelled organic fluid in an amount of from about 0.05 to about .4 alternatively from about 0.1 to about 0.2, although greater and lesser amounts are also possible.

Advantageously then, by utilizing the disclosed method and compositions, non-phosphate gelled organic liquids may be formulated having rheological and viscosity characteristics superior to conventional non-phosphate gelled hydrocarbon compositions. Furthermore, the disclosed organic liquid gels have better high temperature stability than previous non-phosphate systems. Surprisingly, by employing combinations of metal source compounds, such as a carboxylic acid salt in addition to metal saponifier (such as metal hydroxide), improved viscosity performance and stability may be achieved at relatively high temperatures as compared to conventional non-phosphate gelled hydrocarbon systems. In one exemplary embodiment, relatively good viscosity characteristics may be achieved at temperatures up to at least about 300°F. In another possible embodiment, viscosities of up to about 900 centipoise, alternatively up to about 800 centipoise, alternatively from about 300 centipoise to about 900 centipoise, further alternatively from about 300 to about 800 centipoise, further alternatively from about 800

to about 900 centipoise may be achieved at temperatures up to about 250°F to about 275°F. In still another possible embodiment, a viscosity of at least about 400 centipoise as measured at 100^{-1} seconds on a Fann 50C rotational viscometer may be realized at a temperature of up to about 275°F.

In one respect, disclosed is a method of forming a gelled organic-based treatment fluid, including combining at least one organic base fluid, at least one carboxylic acid, and at least one first metal source compound to form the gelled organic fluid. The metal source compound may include at least one of carboxylic acid salt, metal oxide, metal hydroxide, metal alkoxide or mixture thereof. The combining further may include combining a second metal source compound with the hydrocarbon base fluid, carboxylic acid and first metal source compound; wherein the first metal source compound may include salt of carboxylic acid; and wherein the second metal source compound may include at least one of metal oxide, metal hydroxide, metal alkoxide, metal sulfate or mixture thereof. The carboxylic acid may include tall oil fatty acid; wherein the carboxylic acid salt may include aluminum octoate; and wherein the second metal source compound may include aluminum hydroxide. At least one first metal source compound may be combined in the form of a solid compound suspended in an organic fluid. The method may further include introducing the gelled organic-based treatment fluid into a wellbore, subterranean formation, pipeline interior, or fluid processing facility. The method may further included introducing the gelled organic-based treatment fluid into a pipeline interior.

In another respect, disclosed is a method of forming and using a gelled organic-based fluid, including combining at least one organic base fluid, at least one carboxylic acid, at least one first metal source compound, and at least one second metal source compound to form the gelled organic fluid; and introducing the gelled organic fluid into a wellbore, pipeline interior or fluid processing facility; wherein the first and second metal source compounds are different compounds; and wherein the metal of the first metal source has a valence of +3; and wherein the metal of the second metal source has a valence of +3.

In another respect, disclosed is a method of forming a gelled organic-based fluid, including combining the following components to form the gelled organic fluid: at least one

organic base fluid; at least one MSMA-based compound; and at least one first metal source compound.

In another respect, disclosed is a method of treating a subterranean formation, including introducing a hydrocarbon-based treatment fluid into at least a portion of the formation, the hydrocarbon-based treatment fluid including a mixture of at least one hydrocarbon base fluid, at least one carboxylic acid, at least one first metal source compound including salt of carboxylic acid, and at least one second metal source compound. The salt of carboxylic acid may include at least one of aluminum ethyl hexanoate, aluminum methyl pentoate, iron octoate, aluminum stearate, or mixtures thereof. The carboxylic acid may include at least one fatty acid having from about 6 to about 24 carbon atoms, and in one embodiment specifically may be tall oil fatty acid. The second metal source compound may be at least one of metal salt, metal alkoxide, metal oxide, metal chelate, metal hydroxide, or a mixture thereof. The second metal source compound may be at least one of sodium hydroxide, aluminum hydroxide, aluminum isopropoxide, or a mixture thereof. The hydrocarbon-based treatment fluid may be introduced into the formation at a pressure above a fracturing pressure of the formation.

In another respect, disclosed is a method of treating a subterranean formation, including introducing a hydrocarbon-based treatment fluid into at least a portion of the formation, the hydrocarbon-based treatment fluid including a mixture of at least one hydrocarbon base fluid, at least one carboxylic acid, at least one first metal source compound including salt of carboxylic acid, and at least one second metal source compound; wherein the salt of carboxylic acid may include at least one of aluminum ethyl hexoate, aluminum methyl pentoate, iron octoate, aluminum stearate, or mixture thereof; and wherein the hydrocarbon-based treatment fluid may be introduced into the formation at a pressure above a fracturing pressure of the formation. The salt of carboxylic acid may include aluminum ethyl hexanoate. The carboxylic acid may include at least one fatty acid having from about 6 to about 24 carbon atoms, and in one embodiment may be tall oil fatty acid. The second metal source compound may be at least one of metal salt, metal alkoxide, metal hydroxide, metal oxide, metal chelate, or a mixture thereof. The second metal source compound may be at least one of sodium hydroxide, aluminum hydroxide, aluminum isopropoxide, or a mixture thereof. The hydrocarbon base fluid may include at least

one of diesel, aromatic compound, or a mixture thereof. The hydrocarbon-based treatment fluid further may include a surfactant.

In another respect, disclosed is a method of treating a subterranean formation, including introducing a hydrocarbon-based treatment fluid into at least a portion of the formation, the hydrocarbon-based treatment fluid including a mixture of at least one hydrocarbon base fluid, at least one carboxylic acid, at least one first metal source compound including salt of carboxylic acid, and at least one second metal source compound; wherein the carboxylic acid may include at least one fatty acid having from about 6 to about 24 carbon atoms; wherein the salt of carboxylic acid may include at least one of aluminum ethyl hexoate, aluminum methyl pentoate, iron octoate, aluminum stearate, or mixture thereof, or a mixture thereof; wherein the second metal source compound may include at least one of metal salt, metal alkoxide, metal hydroxide, metal oxide, metal chelate, or a mixture thereof; and wherein the hydrocarbon-based treatment fluid may be introduced into the formation at a pressure above a fracturing pressure of the formation. The salt of carboxylic acid may include aluminum ethyl hexanoate; the carboxylic acid may include tall oil fatty acid; and the second metal source compound may be at least one of sodium hydroxide, aluminum hydroxide, aluminum isopropoxide, or a mixture thereof. The carboxylic acid may include tall oil fatty acid; and the second metal source compound may include aluminum hydroxide, aluminum isopropoxide, or a mixture thereof. The hydrocarbon base fluid may include at least one of diesel, aromatic compound, or a mixture thereof. The hydrocarbon-based treatment fluid further may include a surfactant. The surfactant may include at least one of sodium dodecylbenzenesulfonate, ethoxylated stearate, isopropyl alcohol, or a mixture thereof.

In another respect, disclosed is a gelled organic-based treatment fluid including a mixture of at least one organic base fluid, at least one carboxylic acid, at least one first metal source compound including salt of carboxylic acid, and at least one second metal source compound.

In another respect, disclosed is a reaction product of at least one carboxylic acid, at least one metal source compound, and at least one MSMA-based compound.

In another respect, disclosed is a reaction product of at least one carboxylic acid, at least one first metal source compound, and at least one second metal source compound; the first and second metal source compounds being different compounds.

In another respect, disclosed is a solid particulate reaction product of at least one carboxylic acid and at least one salt of carboxylic acid. The reaction product may be of at least one carboxylic acid, at least one salt of carboxylic acid, and at least one second metal source compound including at least one of metal salt, metal alkoxide, metal hydroxide, metal oxide, metal chelate, or a mixture thereof. The reaction particulate may have a particle size of from about 100 mesh to about 325 mesh.

In another respect, disclosed is a method of forming a gelled organic-based treatment fluid, including combining at least one organic base fluid with the solid particulate reaction product, said reaction product being of the combination of at least one carboxylic acid, at least one salt of carboxylic acid, and at least one second metal source compound including at least one of metal salt, metal alkoxide, metal hydroxide, metal oxide, metal chelate, or a mixture thereof. The carboxylic acid may include tall oil fatty acid; wherein the carboxylic acid salt may include aluminum octoate; and wherein the second metal source compound may include aluminum hydroxide. The second metal source compound may be combined in the form of a solid compound suspended in an organic fluid. The method may further include introducing the gelled organic-based treatment fluid into a wellbore. The method may further include introducing the gelled organic-based treatment fluid into a subterranean formation. The method may further include introducing the gelled organic-based treatment fluid into a pipeline interior. The method may further include introducing the gelled organic-based treatment fluid into a fluid processing facility.

In another respect, disclosed is a method of forming a gelled organic-based fluid, including the steps of combining at least one organic base fluid with a solid reaction product of at least one carboxylic acid and at least one first metal source compound to form the gelled organic fluid. The first metal source compound may include at least one of carboxylic acid salt, metal oxide, metal halide, metal hydroxide, metal alkoxide, metal sulfate, or mixture thereof. The

metal of the first metal source compound may be aluminum, iron, or a mixture thereof. The combining further may include combining a second metal source compound with the organic base fluid and the solid reaction product. The first metal source compound may include salt of carboxylic acid; and the second metal source compound may include at least one of metal oxide, metal halide, metal hydroxide, metal alkoxide, metal sulfate or a mixture thereof. The metal of the first and second metal source compounds may be aluminum, iron, or a mixture thereof. The solid reaction product may include a reaction product of at least one carboxylic acid, the first metal source compound and a second metal source compound. The first metal source compound may include salt of carboxylic acid; and the second metal source compound may include at least one of metal oxide, metal hydroxide, metal halide, metal alkoxide, metal sulfate or mixture thereof. The metal of the first and second metal source compounds may be aluminum, iron, or a mixture thereof. The carboxylic acid may include at least one fatty acid having from about 6 to about 24 carbon atoms; and the first metal source compound may include aluminum octoate, aluminum stearate, iron octoate, aluminum 2,4-pentadione, iron 2,4-pentadione, aluminum oxide, iron hydroxide, aluminum hydroxide, aluminum isopropoxide, aluminum chloride, sodium hydroxide, ferric ammonium sulfate, or a mixture thereof. The carboxylic acid may include at least one fatty acid having from about 6 to about 24 carbon atoms; the carboxylic acid salt may include aluminum octoate, aluminum stearate, iron octoate, aluminum 2,4-pentadione, iron 2,4-pentadione, or a mixture thereof; and the second metal source compound may include at least one of aluminum oxide, iron hydroxide, aluminum hydroxide, aluminum isopropoxide, aluminum chloride, sodium hydroxide, ferric ammonium sulfate, or a mixture thereof. The carboxylic acid may include at least one fatty acid having from about 6 to about 24 carbon atoms; the carboxylic acid salt may include aluminum octoate, aluminum stearate, iron octoate, aluminum 2,4-pentadione, iron 2,4-pentadione, or a mixture thereof; and the second metal source compound may include at least one of aluminum oxide, iron hydroxide, aluminum hydroxide, aluminum isopropoxide, aluminum chloride, sodium hydroxide, ferric ammonium sulfate, or a mixture thereof. The carboxylic acid may include oleic acid, linoleic acid, or a mixture thereof. The organic base fluid may be at least one of alcohol, aliphatic hydrocarbon, aromatic hydrocarbon, or a mixture thereof. The organic base fluid may be at least one of diesel, kerosene, gasoline, condensate, crude oil, mineral oil, vegetable oil, xylene, toluene, benzene, ethyl benzene,

napthalene, or a mixture thereof. The solid reaction product may include a reaction product of at least one organic base fluid, at least one carboxylic acid, at least one first metal source compound and at least one second metal source compound. The solid reaction product may be combined with the organic base fluid in the form of a solid compound suspended in an organic fluid. The method may further include combining a surfactant with the organic base fluid. The method may further include combining with the organic base fluid at least one of a surfactant, organic amine, polyacrylic acid or mixture thereof. The surfactant may include at least one of fatty acid derived amine, alkoxylated fatty amine, linear alkyl benzene sulfonates, ethoxylated fatty alcohols, nonylphenols, fatty acid-derived amines, alkoxylated fatty amines, or mixtures thereof. The surfactant may include at least one of sodium dodecylbenzenesulfonate, ethoxylated stearate, isopropyl alcohol, or a mixture thereof. The method may further include combining with the organic base fluid a breaker material. The method may further include introducing the gelled organic-based fluid into a wellbore. The gelled organic-based fluid may be introduced into a subterranean formation at a pressure above a fracturing pressure of the subterranean formation. The method may further include introducing the gelled organic-based fluid into a pipeline interior. The method may further include introducing the gelled organic-based fluid into a fluid processing facility.

In another respect, disclosed is a method of forming and using a gelled organic-based fluid, including: combining at least one organic base fluid, at least one carboxylic acid, at least one first metal source compound, and at least one second metal source compound to form the gelled organic fluid; and introducing the gelled organic fluid into a wellbore, pipeline interior or fluid processing facility; wherein the first and second metal source compounds are different compounds. The first metal source compound may include at least one of carboxylic acid salt, metal oxide, metal halide, metal hydroxide, metal alkoxide, metal sulfate or a mixture thereof; and the second metal source compound may include at least one of carboxylic acid salt, metal oxide, metal halide, metal hydroxide, metal alkoxide, metal sulfate or a mixture thereof. The first metal source compound may include salt of carboxylic acid; and the second metal source compound may include at least one of metal oxide, metal hydroxide, metal halide, metal alkoxide, metal sulfate or a mixture thereof. The metal of the first and second metal source

compounds may be aluminum, iron, or a mixture thereof. The carboxylic acid salt may include aluminum octoate, aluminum stearate, iron octoate, aluminum 2,4-pentadione, iron 2,4-pentadione, or a mixture thereof; and the metal of the second metal source compound may be aluminum, iron, or a mixture thereof. The carboxylic acid salt may include aluminum octoate, aluminum stearate, iron octoate, aluminum 2,4-pentadione, iron 2,4-pentadione, or a mixture thereof; and the second metal source compound may include at least one of aluminum oxide, iron hydroxide, aluminum hydroxide, aluminum isopropoxide, aluminum chloride, sodium hydroxide, ferric ammonium sulfate, or a mixture thereof. The carboxylic acid may include at least one fatty acid having from about 6 to about 24 carbon atoms; the carboxylic acid salt may include aluminum octoate, aluminum stearate, iron octoate, aluminum 2,4-pentadione, iron 2,4-pentadione, or a mixture thereof; and the second metal source compound may include at least one of aluminum oxide, iron hydroxide, aluminum hydroxide, aluminum isopropoxide, aluminum chloride, sodium hydroxide, ferric ammonium sulfate, or a mixture thereof. The carboxylic acid may include oleic acid, linoleic acid, or a mixture thereof. The organic base fluid may be at least one of alcohol, aliphatic hydrocarbon, aromatic hydrocarbon, or a mixture thereof. The organic base fluid may be at least one of diesel, kerosene, gasoline, condensate, crude oil, mineral oil, vegetable oil, xylene, toluene, benzene, ethyl benzene, napthalene, or a mixture thereof. At least one of the metal sources may be combined with the organic base fluid in the form of a solid compound suspended in an organic fluid. The method may further include combining a surfactant with the organic base fluid. The method may further include combining with the organic base fluid at least one of a surfactant, organic amine, polyacrylic acid or mixture thereof. The surfactant may include at least one of fatty acid derived amine, alkoxylated fatty amine, linear alkyl benzene sulfonates, ethoxylated fatty alcohols, nonylphenols, fatty acid-derived amines, alkoxylated fatty amines, or mixtures thereof. The surfactant may include at least one of sodium dodecylbenzenesulfonate, ethoxylated stearate, isopropyl alcohol, or a mixture thereof. The method may further include combining with the organic base fluid a breaker material. The gelled organic-based fluid may be introduced into a wellbore. The gelled organic-based fluid may be introduced into a subterranean formation at a pressure above a fracturing pressure of the subterranean formation. The gelled organic-based fluid may be

introduced into a pipeline interior. The gelled organic-based fluid may be introduced into a fluid processing facility.

In another respect, disclosed is a gelled organic-based fluid including the reaction product of least one organic base fluid, at least one carboxylic acid, at least one first metal source compound, and at least one second metal source compound; wherein the carboxylic acid may include at least one fatty acid having from about 6 to about 24 carbon atoms; the carboxylic acid salt may include aluminum octoate, aluminum stearate, iron octoate, aluminum 2,4-pentadione, iron 2,4-pentadione, or a mixture thereof; and the second metal source compound may include at least one of aluminum oxide, iron hydroxide, aluminum hydroxide, aluminum isopropoxide, aluminum chloride, sodium hydroxide, ferric ammonium sulfate, or a mixture thereof. The carboxylic acid may include oleic acid, linoleic acid, or a mixture thereof. The organic base fluid may be at least one of alcohol, aliphatic hydrocarbon, aromatic hydrocarbon, or a mixture thereof. The organic base fluid may be at least one of diesel, kerosene, gasoline, condensate, crude oil, mineral oil, vegetable oil, xylene, toluene, benzene, ethyl benzene, napthalene, or a mixture thereof.

In another respect, disclosed is a solid reaction product of at least one carboxylic acid and at least one first metal source compound. The first metal source compound may include at least one of carboxylic acid salt, metal oxide, metal halide, metal hydroxide, metal alkoxide, metal sulfate, or mixture thereof. The metal of the first metal source compound may be aluminum, iron, or a mixture thereof. The reaction product may be of at least one carboxylic acid, at least one first metal source compound, and at least one second metal source compound. The first metal source compound may include salt of carboxylic acid; and the second metal source compound may include at least one of metal oxide, metal halide, metal hydroxide, metal alkoxide, metal sulfate or a mixture thereof. The metal of the first and second metal source compounds may be aluminum, iron, or a mixture thereof. The carboxylic acid may include at least one fatty acid having from about 6 to about 24 carbon atoms; and the first metal source compound may include aluminum octoate, aluminum stearate, iron octoate, aluminum 2,4-pentadione, iron 2,4-pentadione, aluminum oxide, iron hydroxide, aluminum hydroxide, aluminum isopropoxide, aluminum chloride, sodium hydroxide, ferric ammonium sulfate, or a

mixture thereof. The carboxylic acid may include at least one fatty acid having from about 6 to about 24 carbon atoms; the carboxylic acid salt may include aluminum octoate, aluminum stearate, iron octoate, aluminum 2,4-pentadione, iron 2,4-pentadione, or a mixture thereof; and the second metal source compound may include at least one of aluminum oxide, iron hydroxide, aluminum hydroxide, aluminum isopropoxide, aluminum chloride, sodium hydroxide, ferric ammonium sulfate, or a mixture thereof. The carboxylic acid may include oleic acid, linoleic acid, or a mixture thereof. The solid reaction product may include a reaction product of at least one organic base fluid, at least one carboxylic acid, at least one first metal source compound and at least one second metal source compound. The solid particulate reaction product may have a particle size of from about 100 mesh to about 325 mesh.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 shows fluid loss data for a MSMA-containing gelled organic fluid according to one embodiment of the disclosed methods and compositions.

DESCRIPTION OF ILLUSTRATIVE EMBODIMENTS

As used herein, the indefinite articles "a" and "an" connote "one or more."

In the practice of the disclosed method and compositions, non-phosphate gelled organic liquids possessing relatively stable rheological characteristics at relatively high temperatures may advantageously be formulated from solid or liquid components combined with organic base fluid.

In one embodiment, a reaction product or gelling agent component may be first formed from individual reaction components. The reaction product may then be combined with an organic base fluid to form a gelled treatment fluid, for example, for use in a well treatment, pipeline treatment, *etc.* For example, at least one carboxylic acid may be combined with at least one metal source compound, such as a salt of carboxylic acid, other metal salt, metal oxide or

metal hydroxide to form a viscous reaction product. In another example, at least one carboxylic acid may be combined with at least one first metal source compound comprising salt of carboxylic acid and at least one second metal source compound comprising another type of metal source compound, such as a metal alkoxide, metal hydroxide, metal oxide, metal sulfate, *etc.* to form a reaction product. These are just two examples only, and it will be understood that any combination of reaction components described herein may be used to form a reaction product or gelling agent, that may be subsequently or later added to an organic base fluid to form a gelled treatment fluid. Such reaction products may be solid or liquid, and in that regard may be relatively viscous liquids or relatively non-viscous liquids.

When reaction components are combined to from a reaction product or gelling agent prior to combination with an organic base fluid, the reaction components may be optionally combined in the presence of an organic solvent or mixture of organic solvents. As used herein, "organic solvent" includes, for example, any organic fluid medium suitable to facilitate ease of reaction and/or intermixing of the disclosed reactants, ease of handling of the disclosed reactants or resulting reaction products, and/or that may be optionally selected to be removable (*e.g.*, by distillation) from a reaction product, following reaction. An organic solvent may also be selected to substantially non-reactive with the chosen reaction components. Organic solvents may be selected to have desired properties relative to the given reactants employed and may be chosen, for example, from any of the hydrocarbon or other organic fluids listed elsewhere herein as suitable for organic base fluids. Alternatively, no organic solvent may be used where the given individual reactants are capable of intermixing and reaction to form a reaction product or gelling agent in the absence of added organic solvent, or where individual reactin of components are added directly to an organic base fluid as described elsewhere herein.

A viscous reaction product or gelling agent may be used to gel or viscosify an organic base fluid by direct combination with an organic base fluid. Alternatively, a viscous reaction product may be dried, such as by desiccation, then ground to a solid particulate reaction product which may then be added to an organic base fluid to form a gelled organic fluid. In a further embodiment, the components of the above-mentioned embodiments may be individually added to, or combined directly with, an organic base fluid to form a gelled organic fluid. Such

individual components may be added as solids or liquids, as appropriate. If desired, any of the solid components described herein may be combined with a suitable solvent prior to combination with an organic base fluid. Alternatively, a slurry of such solid components may be formed prior to combination if so desired.

With benefit of this disclosure, the disclosed non-phosphate gelled organic liquids may be employed in any application known in the art in which, for example, gelled hydrocarbon liquids are suitable for use. As used herein, the terms "gel" and "gelled" refer fluids that exhibit semi-solid elastic behavior. While not wishing to bound by theory, it is believed that the surprising stability of the disclosed temperature stable non-phosphate organic liquid gels results from formation of complexes between carboxyl groups of carboxylic acids and metal groups of carboxylic acid salts and/or other metal source compounds.

Examples of possible applications include, but are not limited to, well treatment fluids (including stimulation fluids such as fracture fluids, matrix stimulation fluids, acidizing fluids, hydrocarbon-based treatment fluids *etc.*), drilling fluids (such as drilling muds, drill-in fluids, workover fluids, packer fluids, completion fluids, fluids for use with coil tubing, *etc.*), pipeline treatment fluids (such as gelled pipeline pigs, separation plugs, *etc.*), as hydrocarbon friction reducer compositions in pipeline and other tubular applications (*e.g.,* for use with crude oil, refined oil or other hydrocarbons, *etc.*), process facility treatment fluids (such as gelled fluids for cleaning and/or chemical processing equipment used in oil field facilities, refineries, chemical plants, refineries, *etc.*).

As used herein, an "organic base fluid" is any organic fluid medium suitable for forming an organic fluid gel, including those organic fluids commonly employed in oil field, pipeline and refinery or chemical plant applications. Suitable organic base fluids include, but are not limited to, hydrocarbon-based fluids and other organic fluids. Types of suitable organic base fluids include, but are not limited to, aliphatic, alicyclic and aromatic hydrocarbons, acids, ketones, aldehydes, ethylene glycols, polyethylene glycols, amines, alcohols, esters, derivatives of these compounds, as well as mixtures thereof. Specific examples of suitable aliphatic hydrocarbons include, but are not limited to, alkanes such as propane, *n*-butane, isobutane, *n*-hexane, *n*-octane,

n-decane, *n*-tridecane, *etc.* Other aliphatics include alkenes and alkadienes. Alicyclic compounds include cyclohexane, *etc.* Specific examples of suitable aromatics include, but are not limited to, benzene, toluene, xylene, ethylbenzene and other alkyl benzenes, napthalene, *etc.* Other examples include nonylphenols, ethoxylated nonylphenol, *etc.* Particular examples of commercial aromatic products include, but are not limited to, "FRACSOL", "FRACSOL-S", "XYSOL" from Trysol of Calgary, Canada or Amsol of the United States.

Other specific examples of suitable organic base fluids include, but are not limited to at least one of diesel, gasoline, kerosene, reformate, naphthalene, xylene, toluene, mineral oil, light mineral oil, condensate, crude oil, lubricating oils, or mixtures thereof (such as diesel mixed with condensate to lower API gravity, *etc.*). Other organic base fluids such as alcohols (like methanol, ethanol, propanol, isopropyl alcohol, butanol, pentanol, hexanol, 2-methylhexanol, *etc.*), alkanes (such as hexane), glycols (such as ethylene glycol "EB" available from Dow Chemical), ester materials (such as "RDPE" available from Rhone Poulenc), and derivatized alkanes (such as alkylhexanes), may also be employed. Organic-based solvents known to those of skill in the art as "mutual solvents" may also be used. Other suitable organic fluids (including oily esters), are described in United States Patent No. 5,519,063, which is incorporated by reference herein in its entirety.

Also suitable are synthetic oils (including, but not limited to, synthetic hydrocarbon-base oils, ester-type oils, alkylene polymers, polysiloxanes, *etc.*). Also suitable are more environmentally compatible (*e.g.*, biodegradable) natural or synthetic organic base fluids such as Exxon's "ESCAID 90" or "ESCAID 110", or refined kerosene (such as "LOTOX" available from Exxon), "ALPHA OLEFIN" (from Baker Performance Chemical), "HYDROSOLV P150" or "HYDROSOLV B100" (from Shrieve Chemical Products), "ISOPAR L" or "ISOPAR M" (from Nalco-Exxon Chemical Company), *etc.* Natural organic based fluids such as animal oils and vegetable oils may also be suitable including, but not limited to, linseed oil, palm oil, cotton seed oil, rapeseed oil, soybean oil, olive oil, canola oil, sunflower oil, peanut oil, *etc.* Also suitable are one or more organic-based solvents known in the art as "mutual solvents." Examples of suitable co-solvents include mutual solvents such as glycol-ethers including, but not limited to, ethylene glycol monobutyl ether ("EGMBE").

With benefit of this disclosure, those of skill in the art will understand that the organic base fluids listed herein, as well as other organic base fluids, may be mixed or blended together as desired to provide a non-phosphate liquid organic gel having desired characteristics. In one exemplary embodiment, an organic fluid may be a liquid hydrocarbon that is at least one of diesel, condensate, or mixtures thereof. It will be understood that these organic base fluids are exemplary only, and that any other suitable organic fluids, including those mentioned elsewhere herein, may also be employed.

Further information on suitable organic-based fluids may be found in the United States Patent Application S/N 09/151,169 entitled "Surfactant Compositions and Uses Therefor" by Joseph E. Thompson, Sr., filed September 10, 1998, which is incorporated herein by reference in its entirety.

Examples of carboxylic acids which may be employed in the practice of the disclosed invention include any carboxylic acid suitable for use in forming a gelled organic liquid when combined with salt of carboxylic acid and other source of metal ions. Such suitable carboxylic acids may be branched, linear or unbranched, saturated, unsaturated, aliphatic and/or aromatic, and/or derivatives thereof. Suitable classes of carboxylic acids include, but are not limited to, solid, semisolid and liquid, saturated and unsaturated, fatty acids, such as those saturated carboxylic acids having from about 4 to about 22 carbon atoms. Additional information on suitable carboxylic acids may be found may be found elsewhere herein, for example, under the heading "Carboxylic Acids." Examples of monomers and polymers containing carboxylic acid functionality may be found in United States Patents No. 4,612,332; 4,673,716; 4,694,046; 4,694,058; 4,709,759; 4,734,205; 4,780,517, 4,960,821; and 5,036,136, which are incorporated by reference herein in their entirety.

In one exemplary embodiment, examples of suitable saturated aliphatic carboxylic acids include, but are not limited to, saturated aliphatic carboxylic acids having from about 6 to about 35 carbon atoms, alternatively about 8 to about 28 carbon atoms, and further alternatively about 8 to about 18 carbon atoms. Specific examples of suitable and exemplary saturated aliphatic carboxylic acids include, but are not limited to, at least one of butyric acid, lauric acid or

mixtures thereof. It will be understood that these acids are exemplary only, and that any other suitable saturated aliphatic carboxylic acid, including those mentioned elsewhere herein, may also be employed.

Examples of suitable unsaturated carboxylic acids include, but are not limited to, unsaturated acids aliphatic carboxylic acids having from about 6 to about 35 carbon atoms, alternatively about 8 to about 28 carbon atoms, and further alternatively about 8 to about 18 carbon atoms. Specific examples of suitable unsaturated carboxylic acids include, but are not limited to, oleic, linoleic, tall oil fatty acids (described elsewhere herein, *e.g.*, in one embodiment primarily oleic and linoleic acids), palmitic acid, stearic acid, or mixtures thereof. It will be understood that these acids are exemplary only, and that any other suitable unsaturated aliphatic carboxylic acid, including those mentioned elsewhere herein, may also be employed.

In another exemplary embodiment, suitable aromatic carboxylic acids include, but are not limited to, aromatic carboxylic acids having from greater than about 6 carbon atoms, alternatively from about 6 to about 30 carbon atoms, further alternatively from about 6 to about 20 carbon atoms, although greater number of carbon atoms are possible. Specific examples of suitable aromatic atoms include, but are not limited to benzoic acid, and mixtures of benzoic acid with other aromatic carboxylic acids. It will be understood that these aromatic carboxylic acids are exemplary only, and that any other suitable aromatic carboxylic acid, including those mentioned elsewhere herein, may also be employed. It will also be understood with benefit of the present disclosure that mixtures and blends of branched, unbranched, saturated, unsaturated, aromatic and/or aliphatic carboxylic acids may be employed.

In the practice of the disclosed method and compositions, one or more metal source compounds may be employed, for example, to impart characteristics of stable viscosity at relatively high temperatures. Any relative amounts of one or more metal source compounds and one or more carboxylic acids may be combined that is suitable for at least partially viscosifying or gelling organic fluids disclosed herein. However, with benefit of this disclosure, those of skill in the art will understand that for complete interaction between metal source compounds and carboxylic acid material, sufficient carboxyl groups should be present to satisfy the valence of

each metal site. For example, in one embodiment, mono carboxylic acids may be combined with aluminum source compound/s in amounts sufficient to achieve a molar ratio of about 3 moles of monocarboxylic acid to about 1 mole of aluminum, including any carboxylic acid groups supplied by carboxylic acid salt present. In another embodiment employing dicarboxylic acid, dicarboxylic acid may be combined with aluminum metal source compound/s in an amount sufficient to achieve a molar ratio of about 1.5 moles of dicarboxylic acid to about 1 mole of aluminum, taking into account any carboxylic acid salt present. However, it will also be understood that complete interaction between metal sites and carboxyl groups is not necessary to achieve benefits of the disclosed method, so that other molar ratios (greater and lesser), are possible. Furthermore, by varying the ratio of carboxyl groups to metal sites (from ratios less than stochiometric to ratios greater than stochiometric), viscosity characteristics may be varied. For example, suitable ranges of molar ratios of aluminum to carboxylic acid for monocarboxylic acid formulations may be from about 1 to about 11, alternatively from about 2 to about 10, further alternatively from about 3 to about 7. Table A is a list of 10 example formulations and molar ratios achieved therewith.

Table A -- Example Formulations and Molar Ratios

Component	**Amount, g/250ml**	**Molecular Weight**	**Moles Carboxylic Acid**	**Moles Al**	**Molar Ratio of Carb. Acid to Al**
Stearic Acid	15	284.47	.0527		
Al Isopropoxide	0.91			.0045	
Al Octoate	3		.0198	.0066	
Totals			**.0724**	**.0110**	**6.570**
Linoleic Acid	13.5	280.44	.0481		
Al Isopropoxide	3.27			.0160	
Al Octoate	3		.0198	.0066	
Totals			**.0678**	**.0226**	**3.005**
Linoleic Acid	13.5	280.44	.0481		
Al Isopropoxide	.91			.0045	
Al Octoate	3		.0198	.0066	
Totals			**.0678**	**.0110**	**6.154**
2-ethylhexanoate acid	13.1	144.21	.0908		
Al Isopropoxide	0.91			.0045	
Al Octoate	3		.0198	.0066	
Totals			**.1106**	**.0110**	**10.027**
Oleic Acid	13.65	282.46	.0483		
Al Isopropoxide	3.3			.0162	

Component	Amount, g/250ml	Molecular Weight	Moles Carboxylic Acid	Moles Al	Molar Ratio of Carb. Acid to Al
Al Octoate	3		.0198	.0066	
Totals			**.0680**	**.0227**	**2.994**
Oleic Acid	13.65	282.46	.0483		
Al isopropoxide	0.91			.0045	
Al octoate	3		.0198	.0066	
Totals			**.0680**	**.0110**	**6.171**
Palmitic Acid	15	256.42	.0585		
Al Isopropoxide	3.98			.0195	
Al Octoate	3		.0198	.0066	
Totals			**.0782**	**.0261**	**3.002**
Palmitic Acid	15	256.42	.0585		
Al Isopropoxide	0.91			.0045	
Al Octoate	3		.0198	.0066	
Totals			**.0782**	**.0110**	**7.093**
2-ethylhexanoic acid	13.1	144.21	.0908		
Al Isopropoxide	6.18			.0303	
Al Octoate	3		.0198	.0066	
Totals			**.1106**	**.0368**	**3.002**
Stearic Acid	15	284.47	.0527	.0527	
Al Isopropoxide	3.6			.0176	
Al Octoate	3		.0198	.0066	
Totals			**.0724**	**.0242**	**2.994**

Suitable "metal source compounds" include any metal source capable of supplying metal atoms capable of complexing, reacting or otherwise interacting with carboxylic acid to form a gelled organic liquid when combined with organic liquid. Metal source compounds may include compounds having ionically or covalently bonded metal ions. Suitable metal ions include, for example, ions of metals from IUPAC Groups 1-14, alternatively IUPAC Groups 1-13, alternatively IUPAC Groups 1, 2, 8, and 3 of the periodic table. These metal ions are also identified in order number 11, 12, 13, 18 and 20 of the periodic table. Included are metal ions selected from the alkali earth and/or alkaline earth metal groups of the periodic table. In one exemplary embodiment, metal ions may be selected from at least one of iron ions, aluminum ions, sodium ions, calcium ions or mixtures thereof.

In another exemplary embodiment, metal source compounds may include a metal atom that has a +3 valence, for example, aluminum, iron, *etc.* For example, first and/or second metal sources containing metal atoms that have a +3 valence may be employed, as desired, in the

embodiments described herein that include such metal source compounds. It will be understood that these types of compounds are exemplary only, and that any other suitable metal source compounds, including those mentioned elsewhere herein, may also be employed.

Salts of carboxylic acid which may be employed as metal source compounds in the practice of the disclosed method and compositions include any carboxylic acid salt suitable for use in forming a gelled organic liquid when combined with carboxylic acid and/or when optionally combined with other metal source compounds. Suitable types of carboxylic acid salts include, but are not limited to, salts of branched, linear or unbranched, saturated, unsaturated, aliphatic and/or aromatic carboxylic acids, such as any of those types of carboxylic acids described elsewhere herein. Suitable metals for forming carboxylic acid salts include any metal selected from the same groups of the periodic table as mentioned elsewhere herein for metal source compounds. Specific exemplary examples include carboxylic salts of the metals aluminum, iron, calcium, sodium, or mixtures thereof. Included are metals suitable for forming so-called heavy metal soaps of carboxylic or fatty acids.

In one more specific exemplary embodiment, a carboxylic acid salt may be at least one of an aluminum salt, iron salt or mixture thereof. Specific examples of such suitable carboxylic acid salts include aluminum salt of 2-ethylhexoic acid (aluminum ethylhexoate or "aluminum octoate"), aluminum salt of 2-methylpentonoic acid (or aluminum methyl pentoate), iron octoate, aluminum stearate, or mixtures thereof. In one particular embodiment, a carboxylic acid salt is aluminum octoate. It will be understood that these compounds are exemplary only, and that any other suitable carboxylic acid salt compound, including those mentioned elsewhere herein, may also be employed. For example, additional information on suitable carboxylic acid salts may be found under the heading "Salts of Carboxylic Acid."

In the practice of the disclosed method and compositions, other metal source compounds and mixtures of metal source compounds may be employed in addition to, or in place of, salts of carboxylic acid. Some exemplary compounds are listed in the following paragraph, although it will be understood that other suitable metal source compounds may be employed, such as those mentioned elsewhere herein. Examples of suitable metal source compounds include other metal

salts (other than salts of carboxylic acids), metal alkoxides, metal oxides, metal hydroxides, metal halides, metal sulfates, metal ammonium sulfates, metal-containing organics, metal-containing inorganics, or mixtures thereof. Specific examples of suitable other metal salts (other than carboxylic acid salts) include, but are not limited to, aluminum hydroxide, aluminum oxide, aluminum sulfate, and aluminum chloride. Examples of suitable metal alkoxides include, but are not limited to, linear or branched metal alkoxides. Specific examples of suitable metal alkoxides include aluminum isopropoxide and aluminum salt of benzoic acid. Examples of suitable metal oxides include, but are not limited to, linear or branched metal oxides. Specific examples of suitable metal oxides include aluminum oxide, magnesium oxide, iron oxide, calcium oxide, or mixtures thereof. Specific examples of suitable metal hydroxides include aluminum hydroxide, sodium hydroxide, iron hydroxide, ammonium hydroxides, magnesium hydroxide, calcium hydroxide or mixtures thereof. Specific examples of suitable metal sulfates include, but are not limited to, aluminum sulfate, iron sulfate, ferric ammonium sulfate, magnesium sulfate, or mixtures thereof. Specific examples of suitable metal ammonium sulfates include, but are not limited to, ferric ammonium sulfate, ferric ammonium citrate, or mixtures thereof. Other possible salts include aluminum acetate. Other suitable metal sources include metal chelates such as chelates of acetyl acetonate (2,4 pentanedione) and other similar organic compounds (ketones, diketones, *etc.*). Exemplary compounds include, but are not limited to, aluminum-2,4 pentanedione, aluminum lactate or mixtures thereof. It will be understood that these compounds are exemplary only, and that any other suitable types of metal source compounds or suitable specific metal source compounds, including those mentioned elsewhere herein, may also be employed. Similarly, other possible salts can include iron hydroxide and ferric-2,4 pentanedione.

In the case of water sensitive materials such as aluminum isoproxide, it is usually desirable to combine the water sensitive material with a non-aqueous base fluid prior to combination with organic base fluid, so as to prevent reaction with water.

Combinations of more than one metal source with a carboxylic acid, such as a fatty acid, may be employed to, for example, vary gelling time and/or vary gelled fluid characteristics. Type and combinations of organic base fluids may also be used to vary gelling time.

Combinations of multiple metal sources may include combinations of two or more of any of the metal source compounds and/or described elsewhere herein. In one exemplary embodiment, aluminum isopropoxide and aluminum hydroxide may be combined with carboxylic acid in a molar ratio of from about 1 to about 9 moles of aluminum isopropoxide per mole of aluminum hydroxide to achieve the desired effect.

In another embodiment, one or more aromatic organic base fluids may be present with or without other organic base fluids to accelerate gellation rate such as would be desirable, for example, in a continuous mix process. In this regard, one or more aromatic compounds may be added to facilitate dissolution of the components to decrease time for gellation of an organic fluid, or may be employed as an organic base fluid. Just a few suitable aromatic compounds include, but are not limited to, benzene, napthalene, xylene, toluene, and derivatives and mixtures thereof. For example, xylene proportioned with diesel at a desired ratio, for example from about 15% to about 95% (alternatively from about 75% to about 95%) diesel by weight of a total organic base fluid mixture, and from about 85% to about 5% (alternatively from about 25% to about 5%) xylene by weight of total a organic base fluid mixture. It will be understood that greater amounts of aromatics, including up to about 100% aromatic (such as xylene) may be employed. It will also be understood that these compounds are exemplary only, and that any other suitable types of aromatic compounds, including those mentioned elsewhere herein, may also be employed.

In addition to the above described components, one or more other additives may be employed to alter the characteristics of a gelled organic fluid. With benefit of the disclosure, those of skill in the art will understand that such additives include any additive known in the art that is suitable for altering characteristics of, for example, a liquid hydrocarbon gel, or for assisting with or modifying the combination or reaction of individual ingredients to form such gels. Examples of such additives which may be employed include, but are not limited to, non emulsifiers and/or surfactants.

In one embodiment, optional surfactant/s may be employed to facilitate interaction between two or more of the components in a mixture, such as any surfactants capable of

behaving as hydrotopes. Both ionic (anionic and cationic) and non-ionic surfactants may be used. Mixtures of anionic and nonionic or cationic surfactants and nonionic surfactants are also possible. Examples of suitable surfactant types include, but are not limited to, linear alkyl benzene sulfonates, ethoxylated fatty alcohols, nonylphenols, fatty acid-derived amines, alkoxylated fatty amines, or mixtures thereof. Specific examples of suitable surfactants include, but are not limited to, sodium dodecylbenzenesulfonate ("DDBSA"), isopropyl alcohol, *etc.*

Additional information on suitable surfactants and surfactant types may be found in United States Patent Application S/N 09/151,169, entitled "SURFACTANT COMPOSITIONS AND USES THEREFOR" by Joseph E. Thompson, Sr., *et al.* filed September 10, 1998, which is incorporated by reference herein in its entirety.

With benefit of this disclosure, specific suitable hydrotopes and/or non-emulsifiers include, but are not limited to, non-emulsifiers compatible with the chosen gelled fluid system and known in the art for use to, for example, ensure water-wetting of a formation during a hydrocarbon-based fracturing treatment. Specific examples include, but are not limited to, a mixture of dodecylbenzene sulphonic acid salt and Pan Acid (known as "NE-110W" and available from Baker Performance Chemicals), and a mixture of isopropyl alcohol ("IPA") and DDBSA (known as "NE-118" and available from Baker Performance Chemicals).

With benefit of this disclosure, those of skill in the art will understand that gelation rate may vary as a function of selected individual components, relative amounts of components, temperature, solid component particle sizes, amount of shear imposed on the fluid, *etc.* For any given metal source/s, smaller solid component particle size, higher temperatures, presence of surfactant and/or aromatics, greater amounts of metal source compound relative to carboxylic acid, and greater amounts of shear are some of the variables that typically result in faster gel development. Ultimate viscosity of an organic liquid gel may be controlled, for example, by varying relative amounts of carboxylic acid and one or more metal source compounds.

In one embodiment, a carboxylic acid-based soap may first be formed (for example using any of the carboxylic acids mentioned herein) to achieve early viscosification. Such a soap may be formed using any method and/or compounds known in the art for forming such soaps. With

benefit of this disclosure, those of skill in the art will understand that viscosity imparted by such a soap may be varied by composition and identity of metal components employed, with formation of heavy metal soaps (using metals such as aluminum, calcium, cobalt, lead, zinc, *etc.*) achieving greater viscosities than soaps formed with lighter metals such as sodium. If desired, additional metal source compound/s may be employed in conjunction with formation of such a soap to further modify rheological properties of the gelled fluid, in some cases on a delayed basis so as to achieve further viscosification after a desired period of time, such as to allow displacement of a fluid into a wellbore prior to further viscosification.

In one exemplary embodiment, a metal source compound (including, but not limited to, metal hydroxide source compound such as sodium hydroxide, aluminum hydroxide, potassium hydroxide *etc.*) may be combined with carboxylic acid (such as tall oil fatty acid from Arizona Chemical or Acme-Hardesty) and optional metal salt of carboxylic acid (such as 325 mesh aluminum octoate carboxylic acid salt from Witco , and/or 100 mesh to 325 mesh aluminum stearate from Acme Hardesty) to achieve early viscosification of an organic fluid followed by delayed viscosification at higher temperatures. In this regard a salt of carboxylic acid may be combined simultaneously, or before or after, the other metal source compound/s. In such an embodiment, it is believed that early viscosification may occur via saponification of the fatty acid by metal hydroxide, followed by later interaction with metal of carboxylic soap upon heating (such as encountered when displaced into a wellbore) to form a more temperature stable gel of aluminum salt of the fatty acid. Furthermore, it will be understood that stoichiometry of the carboxyl groups of the carboxylic acid in relation to the metal groups of the carboxylic acid salt and/or other metal source compounds may be varied to control gelation rate and/or gelled liquid characteristics.

Other optional components which may be employed in the formulation of the disclosed non-phosphate gelled organic fluids include friction reducer components, such as may be formed by incorporation of lengthy high molecular weight neutralized crosslinked anionic polymers into a gelled organic fluid. Such friction reducing compounds may be used to reduce frictional drag in flow through pipes or conduits, for example, in a manner as described in United States Patent No. 4,780,221 which is incorporated by reference herein in its entirety.

In one embodiment, invert emulsion materials such as "FRO 18" or "FRO 19" from BJ Services may be employed. In another embodiment, an anionic polymer may be a polyacrylic acid including, but not limited to, homopolymers of acrylic acid or methacrylic acid or copolymers of these acids or their salts, esters or amides with each other or with one or more other ethylenically unsaturated monomers, like styrene, maleic acid, maleic anhydride, 2-hydroxyethyl acrylate, acrylonitrile, vinylacetate, ethylene, propylene, *etc.* Also suitable are those anionic polymers described elsewhere herein, such as the CARBOPOL polyacrylics, and those polymers, and polymers containing monomers, having carboxylic acid functionality as described elsewhere herein. One or more such anionic polymers may be added to an organic base fluid along with other components described herein, such as one or more carboxylic acids, carboxylic acid salts, oxides, *etc.*

When friction reducing characteristics are desired, polyacrylic acid/s may be neutralized with an organic base, for example an organic amine including, but not limited to, ethanolamines such as diisopropanolamine, triethanolamine, diethanolamine, ethyl diethanolamine, diethylethanolamine, N-methyldiethanolamine, triamylamine, b-dimethlyaminopropionitritite, dodecylamine, morpholine, di-2-(ethyl hexyl) amine, mixtures thereof *etc.* Examples of commercially available organic amines include, but are not limited to, "ETHOMEEN" from BASF-Wyandette Corp., "JEFFAMINE D-1000" from Huntsman Chemical, "ARMEEN" from Armak Industrial Chemical Division, "ALAMINE 7D" from Henkel Corporation, *etc.* Further examples of suitable anionic polymers, organic bases, other components and methods of using the same may be found in United States Patent No. 5,641,890, which is incorporated by reference herein in its entirety. Other examples of polyamines and methods of manufacturing the same may be found, for example, in United States Patent No. 4,615,393; United States Patent No. 4.780,221; European Patent Application No. 88305437.1 (Publication No. 0 295 877); European Patent Application No. 86305124.9 (Publication No. 0 207 787); European Patent Application No. 89303738.2 (Publication No. 0 338 738); and European Patent Application No. 87310946.6 (Publication No. 0 271 362); which are incorporated by reference herein in their entirety.

Table 1 gives a partial list of exemplary additives that may be employed to vary particular characteristics of organic fluid gels. With benefit of this disclosure, those of skill in the art will

understand that the characteristics, as well as listed components, are not exclusive and are exemplary only. Further, it will be understood that two or more individual components and component types may be combined in various ways, both within the same category, and across categories.

Table 1 - Additives to Vary Organic Fluid Gel Characteristics

Desired Characteristic	**Exemplary Additive Types**	**Exemplary Specific Additives**
Decreased Initial Gel Time	Metal Hydroxides Aromatics and Derivatives Thereof	sodium hydroxide, aluminum hydroxide Tall Oil fatty Acid aluminum Ispropoxide toluene, xylene, benzene Fracsol S® Xysol®
High Temperature Viscosity Stability	Carboxylic Acids Carboxylic Metal Salts Refined Oils	aluminum Ispropoxide aluminum octoate, Tall Oil Fatty Acid aluminum Oleiate diesel, kerosene, reformate.
Delayed Viscosity Development at Higher Temperatures	Carboxylic Acids Carboxylic Metal Salts	aluminum Ispropoxide aluminum octoate, Tall Oil Fatty Acid aluminum Oleiate

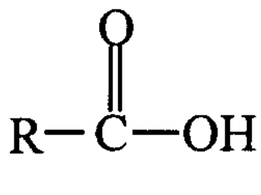
Carboxylic Acids

In the practice of the disclosed methods and compositions, carboxylic acid compositions may be selected from a wide variety of naturally occurring and synthetic carboxylic acids, derivatives of these carboxylic acids, and oils and other compositions which include these carboxylic acids and derivatives thereof. It will be understood with benefit of this disclosure that mixtures of specific carboxylic acids, as well as types of carboxylic acids, are possible.

Carboxylic acids include those compounds containing at least one carboxyl group, -CO_2H. Some example of carboxylic acids are acetylsalicylic acid, oleic acid, methanoic acid, 2-chlorobutanoic acid, propanedioic acid, carboxylic acid dimer, benzoic acid, hexanedioic acid (adipic acid), 2,4,6-trinitrobenzoic acid, *etc.* Just one method of manufacture of suitable carboxylic acids is by hydrolysis of an ester to yield a carboxylic acid and an alcohol.

For example, in one embodiment, carboxylic acids may be:

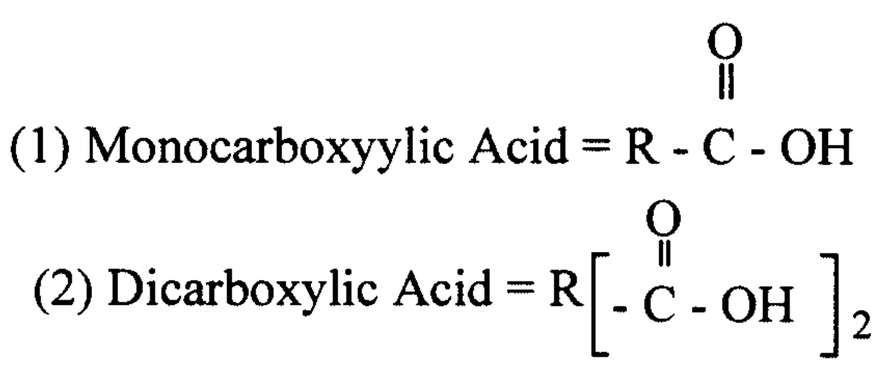
For monocarboxylic acid embodiment:



;

wherein R = carbon chain of about 14 to about 17 carbon atoms (*e.g.*, $-(CH_2)_{13-16}\ CH_3$), and R may be linear or branched; or wherein R = carbon chain of about 5 to about 16 carbon atoms (*e.g.*, $-(CH_2)_{4-15}\ CH_3$), and R may be linear or branched; with it being understood that in either of these cases, a hydrocarbon chain of R may have optional single or multiple unsaturated subsets. Furthermore, in either case R may have optional hydroxyl, mercato or cyand functional groups.

The invention may be practiced with blends of monocarboxylic acids and dicarboxylic acids where:



(1) Monocarboxyylic Acid = R - C - OH

O

(2) Dicarboxylic Acid = R[- C - OH]$_2$

Suitable carboxylic acids for use herein include, but are not limited to, liquid compounds such as *cis*-unsaturated acids through C_{18} and solid compounds such as saturated aliphatic acids (from decanoic through the higher acids) and *trans*-unsaturated acids (*e.g.*, elaidic acid). Naturally occurring carboxylic acids may include both odd- and even-numbered alkanoic acids of molecular formula $C_nH_{2n}O_2$, for example, up through hexanoic acid. Acids which may be manufactured from petrochemical feedstocks include, but are not limited to, formic, acetic, propionic and butyric acids. Tables 1 and 1a list examples of alkanoic or saturated acids.

Fatty acids include a large group of aliphatic monocarboxylic acids, which may occur as glycerides (esters of glycerol) in natural fats and oils, other esters in waxes and essential oils, and as free acids in tall oil.

The term "fatty acids" includes saturated acids of the acetic acid series, $C_nH_{2n+1}COOH$, both normal and branched-chain, as well as related unsaturated acids, certain substituted acids (hydroxy and keto), and aliphatic acids containing alicyclic substituents, such as the chaulmoogra-oil acids. Certain other alicyclic acids (naphthenic acids), containing no aliphatic chain, are also referred to as fatty acids and their salts called soaps.

Naturally occurring fatty acids (also called "fat acids") include higher straight-chain unsubstituted acids containing an even number of carbon atoms. Some branched-chain, hydroxy, and keto acids may be found naturally occurring, and many others may be prepared synthetically. Unsaturated fatty acids include those having differing number of double bonds in the hydrocarbon chain, including monoethenoid, diethenoid, triethenoid, etc. (or monoethylenic, etc.). Also included are acids containing one or more triple-bonded carbon atoms, referred to as acetylenic or ethynoid (ethinoid) acids. Naturally occurring higher fatty acids may be derived from animal fats, vegetable oils, fish oils, *etc.* Higher saturated fatty acids include pelargonic, lauric, myristic, palmitic, stearic acids, *etc.*

Table 2 - Examples of Straight-Chain Alkanoic Acids of the Formula $C_nH_{2n}O_2$

Value of *n*	Systematic Name (Trivial Name)
1	methanoic (formic)
2	ethanoic (acetic)
3	propanoic (propionic)
4	butanoic (butyric)
5	pentanoic (valeric)
6	hexanoic (caproic)
7	heptanoic (enanthic)
8	octanoic (caprylic)
9	nonanoic (pelargonic)
10	decanoic (capric)
11	undecanoic (undecylic)
12	dodecanoic (lauric)
13	tridecanoic (tridecylic)
14	tetradecanoic (myristic)
15	pentadecanoic (pentadecylic)
16	hexadecanoic (palmitic)
17	heptadecanoic (margaric)
18	octadecanoic (stearic)
19	nonadecanoic (nonadecylic)
20	eicosanoic (arachidic)
22	docosanoic (behenic)
24	tetracosanoic (lignoceric)
26	hexacosanoic (cerotic)
28	octacosanoic (montanic)
30	tricontanoic (melissic)
33	tritriacontanoic (psyllic)
35	pentatriacontanoic (ceroplastic)

Table 3 - Alternate List of Saturated Carboxylic Acids

Common Name	Synonyms
Formic	Methanoic
Acetic	Ethanoic
Propionic	Propanoic
Butyric	Butanoic
Valeric	Pentanoic
Caproic	Hexanoic
Enanthic	Heptanoic
Caprylic	Octanoic
Pelargonic	Nomanoic
Capric	Decanoic
η-Undecylic	Undecanoic; hendecanoic
Lauric	Dodecanonc
η-Tridecylic	Tridecanoic
Myristic	Tetradecanoic
η-Pentadecylic	Tetradecanoic
Palmitic	Pentadecanoic
Margaric	Heptadecanoic
Stearic	Octadecanoic
η-Nonadecylic	Nonadecanoic
Arachidic	Eicosanoic; arachic
η-Hencicosoic	Hepeiconsanoic
Behenic	Docosanoic
η-Tricosoic	Tricosanoic
Lignoceric	Tetracosanoic
η-Pentacosoic	Pentacosanoic
Cerotic	Hexacosanoic
η-Heptacosoic	Heptacosanoic
Montanic	Octacosanoic
η-Nonsocosole	Nonacosanoic
Melissic	Triacontanoic
η-Hentriacontoic	Hentriacontanoic
η-Dotriacontoic	Dotriacontanoic
η-Tetratriacontoic	Tetratriacontanoic
Cerophlastic	Pentatriacontanoic
η-Hexatriscontoic	Hexatriacontanoic
η-Octatriacontoic	Octatriacontanoic
η-Hexatetracontoic	Hexatetracontanoic
	Branched-chain acids
Methylbutyric	2-Methylbutanoic; *dextrovaleric*
Isovaleric	3-Methylbutanoic
Pivalic	2,2 Dimethylpropanoic;
	trimethyl-acetic
2-Ethylhexoic	2-Ethylbexanoic; octoic

Alkenoic acids of molecular formula $C_nH_{2n-2}O_2$ include, but are not limited to, acids such as acrylic, methacrylic, undecylenic, oelic acids, *etc.* and those listed in Tables 4 and 5. Of these, acrylic and methacrylic acids may have a petrochemical origin, and undecylenic and oleic acids may have natural sources.

Table 4 - Examples of Straight-Chain Alkenoic Acids of the Formula $C_nH_{2n-2}O_2$

Value of *n*	Systematic Name (Trivial Name)
3	propenoic (acrylic)
4	*trans*-2-butenoic (crotonic)
4	*cis*-2-butenoic (isocrotonic)
4	3-butenoic (vinylacetic)
5	2-pentenoic (β-ethylacrylic)
5	3-pentenoic (β-pentenoic)
5	4-pentenoic (allylacetic)
6	2-hexenoic (isohydroascorbic)
6	3-hexenoic (hydrosorbic)
7	*trans*-2-heptenoic
8	2-octenoic
9	2-nonenoic
10	4-decenoic (obtusilic)
10	9-decenoic (caproleic)
11	10-undecenoic (undecylenic)
12	3-dodecenoic (linderic)
13	tridecenoic
14	9-tetradecenoic (myristoleic)
15	pentadecenoic
16	*cis*-9-hexadecenoic (*cis*-9-palmitoleic)
16	*trans*-9-hexadecenoic (*trans*-9-palmitoleic)
17	9-heptadecenoic
18	*cis*-6-octadecenoic (petroselinic)
18	*trans*-6-octadecenoic (petroselaidic)
18	*cis*-9-octadecenoic (oleic)
18	*trans*-9-octadecenoic (elaidic)
18	*cis*-11-octadecenoic
18	*trans*-11-octadecenoic (vaccenic)
20	*cis*-9-eicosenoic (godoleic)
22	*cis*-11-docosenoic (cetoleic)
22	*cis*-13-docosenoic (erucic)
22	*trans*-13-docosenoic (brassidic)
24	*cis*-15-tetracosenoic (selacholeic)
26	*cis*-17-hexacosenoic (ximenic)
30	*cis*-21-triacontenoic (lumequeiec)

Polyunsaturated aliphatic monocarboxylic acids include, but are not limited to, acids such as sorbic, linoleic, linolenic, eleostearic, and various polyunsaturated fish acids, such as those listed in Table 6. Sorbic acid may be made synthetically. The other acids, except those from tall oil, may occur naturally as glycerides and may be used in this form.

Table 5 - Alternate List of Monoethanoid Acids

Common Name	Synonyms
Obtusilic	4-Decenoic
Caproleic	*cis*-9-Decenoia
10-Undecylenic	10-Undecenoic: 10-hen-decenoic
Lauroleic	cis-9-Dodecenoic
Physeteric	5-Tetradecenoic
Myristoleic	cis-9-Tetradecenoic
Palmitoleic	cis-9-Hexadecenoic
Petroselimic	cis-6-Octadecenoic
Petroselaidic	trans-6-Octadecenoic
Oleic	cis-9-Octadecenoic
Elaidic	trans-9-Octadecenoic
Vacoenic	trans-11-Octadecenoic
Gadoleic	cis-9-Eicosenoic
Cetoleic	11-Docosenoic
Erucic	cis-13-Docosenoic
Brassidic	trans-13-Docosenoic
Selscholeic	cis-15-Tetracosenoio; nevonic
Ximenic	17-Hexacosenoic
Lumequeic	21-Triscontenoic

Table 6 - Examples of Polyunsaturated Fatty Acids

Total Number of Carbon Atoms	Systematic Name (Trivial Name)
Dienoic acids ($C_nH_{2n-4}O_2$)	
5	2,4-pentadienoic (β-vinylacrylic)
6	2,4-hexadienoic (sorbic)
10	2,4-decadienoic
12	2,4-dodecadienoic
18	*cis*-9,*cis*-12-octadecadienoic (linoleic)
18	*trans*-9,*trans*-12-octadecadienoic (linolelaidic)
22	9,13-docosadienoic
Trienoic acids ($C_nH_{2n-6}O_2$)	
16	6,10,14-hexadecatrienoic (hiragonic)
18	*cis*-9,*cis*-12,*cis*-15-octadecatrienoic (linolenic)
18	*cis*-9,*trans*-11,*trans*-13-octadecatrienoic (α-eleostearic)
18	*trans*-9,*trans*-11,*trans*-13-octadecatrienoic (β-eleostearic)
18	*cis*-9,*cis*-11,*trans*-13-octadecatrienoic (punicic)
18	*trans*-9,*trans*-12,*trans*-15-octadecatrienoic (linolenelaidic)
Tetraenoic acids ($C_nH_{2n-8}O_2$)	
18	4,8,12,15-octadecatetraenoic (moroctic)
18	9,11,13,15-octadecatetraenoic (α-parinaric)
18	9,11,13,15-octadecatetraenoic (β-parinaric)
20	5,8,11,14-eicosatetraenoic (arachidonic)
Pentaenoic acids ($C_nH_{2n-10}O_2$)	
22	4,8,12,15,19-docosapentaenoic (clupanodonic)

Shorter-chain alkynoic (acetylenic) acids include, but are not limited to, those made synthetically and those long-chain acids which occur naturally as listed in Table 7.

Table 7 - Examples of Acetylenic Fatty Acids

Total Number of Carbon Atoms	Systematic Name (Trivial Name)
3	propynoic (propiolic propargylic)
4	2-butynoic (tetrolic)
5	4-pentynoic
6	5-hexynoic
7	6-heptynoic
8	7-octynoic
9	8-nonynoic
10	9-decynoic
11	10-undecynoic ([dehydro-10-undecylenic])
18	6-octadecynoic (tariric)
18	9-octadecynoic (stearolic)
18	17-octadecene-9,11-diynoic (isanic, erythrogenic)
18	*trans*-11-octadecene-9-ynoic (ximenynic)
22	13-docosynoic (behenolic)

Substituted fatty acids include, bur are not limited to, acids such as methacrylic acid, 2-ethylhexanoic acid, ricinoleic acid, *etc.* and substituted fatty acids which exist naturally such as those listed in Table 8. Included are fatty acids with a methyl group in the penultimate position and referred to as iso acids, and those with a methyl group in the antepenultimate position and referred anteiso acids.

Table 8 - Examples of Substituted Acids

Total Number of Carbon Atoms	Systematic Name (Trivial Name)
4	2-methylpropenoic (methacrylic)
4	2-methylpropanoic (isobutyric)
5	2-methyl-*cis*-2-butenoic (angelic)
5	2-methyl-*trans*-2-butenoic (tiglic)
5	3-methyl-2-butenoic (β,β-dimethyl acrylic)
5	2-methylbutanoic
5	3-methylbutanoic (isovaleric)
5	2,2-dimethylpropanoic (pivalic)
8	2-ethylhexanoic
14	3,11-dihydroxytetradecanoic (ipurolic)
16	2,15,16-trihydroxyhexadecanoic (ustilic)
16	9,10,16-trihydroxyhexadecanoic (aleuritic)
16	16-hydroxy-7-hexadecenoic (ambrettolic)
18	12-hydroxy-*cis*-9-octadecenoic (ricinoleic)
18	12-hydroxy-*trans*-9-octadecenoic (ricinelaidic)
18	4-oxo-9,11,13-octadecatrienoic (licanic)
18	9,10-dihydroxy-octadecanoic
18	12-hdroxy-octadecanoic (*dl*)
18	12-oxooctadecanoic
18	18-hydroxy-9,11,13-octadecatrienoic (kamlolenic)
18	12,13-epoxy-9-octadecenoic (vernolic)
18	8-hydroxy-*trans*-11-octadecene-9-ynoic (ximenynolic)
18	8-hydroxy-17-octadecene-9,11-diynoic (isanolic)

Also included are naturally occurring fatty acids having alicyclic substituents, such as cyclopentenyl-containing chaulmoogra acids, and cyclopropenyl or sterculic acids (*see* Table 9). Prostaglandins include those formed by *in vivo* oxidation of 20-carbon polyunsaturated fatty acids, such as arachidonic acid. Prostaglandins (*e.g.*, PGE_1) may have different degrees of unsaturation and oxidation when compared to the parent compound, prostanoic acid.

Table 9 - Examples of Fatty Acids with Alicyclic Substituents

Total Number of Carbon Atoms	Common Name
6	aleprolic
10	aleprestic
12	aleprylic
14	alepric
16	hydnocarpic
18	chaulmoogric
18	malvalic (halphenic)
19	sterculic
19	lactobacillic

Naturally occurring aromatic acids include, but are not limited to acids such as benzoic, salicylic, cinnamic, gallic acids, *etc.* Such acids may be generally crystalline solids with relatively high melting points. In this regard, any of the solid carboxylic acid and/or solid metal source compounds described herein may be combined with organic fluids by direct dispersion in such fluids, by addition as an organic-based slurry or solution, *etc.*

Suitable carboxylic acids include branched-chain acids containing at least one branching alkyl group attached to the carbon chain. A few examples are given in Tables 10, 11 and 12.

Among other sources, branched-chain acids may be isolated from wool fat. This includes *iso acids* (with branching methyl on the carbon second from the end of the chain), even-carbon acids from C_{10} to C_{28}, dextrorotatory *anteiso acids* (with branching methyl on the carbon third from the end of chain), odd-carbon acids from C_9 to C_{27}, and normal even-carbon acids from C_{10} to C_{26}. Lower-molecular branched-chain acids (*e.g.,* with seven or less carbons) may be isolated from petroleum.

Table 10 - Some Branched-Chain Acids

Branched-Chain Acid (Trivial Name)
2-methylpropanoic (isobutyric)
2-methylbutanoic (isopentanoic)
3-methylbutanoic isovaleric
2,2-dimethylpropanoic (neopentanoic)
(isooctanoic)
2-ethylhexanoic
(isononanoic)
2,2-dimethyloctanoic (neodecanoic)
(isopalmitic)
(isostearic)

5 **Table 11 - Ethynoid and Substituted Ethenoid Fatty Acids**

Common Name	Synonyms
	Ethynoid acids
Propiolic	2-Propynoic; propargylic
Tetrolic	2-Butynoic
4-Pentynoic	--
Dehydroundecylenic	10-Undecynoic
Tariric	6-Octadecynoic
Stearolic	9-Octadecynoic
Behenolic	I3-Docosynoic
Isanic	Octadec-17-enedi-9,11(°)-ynoic; erythrogenic
Ricinoleic	12-Hydroxy-*cis*-9-octa-decenoic; ricinolic
Licanic	4-Oxo-9,11,13-octadeca-trienoic; couepic

Table 12- Di-, Tri-, and Other Polyethenoid Fatty Acids

Common Name	Synonyms
Sorbic	2,4-Hexadienoic
Linolelaidic	*cis*-9,*cis*-12-Octadecadien-oic; linolic
Linoledlaidic	trans-*9*,trans-*12*-Octadeoa-dienoic
Hiragonic	6,10,14-Hexadecatrienoic
α-Eleostearic	*cis*-9,*cis*-11,*trans*-13-Octa-decatrienoic
β-Eleostearic	*trans*-9,*cis*-11,*cis*-13-Octa-decatrienoic
Punicic	*9,11,13-Octadecatrienoic*
Linolenic	*cis*-9,*cis*-12,*cis*-15-Octa-decatrienoic
Elaidolinolenic	*trans*-9,*trans*-12,*trans*-15-Octadecatrinoic
Pseudoeleostearic	*trans*-10,*trans*-12,*trans*-14-Octadecatrienoic
Moroctic	4,8,12,15-Octadecatetra-enoic
α-Parinaric	9,11,13,15-Octadecatetra-enoic
β-Parinaric	9,11,13,15-Octadecatetra-enoic
Arachidonic	5,8,11,14-Eicosatetraenoic
Clupanodonic	4,8,12,15-19-Docosa-pentaenoic
Nisinic	4,8,12,15,18,21-Tetra-cosabexaenoic

Tables 13 and 14 list other examples of suitable carboxylic acids.

Table 13 - Other Examples of Carboxylic Acids

acetic	palmitic, 90%
acrylic	(hexadecanoic)
benzoic	pelargonic (nonanoic)
butyric	phthalic anhydride
castor oil acids, dehydrated	propionic
coconut oil acids	ricinoleic
distilled	salicylic
double distilled	soybean oil acids
corn oil acids	single-distilled
cottonseed oil acids	double-distilled
formic	stearic
isobutyric	single-pressed
lauric (dodecanoic)	double-pressed
linseed oil acids/	triple-pressed
distilled	tall oil acids
water-white	2% or more rosin
methacrylic	less than 2%
myristic	tallow fatty acids
(tetradecanoic)	technical
oliec	hydrogenated
single-distilled (red)	terephthalic, dimethyl ester
double-distilled (white)	undecylenic
palm oil acids	(10-undecenoic)
single-distilled	
double-distilled	

Table 14 - Other Examples of Carboxylic Acids

trimethylacetic
fluoroacetic
chloroacetic
bromoacetic
iodoacetic
dichloroacetic
trichloroacetic
α-chloropropionic
β-chloropropionic
lactic
Dicarboxylic Acids:
oxalic
malonic
succinic
glutaric
adipic
pimelic
o-phthalic

Tall oil fatty acids primarily consist of oleic and linoleic acids and may be obtained by the distillation of crude tall oil. Crude tall oil is a by-product of the kraft pulping process, and is typically a mixture of fatty acids, rosin acids, and unsaponifiables. Table 15 lists typical components of tall oil fatty acid products, the relative composition of which may vary between crude tall oil products and distilled tall oil products. Table 16 lists examples of fatty acids.

Table 15 - One Embodiment of Typical Fatty Acid Compositions of Tall Oil Products

Fatty Acids:
$C_{16}H_{32}O_2$
$C_{17}H_{34}O_2$
$C_{18}H_{36}O_2$
$C_{18}H_{34}O_2$
$C_{18}H_{32}O_2$
$C_{18}H_{32}O_2$ (isomers)
$C_{19}H_{38}O_2$
$C_{20}H_{36}O_2$
Rosin acids
Unsaponifiables

Table 16 - Examples of Fatty Acids

Acetoacetic acid	2-2-Hydroxytetracosanoic acids
Aleprestic acid	Isovaleric acid
Dotriacontanoic acid	Juniperic acid
Heptacosanoic acid	Ketostearic acids
Docosatrienoic acid	Lanoceric acids
Alepric acid	Lauric acid
Aleprolic acid	Lauroleic acid
Aloprylic acid	Lignocerica acid
Aleuritic acid	Linoleic acid
Ambrettolic acid	Linolelaidic acid
Arachidic acid	Linolelaidie acid
Arachidonic acid	Linolenic
Behenic acid	Margaric acid
Bonotonic acid	Melissic acid
Caproic acid	Methylbutyric acid
Brassidic acid	Montanic Acid
Capric acid	Moroctic acid
Caprolei acid	Myristic acid
Caprylic acid	Myristoleic acid
Cerotic acid	Nisinic acid
Cetoleic acid	Octad
Chaulmootric acid	Oleic acid
Clupanodome acid	Oleyl alcohol
11,12-Dihydroxyeicosanoic acid	13-Oxodotriacontanoic acid
Dihydroxystearic acids	Palmitic acid
Diketostearic acids	Palmitoleic acid
Docosadienoic acid	Pelargonic acid
Docosahexaenoic acid	Pentacosanoic acid
Eicosadienoic acid	Petroselinic acid
Eicosapentaenoic acid	Physoteric acid
Eicosatet-raenoic acid (See also Arachidonic acid)	Pivalic acid
Eicosatrienoic acid	Pseudoeleostearic acid
Elaidic acid	Punicic acid
Elaidolinolenic acid	Tetratriacontanoic acid
Eleostearic acid	Thynnic acid
Enanthic acid	Tricosanoic acid
Eurcic acid	Tridecanoic acid
2-Ethylhexoic acid	Tritriascontaonoic acid
Gadoleic acid	10-undecylenic acid
Gorlio acid	Undecylio acid
Heneicosanoic acid	Vaccenic acid
Hentriacontanoic acid	Valerio acid
Hiragonic acid	Vernolic acid
Hydnocarpic acid	
Hydroxydecanoic acids	
Hydroxystearic acids	

Examples of high rosin fatty acids which may be utilized to accelerate gelling include include, but are not limited to, "UNITOL-S" or UNITOL AR40 (available from International Paper, Chemicals Division) *etc.* Others examples are described elsewhere herein. High rosin fatty acids may be substituted in whole or in part for non-high rosin fatty acids used in embodiments described elsewhere herein. Those of skill in the art will understand with benefit of this disclosure that gel time may be adjusted by varying the amount of high rosin fatty acid, and that gel times may be measured using methods described in the examples herein.

Sources of Fatty Acids

Sources of C_6-C_{24} fatty acids include, but are not limited to, those obtained from natural sources such as animal tallows and greases, vegetable, coconut, palm, marine oils, *etc.* Such acids may also be produced synthetically from petroleum sources. For example, fatty acids may be produced by oxidation of hydrocarbons.

Methods of synthesizing fatty acids include, but are not limited to, the following methods:

Catalytic Oxidation of Paraffinic Hydrocarbons.

Oxidation of Olefins.

Oxidation or Carboxylation of Ethylene-Growth Compounds -- including those compounds obtained from ethylene by the Ziegler process and containing an even number of carbon atoms.

Oxidation of Natural Fats -- including dibasic and straight chain monobasic acids produced by oxidation of unsaturated fatty acids with ozone or other oxidizing agents, (*e.g.*, oleic acid oxidation produces azelaic, $HO_2C(CH_2)_7CO_2H$, and pelargonic acids, $CH_3(CH_2)_7CO_2H$).

Alkali Fusion of Alcohols -- including those acids formed by treatment of fatty alcohols with alkalies at 300°C and ca 5.6 MPa (800 psig) to produce the corresponding fatty acid plus hydrogen.

Telomerization -- including those acids formed by telomerization of ethylene and butadiene with formic and acetic acids, methyl acrylate, or methyl chloride to produce acids of an odd number of carbon atoms.

Saponification of Natural Fats.

Glycerol Recovery -- including those acids present in sweet water from a continuous countercurrent fat splitter that may contain, for example, about 12-20% glycerol, emulsified fat, slight amounts of soluble acids and proteinaceous material, and a trace of inorganic salts.

Crystallization -- such as, for example, separation of oleic, stearic, and monoleic acids by crystallization (qv), either with or without solvents. Cotton seed, soya bean, corn oil, and other liquid edible oils may be winterized by lengthy treatments at low temperatures to allow more saturated triglycerides to crystallize and drop out of solution; followed by filtering of the resulting slurries. Further, liquid acids may be removed from a mass of crystals by cold pressing. The solid fraction may be hot pressed to remove the remaining liquid acids.

Hydrogenation -- including hydrogenation of the solid fractions from crystallization to obtain saturated acids with an IV of less than one, such as hydrogenation by a batch method.

Distillation.

Fatty acids suitable for use in the disclosed method and compositions include, but are not limited to, those produced by processing selected fats and oils such as coconut, soybean, cottonseed, corn, and other vegetable oils, and lard and beef tallow. Such fatty acids may be originally present as triesters of glycerol (triglycerides) with other mixed lipid constituents such as sterols.

Specific examples of suitable fatty acids include, for example, unfractionated fatty acids, each of which typically has the same fatty acid composition as a parent fat or oil. These fatty acids may be referred to as soapstocks, and may be obtained as by-products from alkali treatment during refining of an oil. Other sources include, but are not limited to, from oils such as coconut, and lard and beef tallow. Still other sources of fatty acids, include natural oils and tall oil acids.

Fatty acids may be produced by a combination of crystallization and fractional distillation. Saturated stearic and oleiec fatty acid types may be produced from animal fats such as inedible tallow. As an example, stearic acid may be prepared from them by hydrogenation, crystallization, and distillation. Other examples include types of oleic acid, low poly(unsaturated) oleic, crystallized white oleic, crystallized red oil, and distilled animal acids, are also available.

Other common saturated fatty acids are octanoic, decanoic, lauric, myristic, and palmitic acids which are usually obtained from fractional distillation of coconut oil.

Certain longer chain length fatty acids such as the C_{20} and C_{22} are available from hydrogenated fish oils and rapeseed oil, sources that contain relatively large amounts of these chain lengths in unsaturated forms.

Following is information on a few of the many commercially available carboxylic acid products suitable for use as carboxylic acid components in the disclosed method and apparatus. Included are carboxylic acid products and their derivatives (including fatty acid products and fatty acid derivatives), and carboxylic acid polymers such as polyacrylics.

Table 17 1ists commercially available carboxylic acid products from KIC CHEMICALS, INC., 451 Main Street, P. O. Box 437, Armonk, New York 10504-0437., 451 Main Street, P. O. Box 437, Armonk, New York 10504-0437.

Table 17 - Carboxylic Products Available From Kic Chemicals, Inc.

Fatty Acids	
Capric	Myristic
Caprylic/Capric Blend	Oleic
Caproic	Palmitic
Caprylic	Stearic, Triple-Pressed
Lauric	Stearic, NF Powder
Other Products	
Ascorbic Acid USP	Sesame Oil NF
Benzoic Acid USP/Technical	Sodium Benzoate USP
Citric Acid USP	Succinic Acid FCC
Fumaric Acid NF/FCC	Sulfamic Acid
Malic Acid FCC	Vitamin E Succinate (natural)

Also available from KIC are Isophthalic Acid, Lactic Acid, and Terephthalic Acid. Particular products available form KIC include Oleic Acid (Food Grade Kosher 100% Natural, Vegetable-Based, Product Form - Liquid), Stearic Acid Rubber Grade (100% Natural, Vegetable-Based, Product Form - Flakes/Liquid), Triple-Pressed Stearic Acid 40% Kosher 100% Natural (Vegetable-Based, Product Form - Beads), Triple-Pressed Stearic Acid 50% 100% Natural (Vegetable-Based, Product Form: Flakes).

Tables 18-20 list carboxylic products available from BF GOODRICH CHEMICAL DIVISION, Cleveland, Ohio. These products include CARBOPOL RESINS, such as CARBOPOL 430 Resin, polyacrylic acid in water. CARBOPOL 400 resins are polyacrylic acids of varying molecular weight, available from BF GOODRICH CHEMICAL DIVISION. Other examples are given in Tables 18 and 19.

Table 18 - CARBOPOL Resins

	Liquid Chelating Agents				**Dry Chelating Agents**	
Carbopol Resin	**420**	**430**	**475**	**488**	**421**	**431**
Activity, minimum, %	65	50	45	25	85-90*	85-90*
Molecular weight, dry basis	2,100	5,100	104,000	243,000	2,700	6,000

*Sodium salt of polyacrylic acid

Table 19 - Properties Of CARBOPOL Resins

CARBOPOL RESIN	Molecular Weight
420	2,100
421	2,700
430	5,100
431	6,000
475	104,000
488	243,000

Other resins include CARBOPOL 676, CARBOPOL 940, CARBOPOL 934, CARBOPOL 941, CARBOPOL 970 (*see also* Table 14).

Table 20 - Properties of CARBOPOL Resins

Type	Molecular Weight (Approx.)
907	450,000
910	750,000
941	1,250,000
934	3,000,000
934P	3,000,000
940	4,000,000

Suitable carboxylic products are also available from Arizona Chemical Company, Panama City, Florida. These products include Tall Oil Fatty Acids such as the following fatty acids containing non-conjugated linoleic, conjugated linoleic, oleic and/or saturated components: SYLFAT DFA, SYLFAT FA-1, SYLFAT FA-2, SYLFAT FA-3, SYLFAT EPG, SYLFAT 95C, SYLFAT 94B, SYLFAT 2 and SYLFAT 102. Other products from this supplier include Distilled Tall Oils such as SYLVATAL D30E, SYLVATAL D25LR, SYLVATAL D30LR, SYLVATAL D40LR, SYLVATAL D40T, SYLVATAL D601R, SYLVABLEND RT-29, SYLVATAL RT-30, SYLVATAL S40 and SYLVATAL S40DD. Other products include Disproportionated Rosins/Soaps such as SYLVAROS DR-22, SYLVAROS DRS-40, SYLVAROS DRS-42 and SYLVAROS DRS-43. Other products from this supplier include Co-products of the Tall Oil Fractionation Process such as FA90, FA140, Heads, Pitch, HD19, CC2028, SYLVABLEND EB001, S93 Crude. Other products from this supplier include

Thermal Dimer Acids - SYLVATAL FA-7001 and SYLVABLEND FA-7002. Other products from this supplier include Asphalt and Concrete Blends such as SYLVABLEND AB-155 and SYLVABLEND CB-170. Other products from this supplier include Lower Acid Number Tall Oil Rosins such as SYLVAROS RB and SYLVAROS 315. Other products from this supplier include Dust Control and Flotation Blends such as SYLVABLEND AB-40, SYLVABLEND AD-60, SYLVABLEND FRAN 002 and SYLVABLEND FR-2234 available from Arizona Chemical. Other products from this supplier include Tall Oil Rosins such as SYLVAROS R Type S, SYLVAROS 80, SYLVAROS 10RX and SYLVAROS ACF. Other products from this supplier include Dimer Acids such as SYLVADYM T-17, SYLVADYM T-18, SYLVADYM T-22, SYLVADYM MX, SYLVADYM M-15 and SYLVADYM M-35. Other products from this supplier include Monomer Acids such as SYLFAT D-1 and SYLFAT RD-1. Other products from this supplier include Fatty Acid Esters such as SYLFAT 2249, SYLFAT 2154, SYLFAT 2173, SYLFAT 2210, SYLFAT 2156 and SYLFAT K. Other products from this supplier include Terpenes such as SYLVAPINE DP, SYLVAPINE ANTEHOLE and SYLVAPINE Pine Oil (Natural) available from Arizona Chemical. Other products from this supplier include Specialty Blends such as SYLVABLEND RB-45, SYLVABLEND RB-85, SYLVABLEND RB-90, SYLVABLEND RB95 and SYLVABLEND RB-120 available from Arizona Chemical.

Carboxylic acid products available from Acme-Hardesty Co., Blue Bell, PA, include: Oleic Acid, Stearic Acid, Fractionated Fatty Acids (Caproic, Caprylic, Capric, Caprylic/Capric, Lauric, Myristic, Palmitic, Behenic, Erucic), Distilled Fatty Acids (Coconut, Linseed, Palm Kernal, Tall Oil), Hydrogenated Fatty Acids (Rubber Grade, Marine, Tallow), Hydrogenated Glycerides (Marine, Soya, Tallow), Castor Oil/Derivatives (#1 Castor Oil, Deodorized Castor Oil, Hydrogenated Castor Oil, Pale Pressed Castor Oil, USP Castor Oil, 12-Hydroxy Stearic Acid, Methyl 12-Hydroxy Stearate, N N'Ethylene Bis 12-Hydroxystearamide, Ricinoleic Acid, 70/80 deg. Melt Point Castor Wax-Stick Grade), Vegetable Oils (Coconut, Linseed, Tung). Some other specific products available from Acme-Hardesty include ACME 60-R 85, 70% stearic acid, 745 coconut fatty acid.

A specific example of tall oil fatty acid is TALL OIL FATTY ACID #1 from Acme-Hardesty Co. having the following composition: Linoleic, Nonconjugated 34%, Linoleic,

Conjugated 9%, Oleic 44%, Saturated 5%, Other Fatty Acids 8%. A specific example of PALMITIC ACID 55% available from Acme-Hardesty is Triple Pressed Stearic Acid having a fatty acid composition of C12 (trace), C14 (1.5 % Max), C16 (52-36%), C18 (42-48%), and C18 linear (Trace). TALL OIL FATTY ACID #2 from Acme-Hardesty Co. has the following composition: Linoleic, Nonconjugated 37%, Linoleic, Conjugated 7%, Oleic 50%, Saturated 2%, Other Fatty Acids 4%. 95% PALMITIC ACID from Acme-Hardesty Co. has the following composition: C12 (1.0% MAX), C14 (3.0% MAX), C16 (95% MIN), C18 (3.0% MAX). 90% STEARIC ACID from Acme-Hardesty Co. has the following composition: C16 (10% Max), C18 90% Min), C18 1inear (2.0% Max). DOUBLE PRESSED STEARIC ACID, from Acme-Hardesty Co. has the following composition: C14 (1.5%), C16 (55-60%), C18 (33-41%), C18 1inear (1.5%).

Table 21 lists carboxylic acid products available from HUMKO.

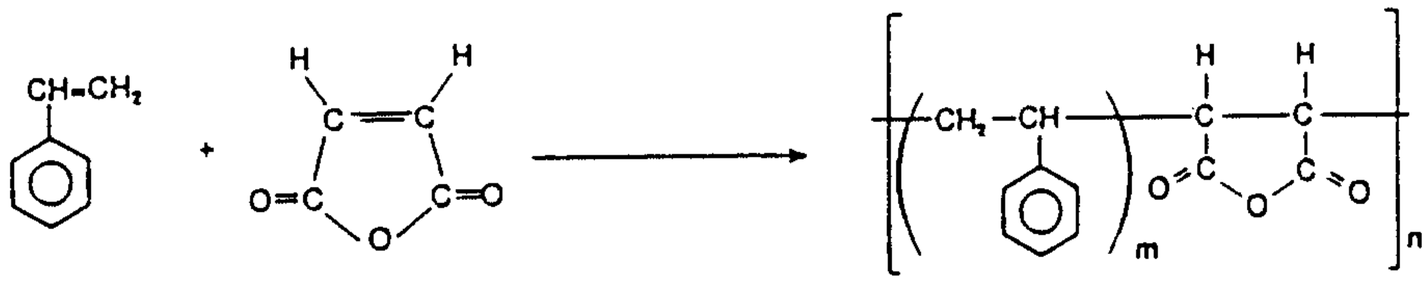
Table 21 - Humko Chemical Product Guide

Product	Description (CTFA Adopted Name)
Lauric and Myristic Acids	
Industrene 365	Caprylic/Capric (Mixture Caprylic/Capric Acid)
Industrene 325	Distilled Coconut (Coconut Acid)
Industrene 223	Hydrogenated Coconut (Hydrogenated Coconut Acid)
Industrene 328	Stripped Coconut (Coconut Acid)
Hystrene 5012	Hydrogenated Stripped Coconut (Hydrogenated Coconut Acid)
Hystrene 9512	95% Lauric (Lauric Acid)
Hystrene 9912	99% Lauric (Lauric Acid)
Hystrene 9014	90% Myristic Acid (Myristic Acid)
Hystrene 9514	95% Myristic Acid (Myristic Acid)
Stearic and Palmitic Acids	
Hystrene 9016	90% Palmitic (Palmitic Acid)
Industrene 4518	Single Pressed Grade (Stearic Acid)
Industrene 5016	Double Pressed Grade (Stearic Acid)
Hystrene 5016	Triple Pressed Grade (Stearic Acid)
Industrene 4516	45% Palmitic (Palmitic Acid)
Hystrene 4516	45% Palmitic (Palmitic Acid)
Industrene R	Stearic Acid
Industrene B	Stearic Acid
Industrene 7018	70% Stearic Acid (Stearic Acid)
Hystrene 7018	70% Stearic Acid (Stearic Acid)
Industrene 9018	90% Stearic (Stearic Acid)
Hystrene 9718	92% Stearic (Stearic Acid)
Behenic and Arachidic Acids	
Hystrene 3022	30% Behenic and Arachidic (Hydrogenated Menhaden Acid)
Hystrene 5522	55% Behenic and Arachidic (Hydrogenated Menhaden Acid)
Hystrene 7022	70% Behenic and Arachidic (Behenic Acid)
Hystrene 9022	90% Behenic and Arachidic (Behenic Acid)
Tallow Type Acids	
Hystrene 1835	Soap Acid Blend (Mixture Tallow/Coconut Acid)
Industrene 145	Tallow Acid
Industrene 143	Tallow Acid
Oleic Acids	
Industrene M	Oleic-Stearic Acid
Industrene 105	Oleic Acid
Industrene 106	Low-Titer (Oleic Acid)
Industrene 205	Oleic Acid
Industrene 206	Low-Titer (Oleic Acid)
Industrene 206LP	Low-Titer (Oleic Acid)
Linoleic and Linolenic Acids	
Industrene 120	Linseed (Linolenic Acid)
Industrene 130	Linoleic Acid (Linoleic Acid)
Industrene 224	Oleic-Linoleic Acid
Industrene 225	Soya Acid (Linoleic Acid)
Industrene 226	Soya Acid (Linoleic Acid)

MSMA-Based Compounds

Partial monoesters of styrene maleic anhydride copolymers and fatty alcohols ("MSMA's") include MSMA's as well as derivatives of MSMA's (such as sodium salts of sulfonated MSMA's). Such compounds are typically available in resin form, and may be utilized in the disclosed methods and compositions by direct combination with other components in an organic base fluid, or by prior dissolution in an organic solvent, such as toluene, xylene, or any other solvent or mixture of solvents suitable for dissolution of the selected MSMA-based compound/s.

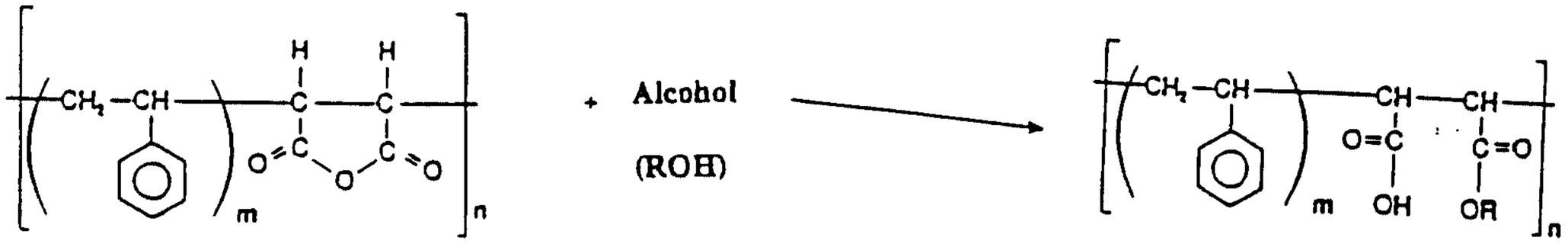
Among suitable MSMA-based compounds are those compounds formed from styrene maleic anhydride copolymers formed via the following reaction:



Styrene Maleic Anhydride Styrene Maleic Anhydride Copolymer

In one embodiment, m = from about 1 to about 3; and n = from about 6 to about 8. It will be understood with benefit of this disclosure that values of m and n may vary outside these ranges as well.

Suitable MSMA compounds include those formed by the esterfication of styrene maleic anhydrides copolymer with one or more fatty alcohols, as in the following reaction:

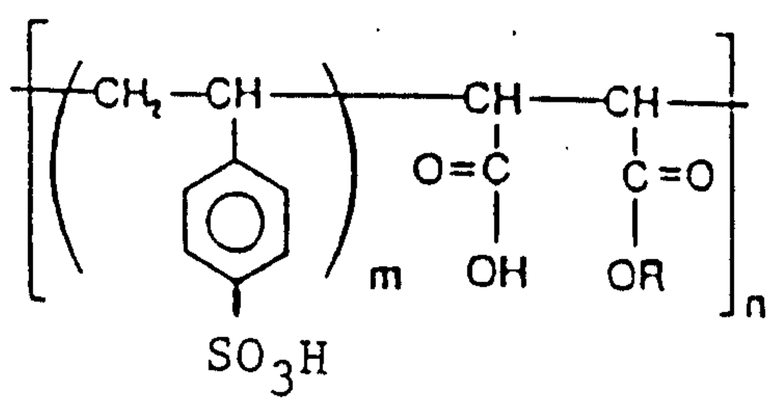


wherein m and n are the same as given above for MSMA compounds. In one embodiment, ROH represents a fatty alcohol in which R is a branched or straight carbon chain that may be saturated or unsaturated, and which may have from about 8 to about 20 carbon atoms, alternatively from about 6 to about 38 carbon atoms. The degree of esterfication of such MSMA compounds may vary from very little to almost complete esterfication, but in one embodiment ranges from about 35% to about 75%.

Specific examples of fatty alcohols for MSMA esterfication include, but are not limited to those produced by the Ziegler and Oxo processes, reduction of vegetable oils and fatty acids with sodium, catalytic hydrogenation at elevated temperatures and pressures, and hydrolysis of spermacetia and sperm oil by saponification and vacuum fractional distillation. Specific examples of saturated fatty alcohols include, but are not limited to, octyl, decyl, lauryl, myristyl, cetyl and stearyl alcohols, *etc*. Specific examples of unsaturated fatty alcohols include, but are not limited to oleyl, linoleyl, linolenyl, *etc*.

Although one embodiment of MSMA compounds formed from monofunctional alcohols are described above, it will be understood with benefit of this disclosure that MSMA compounds formed from multifunctional fatty alcohols (difunctional, trifunctional, *etc*.) are also possible. Furthermore, it is also possible that partial esters of styrene maleic anhydride and alcohols other than fatty alcohols, are also possible. In addition, partial esters of styrene maleic anhydride may be formed with other organic carbon chains having one or more carboxyl functionalities formed thereon. In those cases where multifunctional alcohols and/or alcohols with one or more carboxyl functionalities are employed, those of skill in the art will understand with benefit of this disclosure that properties of a gelled organic fluid may be varied and/or enhanced by virtue of additional hydroxyl sites available for complexation or reaction with metal groups supplied by metal source compounds.

Derivatives of MSMA compounds may also be employed in the disclosed methods and compositions, in a similar manner or in place of MSMA compounds. Examples of such MSMA derivatives include, but are not limited to, MSMA compounds having aryl groups that are substituted or partially substituted. In one exemplary embodiment, sulfornated MSMA derivatives may be formed having the following structure



where m, n, and R have those values described above for MSMA compounds.

Further information on specific suitable MSMA-based compounds available under the tradename SMA® from Elf Atochem may be found in the following publications from Elf Atochem: "SMA Multifunctional Resins General Bulletin"; "The Use of SMA Resins as Multivalent Ion Complexation Agents" (Version 3.0, June 1998); "SMA Fatty Alcohol Esters"; and "Technical Information, Developmental Products, Sulfonated SMA Resins S-SMA X 1000 and S-SMA X 3000," each of the foregoing being incorporated herein by reference. Specific examples include MSMA compounds made from base SMA® resins SMA 1000, SMA 2000, SMA 3000, and SMA 4000, with styrene/maleic anhydride ratios of 1, 2, 3 and 4, respectively. These include ester resins SMA 1440, SMA 17352, SMA 2625 and SMA 3840. These compounds are available in aqueous solution and are designated with a "H" suffix. Additional suitable MSMA-based compounds include SMA X10840, SMA X11825 (C18 fatty alcohol), SMA X11850(C16 to C18 fatty alcohol) and SMA X31890 (C18 fatty alcohol). Still others include, but are not limited to, SMA XGA-10, SMA XGA-30, SMA 1000F, SMA 1440 F, SMA 17352F, SMA 2000F, SMA 2625F, SMA EF-30, SMA 3840F, SMA EF40, SMA 3000F, *etc.*

Further examples of styrene maleic anhydride and styrene maleic anhydride derivative copolymer starting materials (*i.e.,* which may be esterfied), as well as MSMA-based compounds may be found in United States Patents No. 4,284,414; 4,450,261; 5,076,852; 3,650,970; 3,657,123; 3,528,939; 3511,820; 5,132,271; 5,330,588 and 3,741,943; which are each incorporated herein by reference. Still other such information may be found in American Chemical Society Symp. Ser., 1983, Vol. 229, Iss. *Eff. Hostile Environ. Coat. Plast.* pp. 49-64; Japanese Kokai Tokyo Koho, May 16, 1984 (Patent No. 84 84933, Patent Application Number 83-184060); German Offen., May 22, 1969 (Patent No. 1800712); and SU Patent No. 1,482,171; which each incorporated herein by reference.

Optional "activator" materials may be added to a MSMA-containing formulation to achieve, among other things, reduced gellation time and/or smoother gels. In this regard, an activator may be any compound containing carboxylic acid functionalities, typically having a low carbon count. Examples include relatively low carbon count carboxylic acids, including multi-functional carboxylic acids such as citric acid. While not wishing to bound by theory, it is believed that such activator compounds favor aluminum cross linking and in that way affect the gellation reaction. Other suitable activators include, but are not limited to the high rosin fatty acids described elsewhere herein (such as "Unitol S").

Fat and Fatty Oil-based Organic Fluids

Among the organic fluids suitable for use in the disclosed method and compositions are fats and fatty oils, such as those derived from vegetable, animal, and marine sources and which may be by-products in the production of vegetable proteins or fibers and animal marine proteins. Examples of fat sources include, but are not limited to, oilseeds, fruit pulps, animals, and fish. Advantageously, such organic fluids may serve dual functions as both source of fatty acids as well as base fluids for formulating treatment fluids, and component slurries or suspensions. Suitable organic fluids include, but are not limited to, marine fats and *Cruciferae* fats, for example, those characterized by fatty acids having carbon chains of up to about C_{24}.

Although fatty acids in fats may be esterified with glycerol to form glycerides, some fats may have greater than about 5% free fatty acid. Table 22 is a partial list of sources of exemplary organic fluids and fatty acids that may be employed in the disclosed method and compositions.

Table 22 - Some Sources of Organic Fluids and Related Fatty Acids

Fatty Acid	Common Name	Source of Organic Oil/Acid
butanoic	butyric	butter
hexanoic	caproic	butter
octanoic	caprylic	coconut
decanoic	capric	coconut
dodecanoic	lauric	coconut, palm kernel
tetradecanoic	myristic	coconut, palm kernel, butter
hexadecanoic	palmitic	palm, cottonseed, butter, animal fat, marine fats
cis-9-hexadecenoic	palmitoleic	butter, animal fats
octadecanoic	stearic	butter, animal fats
cis-9-octadecenoic	oleic	olive, tall oil, peanut, canbra, animal fats, butter, marine fats
cis,cis-9,12-octadecadienoic	linoleic	safflower, sunflower, corn, soy, cottonseed
cis,cis,cis-9,12,15-octadecatrienoic	linolenic	linseed
cis,cis,cis,cis-6,9,12,15-octadecatetraenoic		marine fat
cis,trans,trans-9,11,13-octadecatrienoic	α-eleostearic	tung
12-hydroxy-*cis*-9-octadecenoic	ricinoleic	castor
cis-9-eicosenoic	gadoleic	marine fat
cis-11-eicosenoic		rapeseed
all *cis*-5,8,11,14-eicosatetraenoic	arachidonic	animal, marine fats
all *cis*-8,11,14,17-eicosatetraenoic		marine fats
all *cis*-5,8,11,14,17-eicosapentaenoic		marine fats
docosanoic	behenic	
cis-11-docosenoic	cetoleic	marine fats
cis-13-docosenoic	erucic	rapeseed
all *cis*-7,10,13,16,19-docosapentaenoic		marine fats
all *cis*-4,7,10,13,16,19-docosahexaenoic		marine fats

Milk fats are typically characterized by low unsaturation and the presence of a wide variety of saturated fatty acids of short chain length. Lauric acid oils are typically distinguished by relatively low unsaturation and a high content of lauric acid as well as other short-chain acids. Lauric acid oils may be derived from seeds of cultivated or noncultivated palms. Vegetable butters are typically low in unsaturation and contain principally C_{14}, C_{16}, and C_{18} acids. Vegetable butters may be derived from seeds of tropical trees. Cocoa butter is one example. Land-animal fats are typically relatively low in unsaturation and contain principally C_{16} and C_{18} acids, with unsaturated acids consisting primarily of oleic and linoleic acids.

Oleic-linoleic acid oils are of medium, but rather variable unsaturation (iodine), with fatty acids being predominantly C_{18} acids. These oils are normally liquid in the raw form but may be hydrogenated to produce plastic fats. These fats may be derived from the fruit pulp of perennial plants (palm, olive) and the seeds of cultivated annual plants (*e.g.*, cotton, peanut, corn, safflower, sesame, and sunflower seeds). Erucic acid oils resemble the oleic-linoleic acid oils in composition except that the predominant unsaturated fatty acid is a C_{22} acid, erucic acid, and there may be a minor proportion (6-10%) of linolenic acid. Exemplary oilseeds include, but are not limited to, ravison, mustard seed, and rapeseed (colza), including zero erucic rapeseed varieties (typically called canbra or canola oil in Canada).

Linolenic acid oils, derived almost wholly from the seeds of cultivated annual plants, are generally similar to the oleic-linoleic acid oils but are distinguished from the latter by containing the more highly unsaturated acid, linolenic acid. Exemplary suitable oils of this type include, but are not limited to, soybean and linseed oils. Conjugated acid oils typically have relatively high content of unsaturated fatty acids with conjugated double bonds. These may be derived from the seeds of subtropical trees, and examples include tung and oiticica oils.

Marine oils are characterized by content of fatty acids that varies considerably in chain length both above and below 18 carbons, and by the presence of highly unsaturated acids (4 or more double bonds), together with a considerable content of saturated acids (as much as 25% of the total acids). Examples include those derived from small oily fishes, such as California sardine (pilchard), menhaden and herring. Other examples include fish-liver oils, typically

derived from different species of fish. Hydroxy-acid oils include castor oil which consists principally of glycerides of ricinoleic (12-hydroxyoleiec) acid.

Table 23 -- Examples of Fats and Related Acid Types

Fat	Acid Type
Vegetable	
babassu	lauric acid
castor	hydroxy acid
coconut	lauric acid
corn	oleic-linoleic acid
cottonseed	oleic-linoleic acid
linseed	linolenic acid
oiticica	conjugated acid
olive	oleic-linoleic acid
palm	oleic-linoleic acid
palm kernel	lauric acid
peanut (groundnut)	oleic-linoleic acid
rapeseed	erucic acid (oleic-linoleic acid)
regular	
low erucic	
(canbra or canola)	
safflower	oleic-linoleic acid
regular	
high oleic	
sesame	oleic-linoleic acid
soybean	linoleic-linolenic acid
sunflower	oleic-linoleic acid
tung	conjugated acid
Animal	
butter	milk
lard	land animal
tallow and grease	land animal
Marine	
whale	marine
sperm whale	marine
fish (liver)	marine
herring	
sardine (pilchard)	
sardine (Peruvian)	
menhaden	

Table 24 -- Examples of Vegetable Oils and Related Acid Types

Fat or Oil	Type or group
Almond oil	Oleio-linoloic acid
Apricot-kernal oil	Oleio-linoloic acid
Babassu oil	Lauric acid
Bornao tallow	Vegetable butter
Candlenut (lumbang) oil	Linolenic acid
Castor oil	Hydroxy acid
Chinese vegetable tallow	Vegetable butter
Cocoa butter	Vegetable butter
Coconut (copra) oil	Lauric acid
Cohune oil	Lauric acid
Corn oil	Oleio-linoloic acid
Cottonseed oil	Oleio-linoloic acid
Grapefruitseed oil	Lauric acid
Hempseed oil	Lauric acid
Kap oil	Oleio-linoloic acid
Linseed oil	Linolenic acid
Mowrab (illip) fat	Vegetable butter
Murumuru oil	Lauric acid
Mustard oil	
O	Conjugated acid
Olive oil	Oleio-linoloic acid
Orangeseed oil	Linolenic acid
	Lauric acid
Palm oil	Oleio-linoloic acid
Palm-kernal oil	Lauric acid
Peanut oil	Oleio-linoloic acid
Perilla oil	Linolenic acid
Poppyseed oil	Oleio-linoloic acid
	Erucic acid
	Erucic acid
Rice-bran oil	Oleio-linoloic acid
Safflower oil	Oleio-linoloic acid
Sesame oil	Oleio-linoloic acid
Shea fat	Vegetable butter
Soybean oil	Linolenic acid
	Conjugated acid
Sunflowerseed oil	Oleio-linoloic acid
Teaseed oil	Oleio-linoloic acid
Tung (China wood oil)	Conjugated acid
Ucuhuba butter	vegetable butter
Walnut (English) oil	Linolenic acid
Wheat germ oil	Linolenic acid

Salts of Carboxylic Acids

In the practice of the disclosed methods and compositions, carboxylic acid salt metal source compounds may be selected from a wide variety of carboxylic salts including, but not limited to, salts of natural and synthetic carboxylic acids and derivatives thereof described elsewhere herein. It will be understood with benefit of this disclosure that mixtures of specific carboxylic acid salts, as well as types of carboxylic acid salts, are possible.

Suitable carboxylic acid salts include, but are not limited to, those salts which occur when a carboxylic acid reacts with an alkaline substance, such as in a reaction of the following type involving carboxylic acid and alkaline hydroxide:

$$RCOOH + MOH \rightarrow RCOO^- + M^+ + H_2O;$$

wherein: M = Li, Na, K, Ca, Mg, Zn, Al, NH_4, or R_4N; and

R = derivatized or underivatized aliphatic or aromatic group (such as R groups of those carboxylic acids described elsewhere herein).

It will be understood with benefit of this disclosure that an alkaline substance employed in salt formation by such a reaction also may be another type of alkaline substance including, but not limited to, an oxide or carbonate of having M and R substituents selected from those given elsewhere herein.

Carboxylic acid salts and other suitable metal source compounds may be based on carboxylic acids or derivatives thereof. A few examples of such derivatives are given in Table 25.

Table 25 - Examples of Fatty Acid Derivatives

Fatty Acid Derivatives
adipic acid esters, total
di(2-ethylhexyl) adipate
diisodecyl adipate
diisopropyl adipate
n-octyl *n*-decyl adipate
complex linear polyesters and polymeric plasticizers
epoxidized esters, total
epoxidized soybean oil
isopropyl myristate
isopropyl palmitate
oleic aid esters, total
butyl oleate
glyceryl trioleate
methyl oleate
propyl oleates
all other oleates
sebacic acid esters
stearic acid esters, total
n-butyl stearate
alcohols, C_{12} and higher, unmixed
alcohols, mixtures, total
distearyl 3,3'-thiodipropionate
dodecyl mercaptan
erucamide
lauroyl chloride
stearic acid salts:
aluminum stearates, total
barium stearate
calcium stearate
magnesium stearate
zinc stearate
sulfurized lard oil for lubricants

In one embodiment of the disclosed method, metal salt/s (*e.g.*, aluminum salt) of 2-ethylhexanoic acid (often called 2-ethylhexoic in industry) is employed. 2-ethylhexoic acid may be made by the hydrogenation of 2-ethyl-2-nexenal (α-ethyl-β-propylacrolein), $CH_3(CH_2)_2CH{:}C(C_2H_5)CHO$, to 2-ethylhexanal (α-ethyl-caproaldehyde), which may be catalytically oxidized in the liquid phase to the acid. Metallic salts of ethylhexoic acid (known

also as octoates) include, but are not limited to those of aluminum, iron, lead, cobalt, copper, nickel, zinc, magnesium and manganese, and may be made, for example, by diffusion or double decomposition. One specific example of an octoate derivative is Oxyaluminum Octoate in an ester carrier available under the product name "OAO" from Chattem Chemicals, Inc. of Chattanooga, TN.

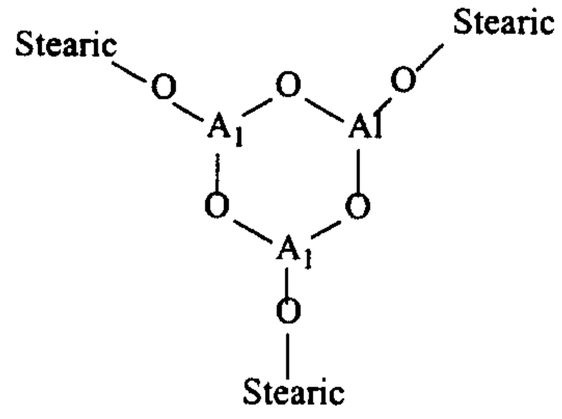
Carboxylic acid salts available from Acme-Hardesty Co. include: Zinc Stearate (Polymer Grade, Powder), Calcium Stearate (Polymer Grade, Powder), and aluminum Stearate as listed in Table 26.

Table 26 - Aluminum Stearate from Acme-Hardesty Co.

	TYPE 1	**TYPE 2**	**TYPE 3**
APPEARANCE	White Powder	White Powder	White Powder
FREE FATTY ACID %	5.8 max	8 max	20 max

Carboxylic acid salts available from Chattem Chemicals, Inc, of Chattanooga, Tennessee include aluminum benzoates, octoates, stearates (such as organo aluminum stearate) and chelates. Table 27 lists examples of metal salt compounds commercially available in organic solution from Chattem.

Table 27 - Commercially Available Carboxylic Acid Salt Liquid Solutions from Chattem

Product	Product Description	Product Characteristics
KHD	liquid oxyaluminum acrylate	Aluminum Content: 8.3 to 8.9% (typical 8.6%)
OAS/MSII	liquid cyclized aluminum mono stearate 	Aluminum Content: 5.0% to 5.5%

Other Metal Source Compounds

In the practice of the disclosed methods and compositions, other metal source compounds (*i.e.*, other than metal salts of carboxylic acid) may be selected from a wide variety of compounds capable of supplying metal ions including, but not limited to, organic and inorganic metal salts and organometallic compounds (including coordination compounds). Such compounds may available be in the solid, liquid or paste form. It will be understood with benefit of this disclosure that mixtures of specific metal source compounds, as well as types of metal source compounds, are possible. Table 28 lists exemplary metal alkoxide compounds, and Tables 29-31 list some commercially available metal source compounds, including some commercially available carboxylic acid salts not previously mentioned.

Table 28 - Metal Alkoxides

Aluminum Butoxide
Aluminum Isoproxide
Aluminum Methoxide
Iodine Pentoxide
Lithium Butoxide
Lithium Methoxide
Lithium t-butoxide
Palladium Methoxide
Potassium t-butoxide
Sodium Butylate
Sodium Ethoxide
Sodium Methoxide
Tin Ethoxide
Titanium Isopropoxide
Titanium Methoxide
Zirconium Butoxide

Table 29 - Commercially Available Metal Salts from Chattem

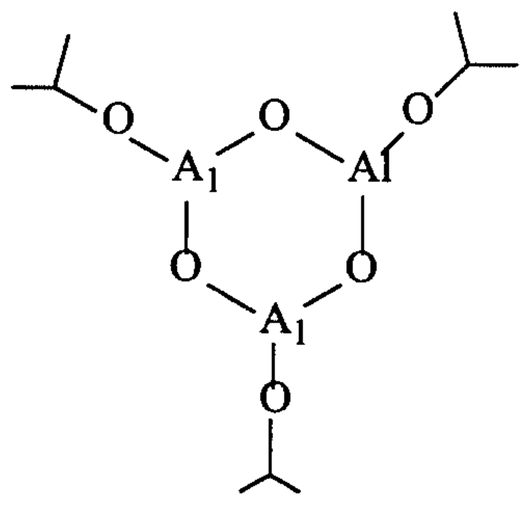
Product	**Product Description**	**Product Characteristics**
AIP (white granular powder)	aluminum isopropoxide (aluminum isopropylate)	Aluminum Content: about 13%
VISCO MASTER 2200 (liquid solution)	liquid aluminum alkoxide	Aluminum Content: 10.2% to 10.8%
TRI-XL LV (liquid solution)	low viscosity cyclic trimer of tri-oxy-aluminum isopropoxide in a severely hydrotreated paraffinic hydrocarbon oil 	Aluminum Content: 12.5% to 13.0%

Table 30 - Examples of Compounds Available from Alfa Aesar, A Johnson Matthey Company, Organics and Organometallics 1999-00

Metal Alkoxides	
Zirconium l-Dutoxide, 99.99% (metals basis)	$[(CH_3)_3CO]_4Zr$
Zirconium Ethoxide	$(CH_3CH_2O)_4Zr$
Zirconium 2-ethylhexanoate, 96±%	
Zirconium 2-ethylhexanoate, ~20% in mineral spirits (6%2r)	
Zirconium isopropoxide, C 43.8%, H 8.8%	$[(CH_3)_2CHO]_4Zr$
Zirconium (IV) 2,4-pentanadlonate	
Zirconium (IV) n-propoxide, 70% w/w in n-propanol	$Zr(OCH_3CH_2CH_3)_4$
Tin (IV) Isopropoxide, 98% (metal basis)	$[(CH_3)_2COH]_4Sn$
Tin (IV) Isopropoxide, 10% w/v in isopropanol, 98% (metal basis)	$[(CH_3)_2COH]_4Sn$
Titanium (IV) n-propoxide, 98%	$Ti(OCH_2CH_2CH_3)_4$
Aromatic Bases	
a-Xylene, 99% (Isotopic)	
m-Xylene, 99%	
p-Xylene, 99%	
p-Xylene-d10, 99% (Isotopic)	
Aluminum Sources	
Aluminum acetate, basic	approx. $(CH_3CO_2)_2AlOH.H_2O$
Aluminum n-butoxide, 90-95%	$[CH_3(CH_2)_3O]_3Al$
Aluminum tert-butoxide	$[CH_3CH_2CH(CH_3)O]_3Al$
Aluminum calcium isopropoxide, 10% w/v in IPA, 99.8% (metals basis)	$[(CH_3)_2CO]_3Al$ $[((CH_3)_2CHO]_4Al)_2Ca$

Table 31 - Examples of Compounds Available from ACROS ORGANICS (Fisher Scientific) Catalog of Fine Chemicals, 98/99

Isopropoxide Group	
Ferric 2-ethylhexanoate	
Metal Alkoxides	
Titanium (IV) n-butoxide, 99%	$[CH_3(CH_2)_3O]_4Ti$
Titanium (IV) cresylate	$(CH_3C_6H_4O)_4Ti$
Titanium (IV) Isopropoxide, 99.999%	$[CH_3)_2CHO]_4Ti$
Aromatic Bases	
Toluene, reagent ACS	$C_6H_5CH_3$
Naphthalene, 99%	$C_{10}H_8$

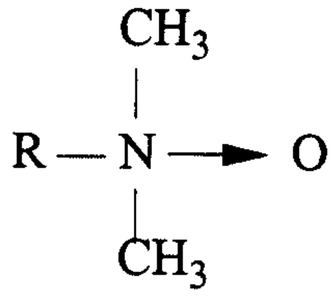
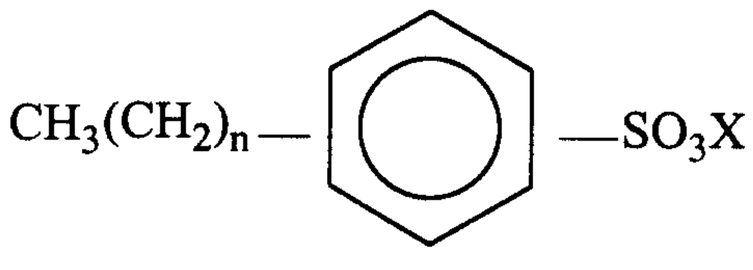
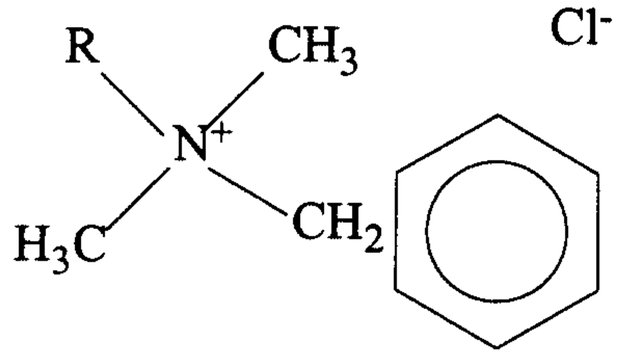
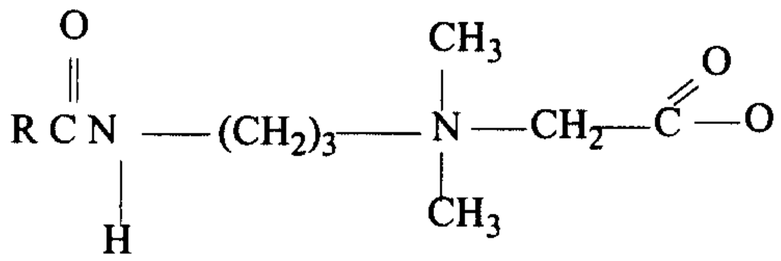
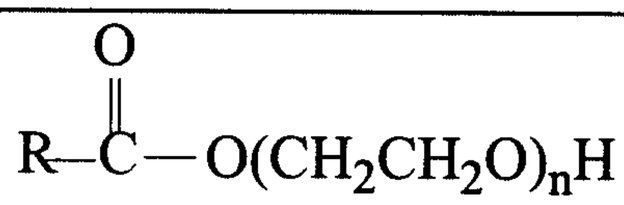
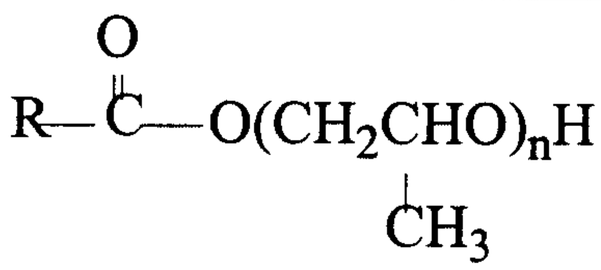
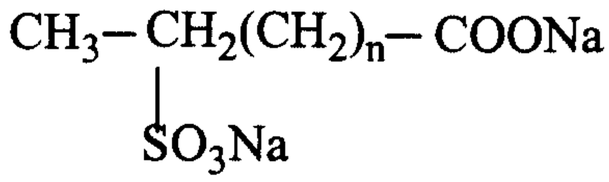
Aluminum Sources	
Aluminum acetylacetonate, 98%	$(CH_3COCH_2COCH_2)_3Al$
Aluminum 2-ethylhexanoate	$[CH_2(CH_2)_3CH(C_2H_5)COO]_2AlOH$
Aluminum hydroxide, powder	H_3AlO_3
Aluminum isopropoxide, 98+%	$[(CH_3)_2CHO]_3Al$
Aluminum tri-sec-butoxide, 97%	$[C_2H_5CH(CH_3)O]_3Al$
Aluminum triethoxide	$(C_2H_5O)_3Al$
Iron Sources	
Ferric acetylacetonate	$(CH_3COCH_2COCH_2)_3Fe$
Ferric benzolacetonate	$C_{30}H_{27}FeO_6$
Ferric oxide	FeO_3

Surfactant Materials

In the practice of the disclosed methods and compositions, surfactants may be selected from a wide variety of compounds capable of facilitating interaction of components of gelled organic fluids. Commercially available surfactants include, but are not limited to, the following surfactants from Akzonobel Chemicals Incorporated: "ARMAK 1730" (alkoxylated fatty amine), "ARMEEN C" (fatty acid derived amine), "ARQUAD 2C-75" (quad in isopropanol base), "ETHOMEEN T/12" (alkoxylated fatty amine), "R-MACK 703." Examples of other suitable surfactants commercially available from Witco, Stepan, Akzo and Ethox are listed in Tables 32, 33, 34 and 35.

Table 32- Witco Surfactants

Ethoxylated Fatty Alcohols	$RO-(CH_2CH_2O)_nH$	*R = fatty alcohol*
Propoxylated Fatty Alcohols	$RO-(CHCH_2O)_nH$ with CH_3	*R = fatty alcohol*
Ethoxylated Fatty Amines	$R-N$ with $(CH_2CH_2O)_nH$ and $(CH_2CH_2O)_nH$	*R = fatty radical*

Amines Oxides		*R = coconut fatty radical*
Alkylbenzene Sulfonates		*X - sodium, calcium, amine, etc.*
Alkyldimethylbenzyl Ammonium Chloride		*R = lauryl or stearyl radical*
Cocoamidopropyl Betaine		*R =coco group*
Ethoxylated Fatty Acids		*R = fatty radical*
Propoxylated Fatty Acids		*R = fatty radical*
Sulfonated Fatty Acids		

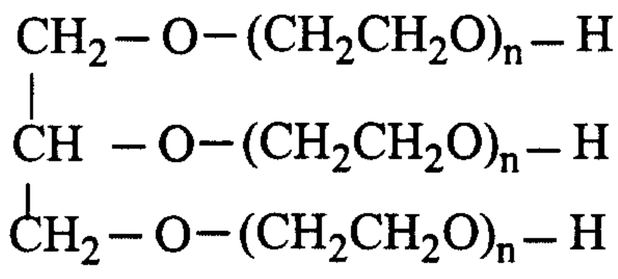
Glycerol Ethoxylates		

Table 33 - Stepan Surfactant Products

Class	Product	Chemical Description
Detergents		
Alkylbenzene Sulfonates	BIO-SOFTD-40	Sodium alkylbenzene sulfonate, linear
	BIO-SOFTD-53	Sodium alkylbenzene sulfonate, linear
	BIO-SOFTD-62	Sodium alkylbenzene sulfonate, linear
	BIO-SOFTN-300	TEA alkylbenzene sulfonate, linear
	NACCONOL-40G	Sodium alkylbenzene sulfonate, linear
	NACCONOL 90G	Sodium alkylbenzene sulfonate, linear
	NINATE 401	Calcium alkylbenzene sulfonate, branched
	NINATE 411	Amine alkylbenzene sulfonate, branched
Sulfonic Acid	BIO-SOFT S-100	Alkylbenzene sulfonic acid, linear
	BIO-SOFT S-130	Alkylbenzene sulfonic acid, linear
	STEPANTAN H-100	Alkylbenzene sulfonic acid, branched
Hydrotropes	STEPANATE SXS	Sodium xylene sulfonate
	STEPANATE AXS	Ammonium xylene sulfonate
	STEPANATE SCS	Sodium cumene sulfonate
Emulsion Polymerization		
Alkyl Ethoxylate Sulfates	POLYSTEP B-11	Ammonium lauryl ether sulfate, 4 EO
	POLYSTEP B-12	Sodium lauryl ether sulfate, 4 EO
	POLYSTEP B-19	Sodium lauryl ether sulfate, 30 EO
	POLYSTEP B-20	Ammonium lauryl ether sulfate, 30 EO
	POLYSTEP B-22	Ammonium lauryl ether sulfate, 12 EO
	POLYSTEP B-23	Sodium lauryl ether sulfate, 12 EO
Alkylphenol Ethoxylate Sulfates	POLYSTEP B-1	Ammonium nonyl phenol ethoxylate sulfate, 4 EO
	POLYSTEP B-27	Sodium nonyl phenol ethoxylate sulfate, 4 EO
	POLYSTEP C-OP3S	Sodium octyl phenol ethoxylate sulfate, 3 EO
Textiles		
Sulfonates	BIO-SOFT D-40	Sodium alkylbenzene sulfonate, linear
	BIO-SOFTD-62	Sodium alkylbenzene sulfonate, linear
	BIO-SOFT AS-40	Sodium olefin sulfonate
	BIO-TERGE PAS-8S	Octane sulfonate salt
	NINATE 411	Alkylamine alkylbenzene sulfonate
Sulfonic Acid	BIO-SOFT S-100	Alkylbenzene sulfonic acid
Alkanolamides	NINOL 11-CM	Coconut diethanolamide
	NINOL 201	Oleic diethanolamide
	NINOL 40-CO	Coconut diethanolamide
	NINOL 1301	Fatty alkanolamide, modified
	AMIDOX C-2	Ethoxylated cocoamide
	AMIDOX C-5	Ethoxylate cocoamide

Table 34- Akzo Industrial Surfactants
(Mixture of $RCO_2(CH_2CH_2O)_xH$ and $RCO_2(CH_2CH_2O)_xOCR$
Ethoxylated Fatty Acids)

Registered Tradename	Common Name
Ethofat O/20	Ethoxylated (10) oleic acid
Ethofat 18/14	Ethoxylated (4) stearic acid
Ethofat 242/25	Ethoxylated (15) tall oil acid
Ethofat 433	Ethoxylated (15) tall oil acid

Table 35 - Ethox Surfactants

Surfactant	Comments
Ethoxylated Alcohols and Alkyl Phenols	
ETHAL OA-23	POE (23) Oleyl Alcohol – Hydrophilic emulsifier and detergent, useful in stabilizing dispersions and scouring textile goods
ETHAL OA-23/70%	POE (23) Oleyl Alcohol - 70% Solution of ETHAL OA-23
ETHAL OA-35	POE (35) Oleyl Alcohol – stabilizer and emulsifier
ETHAL 368	POE (3) C_{16}-C_{18} Alcohol - oil soluble emulsifier and lubricant
ETHAL CSA-20	POE (20) C_{16}-C_{18} Alcohol – Viscosity modifier and emulsifier for aqueous systems. Base for cosmetic creams and lotions.
ETHAL CSA-25	POE (25) C_{16}-C_{18} Alcohol - Hydrophilic emulsifier which exhibits good detergency in mildly acidic of alkaline solutions and hot aqueous systems
ETHAL SA-20	POE (20) C_{18} Alcohol - Viscosity modifier and emulsifier for aqueous systems. Base for cosmetic creams and lotions.
Ethoxylated Glycerides	
ETHOX 1212	Ethoxylated Coconut Glyceride - Excellent lubricant for textiles and metals
ETHOX 2119	Polyoxyalkylene Coconut Glycerides - Lubricant for textiles and metals.
ETHOX 2132	Polyoxyalkylene Coconut Glycerides - Lubricant for textiles and metals.
ETHOX 2976	Polyoxyalkylene Castor Oil - Emulsifier and lubricant
ETHOX 2992	Polyoxyalkylene Coconut Glycerides - Lubricant for textiles and metals.

Preparation of Organic Gels

The disclosed liquid organic gels may be prepared in any manner suitable for combining the components described herein in an organic-based fluid to form a liquid organic gel. For

example, the disclosed organic liquid gels may be prepared by combining individual components with an organic base fluid, or alternatively by mixing a preformulated gelling compound containing these components with an organic fluid.

In one embodiment, organic liquid gels may be formed using the methods described herein that offer substantially stable viscosities at temperatures up to at least about 250°F, alternatively up to at least about 275°F, alternatively up to at least about 300°F, alternatively up to at least about 325°F, alternatively up to at least about 350°F, further alternatively from about -30°F to about 250°F, further alternatively from about -30°F to about 275°F, further alternatively from about -30°F to about 300°F, further alternatively from about -30°F to about 350°F. In this regard, colder temperatures may be encountered, for examples, in pipelines. In such cases, rheology may be modified to suit colder conditions, such as by using greater percentages of aromatics such as xylene. As used herein in relation to well fracture treatments, the term "stabilized viscosity" means that viscosity that allows for effective proppant transport in a fracture in a subterranean formation.

Further, where desired one or more optional breaker materials may be added to a formulation to cause a gelled fluid to lose its structure, viscosity, *etc.* In one embodiment, one or more breaker materials may be added for providing a delayed reduction in viscosity of organic gels prepared herein. Such viscosity reduction may be desirable, for example, when a gelled organic fluid is used as a well treatment fluid such as a hydraulic fracturing fluid. In such a case, a breaker material may be combined with other components of the gelled fluid prior to introduction of the fluid downhole, and may be formulated so that a gelled organic fluid viscosity is substantially maintained or increased during the time the fluid is displaced downhole and into the formation but is decreased, for example, after sufficient time has occurred to allow transport of proppant into the subterranean formation.

Any material/s suitable for imparting viscosity reduction characteristics to the disclosed non-phosphate gelled fluids may be employed as breaker/s. In one embodiment, such materials may function by reacting or interacting with metal atoms or ions therein so as to reduce viscosity or gel characteristics of the fluid by, for example, tying up a portion of the metal ions or atoms

therein. Examples of suitable materials include, but are not limited to, materials (sequestering agents, metal chelating agents, *etc.*) having a higher affinity for metal ions than the carboxylic acid-based materials employed in a given gelled organic fluid. Specific examples of such materials include, but are not limited to, amines, acids, acid salts, acid-producing materials, oxylates, *etc.* Specific examples of suitable acids include, but are not limited to, aminopolycarboxylic acids (*e.g.*, ethylenediaminetetraacetic acid ("EDTA"), ethyleneglycolbis (beta-aminoethyl ether)-*N,N*,-tetraacetic acid, nitrilotriacetic acid, *etc.*), hydroxycaboxylic acids (*e.g.*, gluconic, tartaric, citric acids), salts and mixtures thereof, *etc.* Specific examples of suitable acid salts include, but are not limited to, salts of oxalic acid, sodium salt of citric acid, *etc.* Specific examples of suitable oxylates include, but are not limited to, calcium oxylate, *etc.* Specific examples of suitable amines include, but are not limited to, hexamethylene tetramine, triethylenepentamine ("TEPA"), *etc.*

Optional gel breaker material/s may be combined with other components of a non-phosphate organic gelled fluid in any manner and amount known in the art. For example, in one embodiment, a gel breaker may be added after an organic fluid has been gelled using components described elsewhere herein, such as added at a point at or near a downhole blender.

In one embodiment, a breaker material may be a solid (such as citric acid-based solid), or in other form that partitions over time into a gelled organic fluid where it may interact with metals in the gelled organic fluid. In an alternative embodiment, a breaker material may be encapsulated or coated with a material (such as vinyl co-polymer, like poly-vinylidine chloride) that breaks down over time to allow partitioning of the breaker material into the gelled organic fluid. In still another alternative embodiment, encapsulated breaker materials may be formed by impregnating particulate carrier material with breaker materials, such as those described elsewhere herein. Examples of suitable particulate carrier materials include those made from individual porous particles of material impregnated with breaker material, and coated with a material (such as vinyl co-polymer, like poly-vinylidine chloride) selected to dissolve or otherwise break down in the selected organic phase, so as to allow diffusion or dispersion of the breaker material into the organic phase. In any case, when particles of breaker material (encapsulated or not) are employed for hydraulic fracturing, it may be desirable to use particle

sizes that are equivalent to, or similar to, the size of proppant employed in the fracture job. However, any other size particles suitable for imparting breaker action to a gel may be employed. With benefit of this disclosure, those of skill in the art will understand that breaker concentration may be selected based on amount and type of gelling components employed, and on the specific pump-time and extent and time of breaking action that is desired.

With benefit of this disclosure, those of skill in the art will understand that viscosity reduction rate may depend on a number of factors including, but not limited to, identity and relative amounts of breaker and gelled fluid components employed, temperature, and when encapsulated breakers are employed, particle size and porosity, particle coating thickness, *etc.* As such, desired break time may be achieved by varying component characteristics and amounts to fit individual applications.

Direct Combination of Individual Components with Organic Fluid

For example, in one exemplary embodiment a gelled organic liquid may be prepared by combining suitable quantities of at least one carboxylic acid, at least one salt of carboxylic acid, and at least one metal source compound directly with an organic-base fluid, and agitating the mixture to achieve gellation. Examples of such suitable components are described elsewhere herein. In such an embodiment, individual components may be combined directly with an organic-based fluid in any relative amount suitable for forming a liquid organic gel. As used herein, the terms "combine" or "combining" include any method suitable for admixing, exposing, contacting or otherwise causing two or more materials, compounds, or components to come together.

In one embodiment of a batch mixed process, carboxylic acid is typically first dispersed in an organic fluid in a mixing vessel (for example in a frac tank containing circulating organic fluid). Next, carboxylic acid salt (such as aluminum octoate) is added (as a solid or as a suspension in organic fluid), and mixed or circulated (such as in a frac tank) with the organic fluid. Then, the mixture is withdrawn from the mixing vessel, and a metal hydroxide (such as

aluminum hydroxide and/or aluminum isopropoxide) is added for fast viscosity development as the fluid is displaced to a wellbore, pipeline, process facility, *etc.*

In one particular example, individual components may be blended or mixed with diesel to achieve a diesel-based hydrocarbon gel. In this embodiment liquid tall oil fatty acid may be combined in an amount of from about 0.5% to about 10% by total weight of mixture, alternatively from about 2% to about 8% by weight of total mixture, and further alternatively from about 4% to about 7% by weight of total mixture. Aluminum octoate carboxylic salt may be combined in an amount of from about 0.25% to about 10% by total weight of mixture, alternatively from about 0.5% to about 8% by weight of total mixture, and further alternatively form about 1.5% to about 6% by weight of total mixture. A 10% by weight aluminum isopropoxide metal source compound solution may be combined in an amount of from about 0.1% to about 1% by weight of total mixture, alternatively from about 0.2% to about 0.8% by weight of total mixture, and further alternatively from about 0.4% to about 0.6% by weight of total mixture. From about 0.1% to about 2% by total weight of mixture, alternatively from about 0.5% to about 1.5% by total weight alternatively from about 0.75% to about 1.25% by total weight of mixture of "NE-110W" (from Baker Performance Chemical) DDBSA (or alternatively "ETHOX MS-8" ethoxylated stearate from Ethox Chemicals) surfactant may optionally be added to facilitate dissolution of solid reactants. Although particular ranges of amounts of components are given for this embodiment, other amounts and/or components are also possible. In one embodiment, a gelled diesel based hydrocarbon liquid may be so formed to have a minimum viscosity of greater than about 300 centipoise at $100s^{-1}$ at up to about 250°F.

Formation of Viscous or Solid Reactant Product for Subsequent Addition to Organic Fluid

In an alternate exemplary embodiment, at least one carboxylic acid and at least one salt of carboxylic acid as described herein may be combined to form a reaction product. The reaction product may be a viscous mass that may be added to an organic fluid, or alternatively may be dried to form a solid and then ground to a desired particle size. In either case at a later time a viscous or particulate reaction product material may be combined with an organic-based fluid (such as by dispersing or blending) to achieve an organic liquid gel.

In this embodiment, individual carboxylic acid and carboxylic acid salt and/or other metal source compound components may be blended or mixed in any amounts suitable for forming a viscous reaction product, or a reaction product which may be dried and ground to form a particulate solid capable of gelling hydrocarbon liquids.

In one exemplary embodiment, a solid particulate reaction product may be formed by blending or mixing aluminum octoate carboxylic acid salt into tall oil fatty acid in, for example, an agitated reaction vessel. In this embodiment, aluminum octoate may be combined with a tall oil fatty acid and optional aluminum isopropoxide in an amount of from about 5% to about 95%, alternatively from about 15% to about 85%, and further alternatively from about 20% to about 80% by total weight of mixture. The tall oil fatty acid may be present in an amount of from about 5% to about 95%, alternatively from about 15% to about 85%, and further alternatively from about 20% to about 80% by total weight of mixture. Aluminum isopropoxide may be combined in an amount of from about 0.1% to about 1.0%, alternatively from about 25% to about 8%, and further alternatively from about .35% to about 7% by total weight of mixture. Surfactant may optionally be added to facilitate dissolution of the reactants, typically at a concentration of less than about .75% by volume of the mixture. The mixture may be agitated using any suitable agitation method in the art. Although particular ranges of amounts of components are given for this embodiment, other amounts and/or components are also possible.

A reaction product of the above-described embodiment may be converted to a solid using any method known in the art suitable for drying or removing liquid components from the reaction mixture. Such suitable methods include, but are not limited to, exposure to the atmosphere, drum heat, *etc.*. A reaction product that is a paste or a rigid gel can be metered as a paste or extruded into hydrocarbon and subsequently sheared until an elastic gel is formed.

Once a reaction product has been dried, it may be ground or pulverized to form particulate solid using any suitable particulatizing method known in the art, for example including, but not limited to, ball mill grinder, air-classified grinder, *etc.* The material may then be bagged for further use, *etc.*

Although the solid reaction product described above may be ground or otherwise processed to any particle size desired, in one embodiment a particle size of the reaction product is from about 100 mesh to about 325 mesh. Smaller particle sizes yield more surface area and speed gelation times.

When added to an organic-base fluid, such solid particulate reaction product may be added in any amount suitable for forming a liquid organic gel. However, in one embodiment, from about 50 pounds per thousand gallons of total mixture ("ppt") to about 1000 ppt, alternatively from about 200 ppt to about 800 ppt, alternatively from about 300 ppt to 700 ppt of dried particulate reaction product may be added to a diesel base fluid. In one embodiment, about 0.1% by volume of mixture of surfactant as previously described may optionally be added to facilitate dissolution of the solid reaction product particulate. The fluid may be agitated or otherwise sheared to form a gel having desired consistency or rheology.

Well Treatment Fluids

Among many possible uses, the disclosed liquid organic gels may be employed as a component of a well treatment fluid, such as a drilling, stimulation, completion or workover fluid. In this regard, the disclosed organic-based fluids may be introduced into a wellbore and/or subterranean formation to function as viscosifiers or gelled components of circulating, lost circulation, or kill fluids (drilling muds, drill-in fluids, packer fluids, workover fluids, gelled pills, *etc.*), as well as fulfilling similar purposes as components of stimulation fluids (such as fracture fluids, gelled acids, foamed fluids, diversion fluids, *etc.*), injection profile modification fluids, *etc.*. With benefit of this disclosure, it will be understood that the disclosed liquid organic gels may be employed in any drilling or well treatment application known in the art in which, for example, gelled liquid hydrocarbons may be employed, just a few examples of which may be found in United States Patents No. 5,609,207; 5,552,377; 5,492,178; 5,426,137; 5,411,091; 5,382,411; 5,381,864; 5,082,059; 5,057,233; 4,877,894; 4,665,982; 4,404,112; 4,301,868; 4,186,802; 3,757,864; 3,654,992; 3,654,991; and 3,654,990, each of which is incorporated by reference herein in its entirety.

A well treatment fluid may be prepared using the disclosed methods and compositions in any suitable manner including, but not limited to, using those preparation techniques described elsewhere herein. For example, an organic liquid gel may be prepared by combining the separate carboxylic acid, carboxylic salt and metal source components directly with an organic-based fluid as previously described. In such case, these components may be combined in a batch process performed at the wellsite using mixing vessels such as frac tanks.

Alternatively, the components may be batched mixed away from the wellsite and transported to the wellsite using methods known in the art. A liquid organic gel may be similarly prepared at or away from the wellsite by mixing particulate reaction product prepared in a manner previously described herein.

The disclosed organic gelled fluids may also be prepared using continuous mixing methods at the wellsite, such as those employing concomitantly introduced component process streams. In this regard, with benefit of this disclosure, those of skill in the art will understand that any continuous mixing method known in the art which is suitable for combining the disclosed components to form gelled organic fluids may be employed.

For example, when formulating well stimulation fluids individual liquid components may be combined with organic base fluid (such as in a blender tub, or upstream or downstream thereof) to form a well treatment fluid just prior to being introduced into a wellbore.

Similarly, solid components may be combined in a similar manner as liquid components, for example, by combining a first organic-based liquid (such as diesel, a diesel/fatty acid mixture, a diesel/fatty acid salt mixture, or a diesel/fatty acid/fatty acid salt mixture *etc.*) with a slurry or suspension comprising the solid material (such as aluminum hydroxide) in a second organic liquid (such as one or more vegetable oils described elsewhere herein, *e.g.*, sunflower, coconut oil, *etc.*) at similar locations. Metal source compounds or mixtures thereof may be combined in a second organic liquid at any concentration suitable for forming a solid/liquid suspension therein, and which may be pumped or is otherwise flowable. In one embodiment, metal source compound/s (such as aluminum oxide, aluminum hydroxide, caustic powder, *etc.*) may be suspended in a second organic liquid at a concentration of, for example, from about 1

lb/gallon to about 7 lb/gallon, alternatively from about 3 lb/gallon to about 5 lb/gallon, by weight of total solution. However, concentrations outside this range are also possible. Furthermore, optional suspension agents, such as organophilic clays, may be added to help suspend metal source compounds in a suspension.

Metal source compound suspensions may be combined, for example, by delivering a second organic liquid slurry or suspension containing the metal source compound to the first organic liquid already containing the other metal source compounds and carboxylic acid, or by concomitantly delivering to an organic fluid process stream separate organic liquid slurries or suspensions containing each of the solid components. One example of the latter scheme would be concomitant delivery to a first organic fluid process stream (such as diesel) of fatty acid diluted with vegetable oil, fatty acid salt/vegetable oil suspension and/or aluminum hydroxide vegetable oil suspension. A sodium hydroxide fine powder dispersed in vegetable oil may also be added to saponify the fatty acid. Many variations and modifications are possible.

Advantageously, such use of organic fluid base slurries avoids exposing metal source compounds to water or substantial amounts thereof, which may be desirable when handling such materials. In either case, it will be understood that separate components may be combined with organic base fluid at the same location, or in separate locations of a process stream being formulated and introduced, for example, into a well bore.

In formulating a slurry of solid metal source compound, it is usually desirable to choose an organic fluid that will not react with the solid metal source compound under conditions encountered prior to combination with an organic fluid/carboxylic acid mixture. Advantageously, by selecting an organic base fluid for formulating the metal source compound slurry (and/or by selecting a treatment fluid base fluid) that converts to carboxylic or fatty acids upon heating to react with metal components of the treatment fluid, additional enhancement of viscosity may be achieved as a treatment fluid is heated, such as when being displaced downhole as a well treatment fluid.

It will be understood by those of skill in the art with benefit of this disclosure that various components may advantageously be selected based on the anticipated treatment conditions, such

as downhole temperature, so that desired viscosities may exist at different points in the mixing process (*e.g.*, at mixing points, in the wellbore, in the formation, *etc.*) Similar methodology may also be employed when mixing other types of treatment fluids (such as pipeline or process equipment treatment fluids), based on the conditions expected therein. Furthermore, in those applications where temperature and shear may be controlled, these variables may be manipulated to cause desired viscosity changes as well.

For example, carboxylic acid (*e.g.*, fatty acid) and carboxylic acid salt (*e.g.*, aluminum octoate) may be combined with organic fluid (*e.g.*, diesel, Fracsol, xylene) in a blender tub of a continuous mix process, with a metal hydroxide or saponifier (*e.g.*, potassium hydroxide, sodium hydroxide, aluminum hydroxide, or alternatively, any other metal source compound capable of saponifying or forming soap with the carboxylic acid at ambient or relatively lower temperatures) being added to the process stream downhole of the blender tub and, if desired, such that shear is induced to the fluid by a centrifugal pump displacing the fluid. In such an embodiment, substantially immediate viscosity development is achieved by soap formation with the metal hydroxide or other suitable saponifier, for example to help transport proppant downhole. Secondary viscosity may then be advantageously realized due to the carboxylic acid salt as the treatment fluid is displaced downhole and heated and/or exposed to shearing. Such secondary viscosity may serve, for example, to impart increased high temperature stability and/or rheology for proppant transport, fluid loss control, *etc.* Other suitable metal source compound components for developing delayed or secondary viscosity include, but are not limited to metal alkoxides (such as aluminum isopropoxide), *etc.*

It will also be understood with benefit of this disclosure by those of skill in the art that any batch mixing method known in the art which is suitable for combining the disclosed components to form gelled organic fluids may also be employed. For example, individual liquid and/or solid components described herein may be combined in a mixing vessel (for example, one or more frac tanks), and circulated until suitable mixing or gellation occurs. Slurried or suspended solid components may also be added to a mixing vessel in a similar manner. In one exemplary embodiment, carboxylic acid and carboxylic acid salt components may be combined with organic base fluid in a mixing vessel to form a treatment fluid, then saponifying or

relatively rapid soap-forming metal source compound/s (such as previously described) may be combined with the treatment fluid as it is displaced to the wellbore to achieve early viscosification in a manner similar to that previously described for a continuous mixing process. In another embodiment, only carboxylic acid component may be added to organic fluid in a mixing vessel, then all other metal source compounds added to form a treatment fluid as the mixture is displaced to the wellhead. Other variations are also possible. In any case, it is typically desirable in such a batch mixing process to combine components in such a way that the organic fluid does not develop excess viscosity that would impede removal or displacement of the fluid from the mixing vessel.

In either of batch or continuous mixing processes, one or more optional surfactant/s and/or aromatic compounds as previously described may be combined with a treatment fluid, for example, to facilitate speed of dispersion/integration and/or interaction of solid components with the treatment fluid. Such surfactant or aromatic addition may be particularly desirable, for example, when using a continuous mixing process and solid components.

For hydraulic fracturing, a batch or continuous mixed gelled organic-based treatment fluid may be combined with proppant in any manner known in the art and introduced into the wellbore in subterranean formation at a pressure above the fracturing pressure of the subterranean formation. With benefit of this disclosure, those of skill in the art will understand that the disclosed non-phosphate organic liquid gels may be employed to hydraulically fracture a subterranean formation using any method in combination of components known in the art of, for example, oil-based fracturing. In one example, the disclosed non-phosphate gelled organic fluids may be displaced into a subterranean formation above the fracturing pressure of the formation, and with or without proppants like sand (such as Ottawa, Brady or Colorado Sands), synthetic organic particles, glass microspheres, ceramics (including aluminosilicates such as "CARBOLITE," "NAPLITE" or "ECONOPROP"), resin-coated sand (such as "ACME BORDEN PR 6000" or "SANTROL TEMPERED HS"), sintered bauxite, and mixtures thereof.

It will be understood with benefit of this disclosure that one or more of the above-described methods of combining components of the disclosed non-phosphate gelled organic

fluids, as well as variations thereof, may be employed to other types of organic based treatment fluids including, but not limited to, pipeline treatment fluids and fluid processing equipment treatment fluids.

Pipeline Treatment Fluids

With benefit of the present disclosure, the disclosed non-phosphate organic liquid gels may be employed by those of skill in the art in a number of ways including, but not limited to, in any manner and/or for any purpose known in the art that makes use of, for example, gelled hydrocarbon fluids within a pipeline interior. For example, a pipeline treatment fluid may be used to clean and/or convert pipeline transmission lines, isolate a pipeline from invasive materials, displace solid materials and/or fluids through a pipeline, or to separate pipeline products from each other or from other materials within the pipeline. Specific examples of such uses include, but are not limited to, use of a gelled plug or pig to isolate two separate fluids (such as different pipeline products) under static or dynamic conditions of flow within a pipeline interior. The disclosed liquid organic gels may also be used to remove debris or contaminants from the interior of the pipeline, such as by displacing a gelled pig of a treatment fluid containing non-phosphate organic liquid gel through at least a portion of a pipeline. Further information on using gelled materials in pipeline include, but are not limited to, those methods described in United States Patent No. 5,419,183; United States Patent No. 5,197,324; United States Patent No. 4,635,727; United States Patent No. 4,543,131; United States Patent No. 4,416,703; United States Patent No. 4,252,465; United States Patent No. 4,003,393, and United States Patent No. 5,145,590, each of which is incorporated herein by reference in its entirety.

In one exemplary embodiment, when used as a gel pig, the pipeline treatment fluid may be employed in conjunction with a mechanical pig as is known in the art. In one exemplary embodiment, a gel pig may be formed from a liquid organic gel and displaced through a pipeline by fluid under pressure. In this regard, displacement fluid may be gas or liquid, depending upon the needs of the user and the availability of fluids. A gel pig may be used alone or as an element of a "pig train" in a pipeline cleaning process. Such a pig train may be formed, for example, by preceding and/or following a pipeline treatment fluid gel plug with mechanical pigs and/or other

chemical pig segments. Such chemical pig segments may be of the same or different composition and may include the additives such as corrosion inhibitors, bactericides, passivation agents, *etc.* Such chemical pig segments may be liquids or gels.

In other exemplary embodiments, a non-phosphate liquid organic gel pipeline treatment fluid may be employed as a separation plug or pig to separate one or more materials, such as pipeline product fluids (*e.g.,* hydrocarbons, paraffins, asphaltenes, fuel oil, condensate, *etc.*), existing within a pipeline, under static or dynamic conditions, or as a microplug to remove fluids, solids and semi-solids (such as sand, tar, corrosion products and other debris and contaminants, *etc.*) from the interior of a pipeline.

It will be further understood with benefit of this disclosure that a non-phosphate gelled organic pipeline treatment fluid may be combined with other common pipeline chemicals or additives, such as biocides, oxygens, scavengers, scale inhibitors, dyes, *etc.*

Process Equipment Treatment Fluids

In other embodiments of the disclosed method and compositions, the disclosed non-phosphate liquid organic gels may be employed in fluid processing applications including, but not limited to, oil field production facility, refinery, and chemical plant applications.

Breaker Materials

In the practice of the disclosed method, any breaker material suitable for reducing viscosity of the disclosed gels may be employed. Examples include calcined magnesium oxide and tetraethylenepentamine.

Calcined magnesium oxide used in an amount of from about 10 to about 50 pounds per thousand gallons of gelled fluid. In one embodiment, calcined magnesium oxide (such as –325 mesh "Mag Chem 10" from Martin Marietta, or RG-35 from BJ Services) may be encapsulated with, for example, an oil soluble resin such as described in United States Patent No. 5,497,830, which is incorporated herein by reference. Calcined magnesium oxide may be used in size suitable for imparting gel breaking charactertics, such as from about –40 mesh to about –325

mesh, although smaller and larger sizes are also possible. Reactivity (or degree of calcination) may be varied to meet particular conditions and desired breaking times. In one embodiment, -325 mesh calcined magnesium oxide may be suspended in diesel in an amount of 5 pounds per gallons to form a slurry having about 52% calcined magnesium oxide by weight of the slurry, and also contains about 1.1% organophillic clay ("A140" available from Rheox) by weight of the slurry, 0.7% amidozaline dispersant/surfactant by weight of total slurry. One example of such a suspension is available as "GBL-5L" from BJ Services, and in one embodiment it may be added in an amount sufficient to supply from about 10 to about 50 pounds of active magnesium oxide per thousand gallons of gelled fluid.

Additional information on breakers includes the following: Mag Chem 10 from Martin Marietta, or RG-35 from BJ Services) may be encapsulated with, for example, an hydrocarbon(oil) soluble resin such as "VINSOL Resin" by Hercules Incorporated, Wilmington, Delaware, which is described in United States Patent No. 5,497,830, which is incorporated by reference herein. Calcined magnesium oxide may be used in size suitable for imparting gel breaking characteristics, such as from about -40 mesh to about -325 mesh, although smaller and larger sizes are also possible. Reactivity (or degree of calcination) may be varied to meet particular conditions and desired breaking times. In one embodiment, -325 mesh calcined magnesium oxide may be suspended in diesel in an amount of 5 pounds per gallons to form a slurry having about 52% calcined magnesium oxide by weight of the slurry, and also contains about 1.1% organophillic clay ("Bentone A140" available from Rheox, Inc., Highstown, N.J.) by weight of the slurry, 0.7% amidozaline dispersant/surfactant by weight of total slurry. One example of such a suspension is available as "GBL-5L"from BJ Services, and in one embodiment it may be added in an amount sufficient to supply from about 10 to about 50 pounds of active magnesium oxide per thousand gallons of gelled fluid. Solid amine breakers such as hexamethylenetetraamine (available, for example from Spectrum Chemical Manufacturing Corporation, Gardena, California) and tetramethylenepentamine ("En Cap 90706" available from Fritz Industries, Inc. of Dallas, Texas) may be used alone or in combination in amounts of from about 5 to about 20 pounds per thousand gallons of gelled fluid, although greater and lesser amounts are also possible. Such solid breaker materials may

be added at any point in a continuous or batch mix process. Breaker reactivity, size, composition, etc. may be varied by those of skill in the art to achieve control break of the gel at a desired point, such as when a fracturing fluid encounters downhole conditions.

Solid amine breakers such as hexamethylenetetraamine and tetraethylenepentamine ("En Cap 90706", "En Cap 80715" available from Fritz Industries, Inc. of Dallas, Texas) may be used alone or in combination in amounts of from about 5 to about 20 pounds per thousand gallons of gelled fluid, although greater and lesser amounts are also possible .

Such solid breaker materials may be added at any point in a continuous or batch mix process. Breaker reactivity, size, composition, *etc.* may be varied by those of skill in the art to achieve control break of the gel at a desired point, such as when a fracturing fluid encounters downhole conditions.

EXAMPLES

The following examples are illustrative and should not be construed as limiting the scope of the invention or claims thereof.

In Examples 1-15, non-phosphate gelled fluids were mixed using the following procedure: 214g diesel organic fluid is measured into clean dry jar & mounted on a Servodyne Lightning Mixture Model 444530 made by Cole-Palmer Instruments. A 1" diameter 6 blade paddle is immersed half-way into the volume of the fluid in a slightly off-center position. The mixer is set at 2000 RPM (+/- 50 RPM) and the components added and mixed.

Examples 1-15 were each carried out at a temperature of 75°C.

Example 1
Preparation and Use of Particulate Reaction Product Formed From Fatty Acid, Aluminum Carboxylic Acid Salt, and Aluminum Second Metal Source Compound

13.65 grams of tall oil fatty acid ("SLYFAT FA-1" available from Arizona Chemicals, also available as "G20" from BJ Services) was delivered into a clean, dry 250 milliliter beaker.

SYLFAT FA-1 contains 92.7% fatty acids, 2.8% unsaponifiables and 4.5% rosin acids, with less than 0.1% moisture and less than 0.01% ash. The fatty acid content of SYLFAT FA-1 includes 34% non-conjugated linoleic, 9% conjugated linoleic, 44% oleic, and 5% saturated. SYLFAT FA-1 has an acid number of 194, a saponification number of 197, and an iodine number of 131. SYLFAT FA-1 Sp has a saponification number of 198.

In this example, 3 grams of aluminum 2-ethylhexanoate (aluminum octoate) was dispersed into the tall oil fatty acid. 1 gram of a 10% aluminum isopropoxide solution was also added. This mixture was then blended with a spatula until a viscous to solid mass reaction product was developed. This reaction product was then placed in a desicator and allow to continue solidify and/or dry for 16 hours. After this period, the material was ground with mortar and pestle to approximately a 100 to 325 mesh particle size. A 214 gram sample of "off road" No.2 diesel was delivered into a clean, dry 16 ounce graduated wide-mouth jar. "Off-road diesel" is a term used herein to describe diesel fuel sold for non-highway use, and selected for use in the examples due to its lower cost. This solution was then positioned on a Lightning Mixer apparatus. Solution was blended at 2000 rpm (+/-) 50. The 100-325 mesh reaction product was then dispersed into the diesel solution at a concentration of 17.65 grams per 250 milliliters diesel. Mixing continued until a viscous gel developed.

Example 2
Gellation of Diesel from Fatty Acid, Aluminum Carboxylic Acid Salt and Aluminum Second Metal Source Compound

A 214 gram of "off road" No.2 diesel was delivered into a clean, dry 16 ounce graduated wide-mouth jar. This solution was then positioned on a Lightning Mixer apparatus. Solution was blended at about 2000 rpm (+/-) 50. A proportional concentration equaling 40 L/M^3 of tall oil fatty acid(SYLFAT FA-1) was then added to the diesel solution and mixing continued at the same speed. Aluminum 2-ethylhexanoate (aluminum octoate) was dispersed at a concentration of 4.8 Kg/M3 into the mixing solution. Aluminum chloride solution was delivered at 0.6 Kg/M^3. A 50% by weight sodium hydroxide solution was then delivered at 2 L/M^3 . Solution mixing continued until a viscous gel developed.

Example 3
Preparation and Use of Particulate Reaction Product Formed From Fatty Acid and Aluminum Carboxylic Acid Salt

60 grams of tall oil fatty acid (SYLFAT FA-1) was delivered into a clean, dry 250 milliliter beaker. 20 grams of aluminum 2-ethylhexanoate (aluminum octoate) was dispersed into the tall oil fatty acid and mixed with spatula until a viscous to solid mass developed. This reaction product was then placed in a desicator and allow to continue solidify and/or dry for 16 hours. After this period, the material was ground with mortar and pestle to approximately a 100 to 325 mesh particle size. A 214 gram sample of "off road" No.2 diesel was delivered into a clean, dry 16 ounce graduated wide-mouth jar. This solution was then positioned on a Lightning Mixer apparatus. The solution was blended at 2000 rpm (+/-) 50. The 100-325 mesh reaction product was then dispersed into the diesel solution at a concentration of 17.65 grams per 250 milliliters diesel. Mixing continued until a viscous gel developed.

Example 4
Preparation and Use of Particulate Reaction Product Formed From Fatty Acid, Aluminum Carboxylic Acid Salt and Aluminum Second Metal Source Compound

Sixty (60) grams of tall oil fatty acid (SYLFAT FA-1) was delivered into a clean, dry 250 milliliter beaker. Three (3) grams of aluminum 2,4 pentanedione was dispersed into the tall oil fatty acid and twenty (20) grams of aluminum 2-ethylhexanoate (aluminum octoate) was dispersed into the tall oil fatty acid and mixed with spatula until a viscous to solid mass developed. This reaction product was then placed in a desicator and allowed to continue solidify and/or dry for 16 hours. After this period, the material was ground with mortar and pestle to approximately a 100 to 325 mesh particle size distribution. A 214 gram aliquot of "off road" No.2 diesel was delivered into a clean, dry 16 ounce graduated wide-mouth jar. This solution was then positioned on a Lightning Mixer apparatus. Solution was blended at 2000 rpm (+/-) 50. The 100-325 mesh reaction product was then dispersed into the diesel solution at a concentration of 17.65 grams per 250 milliliters diesel. Mixing continued until a viscous gel developed.

Example 5
Preparation and Use of Particulate Reaction Product Formed From Fatty Acid, Iron Carboxylic Acid Salt and Aluminum Second Metal Source Compound

13.65 grams of tall oil fatty acid (SYLFAT FA-1) was delivered into a clean, dry 250 milliliter beaker. 3 grams of iron 2-ethylhexanoate (iron octoate) was then dispersed into the tall oil fatty acid. 1 gram of a 10% aluminum isopropoxide solution was also added This mixture was then blended with a spatula until a viscous to solid mass reaction product was developed. This reaction product was then placed in a desicator and allow to continue solidify and/or dry for 16 hours. After this period, the material was ground with mortar and pestle to approximately a 100 to 325 mesh particle size distribution. A 214 gram of "off road" No.2 diesel was delivered into a clean, dry 16 ounce graduated wide-mouth jar. This sample solution was then positioned on a Lightning Mixer apparatus. Solution was blended at 2000 rpm (+/-) 50. The 100-325 mesh reaction product was then dispersed into the diesel solution at a concentration of 17.65 grams per 250 milliliters diesel. Mixing continued until a viscous gel developed.

Example 6
Preparation and Use of Particulate Reaction Product Formed From Fatty Acid, Iron Metal Source and Aluminum Second Metal Source Compound

13.65 grams of tall oil fatty acid (SYLFAT FA-1) was delivered into a clean, dry 250 milliliter beaker. 4 grams of ferric ammonium sulfate was then dispersed into the tall oil fatty acid. 1 gram of a 10% aluminum isopropoxide solution was also added. This mixture was then blended with a spatula until a viscous to solid mass reaction product was developed. This reaction product was then placed in a desicator and allow to continue solidify and/or dry for 16 hours. After this period, the material was ground with mortar and pestle to approximately a 100 to 325 mesh particle size. A 214 gram sample of "off road" No.2 diesel was delivered into a clean, dry 16 ounce graduated wide-mouth jar. This solution was then positioned on a Lightning Mixer apparatus. Solution was blended at 2000 rpm (+/-) 50. The 100-200 mesh reaction product was then dispersed into the diesel solution at a concentration of 17.65 grams per 250 milliliters diesel. Mixing continued until a viscous gel developed.

Example 7
Preparation and Use of Particulate Reaction Product Formed From Fatty Acid, Iron Metal Source and Aluminum Second Metal Source Compound

13.65 grams of tall oil fatty acid (SYLFAT FA-1) was delivered into a clean, dry 250 milliliter beaker. 3 grams of ferric hydroxide was then dispersed into the tall oil fatty acid. 1 gram of a 10% aluminum isopropoxide solution was also added. This mixture was then blended with a spatula until a viscous to solid reaction product was developed. This reaction product was then placed in a desicator and allow to continue solidify and/or dry for 16 hours. After this period, the material was ground with mortar and pestle to approximately a 100 to 325 mesh particle size. A 214 gram sample of "off road" No.2 diesel was delivered into a clean, dry 16 ounce graduated wide-mouth jar. This solution was then positioned on a Lightning Mixer apparatus. Solution was blended at 2000 rpm (+/-) 50. The 100-200 mesh reaction product was then dispersed into the diesel solution at a concentration of 17.65 grams per 250 milliliters diesel. Mixing continued until a viscous gel developed.

Example 8
Preparation and Use of Particulate Reaction Product Formed From Fatty Acid, Aluminum Salt of Carboxylic Acid and Two Aluminum Second Metal Source Compounds

13.65 grams of tall oil fatty acid (SYLFAT FA-1) was delivered into a clean, dry 250 milliliter beaker. 3 grams of aluminum 2-ethylhexanoate (aluminum octoate) was dispersed into the tall oil fatty acid. 0.3 grams of aluminum oxide was also dispersed into the mixing fluid. 1 gram of a 10% aluminum isopropoxide solution was also added. This mixture was then blended with a spatula until a viscous to solid mass reaction product was developed. This reaction product was then placed in a desicator and allow to continue solidify and/or dry for 16 hours. After this period, the material was ground with mortar and pestle to approximately a 100 to 200 mesh particle size distribution. This reaction product was then placed in a desicator and allow to continue solidify and/or dry for 16 hours. A 214 gram sample of "off road" No.2 diesel was delivered into a clean, dry 16 ounce graduated wide-mouth jar. This solution was then positioned on a Lightning Mixer apparatus. Solution was blended at 2000 rpm (+/-) 50. The 100-325 mesh

reaction product was then dispersed into the diesel solution at a concentration of 17.65 grams per 250 milliliters diesel. Mixing continued until a viscous gel developed.

Example 9
Gellation of Diesel Using Fatty Acid, Aluminum Salt of Carboxylic Acid and Aluminum Second Metal Source Compound

A 214 gram sample of "off road" No.2 diesel was delivered into a clean, dry 16 ounce graduated wide-mouth jar. This solution was then positioned on a Lightning Mixer apparatus. Solution was blended at about 2000 rpm (+/-) 50. A proportional concentration equaling 60 L/M^3 of tall oil fatty acid (SYLFAT FA-1) was then added to the diesel solution and mixing continued at the same speed. Aluminum 2-ethylhexanoate (aluminum octoate) at a concentration of 12 Kg/M3 was dispersed into the mixing solution. A 10% Aluminum isopropoxide solution was delivered at 4 L/M^3. Solution mixing continued until a viscous gel developed.

Example 10
Gellation of Diesel Using Fatty Acid, Aluminum Salt of Carboxylic Acid and Aluminum Second Metal Source Compound

A 214 gram sample of "off road" No.2 diesel was delivered into a clean, dry 16 ounce graduated wide-mouth jar. This solution was then positioned on a Lightning Mixer apparatus. Solution was blended at about 2000 rpm (+/-) 50. A proportional concentration equaling 20 L/M^3 of tall oil fatty acid ("SYLFAT FA-1") was then added to the diesel solution and mixing continued at the same speed. Aluminum 2-ethylhexanoate (aluminum octoate) at a concentration of 2.4 Kg/M3 was dispersed into the mixing solution. A 10% Aluminum isopropoxide solution was delivered at 1.25 L/M^3. Solution mixing continued until a viscous gel developed.

Example 11
Gellation of Diesel Using Fatty Acid, Aluminum Salt of Carboxylic Acid and Aluminum Second Metal Source Compound in Combination with Surfactant

A 214 gram sample of "off road" No.2 diesel was delivered into a clean, dry 16 ounce graduated wide-mouth jar. This solution was then positioned on a Lightning Mixer apparatus. Solution was blended at about 2000 rpm (+/-) 50. A proportional concentration equaling 20 L/M^3 of tall oil fatty acid (SYLFAT FA-1) was then added to the diesel solution and mixing

continued at the same speed. Aluminum 2-ethylhexanoate (aluminum octoate) at a concentration of 2.4 Kg/M3 was dispersed into the mixing solution. A 10% Aluminum isopropoxide solution was delivered at 1.25 L/M^3. A fatty acid derived amine surfactant ("ARMEEN C" from Akzonobel Chemicals Incorporated) solution was then delivered at a concentration of 2 L/M^3. Solution mixing continued until a viscous gel developed.

Example 12
Gellation of Diesel Using Fatty Acid, Aluminum Salt of Carboxylic Acid and Aluminum Second Metal Source Compound in Combination with Surfactant

A 214 gram sample of "off road" No.2 diesel was delivered into a clean, dry 16 ounce graduated wide-mouth jar. This solution was then positioned on a Lightning Mixer apparatus. Solution was blended at about 2000 rpm (+/-) 50. A proportional concentration equaling 20 L/M^3 of tall oil fatty acid(SYLFAT FA-1) was then added to the diesel solution and mixing continued at the same speed. Aluminum 2-ethylhexanoate (aluminum octoate) at a concentration of 2.4 Kg/M3 was dispersed into the mixing solution. A 10% Aluminum isopropoxide solution was delivered at 1.25 L/M^3. A alkoxylated fatty amine surfactant solution ("ARMAK 1730" from Akzonobel Chemicals Incorporated) was then delivered at 2 L/M^3. Solution mixing continued until a viscous gel developed.

Example 13
Gellation of Diesel Using Fatty Acid, Aluminum Salt of Carboxylic Acid and Two Aluminum Second Metal Source Compounds

A 214 gram aliquot of "off road" No.2 diesel was delivered into a clean, dry 16 ounce graduated wide-mouth jar. This solution was then positioned on a Lightning Mixer apparatus. Solution was blended at about 2000 rpm (+/-) 50. A proportional concentration equaling 20 L/M^3 of tall oil fatty acid (SYLFAT FA-1) was then added to the diesel solution and mixing continued at the same speed. Aluminum 2-ethylhexanoate (aluminum octoate) at a concentration of 2.4 Kg/M3 was dispersed into the mixing solution. A 10% Aluminum isopropoxide solution was delivered at 1.25 L/M^3. An aluminum hydroxide/vegetable cooking oil suspension solution

containing 4 lb/gallon aluminum hydroxide was then delivered at 1-5 L/M^3. Solution mixing continued until a viscous gel developed.

Example 14
Preparation and Use of Particulate Reaction Product Formed From Fatty Acid and Aluminum Salt of Carboxylic Acid

Sixty (60) grams of tall oil fatty acid (SYLFAT FA-1) was delivered into a clean, dry 250 milliliter beaker. Twenty (20) grams of aluminum stearate was then dispersed into the tall oil fatty acid and mixed with spatula until a viscous to solid mass developed. This reaction product was then placed in a desicator and allow to continue solidify and/or dry for 16 hours. After this period, the material was ground with mortar and pestle to approximately a 100 to 325 mesh particle size. A 214 gram aliquot of "off road" No.2 diesel was delivered into a clean, dry 16 ounce graduated wide-mouth jar. This solution was then positioned on a Lightning Mixer apparatus. Solution was blended at 2000 rpm (+/-) 50. The 100-325 mesh reaction product was then dispersed into the diesel solution at a concentration of 17.65 grams per 250 milliliters diesel. Mixing continued until a viscous gel developed.

Example 15
Preparation and Use of Particulate Reaction Product Formed From Fatty Acid and Aluminum Salt of Carboxylic Acid

Sixty (60) grams oleic acid was delivered into a clean , dry 250 milliliter beaker. Twenty (20) grams of aluminum stearate was dispersed into the tall oil fatty acid a and mixed with spatula until a viscous to solid mass developed. This reaction product was then placed in a desicator and allow to continue solidify and/or dry for 16 hours. After this period, the material was ground with mortar and pestle to approximately a 100 to 325 mesh particle size. A 214 gram sample of "off road" No.2 diesel was delivered into a clean, dry 16 ounce graduated wide-mouth jar. This solution was then positioned on a Lightning Mixer apparatus. Solution was blended at 2000 rpm (+/-) 50. The 100-325 mesh reaction product was then dispersed into the diesel solution at a concentration of 17.65 grams per 250 milliliters diesel. Mixing continued until a viscous gel developed.

Examples 16-18

In examples 16-18, as well as each of the other examples herein where viscosity is measured on a FANN rotational visocometer, the following procedure was employed. First, the described materials were mixed according to the mixing instructions for achieving "vortex closure" as outlined in relation to Example 20. Then, to measure viscosity, a 45 milliliter sample of the individual gelled organic fluid was delivered to a FANN 50C rotational viscometer rotor cup. The sample was then mounted on the viscometer and pressurized to 300 PSI with nitrogen. The viscometer was zeroed, and its viscosity measurement program initiated, and viscosity measurements taken as heating is applied. Results are shown in the tables accompanying each example.

Example 16
Rheological Measurements at 150°F of Gelled Fluid System
Comprising Diesel, Fatty Acid, Aluminum Salt of Carboxylic Acid and
Aluminum Second Metal Source Compound

A non-phosphate gelled fluid system was formed by combining the following components with "off road" No.2 diesel to achieve a viscous gel: tall oil fatty acid ("SYLFAT FA-1" from Arizona Chemical / "G-20" from BJ Services) at a concentration of 60 gallons per thousand gallons of diesel ("GPT"); aluminum 2-ethylhexanoate (aluminum octoate) powder at a concentration of 100 pounds per thousand gallons of diesel ("PPT"); and aluminum isopropoxide ("PETROSURF XL" from Rhone Poulenc) at a concentration of 4 GPT.

Rheological characteristics of the gel were evaluated at 150°F using a "FANN 50C" rheometer, and are presented in Table 36. Results of this example show that suitable fracturing rheology is obtained at this temperature.

Table 36 - Example 16 Fann 50c Readings at 150°F

TIME	TEMP			Viscosity (Cp)		
(minutes)	(°F)	n'	K	170 s^{-1}	100 s^{-1}	40 s^{-1}
2	87	.597	.1636	989	1225	1772
18	143	.439	.2526	678	913	1527
35	150	.426	.2748	690	936	1583
51	152	.415	.291	691	942	1610

TIME	TEMP			Viscosity (Cp)		
(minutes)	(°F)	n'	K	170 s^{-1}	100 s^{-1}	40 s^{-1}
68	153	.403	.307	685	940	1625
84	153	.398	.3135	682	939	1629
100	153	.389	.3259	677	936	1638
117	153	.389	.3265	678	938	1641
133	153	.384	.3321	672	932	1639
150	153	.379	.3386	668	929	1640
166	153	.372	.3475	661	923	1641
182	153	.372	.3473	661	922	1640
199	153	.372	.3468	660	921	1638
215	153	.364	.3565	651	912	1634
232	153	.366	.3527	651	911	1629
248	153	.359	.3626	645	907	1632
264	153	.362	.3575	646	907	1627
281	153	.361	.3578	643	903	1622
297	153	.356	.3644	639	899	1622
314	153	.354	.3647	633	891	1611
330	153	.35	.3707	630	890	1614
346	153	.352	.3675	631	890	1612
363	153	.348	.3717	625	884	1606
379	153	.345	.3761	623	882	1607
396	153	.346	.3729	621	878	1599
412	153	.347	.3691	618	874	1589
428	153	.349	.3643	616	870	1580
431	153	.339	.3806	611	868	1591
448	153	.341	.376	610	866	1583
464	153	.342	.3738	610	865	1580
480	153	.336	.3816	604	858	1578
497	153	.334	.3835	600	855	1574
513	153	.335	.3804	599	852	1567
530	153	.33	.388	595	849	1569
546	153	.329	.3874	591	844	1561
562	153	.329	.3871	591	843	1560
579	153	.327	.3885	587	839	1554
595	153	.328	.3858	586	837	1549
612	153	.324	.3906	581	832	1545
628	153	.326	.3866	581	831	1541
644	153	.323	.39	577	827	1537
661	153	.321	.3933	576	826	1538
677	153	.321	.3913	573	822	1530
694	153	.322	.3895	573	822	1529

TIME	TEMP			Viscosity (Cp)		
(minutes)	(°F)	n'	K	170 s^{-1}	100 s^{-1}	40 s^{-1}
710	153	.318	.3955	570	819	1530
726	153	.316	.397	567	815	1525
743	153	.315	.3987	566	814	1525
759	153	.314	.3985	563	810	1519
776	153	.31	.404	559	806	1517
792	153	.313	.3986	560	807	1514
808	153	.31	.403	558	804	1514
825	153	.311	.4001	557	802	1508
841	153	.311	.4005	557	803	1510
858	153	.309	.4016	553	798	1503
874	153	.309	.4014	553	797	1502
890	153	.306	.4059	550	795	1502
907	153	.302	.4124	548	793	1504
923	153	.307	4035	550	794	1499
939	153	.303	.4089	546	790	1497
956	153	.303	.4084	545	789	1495
972	153	.305	.4058	547	791	1496
989	153	.298	.417	543	788	1499
1005	153	.305	.4035	544	787	1488
1021	153	.305	.4044	545	789	1491

Example 17
Rheological Measurements at 215°F of Gelled Fluid System Comprising Diesel, Fatty Acid, Aluminum Salt of Carboxylic Acid and Aluminum Second Metal Source Compound

A non-phosphate gelled fluid system was formed by combining the following components with "off road" No.2 diesel to achieve a viscous gel: tall oil fatty acid ("SYLFAT FA-1" from Arizona Chemical / "G-20" from BJ Services) at a concentration of 60 gallons per thousand gallons of diesel ("GPT"); aluminum 2-ethylhexanoate (aluminum octoate) powder at a concentration of 100 pounds per thousand gallons of diesel ("PPT"); and aluminum isopropoxide ("PETROSURF XL" from Rhone Poulenc) at a concentration of 4 GPT.

Rheological characteristics of the gel were evaluated at 215°F using a "FANN 50C" rheometer, and are presented in Table 37. Results of this example show that suitable fracturing rheology is obtained at this temperature.

Table 37 -- Example 17 Fann 50c Readings at 215°F

TIME	TEMP			Viscosity (Cp)		
(minutes)	(°F)	n'	K	170	100	40
2	90	.577	.1775	968	1212	1786
19	185	.341	.2979	483	686	1254
35	213	.331	.2986	460	656	1212
51	217	.37	.254	478	668	1190
68	217	.369	.2493	467	653	1164
84	217	.376	.2361	459	639	1131
100	218	.372	.2357	449	626	1113
117	218	.376	.225	437	609	1078
133	218	.376	.2201	428	595	1055
150	218	.368	.2238	417	583	1041
166	217	.365	.2224	408	572	1023
182	218	.365	.2195	403	565	1010
199	218	.356	.2255	395	556	1004
215	217	.355	.2229	389	548	989
232	218	.352	.2235	384	541	980
248	218	.352	.2203	378	534	966
264	218	.341	.2286	371	526	963
281	218	.333	.2343	365	520	958
297	218	.326	.2391	359	514	953
314	218	.347	.2158	361	511	929
330	218	.332	.2283	354	504	930
346	218	.336	.2223	352	500	919
363	219	.34	.2151	347	493	903
379	218	.328	.2261	343	490	908
396	218	.337	.215	342	486	892
412	219	.335	.2149	338	481	885
429	218	.33	.2186	335	478	884
445	218	.339	.2082	334	475	870
461	219	.334	.2114	331	471	868
478	218	.343	.2028	332	471	860
494	218	.336	.2068	327	465	855
511	218	.333	.2086	325	463	853
527	218	.327	.2138	323	462	855
543	218	.321	.2171	318	456	849
560	218	.335	.2027	319	454	835
576	218	.329	.2076	317	452	837
593	218	.343	.1942	318	451	824
609	218	.34	.1948	314	446	817

TIME	TEMP			Viscosity (Cp)		
(minutes)	(°F)	n'	K	170	100	40
625	219	.324	.2077	309	442	822
642	218	.331	.2012	310	442	817
658	218	.337	.1947	310	440	808
675	219	.335	.195	307	437	803
691	218	.341	.1893	307	436	797
707	218	.343	.1869	307	434	793
724	219	.335	.1918	302	430	790
740	218	.325	.2002	299	428	795
757	218	.349	.18	304	430	781
773	218	.351	.1772	303	427	774
789	218	.335	.1891	298	424	779
806	218	.348	.1784	300	424	771
822	218	.333	.1893	295	420	774
839	218	.332	.1893	293	418	771
855	218	.351	.1741	297	420	761
871	218	.361	.1659	298	419	752
888	218	.348	.1742	293	414	753
904	218	.364	.1625	297	416	745
921	218	.339	.1805	290	412	755
937	218	.354	.1687	293	412	745
953	218	.347	.1738	291	411	749
970	218	.348	.1725	290	410	745
986	217	.35	.1709	291	410	744
1003	217	.342	.1764	288	408	746
1019	217	.335	.1814	286	406	747
1035	217	.334	.182	285	406	747
1052	218	.338	.1777	284	403	740

Example 17A
Rheological Measurements at 275°F of Gelled Fluid System Comprising Diesel, Fatty Acid, Aluminum Salt of Carboxylic Acid and Aluminum Second Metal Source Compound

A non-phosphate gelled fluid system was formed by combining the following components with "off road" No.2 diesel to achieve a viscous gel: tall oil fatty acid ("SYLFAT FA-1" from Arizona Chemical / "G-20" from BJ Services) at a concentration of 60 gallons per thousand gallons of diesel ("GPT"); aluminum 2-ethylhexanoate (aluminum octoate) powder at a

concentration of 100 pounds per thousand gallons of diesel ("PPT"); and aluminum isopropoxide ("PETROSURF XL" from Rhone Poulenc) at a concentration of 4 GPT.

Rheological characteristics of the gel were evaluated at 275°F using a "FANN 50C" rheometer, and are presented in Table 38. Results of this example show that suitable fracturing rheology is obtained at this temperature.

Table 38 - Example 17a Fann 50c Readings at 275°F

TIME	TEMP			Viscosity (Cp)		
(minutes)	(°F)	n'	K	170	100	40
2	79	.562	.2016	1018	1284	1919
19	247	.503	.1123	419	545	860
35	268	.54	.0815	368	470	716
52	271	.566	.0686	354	445	663
68	272	.554	.0702	340	431	649
85	272	.553	.0692	334	423	638
101	272	.549	.0691	326	415	627
118	272	.543	.0701	321	409	622
134	272	.544	.0681	314	400	607
151	272	.538	.0686	306	392	598
167	272	.535	.0684	301	385	590
183	272	.53	.0686	294	378	581
200	272	.538	.0656	293	374	572
216	272	.529	.0672	287	368	567
233	272	.534	.0652	285	365	560
239	272	.53	.066	283	363	559

Example 18
Rheological Measurements at 300°F of Gelled Fluid System Comprising Diesel, Fatty Acid, Aluminum Salt of Carboxylic Acid and Aluminum Second Metal Source Compound

A non-phosphate gelled fluid system was formed by combining the following components with "off road" No.2 diesel to achieve a viscous gel: tall oil fatty acid ("SYLFAT FA-1" from Arizona Chemical / "G-20" from BJ Services) at a concentration of 60 gallons per thousand gallons of diesel ("GPT"); aluminum 2-ethylhexanoate (aluminum octoate) powder at a concentration of 100 pounds per thousand gallons of diesel ("PPT"); and aluminum isopropoxide ("PETROSURF XL" from Rhone Poulenc) at a concentration of 4 GPT.

Rheological characteristics of the gel were evaluated at 300°F using a "FANN 50C" rheometer, and are presented in Table 39.

Table 39 - Example 18 Fann 50c Readings at 300°F

TIME	TEMP			Viscosity (Cp)		
(minutes)	(°F)	n'	K	170	100	40
2	79	.543	.1994	913	1164	1769
19	273	.575	.0427	231	289	426
38	296	.843	.0078	167	182	210
56	300	1	.0033	159	159	159
75	300	1.063	.0022	148	143	135
93	300	1.136	.0015	145	134	119
109	300	1.164	.0012	135	123	106
121	300	1.04	.0019	115	113	109
138	300	1.232	.0007	121	107	87
156	300	1.187	.0008	110	100	84
173	300	1.31	.0004	106	90	68
189	300	1.24	.0005	88	78	62

Example 19
Gelled Organic Fluid Including Mixture of Diesel and Aromatic Organic Base Fluids

A non-phosphate gelled fluid system was formed by combining the following components with diesel to achieve a viscous gel: xylene at a concentration of 60 GPT of total fluid volume; tall oil fatty acid at a concentration of 60 GPT of total fluid volume; and aluminum hydroxide.

These components were combined allowed to sit overnight. The next morning, the gelled organic fluid had a consistency of jello. When shear was applied to the sample using a Waring Blender, shear was only conveyed to a portion of the sample in the vicinity of the blender impeller, indicating the wide range of fluid rheological properties that may be achieved with the disclosed compositions and methods.

Example 20
Gellation Time for a Various Gelled Hydrocarbon Fluids

In each test of the following example, the indicated components were combined at 75°F to form a gelled organic fluid. The following proportions were employed for each test: 1000 gpt hydrocarbon base, 20 ppt metal salt, 100 ppt fatty acid salt, 60 gpt fatty acid, and 4 gpt metal alkoxide. In each case, the indicated components were introduced to a Waring blender, and mixed to form a gelled organic fluid as follows. Mixing speed was established and maintained within 50 RPM of 4000 RPM using a Strobotach. For each test, the components were added to the mixer within a 5 second interval, & a stopwatch started. Mixing of the fluid was continued until vortex closure occurred, indicating gellation, and the stopwatch stopped. The elapsed time from addition of components until vortex closure was recorded as the gel time, and is listed for each test in Table 40.

Table 40 - Non-Phosphate Hydrocarbon Gelling System
Vortex Closure Test at 75°F, (25°C)

Test No.	Hydrocarbon Base	Metal Salt	Metal Alkoxide	Fatty Acid Salt	Fatty Acid	Vortex Closure Time (minutes: Sec.)
1	Xylene	Aluminum Hydroxide	Petrosurf XL (aluminum isopropoxide)	Aluminum 2-Ethylhexanoate	SYLFAT FA-1	2:45
2	Xylene	Aluminum Hydroxide	Petrosurf XL	Aluminum stearate	SYLFAT FA-1	>15:00
3	No. 2 Diesel	Aluminum Hydroxide	Petrosurf XL	Aluminum 2-Ethylhexanoate	SYLFAT FA-1	9:10
4	70:30 v/v, No.2 diesel:xylene	Aluminum Hydroxide	Petrosurf XL	Aluminum 2-Ethylhexanoate	SYLFAT FA-1	3:25
5	50:50 v/v, No.2 diesel:xylene	Aluminum Hydroxide	Petrosurf XL	Aluminum 2-Ethylhexanoate	SYLFAT FA-1	3:10
6	Fracsol S	Aluminum Hydroxide	Petrosurf XL	Aluminum 2-Ethylhexanoate	SYLFAT FA-1	1:40
7	Xysol	Aluminum Hydroxide	Petrosurf XL	Aluminum 2-Ethylhexanoate	SYLFAT FA-1	1:31

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Example 21
Formulation of Solid Reaction Product and
Measurement of Gellation Time Using Same

I. EQUIPMENT NEEDED FOR EXAMPLE 21

Top Load Balance
Stopwatch
Waring® Blender-Tachometer Assembly
(Reference API 39)
Small Wide Mouth Waring® Blender
Thermometer
Strobe-Tachometer
Syringes (3ml, 5ml, 10 ml, 20 ml)
Weigh Boats

II. CHEMICALS NEEDED FOR EXAMPLE 21

Off Road No. 2 Diesel
Carboxylic Acid
Carboxylic Acid Salt
Metal Salt
Metal Alkoxide

Test Procedure Using Reaction Product System

Six (6) grams aluminum 2- ethyl hexanoate, 27.3 grams (15 milliliters) SYLFAT FA-1, 1.3 grams aluminum hydroxide, 1.82 grams Petrosurf XL, and 12.9 grams (15 milliliters) xylene were measure into an 8 ounce wide mouth glass jar. This mixture was blended with a six blade stirrer for 2 minutes at high speed. The sample was then transferred to a preweighed laboratory petri dish, placed in a laboratory hood, and allowed to react under static conditions at room temperature for 24 hours. At the end of this period the weight of the final composition was weighed. Volatile xylene lost via evaporation was calculated. The final gelatinous sample was cut into small pieces. A small wide mouth Waring® Blender jar was tared on a top load balance. Two hundred fourteen grams (214) grams of off-road diesel was measure into this vessel. The jar was placed on the blend assembly and blended a 400 rpm.

The reaction product was delivered to the mixing fluid to deliver the following concentration of reaction product plus excess xylene remaining in the material:

Component	**Concentration per Liter**
Aluminum 2-ethyl hexanoate	12.0 grams
Petrosurf XL	4.0 milliliters
Aluminum hydroxide	4.8 grams
SYLFAT FA-1	7.2 grams
Xylene	Excess

The reaction product was disperse into the off-road diesel while mixing at 4000 rpm. A stop watch was started immediately. The mixing fluid was monitored for vortex closure. The fluid vortex closure was then observed and recorded as 1 minute, 15 seconds. The fluid temperature was also measured as 75°F (25°C).

The results of Examples 20 and 21 indicate how the disclosed non-phosphate gelled organic fluids may be tailored to meet suitable gellation time requirements. For example, shorter gellation times may be desirable for use in treating shallow wells and/or where a well treatment fluid will encounter short residence time while being displaced through tubulars. Longer gellation times may be desirable for deeper wells and/or longer tubular residence time.

Example 22
Exemplary Formulations and Potential Uses Therefor

Tables 41-44 give exemplary embodiments of fluids that may be employed in the formulation of the disclosed non-phosphate organic fluids. With benefit of this disclosure, those of skill in the art will understand that these combinations of components, and the applications described, are not exclusive, and are exemplary only. In these tables the following designations are employed:

Hydrocarbon 1 = Crude

Hydrocarbon 2 = Condensate

Hydrocarbon 3 = Off-Road No.2 Diesel

Hydrocarbon 4 = Reformate

Hydrocarbon 5 = Kerosene

Hydrocarbon 6 = Xylene

Hydrocarbon 7 = Fracsol®

Table 41 - Some Exemplary Embodiments of Gelled Organic Fluids

Organic Fluid	Carb. Acid	First Metal Source	Second Metal Source	Additional Metal Source	Other Materials	Exemplary Characteristics and/or Applications for this Gelled Fluid
Compound Types/Classes						
Hydrocarbon 1	Carboxylic acid	Carboxylic acid metal salt	Metal Alkoxide	Metal Salt	Benzene, Xylene, Toluene, Napthalene	Oil & Gas Well Stimulation or Completion(s), Pipeline & Chemical Process App.
Hydrocarbon 2	Carboxylic acid	Carboxylic acid metal salt	Metal Alkoxide	Metal Salt	Benzene, Xylene, Toluene, Napthalene	Oil & Gas Well Stimulation or Completion(s), Pipeline & Chemical Process App.
Hydrocarbon 3	Carboxylic acid	Carboxylic acid metal salt	Metal Alkoxide	Metal Salt	Benzene, Xylene, Toluene, Napthalene	Oil & Gas Well Stimulation or Completion(s), Pipeline & Chemical Process App.

Organic Fluid	Carb. Acid	First Metal Source	Second Metal Source	Additional Metal Source	Other Materials	Exemplary Characteristics and/or Applications for this Gelled Fluid
Hydrocarbon 4	Carboxylic acid	Carboxylic acid metal salt	Metal Alkoxide	Metal Salt	Benzene, Xylene, Toluene, Napthalene	Oil & Gas Well Stimulation or Completion(s), Pipeline & Chemical Process App.
Hydrocarbon 5	Carboxylic acid	Carboxylic acid metal salt	Metal Alkoxide	Metal Salt	Benzene, Xylene, Toluene, Napthalene	Oil & Gas Well Stimulation or Completion(s), Pipeline & Chemical Process App.
Hydrocarbon 6	Carboxylic acid	Carboxylic acid metal salt	Metal Alkoxide	Metal Salt	Benzene, Xylene, Toluene, Napthalene	Oil & Gas Well Stimulation or Completion(s), Pipeline & Chemical Process App.
Hydrocarbon 7	Carboxylic acid	Carboxylic acid metal salt	Metal Alkoxide	Metal Salt	Benzene, Xylene, Toluene, Napthalene	Oil & Gas Well Stimulation or Completion(s), Pipeline & Chemical Process A

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Organic Fluid	Carb. Acid	First Metal Source	Second Metal Source	Additional Metal Source	Other Materials	Exemplary Characteristics and/or Applications for this Gelled Fluid
Specific Compounds						
Hydrocarbon 3	Palmitic acid	Al 2-ethyl hexanoate	Al ispropoxide	Al Sulfate	Xylene	Oil & Gas Well Stimulation or Completion(s), Pipeline & Chemical Process A
Hydrocarbon 3	Palmitic acid	Al Stearate	Al ispropoxide	Al Sulfate	Xylene	Oil & Gas Well Stimulation or Completion(s), Pipeline & Chemical Process A
Hydrocarbon 3	Palmitic acid	Al Oleiate	Al ispropoxide	Al Sulfate	Xylene	Oil & Gas Well Stimulation or Completion(s), Pipeline & Chemical Process A

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Organic Fluid	Carb. Acid	First Metal Source	Second Metal Source	Additional Metal Source	Other Materials	Exemplary Characteristics and/or Applications for this Gelled Fluid
Hydrocarbon 3	Palmitic acid	Al Palmate	Al ispropoxide	Al Sulfate	Xylene	Oil & Gas Well Stimulation or Completion(s), Pipeline & Chemical Process A
Hydrocarbon 3	Palmitic acid	Al Mealiate	Al ispropoxide	Al Sulfate	Xylene	Oil & Gas Well Stimulation or Completion(s), Pipeline & Chemical Process A
Hydrocarbon 3	Palmitic acid	Al Benzoate	Al ispropoxide	Al Sulfate	Xylene	Oil & Gas Well Stimulation or Completion(s), Pipeline & Chemical Process A
Hydrocarbon 3	Palmitic acid	Al Coco Fatty	Al ispropoxide	Al Sulfate	Xylene	Oil & Gas Well Stimulation or Completion(s), Pipeline & Chemical Process A

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Table 42 - Further Exemplary Embodiments of Gelled Organic Fluids

Organic Fluid	Carb. Acid	First Metal Source	Second Metal Source	Additional Metal Source	Other Materials	Exemplary Characteristics and/or Applications for this Gelled Fluid
Compound Types/Classes						
Hydrocarbon 1	Tall oil fatty acid	Carboxylic acid metal salt	Metal Alkoxide	Metal Hydroxide	Benzene, Xylene, Toluene, Napthalene	Oil & Gas Well Stimulation or Completion(s), Pipeline & Chemical Process App.
Hydrocarbon 2	Tall oil fatty acid	Carboxylic acid metal salt	Metal Alkoxide	Metal Hydroxide	Benzene, Xylene, Toluene, Napthalene	Oil & Gas Well Stimulation or Completion(s), Pipeline & Chemical Process App.

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Organic Fluid	Carb. Acid	First Metal Source	Second Metal Source	Additional Metal Source	Other Materials	Exemplary Characteristics and/or Applications for this Gelled Fluid
Hydrocarbon 3	Tall oil fatty acid	Carboxylic acid metal salt	Metal Alkoxide	Metal Hydroxide	Benzene, Xylene, Toluene, Napthalene	Oil & Gas Well Stimulation or Completion(s), Pipeline & Chemical Process App.
Hydrocarbon 4	Tall oil fatty acid	Carboxylic acid metal salt	Metal Alkoxide	Metal Hydroxide	Benzene, Xylene, Toluene, Napthalene	Oil & Gas Well Stimulation or Completion(s), Pipeline & Chemical Process App.
Hydrocarbon 5	Tall oil fatty acid	Carboxylic acid metal salt	Metal Alkoxide	Metal Hydroxide	Benzene, Xylene, Toluene, Napthalene	Oil & Gas Well Stimulation or Completion(s), Pipeline & Chemical Process App.
Hydrocarbon 6	Tall oil fatty acid	Carboxylic acid metal salt	Metal Alkoxide	Metal Hydroxide	Benzene, Xylene, Toluene, Napthalene	Oil & Gas Well Stimulation or Completion(s), Pipeline & Chemical Process App.

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Organic Fluid	Carb. Acid	First Metal Source	Second Metal Source	Additional Metal Source	Other Materials	Exemplary Characteristics and/or Applications for this Gelled Fluid
Hydrocarbon 7	Tall oil fatty acid	Carboxylic acid metal salt	Metal Alkoxide	Metal Hydroxide	Benzene, Xylene, Toluene, Napthalene	Oil & Gas Well Stimulation or Completion(s), Pipeline & Chemical Process A
Specific Compounds						
Hydrocarbon 3	SYLFAT FA-1	Al 2-ethyl hexanoate	Al ispropoxide	Aluminum Hydroxide	Xylene	Oil & Gas Well Stimulation or Completion(s), Pipeline & Chemical Process A
Hydrocarbon 3	SYLFAT FA-1	Al Stearate	Al ispropoxide	Aluminum Hydroxide	Xylene	Oil & Gas Well Stimulation or Completion(s), Pipeline & Chemical Process A

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Organic Fluid	Carb. Acid	First Metal Source	Second Metal Source	Additional Metal Source	Other Materials	Exemplary Characteristics and/or Applications for this Gelled Fluid
Hydrocarbon 3	SYLFAT FA-1	Al Oleiate	Al ispropoxide	Aluminum Hydroxide	Xylene	Oil & Gas Well Stimulation or Completion(s), Pipeline & Chemical Process A
Hydrocarbon 3	SYLFAT FA-1	Al Palmate	Al ispropoxide	Aluminum Hydroxide	Xylene	Oil & Gas Well Stimulation or Completion(s), Pipeline & Chemical Process A
Hydrocarbon 3	SYLFAT FA-1	Al Mealiate	Al ispropoxide	Aluminum Hydroxide	Xylene	Oil & Gas Well Stimulation or Completion(s), Pipeline & Chemical Process A
Hydrocarbon 3	SYLFAT FA-1	Al Benzoate	Al ispropoxide	Aluminum Hydroxide	Xylene	Oil & Gas Well Stimulation or Completion(s), Pipeline & Chemical Process A

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Organic Fluid	Carb. Acid	First Metal Source	Second Metal Source	Additional Metal Source	Other Materials	Exemplary Characteristics and/or Applications for this Gelled Fluid
Hydrocarbon 3	SYLFAT FA-1	Al Coco Fatty	Al ispropoxide	Aluminum Hydroxide	Xylene	Oil & Gas Well Stimulation or Completion(s), Pipeline & Chemical Process A

Table 43 - Further Exemplary Embodiments of Gelled Organic Fluids

Organic Fluid	Carb. Acid	First Metal Source	Second Metal Source	Additional Metal Source	Other Materials	Exemplary Characteristics and/or Applications for this Gelled Fluid
Compound Types/Classes						
Hydrocarbon 1	Fatty acid	Carboxylic acid metal salt	Metal Alkoxide	None	Benzene, Xylene, Toluene, Napthalene	Oil & Gas Well Stimulation or Completion(s), Pipeline & Chemical Process App.

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Organic Fluid	Carb. Acid	First Metal Source	Second Metal Source	Additional Metal Source	Other Materials	Exemplary Characteristics and/or Applications for this Gelled Fluid
Hydrocarbon 2	Fatty acid	Carboxylic acid metal salt	Metal Alkoxide	None	Benzene, Xylene, Toluene, Napthalene	Oil & Gas Well Stimulation or Completion(s), Pipeline & Chemical Process App.
Hydrocarbon 3	Fatty acid	Carboxylic acid metal salt	Metal Alkoxide	None	Benzene, Xylene, Toluene, Napthalene	Oil & Gas Well Stimulation or Completion(s), Pipeline & Chemical Process App.
Hydrocarbon 4	Fatty acid	Carboxylic acid metal salt	Metal Alkoxide	None	Benzene, Xylene, Toluene, Napthalene	Oil & Gas Well Stimulation or Completion(s), Pipeline & Chemical Process App.
Hydrocarbon 5	Fatty acid	Carboxylic acid metal salt	Metal Alkoxide	None	Benzene, Xylene, Toluene, Napthalene	Oil & Gas Well Stimulation or Completion(s), Pipeline & Chemical Process App.

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Organic Fluid	Carb. Acid	First Metal Source	Second Metal Source	Additional Metal Source	Other Materials	Exemplary Characteristics and/or Applications for this Gelled Fluid
Hydrocarbon 6	Fatty acid	Carboxylic acid metal salt	Metal Alkoxide	None	Benzene, Xylene, Toluene, Napthalene	Oil & Gas Well Stimulation or Completion(s), Pipeline & Chemical Process App.
Hydrocarbon 7	Fatty acid	Carboxylic acid metal salt	Metal Alkoxide	None	Benzene, Xylene, Toluene, Napthalene	Oil & Gas Well Stimulation or Completion(s), Pipeline & Chemical Process A
Specific Compounds						
Hydrocarbon 3	Oleic acid	Al 2-ethyl hexanoate	Al ispropoxide	None	Xylene	Oil & Gas Well Stimulation or Completion(s), Pipeline & Chemical Process A

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Organic Fluid	Carb. Acid	First Metal Source	Second Metal Source	Additional Metal Source	Other Materials	Exemplary Characteristics and/or Applications for this Gelled Fluid
Hydrocarbon 3	Oleic acid	Al Stearate	Al ispropoxide	None	Xylene	Oil & Gas Well Stimulation or Completion(s), Pipeline & Chemical Process A
Hydrocarbon 3	Oleic acid	Al Oleiate	Al ispropoxide	None	Xylene	Oil & Gas Well Stimulation or Completion(s), Pipeline & Chemical Process A
Hydrocarbon 3	Oleic acid	Al Palmate	Al ispropoxide	None	Xylene	Oil & Gas Well Stimulation or Completion(s), Pipeline & Chemical Process A
Hydrocarbon 3	Oleic acid	Al Mealiate	Al ispropoxide	None	Xylene	Oil & Gas Well Stimulation or Completion(s), Pipeline & Chemical Process A

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Organic Fluid	Carb. Acid	First Metal Source	Second Metal Source	Additional Metal Source	Other Materials	Exemplary Characteristics and/or Applications for this Gelled Fluid
Hydrocarbon 3	Oleic acid	Al Benzoate	Al ispropoxide	None	Xylene	Oil & Gas Well Stimulation or Completion(s), Pipeline & Chemical Process A
Hydrocarbon 3	Oleic acid	Al Coco Fatty	Al ispropoxide	None	Xylene	Oil & Gas Well Stimulation or Completion(s), Pipeline & Chemical Process A

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Table 44 -Further Exemplary Embodiments of Gelled Organic Fluids

Organic Fluid	Carb. Acid	First Metal Source	Second Metal Source	Additional Metal Source	Other Materials	Exemplary Characteristics and/or Applications for this Gelled Fluid
Compound Types/Classes						

Organic Fluid	Carb. Acid	First Metal Source	Second Metal Source	Additional Metal Source	Other Materials	Exemplary Characteristics and/or Applications for this Gelled Fluid
Hydrocarbon 1	Tall oil fatty acid	Carboxylic acid metal salt	Metal Alkoxide	None	Benzene, Xylene, Toluene, Napthalene	Oil & Gas Well Stimulation or Completion(s), Pipeline & Chemical Process App.
Hydrocarbon 2	Tall oil fatty acid	Carboxylic acid metal salt	Metal Alkoxide	None	Benzene, Xylene, Toluene, Napthalene	Oil & Gas Well Stimulation or Completion(s), Pipeline & Chemical Process App.
Hydrocarbon 3	Tall oil fatty acid	Carboxylic acid metal salt	Metal Alkoxide	None	Benzene, Xylene, Toluene, Napthalene	Oil & Gas Well Stimulation or Completion(s), Pipeline & Chemical Process App.
Hydrocarbon 4	Tall oil fatty acid	Carboxylic acid metal salt	Metal Alkoxide	None	Benzene, Xylene, Toluene, Napthalene	Oil & Gas Well Stimulation or Completion(s), Pipeline & Chemical Process App.

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Organic Fluid	Carb. Acid	First Metal Source	Second Metal Source	Additional Metal Source	Other Materials	Exemplary Characteristics and/or Applications for this Gelled Fluid
Hydrocarbon 5	Tall oil fatty acid	Carboxylic acid metal salt	Metal Alkoxide	None	Benzene, Xylene, Toluene, Napthalene	Oil & Gas Well Stimulation or Completion(s), Pipeline & Chemical Process App.
Hydrocarbon 6	Tall oil fatty acid	Carboxylic acid metal salt	Metal Alkoxide	None	Benzene, Xylene, Toluene, Napthalene	Oil & Gas Well Stimulation or Completion(s), Pipeline & Chemical Process App.
Hydrocarbon 7	Tall oil fatty acid	Carboxylic acid metal salt	Metal Alkoxide	None	Benzene, Xylene, Toluene, Napthalene	Oil & Gas Well Stimulation or Completion(s), Pipeline & Chemical Process A
Specific Compounds						

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Organic Fluid	Carb. Acid	First Metal Source	Second Metal Source	Additional Metal Source	Other Materials	Exemplary Characteristics and/or Applications for this Gelled Fluid
Off-Road No. 2 Diesel	SYLFAT FA-1	Al 2-ethyl hexanoate	Al ispropoxide	None	Xylene	Oil & Gas Well Stimulation or Completion(s), Pipeline & Chemical Process A
Off-Road No. 2 Diesel	SYLFAT FA-1	Al Stearate	Al ispropoxide	None	Xylene	Oil & Gas Well Stimulation or Completion(s), Pipeline & Chemical Process A
Off-Road No. 2 Diesel	SYLFAT FA-1	Al Oleiate	Al ispropoxide	None	Xylene	Oil & Gas Well Stimulation or Completion(s), Pipeline & Chemical Process A
Off-Road No. 2 Diesel	SYLFAT FA-1	Al Palmate	Al ispropoxide	None	Xylene	Oil & Gas Well Stimulation or Completion(s), Pipeline & Chemical Process A

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Organic Fluid	Carb. Acid	First Metal Source	Second Metal Source	Additional Metal Source	Other Materials	Exemplary Characteristics and/or Applications for this Gelled Fluid
Hydrocarbon 3	SYLFAT FA-1	Al Mealiate	Al ispropoxide	None	Xylene	Oil & Gas Well Stimulation or Completion(s), Pipeline & Chemical Process A
Hydrocarbon 3	SYLFAT FA-1	Al Benzoate	Al ispropoxide	None	Xylene	Oil & Gas Well Stimulation or Completion(s), Pipeline & Chemical Process A
Hydrocarbon 3	SYLFAT FA-1	Al Coco Fatty	Al ispropoxide	None	Xylene	Oil & Gas Well Stimulation or Completion(s), Pipeline & Chemical Process A

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Examples 23-37

In the following examples, viscosity measurements were made on gelled organic fluids containing the indicated fluids, and at the indicated temperatures, using the same procedure as employed in Examples 16-18.

Example 23

Table 45 - Temperature 200°F

Additives - Off Road Diesel, 60 gpt Oleic Acid-Veg.,
10 ppt Aluminum Oxide, 100 ppt Aluminum Octoate, 4 gpt Petrosurf XL

Comments: R1B5HC/Fann #1SC (HC BS)

TIME	TEMP			Viscosity (Cp)		
(minutes)	(°F)	n'	K	40	100	170
2.10	84	0.2976	0.43502	1561	820	565
36.10	190	0.3797	0.14633	711	403	290
70.10	194	0.3712	0.13231	623	350	251
104.10	194	0.3603	0.13229	598	333	237
138.10	194	0.3519	0.13347	585	323	229
172.10	194	0.3456	0.13485	578	317	224
206.10	194	0.3417	0.13560	573	313	221
240.10	194	0.3378	0.13742	572	312	219
274.10	194	0.3395	0.13587	569	311	219

Example 24

Table 46 - Temperature 150°F

Additives - Off Road Diesel, 10 ppt Aluminum Oxide, 60 gpt Oleic Acid-Veg., 100 ppt Aluminum Oxide, 4 gpt Petrosurf XL

Comments: R1B5HC/Fann #1 (HC BS)

TIME	TEMP			Viscosity (Cp)		
(minutes)	(°F)	n'	K	40	100	170
2.10	87	0.4006	0.27556	1446	835	607
36.10	144	0.5912	0.08747	927	637	513
70.10	146	0.5456	0.09378	840	554	435
104.10	146	0.5105	0.09929	781	499	385
138.10	145	0.4862	0.10118	728	455	346
172.10	145	0.4716	0.10086	688	424	320
206.10	146	0.4684	0.09707	654	402	303
240.10	146	0.4512	0.10031	634	384	287
274.10	146	0.4415	0.10094	616	369	274

Example 25

Table 47 - Temperature 200°F

Additives - Off Road Diesel, 500 ppt, 95% Palmitic Acid-Veg.,
10 ppt Aluminum Oxide, 100 ppt Aluminum Octoate, 4 gpt Petrosurf XL

Comments: R1B5HC/Fann #1SC (HC BS)

TIME	TEMP			Viscosity (Cp)		
(minutes)	(°F)	n'	K	40	100	170
2.10	85	0.3939	0.14086	721	414	300
36.10	190	0.3227	0.21201	835	449	313
70.10	194	0.3318	0.19210	782	424	297
104.10	194	0.3282	0.19200	771	417	292
138.10	194	0.3534	0.17168	757	418	297
172.10	194	0.3729	0.15239	722	406	291
206.10	194	0.3689	0.15136	706	396	283
240.10	194	0.3734	0.14394	683	385	276
274.10	194	0.3709	0.14257	670	377	270
308.10	194	0.3665	0.14249	659	369	264
342.10	194	0.3645	0.14135	649	363	259
376.10	194	0.3635	0.13990	640	357	255
410.10	194	0.3617	0.13924	633	353	251
444.10	194	0.3595	0.13892	626	348	248
478.10	194	0.3846	0.11714	579	330	238
512.10	194	0.3873	0.11348	567	323	234
546.10	194	0.3854	0.11343	563	320	231
580.10	194	0.3855	0.11220	557	317	229
614.10	194	0.3859	0.11129	553	315	227
648.10	194	0.3814	0.11234	549	312	224
682.10	194	0.3823	0.11112	545	309	223
716.10	194	0.3815	0.11088	542	308	222
750.10	194	0.3791	0.11129	539	305	220
784.10	194	0.3790	0.11086	537	304	219
818.10	194	0.3790	0.11007	533	302	217
852.10	194	0.3775	0.11058	533	301	216
886.10	194	0.3770	0.11027	530	300	215
920.10	194	0.3739	0.11131	529	298	214
954.10	194	0.3719	0.11215	529	298	213
988.10	194	0.3726	0.11144	527	297	213
1022.10	194	0.3707	0.11202	526	296	212
1056.10	194	0.3717	0.11115	524	295	211
1090.10	194	0.3685	0.11248	524	294	210
1124.10	194	0.3682	0.11239	523	293	210
1158.10	193	0.3682	0.11229	523	293	210
1192.10	194	0.3660	0.11245	519	290	207
1226.10	194	0.3661	0.11267	520	291	208
1260.10	194	0.3638	0.11376	521	291	208

Example 26

Table 48 - Temperature 150°F

Additives - Off Road Diesel, 10 ppt Aluminum Oxide
95% Palmitic Acid-Veg., 100 ppt Aluminum Oxide, 4 gpt Petrosurf XL

Comments: R1B5HC/Fann #1 (HC BS)

TIME	TEMP			Viscosity (Cp)		
(minutes)	(°F)	n'	K	40	100	170
2.10	88	0.4587	0.10127	658	401	301
36.10	145	0.3384	0.21751	907	495	348
70.10	146	0.3370	0.20984	871	474	334
104.10	146	0.3336	0.20497	840	456	320
138.10	145	0.3291	0.20228	815	441	309
172.10	146	0.3249	0.19992	793	427	299
206.10	145	0.3214	0.19833	777	417	291
240.10	145	0.3138	0.20053	764	407	283
274.10	145	0.3120	0.19835	751	400	277
308.10	146	0.3144	0.19303	737	393	273
342.10	145	0.3138	0.19063	726	387	269
376.10	146	0.3072	0.19277	717	380	263
410.10	146	0.3083	0.18941	707	375	260
444.10	145	0.3068	0.18910	702	372	257
478.10	145	0.3092	0.18535	694	369	225
512.10	146	0.3074	0.18433	686	364	252
546.10	145	0.3068	0.18348	681	361	250
580.10	146	0.3066	0.18186	675	357	247
614.10	146	0.3064	0.18121	672	356	246
648.10	146	0.3041	0.18131	666	352	243
682.10	146	0.3086	0.17694	661	351	243
716.10	145	0.3007	0.18222	661	348	240
750.10	146	0.3076	0.17562	654	347	240
784.10	146	0.3045	0.17705	652	345	238
818.10	145	0.3052	0.17593	649	343	238
852.10	146	0.3035	0.17636	647	342	236
886.10	145	0.3029	0.17599	644	340	235
920.10	146	0.3001	0.17718	642	338	233
954.10	145	0.3066	0.17229	639	339	234
988.10	146	0.3008	0.17555	637	336	232
1022.10	145	0.2992	0.17635	637	335	231
1056.10	146	0.3037	0.17248	633	334	231
1090.10	145	0.3009	0.17401	632	333	230
1124.10	145	0.3042	0.17083	628	332	229
1158.10	145	0.3026	0.17163	627	331	229
1192.10	146	0.3065	0.16819	624	330	229
1226.10	146	0.3046	0.16912	623	329	228
1260.10	146	0.3073	0.16690	621	329	228

Example 27

Table 49 - Temperature 200°F

Additives - Off Road Diesel, 500 ppt, Stearic Acid-Veg.,
10 ppt Aluminum Oxide, 100 ppt Aluminum Octoate, 4 gpt Petrosurf XL

Comments: R1B5HC/Fann #1SC (HC BS)

TIME	TEMP			Viscosity (Cp)		
(minutes)	(°F)	n'	K	40	100	170
2.10	85	0.3911	0.10591	537	307	222
36.10	195	0.3158	0.16654	639	341	237
70.10	199	0.3364	0.16168	669	364	256
104.10	199	0.3435	0.16151	686	376	265
138.10	199	0.3418	0.16521	698	382	269
172.10	199	0.3417	0.16674	704	385	272
206.10	199	0.3403	0.16770	704	385	271
240.10	199	0.3436	0.16456	700	383	271
274.10	199	0.3418	0.16469	696	381	268
308.10	199	0.3408	0.16420	691	378	266
342.10	199	0.3418	0.16233	686	375	265
376.10	199	0.3406	0.16213	682	373	263
410.10	199	0.3382	0.16294	679	370	261
444.10	199	0.3402	0.16041	674	368	259
478.10	199	0.3405	0.15955	671	366	258
512.10	199	0.3405	0.15882	668	365	257
546.10	199	0.3418	0.15713	664	363	256
580.10	199	0.3396	0.15789	661	361	254
614.10	199	0.3410	0.15629	658	360	254
648.10	199	0.3414	0.15538	655	358	253
682.10	199	0.3409	0.15509	653	357	252
716.10	199	0.3411	0.15416	649	355	250
750.10	199	0.3398	0.15427	647	353	249
784.10	199	0.3418	0.15249	644	352	248
818.10	199	0.3414	0.15218	642	351	247
852.10	199	0.3387	0.15312	639	349	246
886.10	199	0.3399	0.15182	637	348	245
920.10	199	0.3416	0.14993	633	346	244
954.10	199	0.3400	0.15042	631	345	243
988.10	199	0.3430	0.14782	627	343	242
1022.10	199	0.3415	0.14800	624	342	241
1056.10	199	0.3396	0.14849	622	340	239

Example 28

Table 50 - Temperature 150°F

Additives - Off Road Diesel, 10 ppt Aluminum Oxide, Stearic Acid-Veg., 10 ppt Aluminum Oxide, 4 gpt Petrosurf XL

Comments: R1B5HC/Fann #1 (HC BS)

TIME	TEMP			Viscosity (Cp)		
(minutes)	(°F)	n'	K	40	100	170
2.10	88	0.4451	0.07523	465	280	208
36.10	150	0.3172	0.15075	581	311	217
70.10	151	0.3005	0.16801	609	321	221
104.10	151	0.3024	0.17080	624	329	227
138.10	151	0.3091	0.16884	632	336	233
172.10	151	0.3091	0.17029	637	338	235
206.10	151	0.3103	0.17064	642	341	237
240.10	151	0.3086	0.17273	645	343	237
274.10	151	0.3095	0.17241	646	343	238
308.10	151	0.3106	0.17217	648	345	239
342.10	151	0.3095	0.17352	651	346	240
376.10	151	0.3156	0.16940	650	347	241
410.10	151	0.3124	0.17164	650	346	241
444.10	151	0.3137	0.17066	650	346	241
478.10	151	0.3143	0.16972	648	346	240
512.10	151	0.3160	0.16847	647	346	240
546.10	151	0.3134	0.17054	649	346	240
580.10	151	0.3138	0.17030	649	346	240
614.10	151	0.3219	0.16466	646	347	242
648.10	151	0.3177	0.16747	647	346	241
682.10	151	0.3144	0.16972	648	346	240
716.10	151	0.3163	0.16840	647	346	241
750.10	151	0.3186	0.16666	646	346	241
784.10	151	0.3183	0.166511	645	345	240
818.10	151	0.3151	0.16877	646	345	240
852.10	151	0.3158	0.16809	645	345	240
886.10	151	0.3140	0.16952	646	345	239
920.10	151	0.3165	0.16725	643	344	239
954.10	151	0.3127	0.17026	646	344	239
988.10	151	0.3136	0.16917	644	343	239
1022.10	151	0.3163	0.16718	643	344	239
1056.10	151	0.3114	0.17062	644	343	238

Example 29

Table 51 -Temperature 200°F

Additives - Xylene, 10 ppt Aluminum Oxide,
100 ppt Aluminum 2-Ethylhexoate, 60 gpt "SYLFAT FA-1 Sp"

TIME	TEMP			Viscosity (Cp)		
(minutes)	(°F)	n'	K	40	100	170
2.10	80	0.1958	0.24115	594	284	186
36.10	176	0.3178	0.24717	955	511	365
70.10	192	0.2591	0.28117	875	444	300
104.10	194	0.2557	0.28448	875	442	298
138.10	194	0.2521	0.28373	861	434	292
172.10	194	0.2501	0.28331	853	429	288
206.10	194	0.2492	0.28464	854	429	288
240.10	194	0.2498	0.28534	858	432	290
274.10	194	0.2511	0.28519	862	434	292
308.10	194	0.2497	0.28846	867	436	293
342.10	194	0.2479	0.29214	873	438	294
376.10	194	0.2483	0.29349	878	441	296
410.10	194	0.2481	0.29597	885	444	298
444.10	194	0.2481	0.29724	889	446	299
478.10	194	0.2482	0.29922	895	449	302
512.10	194	0.2511	0.29684	897	452	304
546.10	194	0.2530	0.29602	901	454	306
580.10	194	0.2537	0.29600	903	456	307
614.10	194	0.2559	0.29434	906	458	309
648.10	194	0.2572	0.29317	906	459	309
682.10	194	0.2592	0.29128	907	460	311
716.10	194	0.2600	0.29079	908	461	311
750.10	194	0.2566	0.29478	909	460	310
784.10	194	0.2373	0.32290	928	461	308
818.10	194	0.2597	0.29804	930	472	319
852.10	194	0.2606	0.29636	928	471	318
886.10	194	0.2602	0.29465	921	468	316

Example 30

Table 52 - Temperature 150°F

Additives - Xylene, 10 ppt Aluminum Oxide,
100 ppt 2-Ethylhexoate, 60 gpt SYLFAT FA-1 Sp, 4 gpt Petrosurf XL

TIME	TEMP			Viscosity (Cp)		
(minutes)	(°F)	n'	K	40	100	170
2.10	83	0.2675	0.13145	422	216	146
36.10	131	0.4678	0.15060	1012	622	469
70.10	143	0.4451	0.15348	949	571	425
104.10	145	0.4170	0.17057	951	557	409
138.10	145	0.4035	0.18060	958	554	404
172.10	145	0.4158	0.17407	966	566	415
206.10	145	0.4246	0.16893	968	572	421
240.10	145	0.4270	0.16769	970	574	423
274.10	145	0.4050	0.18235	972	564	411
308.10	145	0.4178	0.17472	977	573	421
342.10	145	0.4249	0.16960	973	575	423
376.10	145	0.4182	0.17341	971	570	418
410.10	145	0.4154	0.17638	977	572	419
444.10	145	0.4197	0.17418	981	576	423
478.10	145	0.4161	0.17805	989	579	425
512.10	145	0.4213	0.17532	993	584	430
546.10	145	0.4191	0.17799	1000	587	431
580.10	145	0.4131	0.18396	1011	590	432
614.10	145	0.4184	0.18185	1019	598	439
648.10	145	0.4227	0.17991	1024	603	444
682.10	145	0.4253	0.17927	1030	609	449
716.10	145	0.4235	0.18118	1034	610	449
750.10	145	0.4178	0.18693	1045	613	450
784.10	145	0.4231	0.18420	1050	619	456
818.10	145	0.4129	0.19316	1060	619	453
852.10	145	0.4168	0.19114	1065	624	458

Example 31

Table 53 - Temperature 200°F

Additives - Kerosene, 60 gpt Tall Oil SYLFAT FA-1,
100 ppt Aluminum Octoate, 10 ppt Aluminum Hydroxide, 4 gpt Petrosurf XL
Comments: R1B5HC/Fann #1

TIME	TEMP			Viscosity (Cp)		
(minutes)	(°F)	n'	K	40	100	170
2.10	89	0.3213	0.08951	351	188	131
36.10	197	0.4792	0.07746	543	337	256
70.10	198	0.4849	0.06580	471	294	224
104.10	198	0.4847	0.06215	445	277	211
138.10	199	0.4900	0.05830	425	267	203
172.10	199	0.4850	0.05758	412	257	196
206.10	199	0.4868	0.05557	401	250	191
240.10	199	0.4920	0.05326	391	246	188
274.10	199	0.4281	0.07672	445	264	195
308.10	200	0.4310	0.07430	436	259	191
342.10	200	0.4338	0.07218	428	255	189
376.10	200	0.4316	0.07175	422	251	185
410.10	199	0.4350	0.07025	418	249	185
444.10	199	0.4373	0.06914	415	248	184
478.10	198	0.4376	0.06912	416	248	184
512.10	198	0.4392	0.06873	416	249	185
546.10	198	0.4387	0.06878	415	248	184
580.10	197	0.4419	0.06769	414	248	184
614.10	197	0.4434	0.06678	410	246	183
648.10	198	0.4441	0.06636	409	246	183
682.10	198	0.4476	0.06515	407	245	183
716.10	198	0.4443	0.06581	406	244	182
750.10	198	0.4521	0.06361	404	244	183
784.10	198	0.4538	0.06286	401	243	182
818.10	198	0.4548	0.06237	400	243	182
852.10	198	0.4599	0.06084	397	242	182
886.10	198	0.4648	0.05910	393	241	181
920.10	198	0.4606	0.05990	392	239	180
954.10	198	0.4623	0.05932	391	239	179
988.10	198	0.4659	0.05807	388	238	179
1022.10	198	0.4716	0.05659	386	238	180
1056.10	198	0.4770	0.05507	383	237	180
1090.10	198	0.4752	0.05528	382	236	179
1124.10	198	0.4743	0.05518	380	235	178
1158.10	198	0.4731	0.05522	379	234	177
1192.10	198	0.4801	0.05333	375	233	177
1226.10	199	0.4843	0.05238	374	233	177
1260.10	198	0.4855	0.05194	373	233	177
1294.10	198	0.4882	0.05136	372	233	178

Example 32

Table 54 - Temperature 150°F with Surfactant

Additives - Off Road Diesel, 100 ppt Aluminum Octoate,
10 ppt AL203, 20 gpt Xylene, 60 gpt SYLFAT FA-1 Sp, 4 gpt Petrosurf XL

TIME	TEMP			Viscosity (Cp)		
(minutes)	(°F)	n'	K	40	100	170
2.10	129	0.4419	0.14576	891	534	397

Example 33

Table 55 - Temperature 200°F with Surfactant (ETHOX)

Additives - Off Road Diesel, 100 ppt Aluminum Octoate,
10 ppt $AL(OH)_3$, 60 gpt SYLFAT FA-1, 10 ppt Polyglycerol Stearate, 4 gpt Petrosurf XL

TIME	TEMP			Viscosity (Cp)		
(minutes)	(°F)	n'	K	40	100	170
2.10	74	0.5442	0.04060	362	238	187
36.10	194	1.2120	0.00069	72	88	98
70.10	197	1.3821	0.00025	49	70	85
104.10	197	1.4403	0.00018	44	65	83
138.10	197	1.4689	0.00015	40	62	80
172.10	196	1.5750	0.00009	36	61	83
206.10	196	1.6035	0.00008	35	62	85
240.10	197	1.4734	0.00014	38	59	76
274.10	196	1.3645	0.00023	42	59	72
308.10	197	1.3557	0.00024	43	59	71
342.10	197	1.2545	0.00039	48	60	69
376.10	197	1.3126	0.00030	46	61	72
410.10	197	1.3293	0.00027	44	59	70
444.10	197	2.0167	0.00001	20	52	89
478.10	197	1.4738	0.00013	36	55	71
512.10	197	2.1058	0.00001	28	78	140
546.10	197	1.9656	0.00001	17	41	68
580.10	197	2.3640	0.00000	0	0	0
614.10	197	2.2271	0.00000	0	0	0
648.10	197	2.0052	0.00001	20	49	84
682.10	197	2.7048	0.00000	0	0	0
716.10	197	4.0607	0.00000	0	0	0
750.10	197	5.1050	0.00000	0	0	0
784.10	197	NaN	NaN	NaN	NaN	NaN
818.10	197	NaN	NaN	NaN	NaN	NaN
852.10	196	NaN	NaN	NaN	NaN	NaN

TIME	TEMP			Viscosity (Cp)		
(minutes)	(°F)	n'	K	40	100	170
886.10	197	NaN	NaN	NaN	NaN	NaN
920.10	197	NaN	NaN	NaN	NaN	NaN
954.10	197	NaN	NaN	NaN	NaN	NaN
988.10	196	NaN	NaN	NaN	NaN	NaN

Example 34

Table 56 - Temperature 200°F

Additives - Off Road Diesel, 32.4 g of reaction product of Example 21 per 250 ml, 45 Sec. Gelation at 3000-4000 RPM

TIME	TEMP			Viscosity (Cp)		
(minutes)	(°F)	n'	K	40	100	170
2.10	82	0.7077	0.14811	2412	1846	1580
36.10	194	0.3786	0.28141	1361	770	554
70.10	197	0.3891	0.24406	1227	701	507
104.10	197	0.3908	0.23228	1175	673	487
138.10	197	0.3897	0.22727	1145	655	474
172.10	197	0.3945	0.21741	1115	640	464
206.10	197	0.3908	0.21628	1094	626	453
240.10	197	0.4029	0.20189	1068	618	450
274.10	197	0.4125	0.19078	1046	611	447
308.10	197	0.4123	0.18842	1032	602	441
342.10	197	0.4116	0.18674	1020	595	436
376.10	197	0.4243	0.17525	1003	592	436
410.10	197	0.4230	0.17511	998	588	433
444.10	197	0.4191	0.17703	994	584	429
478.10	197	0.4250	0.17173	986	582	429
512.10	197	0.4194	0.17497	984	578	425
546.10	197	0.4219	0.17317	983	579	426
580.10	197	0.4164	0.17771	988	579	425
614.10	197	0.4124	0.18088	991	579	424
648.10	197	0.4138	0.18034	993	581	425
682.10	197	0.4084	0.18475	998	580	424
716.10	197	0.4125	0.18232	999	583	427
750.10	197	0.4104	0.18465	1004	585	428
784.10	197	0.3999	0.19407	1016	586	426
818.10	197	0.3946	0.19939	1023	588	426
852.10	197	0.3986	0.19661	1024	590	429
886.10	197	0.4005	0.19583	1027	593	431

TIME	TEMP			Viscosity (Cp)		
(minutes)	(°F)	n'	K	40	100	170
920.10	197	0.3582	0.23620	1060	589	419
954.10	197	0.4091	0.20239	1096	638	466
988.10	197	0.4081	0.20206	1090	634	463
1022.10	197	0.4089	0.20045	1084	631	461

Example 35

Table 57 - Temperature 200°F

Additives - Off Road Diesel, 32.4 g of reaction product of Example 21 per 250 ml

TIME	TEMP			Viscosity (Cp)		
(minutes)	(°F)	n'	K	40	100	170
2.10	83	0.9036	0.10181	3416	3127	2971
36.10	193	0.5079	0.19393	1512	963	742
70.10	197	0.5819	0.13535	1386	945	757
104.10	197	0.5807	0.13180	1344	915	733
138.10	197	0.5746	0.13293	1325	897	716
172.10	197	0.5729	0.13227	1310	886	706
206.10	197	0.5584	0.13914	1307	872	690
240.10	197	0.5506	0.14293	1304	864	681
274.10	197	0.5422	0.14661	1297	853	669
308.10	197	0.5415	0.13542	1195	785	615
342.10	197	0.3764	0.24289	1166	658	473
376.10	197	0.3340	0.31048	1274	692	486
410.10	197	0.5262	0.15718	1311	849	660
444.10	197	0.4874	0.19614	1417	886	675
478.10	197	0.4726	0.19603	1341	827	625
512.10	197	0.3240	0.33572	1328	715	499
546.10	197	0.5172	0.16431	1325	852	659
580.10	197	0.4668	0.21378	1432	878	662
614.10	197	0.4620	0.21656	1425	870	654
648.10	197	0.3202	0.33555	1309	702	489
682.10	197	0.3209	0.33367	1305	700	488
716.10	197	0.3242	0.32778	1297	698	488
750.10	197	0.5140	0.16142	1287	824	637
784.10	197	0.4553	0.22006	1413	858	642
818.10	197	0.4381	0.23677	1427	852	633
852.10	197	0.4317	0.24349	1433	851	630
886.10	197	0.4470	0.22133	1378	830	619

TIME	TEMP			Viscosity (Cp)		
(minutes)	(°F)	n'	K	40	100	170
920.10	197	0.4367	0.23643	1417	846	627
954.10	197	0.4233	0.25075	1430	843	621
988.10	197	0.3203	0.32598	1272	682	476
1022.10	197	0.3232	0.32201	1270	683	477

Example 36

Table 58 - Temperature 200°F

Fluid System - Xylene/Al Stearate, Acme-Hardesty Lot 12356-B
Additives - Xylene, 100 ppt Al Stearate III, 60 gpt SYLFAT FA-1 Sp

TIME	TEMP			Viscosity (Cp)		
(minutes)	(°F)	n'	K	40	100	170
2.10	202	0.4724	0.06012	411	253	192
36.10	202	0.4761	0.05843	405	251	190
70.10	202	0.4517	0.06318	400	242	181
104.10	202	0.4434	0.06395	393	236	176
138.10	202	0.4493	0.06088	382	231	172
172.10	202	0.4649	0.05545	369	226	170
206.10	202	0.4362	0.06170	369	220	163
240.10	202	0.4634	0.05384	356	218	164
274.10	202	0.4522	0.05544	352	213	159
308.10	202	0.4451	0.05628	348	209	156
342.10	202	0.4505	0.05410	341	206	154
376.10	202	0.4520	0.05303	336	204	152
410.10	202	0.4492	0.05294	332	201	150
444.10	202	0.4570	0.05058	327	199	149
478.10	202	0.4484	0.05164	323	195	145
512.10	202	0.4634	0.04779	316	193	145
546.10	202	0.4616	0.04766	313	191	144
580.10	202	0.4562	0.04840	312	189	142
614.10	202	0.4768	0.04372	304	188	143
648.10	202	0.4675	0.04521	304	186	140
682.10	202	0.4695	0.04426	299	184	139
716.10	202	0.4620	0.04557	300	183	138
750.10	202	0.4591	0.04568	297	181	136
784.10	202	0.4665	0.04385	293	180	136

Example 37

Table 59 - Temperature 200°F

Fluid System - 50% Off Road Diesel:50% Xylene V/V
Additives - 50% Off Road Diesel V/V, 50% Xylene V/V, 100 ppt Al 2-Ethylehexanoate, 60 gpt SYLFAT FA-1, 4 gpt Petrosurf XL

TIME	TEMP			Viscosity (Cp)		
(minutes)	(°F)	n'	K	40	100	170
2.10	77	0.3066	0.13265	492	261	180
36.10	194	0.3301	0.12813	518	281	197
70.10	197	0.3812	0.08449	413	234	169
104.10	197	0.3829	0.08133	400	227	164
138.10	197	0.3792	0.07963	386	219	157
172.10	196	0.3694	0.08180	383	215	154
206.10	197	0.3794	0.07711	374	212	152
240.10	197	0.3795	0.07493	364	206	148
274.10	196	0.3763	0.07493	359	203	146
308.10	197	0.3868	0.07011	350	199	144
342.10	197	0.3840	0.06977	344	196	141
376.10	197	0.3904	0.06699	338	194	140
410.10	197	0.3894	0.06566	331	189	137
444.10	197	0.3938	0.06409	328	188	136
478.10	197	0.3983	0.06191	322	186	135
512.10	197	0.3963	0.06193	320	184	134
546.10	197	0.4054	0.05847	312	181	132
580.10	197	0.3966	0.06052	313	180	131
614.10	197	0.4044	0.05715	304	176	128
648.10	197	0.3966	0.05942	307	177	128
682.10	197	0.4081	0.05558	300	174	127
716.10	197	0.4096	0.05519	299	174	127
750.10	197	0.4101	0.05453	296	173	126
784.10	197	0.4149	0.05308	294	172	126
818.10	197	0.4179	0.05205	291	171	125

Example 38 –

MSMA-Containing Gelled Organic Fluid

Fluid loss data was obtained on a MSMA-containing gelled organic fluid based on "JET062455". In this case, the MSMA used was "SMA 3840"available from Elf

Atochem. JET062455 was formulated as shown in Table 60A below and as described in Example 45.

Table 60A -- JET062455 Formulation

COMPONENT	FORM	WT. (GMS)	WT. %	* LBS. COMP./GAL	SP. GR.
SYLFAT F-1	LIQUID	156.2	0.2466	1.9112	0.92
2- ETHYL HEXANOIC ACID	LIQUID	156.2	0.2466	1.9112	0.95
AL ISOPROPOXIDE	SOLID	104	0.1642	1.2725	1.035
IPA	LIQUID	50	0.0789	0.6118	0.781
SMA 3840	SOLID	46.8	0.0739	0.5726	1.09
TOLUENE	LIQUID	100	0.1579	1.2236	0.87
AL ISOPROPOXIDE	SOLID	5.2	0.0082	0.0636	1.035
IPA	LIQUID	15	0.0237	0.1835	0.781
TOTALS		633.4	1.0000	7.5420	

Gelled diesel was formulated with JET062455 as follows:

Component	Concentration per 1000 gallons
Off-Road diesel	1000 Gallons
Petrosurf XL	5 Gallons
Water	1 Gallon
JET 062455	30 Gallons
-325 Mesh Calcined Magnesium Oxide ("Magchem 10" available from Martin-Marietta)	10 pounds per thousand ("ppt")

Fluid loss was determined using Recommend Practice for Evaluation of Fracturing Fluids, API RP-39 (March, 1983). Test temperature was 200°F and test pressure was 1000 psi. Results are shown in **FIG. 1**.

Example 39

Crude Oil Analysis

Crude oil analysis was as indicated in Table 60B below.

Table 60B – Crude Oil Analysis

Parameter	**Crude Oil Sample 1 (Also denoted herein as TTC #10)**	**Crude Oil Sample 2**
Paraffins (% by wt.)	15.1	14.8
Asphaltenes (% by wt.)	1.0	0.8
Polar Aromatics (% by wt.)	23.7	23.7
Maltenes (% by wt.)	8.4	6.5
API Gravity @ 60F	28.4	30.5

Example 40

Synthesis Procedure for Gellant Formulation known as "JET061334A-E"

280 grams (28.91% by weight of the total composition weight)of 2-ethyl hexanoic acid (liquid)was transferred to a 2000 ml reaction flask. 280 grams (28.91%) of tall oil fatty acid ("SLYFAT FA-1" available from Arizona Chemicals, also available as "G20" from BJ Services) was delivered into a clean, dry 250 milliliter beaker. SYLFAT FA-1 contains 92.7% fatty acids, 2.8% unsaponifiables and 4.5% rosin acids, with less than 0.1% moisture and less than 0.01% ash. The fatty acid content of SYLFAT FA-1

includes 34% non-conjugated linoleic, 9% conjugated linoleic, 44% oleic, and 5% saturated. SYLFAT FA-1 has an acid number of 194, a saponification number of 197, and an iodine number of 131. SYLFAT FA-1 Sp has a saponification number of 198. 50 grams (5.16%)of Isopropyl alcohol was added and this mixture was then blended at moderated speed. 188.6 grams(19.47%) of aluminum isopropoxide was delivered while blending continued. An exothermic reaction follows the delivery of aluminum isopropoxide. The mixture typically heats to about 50°C. The reaction was allowed to proceed at 50°C for one (1) hour. The temperature was maintained at 50°C using laboratory heating mantle. After that period, 70 grams (7.23%) of a reaction product of a partial monoester of styrene maleic anhydride and a fatty alcohol polymer (SMA® Fatty-Alcohol Ester X.31890) was added. 100 grams (10.32%) toluene was added and the temperature was increased to 90°C while blended continued at the speed for 2 hours. During that period the isopropyl component of the mixture was extracted via laboratory distillation techniques while the composition was condensed to the desired density.(0.93-0.96 gms/ml).

Example 41

Gellation of Diesel from Gellant Formulation JET061334A-E (from Example 40) and Aluminum Second Metal Source Compound

A 197 gram of "off road" No.2 diesel was delivered into a clean, dry, small wide-mouth Waring® Blender jar. Solution blended at about 2000 rpm (+/-) 50 (variac voltage controller setting of 30). A proportional concentration equaling 1 L/M3 of tap water was delivered to the mixing fluid. Immediately following that addition a proportional concentration equaling 30 L/M3 of Gellant Formlaton JET061334A-E, 5 L\M3 of Petrosurf XL (aluminum alkoxide), and 2 L/M3 of a high rosin TOFA solution ("UNITOL S" from International Paper Company in 50:50 w/w in toluene) was then added to the diesel solution at the same time. A proportional concentration equaling 30 L/M3 and mixing continued at the same speed Solution mixing continued until a viscous

gel developed. A similar procedure was repeated for other gelled formulations from JET061334A-E that are described or referred to elsewhere herein.

Example 42
Synthesis Procedure for Gellant Formulation known as "JET062455A-E"

280 grams (28.91% by weight of the total composition weight)of 2-ethyl hexanoic acid (liquid)was transferred to a 2000 ml reaction flask. 280 grams (28.91%) of tall oil fatty acid ("SLYFAT FA-1" available from Arizona Chemicals, also available as "G20" from BJ Services) was delivered into a clean, dry 250 milliliter beaker. (SYLFAT FA-1 contains 92.7% fatty acids, 2.8% unsaponifiables and 4.5% rosin acids, with less than 0.1% moisture and less than 0.01% ash. The fatty acid content of SYLFAT FA-1 includes 34% non-conjugated linoleic, 9% conjugated linoleic, 44% oleic, and 5% saturated. SYLFAT FA-1 has an acid number of 194, a saponification number of 197, and an iodine number of 131. SYLFAT FA-1 Sp has a saponification number of 198).

50 grams (5.16%)of Isopropyl alcohol was added and this mixture was then blended at moderated speed. 188.6 grams(19.47%) of aluminum isopropoxide was delivered while blending continued. An exothermic reaction follows the delivery of aluminum isopropoxide. The mixture typically heats to about 50°C. The reaction was allowed to proceed at 50°C for one (1) hour. The temperature was maintained at 50°C using laboratory heating mantle. After that period, 70 grams (7.23%) of a reaction product of a partial monoester of styrene maleic anhydride and a fatty alcohol polymer (SMA® Fatty-Alcohol Ester SMA 3840) was added. 100 grams (10.32%) toluene was added and the temperature was increased to 90°C while blended continued at the speed for 2 hours. During that period the isopropyl component of the mixture was extracted via laboratory distillation techniques while the composition was condensed to the desired density.(0.93-0.96 gms/ml).

JET062455A-E is a synthesized material at 6.7/1 by weight ratio of fatty acids to SMA monoester (x.31890).

Example 43
Gellation of Diesel from Gellant Formulation JET062455A-E (from Example 42) and Aluminum Second Metal Source Compound

A 197 gram of "off road" No.2 diesel was delivered into a clean, dry, small wide-mouth Waring® Blender jar. Solution sample blended at about 2000 rpm (+/-) 50 (variac voltage controller setting of 30). A proportional concentration equaling 1 L/M3 of tap water was delivered to the mixing fluid. Immediately following that addition a proportional concentration equaling 30 L/M3 of Gellant Formlation JET062455A-E, 5 L\M3 of Petrosurf XL (aluminum alkoxide), and 2 L/M3 of a high rosin TOFA ("UNITOL S" from International Paper Company, 50:50 w/w in toluene) solution was then added to the diesel solution at the same time A proportional concentration equaling 30 L/M3 and mixing continued at the same speed Solution mixing continued until a viscous gel developed.

Example 44
Alternate "Back Adding" Synthesis Procedure for Gellant Formulation known as "JET061334A-E"

In the following example, a portion of the amount of the total reactant employed was withheld during the initial combination of ingredients, and added later (after initiation of reaction). This method is defined herein as "back adding". In this regard, any amount of one or more of the chosen reactants may be withheld. In one embodiment, the withheld amount may be from about 7% to about 15% by weight of the total weight of the reactants withheld.

In this example, 156.2 grams (24.66%) of tall oil fatty acid ("SLYFAT FA-1" available from Arizona Chemicals, also available as "G20" from BJ Services) was delivered into a clean, dry 2000 milliliter reaction flask. SYLFAT FA-1 contains 92.7% fatty acids, 2.8% unsaponifiables and 4.5% rosin acids, with less than 0.1% moisture and less than 0.01% ash. The fatty acid content of SYLFAT FA-1 includes 34% non-

conjugated linoleic, 9% conjugated linoleic, 44% oleic, and 5% saturated. SYLFAT FA-1 has an acid number of 194, a saponification number of 197, and an iodine number of 131. SYLFAT FA-1 Sp has a saponification number of 198. 156.2 grams (24.66%) by weight of the total composition weight)of 2-ethyl hexanoic acid (liquid)was transferred to the reaction flask. 50 grams (7.89%)of Isopropyl alcohol was added and this mixture was then blended at moderated speed. 104 grams(16.42%) of aluminum isopropoxide was delivered while blending continued. An exothermic reaction follows the delivery of aluminum isopropoxide. The mixture typically heats to about 50°C. The reaction was allowed to proceed at 50°C for one (1) hour. The temperature was maintained at 50°C using laboratory heating mantle. After that period, 46.8 grams (7.39%) of a reaction product of a partial monoester of styrene maleic anhydride and a fatty alcohol polymer (SMA® Fatty-Alcohol Ester "X.31890") was added. 100 grams (15.79%) toluene was added and the temperature was increased to 90°C while blended continued at the speed for 2 hours. After that period and using the process called 'back adding", 5.2 grams (0.82%) additional aluminum isopropoxide and 15 grams (2.37%) isopropyl alcohol was added to the mixture. Isopropyl component of the mixture was then extracted via laboratory distillation techniques while the composition was condensed to the desired density.(0.93-0.96 gms/ml).

Gellation of an organic fluid, such as diesel, may be accomplished using the above "back added" product, for example, using the same procedure as given in Example 41.

Example 45
Alternate "Back Adding" Synthesis Procedure for Gellant
Formulation known as "JET062455A-E"

156.2 grams (24.66%) of tall oil fatty acid ("SLYFAT FA-1" available from Arizona Chemicals, also available as "G20" from BJ Services) was delivered into a clean, dry 2000 milliliter reaction flask. SYLFAT FA-1 contains 92.7% fatty acids, 2.8% unsaponifiables and 4.5% rosin acids, with less than 0.1% moisture and less than 0.01% ash. The fatty acid content of SYLFAT FA-1 includes 34% non-conjugated linoleic, 9% conjugated linoleic, 44% oleic, and 5% saturated. SYLFAT FA-1 has an acid number of 194, a saponification number of 197, and an iodine number of 131. SYLFAT FA-1 Sp has a saponification number of 198. 156.2 grams (24.66%) by weight of the total composition weight) of 2-ethyl hexanoic acid (liquid)was transferred to the reaction flask. 50 grams (7.89%)of Isopropyl alcohol was added and this mixture was then blended at moderated speed. 104 grams (16.42%) of aluminum isopropoxide was delivered while blending continued. An exothermic reaction follows the delivery of aluminum isopropoxide. The mixture typically heats to about 50°C. The reaction was allowed to proceed at 50°C for one (1) hour. The temperature was maintained at 50°C using laboratory heating mantle. After that period, 46.8 grams (7.39%) of a reaction product of a partial monoester of styrene maleic anhydride and a fatty alcohol polymer (SMA® Fatty-Alcohol Ester "SMA 3840") was added. 100 grams (15.79%) toluene was added and the temperature was increased to 90°C while blended continued at the speed for 2 hours. After that period and using the process called 'back adding", 5.2 grams (0.82%) additional aluminum isopropoxide and 15 grams (2.37%) isopropyl alcohol was added to the mixture. Isopropyl component of the mixture was then extracted via laboratory distillation techniques while the composition was condensed to the desired density.(0.93-0.96 gms/ml).

Gellation of an organic fluid, such as diesel, may be accomplished using the above "back added" product, for example, using the same procedure as given in Example 43.

Example 46
Gellation Using Back-Added Formulation of JET061334A-E
with Optional Citric Acid Activator

The following example shows the use of an optional activator in the formulation of gellant materials.

A 197 gram of "off road" No.2 diesel was delivered into a clean, dry, small wide-mouth Waring® Blender jar. Solution sample blended at about 2000 rpm (+/-) 50 (variac voltage controller setting of 30). Immediately following that addition a proportional concentration equaling 30 L/M3 of "back added" Gellant Formlation JET061334A-E (of Example 44), 5 L\M3 of Petrosurf XL (aluminum alkoxide), and 2 L/M3 of a citric acid (50:50 w/w in water) solution was then added to the diesel solution at the same time A proportional concentration equaling 30 L/M3 and mixing continued at the same speed Solution mixing continued until a viscous gel developed.

Example 47
Example Synthesis of Gelling Agent

One exemplary embodiment of manufacturing a gelling agent according to the disclosed method is given in this example. In this example, manufacture of gelling agent may occur offsite (*e.g.*, at a manufacturing plant or other facility) and the gelling agent stored in drums or other suitable container, for transportation and later user onsite (*e.g.*, at a well site or pipeline site).

In this exemplary embodiment, one or more carboxylic acids having from about 16 to about 20 carbon atoms (*e.g.*, tall oil fatty acid carboxylic acids, *etc.*) may be combined with one or more MSMA-based compounds (as defined elsewhere herein), one or more solvents (*e.g.*, aromatic compounds, alcohols, *etc.*), and one or more metal source compounds (*e.g.*, as defined elsewhere herein). Isopropyl alcohol and toluene are just two examples of organic solvents that may be employed in this embodiment. Such a combination of solvents may be chosen, for example, to reduce overall solvent cost,

facilitate distillation or solvent removal, to be non-reactant with other reaction components, and/or to be the same as a by-product of the reaction (to reduce number of components in the reaction product, *etc.* Examples of other organic solvents that may be employed in this exemplary embodiment include, but are not limited to, other aromatic compounds (such as benzene, xylene, benzyl alcohol, and other aromatic solvents described elsewhere herein) and linear or branched chain alcohols having from about 3 to about 12, alternatively from about 3 to about 10 carbon atoms. As described elsewhere herein, any solvent or mixture of solvents suitable, for example, to facilitate ease of reactant mixture handling, intermixing of reactants, *etc.* may be employed. Furthermore, organic solvents may be selected to have desirable separation or distillation characteristics.

A mixture of carboxylic acids may be employed, for example, to reduce overall cost by combining a more expensive carboxylic acid with a less expensive carboxylic acid, it being understood that a single type of carboxylic acid may also be employed alone. In this example, "SYLFAT FA-1"(*i.e.,* mixture of oleic and linoleic acids) and liquid 2-ethylhexanoic acid may be combined with a MSMA-based compound (such as solid "SMA X31890" from Elf Atochem and/or "LUBRIZOL 2002" from Lubrizol Corporation), isopropyl alcohol, toluene, and aluminum isopropoxide (metal source compound). The foregoing ingredients may be combined in a reactor or reaction vessel, for example, in the order mentioned in the preceding sentence. In this regard, it may be desirable to add the metal source compound (*e.g.,* aluminum isopropoxide) last, as its addition initiates an exothermic reaction within the reactor or reaction vessel. Otherwise, if desired, liquid components may be added first, followed by solid components, to facilitate intermixing.

The reactor or reaction vessel may be sealed immediately following addition of the first metal source compound (*e.g.,* aluminum isopropoxide) and the reaction allowed to proceed exothermically to a temperature of, for example, about 60°C, while maintaining a pressure (*e.g.,* from about 150 psi to about 200 psi) on the vessel to keep the contents from boiling. The reaction components may be allowed to sit for a length of

time sufficient to allow the components to go into solution, *e.g.*, about 30 minutes. At this point additional heat may be added to bring the temperature within the reactor or reaction vessel to from about 90°C to about 100°C, alternatively about 95°C and the pressure maintained within the reactor or reaction vessel at from about 150 psi to about 200 psi. The reaction may then be allowed to proceed in the closed reactor or reaction vessel and under these temperature and pressure conditions for a desired reaction time period (*e.g.*, from about 2 to 4 hours, alternatively for a period of about 2 to 3 hours, alternatively for a period of about 2 hours). If desired at this point, additional metal source compound/s (*e.g.*, about 15% by weight of total metal source compound may be reserved for later addition at this time) may optionally be "back added" to the reactor or reaction vessel, along with additional optional organic solvent/s, and allowed to react, for example, an additional time period of about 1 hour. In either case, after passage of the desired reaction time, pressure may be bled off the reactor or reaction vessel.

The resulting reaction product may be distilled to remove organic solvent/s and obtain a gelling agent product having desired characteristics, *e.g.*, viscosity and/or density. This may be accomplished using any distillation method known in the art, for example, through a condenser connected to the reactor or reaction vessel, using a separate distillation vessel and system, *etc.*. For example, a reaction product obtained using the procedure and components described above may be distilled at a temperature of about 90°C and at atmospheric pressure to achieve a reaction product having a specific gravity of from about 0.94 to about 0.99, alternatively from about 0.95 to about 0.97. During distillation, lighter components, such as toluene and/or isopropyl alcohol, may be removed from the reaction product to form a more viscous and/or dense liquid, or a majority to all of the liquid components removed to form a solid or paste. In this regard, it will be understood with benefit of this disclosure by those of skill in the art that distillation conditions and/or time may be varied as necessary for a particular reaction product to achieve the desired gelling agent product characteristics, *e.g.*, solid, paste, or liquid of desired viscosity and/or specific gravity. In one example, a liquid reaction

product using the above described procedure and components may be allowed to cool and then poured into drums for transportation and later use.

Tables 61-69 list information for exemplary types and amounts of individual components that may be combined using the procedure described in this example. In addition to the specific formulation described below, the last column in Table 61 gives exemplary ranges of each component that may be employed. It will be understood that the procedures, component types, and amounts described in this example are exemplary only, and may be varied as desired by those of skill in the art with the benefit of this disclosure.

Table 61 – Exemplary Component Information

General Type	Specific Example	Form	Weight (Grams)	Weight of Total Solution (%)	Lbs per Gallon ("PPG")	Specific Gravity	Weight of Total Solution (Exemplary % Range)
Carboxylic Acid	"SYLFAT F-1" Tall Oil Fatty Acid	Liquid	231.8	23.18	1.7963	0.92	* About 20% to about 30%
Carboxylic Acid	2-ethyl hexanoic acid	Liquid	231.8	23.18	1.7963	0.92	* About 20% to about 30%
Metal Source	Aluminum Isopropoxide	Solid	172.2	17.22	1.3344	1.035	Stochiometrically determined relative to carboxylic acid as described elsewhere herein
Solvent	Isoproyl Alcohol ("IPA")	Liquid	165.6	16.56	1.2832	0.781	***
MSMA-based Compound	"SMA X31890"	Solid	115.9	11.59	0.8981	1.09	**
Solvent	Toluene	Liquid	82.8	8.28	0.6417	0.87	***
Totals	--	--	1000	100.00	8.1351	--	--

* -- Ranges given are for each of the two given separate carboxylic acids present in this embodiment. Alternatively, total carboxylic acid exemplary weight percent range in one embodiment may be from about 5% to about 60% by total weight, alternatively from about 40% to about 60% by total weight, further alternatively from about 40% to about 50% by total weight.

** -- In this embodiment, weight of MSMA-based compound may be present in amount relative to total carboxylic acid weight as follows: MSMA-based compound weight to carboxylic acid of from about 4:1 to about 10:1, alternatively about 4:1 to about 8:1, further alternatively from about 4:1 to about 6:1). However these values are exemplary only, and values greater or less than these ranges may also be employed.

*** -- In this embodiment, total amount of solvent may be from about 5% to about 30% by weight, alternatively from about 8% to about 25% by weight. Ratio of toluene to IPA may be about 1:2, alternatively from about 1:2 to about 6:1 or as otherwise desired. However the given values are exemplary only, and values greater or less than these may also be employed.

Table 62

4:1 SMA ADDITION			
COMPONENT	WT.	WT%	REACTOR 1
SYLFAT F-1	156.2	0.238	21.4
2- ETHYL HEXANOIC ACID	156.2	0.238	21.4
IPA	100	0.152	13.7
SMA X.31890	78.1	0.119	10.7
AL ISOPROPOXIDE	116	0.177	15.9
TOLUENE	50	0.076	6.9
TOTALS	656.5	1.00	90

Table 63

4:1 SMA ADDITION			
COMPONENT	WT.	WT%	REACTOR 1
SYLFAT F-1	156.2	0.238	21.4
2- ETHYL HEXANOIC ACID	156.2	0.238	21.4
IPA	100	0.152	13.7
SMA 3840	78.1	0.119	10.7
AL ISOPROPOXIDE	116	0.177	15.9
TOLUENE	50	0.076	6.9
TOTALS	656.5	1.00	90

Table 64

5:1 SMA ADDITION				
COMPONENT	WT.	WT%	REACTOR 1	
SYLFAT F-1	156.2	0.244	21.9	
2- ETHYL HEXANOIC ACID	156.2	0.244	21.9	
IPA	100	0.156	14.0	
SMA X.31890	62.5	0.098	8.8	
AL ISOPROPOXIDE	116	0.181	16.3	
TOLUENE	50	0.078	7.0	
TOTALS	640.9	1.00	90	

Table 65

5:1 SMA ADDITION			
COMPONENT	**WT.**	**WT%**	**REACTOR 1**
SYLFAT F-1	156.2	0.244	21.9
2- ETHYL HEXANOIC ACID	156.2	0.244	21.9
IPA	100	0.156	14.0
SMA 3840	62.5	0.098	8.8
AL ISOPROPOXIDE	116	0.181	16.3
TOLUENE	50	0.078	7.0
TOTALS	640.9	1.00	90

Table 66

6.67:1 SMA ADDITION			
COMPONENT	**WT.**	**WT%**	**REACTOR 1**
SYLFAT F-1	156.2	0.250	22.5
2- ETHYL HEXANOIC ACID	156.2	0.250	22.5
IPA	100	0.160	14.4
SMA X.31890	46.8	0.075	6.7
AL ISOPROPOXIDE	116	0.186	16.7
TOLUENE	50	0.080	7.2
TOTALS	625.2	1.00	90

Table 67

6.67:1 SMA ADDITION			
COMPONENT	**WT.**	**WT%**	**REACTOR 1**
SYLFAT F-1	156.2	0.250	22.5
2- ETHYL HEXANOIC ACID	156.2	0.250	22.5
IPA	100	0.160	14.4
SMA 3840	46.8	0.075	6.7
AL ISOPROPOXIDE	116	0.186	16.7
TOLUENE	50	0.080	7.2
TOTALS	625.2	1.00	90

Table 68

COMPONENT	FORM	WT. (GMS)	WT. %	* LBS. COMP./GAL	SP. GR.
SYLFAT F-1	LIQUID	280	0.2891	2.2403	0.92
2- ETHYL HEXANOIC ACID	LIQUID	280	0.2891	2.2403	0.95
AL ISOPROPOXIDE	SOLID	188.6	0.1947	1.5090	1.035
IPA	LIQUID	50	0.0516	0.4001	0.781
SMA X.31890 OR SMA 3840	SOLID	70	0.0723	0.5601	1.09
TOLUENE	LIQUID	100	0.1032	0.8001	0.87
TOTALS		968.6	0.9277	7.5900	
MEASURED FLUID DENSITY	0.929				

Table 69

COMPONENT	FORM	WT. (GMS)	WT. %	* LBS. COMP./GAL	SP. GR.
SYLFAT F-1	LIQUID	156.2	0.2466	1.9112	0.92
2- ETHYL HEXANOIC ACID	LIQUID	156.2	0.2466	1.9112	0.95
AL ISOPROPOXIDE	SOLID	104	0.1642	1.2725	1.035
IPA	LIQUID	50	0.0789	0.6118	0.781
SMA 3840	SOLID	46.8	0.0739	0.5726	1.09
TOLUENE	LIQUID	100	0.1579	1.2236	0.87
AL ISOPROPOXIDE	SOLID	5.2	0.0082	0.0636	1.035
IPA	LIQUID	15	0.0237	0.1835	0.781
TOTALS		633.4	1.0000	7.5420	
MEASURED FLUID DENSITY	0.929				
* CALCULATION IS BASED MEASURE DENSITYOF FINAL PRODUCT					

Example 48

Formulation of Well Treatment Fluid from Gelling Agent

Using the procedure of Example 47, a liquid gelling agent may be formulated, for example, using the components of Table 61. As previously mentioned, such a gelling agent may be stored in drums or other suitable container, and transported to a well or

pipeline facility site for formulation of gelled treatment fluid. One exemplary method of performing a well treatment using such a gelling agent is described below.

At a well site, an organic (*e.g.,* hydrocarbon base fluid) may be combined with a gelling agent and other components to form a well treatment fluid in the following manner. In one embodiment, an organic base fluid may be combined in a downhole blender with a metal source, gelling agent, water and other optional components to form a gelled well treatment fluid, for example, to be used as part of a hydraulic fracturing treatment or as part of any other type of gelled well treatment fluid known in the art. Depending on components employed, gellation may occur almost immediately, or may occur over time as a treatment fluid is pumped downhole and/or exposed to downhole temperatures.

In one example, a diesel base fluid (*e.g.,* no. 2 diesel) may be combined at ambient temperature, or at a temperature of from about 4°C to about 24°C in a blender with the following components and subjected to shear prior to being introduced into a wellbore: (1) metal source compound in the form of "PETROSURF XL" (aluminum isopropoxide solution containing 10% by weight of aluminum in a naptha/tri secondary butyl alcohol base) in an amount of from about 0.1% to about 1.0% by volume of total volume of well treatment fluid (alternatively about 0.5% by volume of total volume of well treatment fluid); (2) liquid gelling agent of Example 46 in an amount of from about 5 gallons to about 50 gallons per thousand gallons, alternatively about 20 gallons per thousand gallons of base fluid (or alternatively from about 0.5% to about 4% by volume, alternatively from about 1% to about 4% by volume, alternatively about 2% by volume of total volume of total volume of well treatment fluid); and (3) water in an amount of from about 0.05% to about 0.5% alternatively about 0.1% by volume of total volume of well treatment fluid. Other optional components that may be combined in the blender include, but are not limited to, non-emulsifiers or hydrotopes, and other optional well treatment components described elsewhere herein or known to those of skill in the well treating art. Order of addition of the components to the blender may be as desired.

Following formation of a gelled treatment fluid as described above additional components desired for well treatment (such as proppant, gel breaker material, *etc.*), may be combined with the gelled treatment fluid before introduction in the wellbore.

In another optional embodiment, where acceleration of crosslinking and gellation may be desirable, from about 2% to about 4% of the gelling agent of Example 46 may be added to organic base fluid (*e.g.*, diesel) in a blender in a manner as described above. Also added may be from about 0.1% to about 0.5% of a hydrotrope-type surfactant (*e.g.*, NE-42 or NE-118 from BJ Services Company), from about 0.1% to about 0.5% water, and from about 0.1% to about 0.5% of a high-resin content tall oil fatty acid (*e.g.*, Unitol AR40 from Arizona Chemical). Using this method gellation may occur in, for example, about 90 seconds.

Further reduction in gellation time may be achieved by the addition of phase transfer catalyst materials ("PTCs"). Examples of suitable PTC materials include, but are not limited to, benzoic acid, napthenic acid, other aromatic organic or carboxylic acids, *etc.* Use of such materials may be desirable, for example, for treating wells of shallow depths or which have relatively low bottom hole static temperatures. For example, an aluminum isopropoxide metal source compound, available from Chattem Chemical of Chatanooga, Tennessee (as product code "RNB-1-19[XCP-1053]") that has been modified with an organic acid PTC (Benzoic acid) at a ratio of about 0.5 mole or greater of PTC per mole of metal source compound, may be employed as a metal source compound/PTC reactant additive using methods described elsewhere herein. Further information on PTC's may be found in "Catalysis, Phase Transfer," *Encyclopedia of Chemical Technology*, 3rd Ed., Volume 5, John Wiley & Sons (1979), pp. 62-69, which is incorporated herein by reference.

Example 49

Formulation of Well Treatment Fluid from Individual Components at the Wellsite

As an alternative to formulation of a treatment fluid using a pre-formulated gelling agent, a gelled treatment fluid may be synthesized on location from individual

ingredients, such as organic base fluid, metal source compound/s, carboxylic acid/s and MSMA-based compound/s. In one embodiment, at a well site an organic (*e.g.*, hydrocarbon base fluid such as diesel) may be combined in a blender with metal source compound/s, MSMA-based compound/s and other optional components to form a well treatment fluid, for example, to be used as part of a hydraulic fracturing treatment or as part of any other type of gelled well treatment fluid known in the art. In one example, the metal source compound may be aluminum octoate and the MSMA-based compound delivered to a blender in a solvent as described elsewhere herein. Once a gelled treatment fluid is formed, it may be employed for a desired application using, for example, any of the methods described elsewhere herein.

Example 50
Breaker Materials for Use with Gelled Treatment Fluids

Breaker materials that may be employed with gelled treatment fluids include, for example, gelled treatment fluids formulated according to the preceding Examples 48 and 49.

In one embodiment, breaker material may include sodium metasilicate and/or sodium metaborate that may be employed in any amount suitable for partially or completely breaking a gelled treatment fluid. In one exemplary embodiment, such materials may be combined with an organic base fluid or a gelled treatment fluid in an amount sufficient to result in from about 1 to about 5 pound of breaker material per thousand gallons of gelled treatment fluid. Suitable materials include, for example, sodium metasilicate or sodium metaborate materials having a minimum particle size of about 20/40 mesh and which have relatively low solubility in water, or that are substantially insoluble in water. Such materials are available from suppliers such as "BASF" and "US BORAX." It will be understood that these materials are exemplary only, and that similar materials having other particle sizes may also be employed. It will also be understood that such materials may be encapsulated, for example, in a manner and using materials as described elsewhere herein.

It will also be understood that other solid particulate materials suitable for performing the breaker function described herein (including, but not limited to, solid amines such as melamine, *etc.*) may be encapsulated, for example with paraffin or other suitable encapsulant).

In another embodiment, breaker materials may be formed by impregnating porous particulate carrier material with breaker materials such as those breaker materials described elsewhere herein (*e.g.,* solutions of salts such as sodium metasilicate or sodium metaborate, amines such as TEPA, hexamethylene tetramine, *etc.*). Impregnations may be accomplished, for example, by submersion of porous material in a liquid breaker material or breaker solution which is exposed to a suitable breaker material-impregnating vacuum (*e.g.,* 30 mm HG, *etc.*), washed with solvent, and allowed to dry. Impregnated breaker materials may be optionally encapsulated, such as in a manner and using materials described elsewhere herein for breaker encapsulation. Examples of suitable porous materials include any porous particulate material including, but not limited to, particulate material such as ground or crushed nut shells, ground or crushed seed shells, ground or crushed fruit pits, processed wood, porous ceramics, agglomerated particulates of resin and other materials manufactured by, for example, BORDEN CHEMICAL (such as agglomerates of phenolic and/or urethane resins with particles of Silica and/or Feldspar). Additional information on such particles may be found in co–pending United States Patent Application Serial No. 09/085,416, filed May 27, 1998, and in co–pending United States Patent Application Serial No. 09/519,238, filed March 6, 2000, entitled "Formation Treatment Method Using Deformable Particles" by Allan R. Rickards, Harold D. Brannon, Philip J. Rae, Gino A. DiLullo and Christopher J. Stephenson, each of which are incorporated herein.

It will be understood that any suitable combination of breaker materials, encapsulants and/or carrier materials may be employed, whether or not the particular combination is specifically described herein.

Additional Examples and Appendices

Additional examples of gelled organic fluids, and rheological testing performed thereon, may be found in Appendices A and B attached to this disclosure. With regard to those formulations described in these Examples, components and amounts thereof are listed in the row marked "Additives". Where gel breaker materials were included, these materials are identified in the row entitled "Breaker". Fann viscosity readings were performed using the procedure as previously described herein.

Using the Fann procedures previously described herein, viscosity readings were performed on gelled fluid systems formulated with JET061334A-E. Results are provided in Appendix C attached hereto. With regard to Fann reading results (such as those in Appendix C), components and amounts of components for each individual gelled fluid system may be found listed in the row marked "Additives = ". In some cases, abbreviations have been employed to denote components in these "Additives" lists, and these may be found defined in the text of the specification or in one or more of the individual Fann Viscosity reports themselves.

Using the Fann procedures previously described herein, viscosity readings were performed on gelled fluid systems formulated with JET062455A-E. Results are provided in Appendix D attached hereto. With regard to Fann reading results (such as those in Appendix D), components and amounts of components for each individual gelled fluid system may be found listed in the row marked "Additives = ". In some cases, abbreviations have been employed to denote components in these "Additives" lists, and these may be found defined in the text of the specification or in one or more of the individual Fann Viscosity reports themselves.

Other examples of specific fatty acids and high rosin fatty acids include, but are not limited to those "UNITOL" products listed in Appendix E (available from Arizona Chemical and International Paper).

Some components utilized in the formulations described herein have been denoted with various codes and/or product names. The following legend provides definitions for

codes and/or product names, or for products which otherwise may be useful in the practice of the disclosed methods and compositions:

"ENCA 80715" is shorthand notation for "En Cap 80715", which is a styrenated acrylic paint encapsulated potassium carbonate available from Fritz Industries of Dallas, Texas

"ECA-2" is used shorthand notation for a citric acid solution (50% w/w citric acid in water, with "w/w" used herein to denote percentage on a weight basis of the solution)

"GBL-5L" is sometimes used to denote "GBO-5L"

"Viscomaster 2100" is an Aluminum Octoate solution available from Chattem Chemicals.

"FE-300L" is used to denote a 50% w/w citric acid solution

"HEXA" is used to denote hexamethylenetetetramine

"JET0707-1" denotes "JET062455A-E" (having a specific gravity of 0.948).

"JET0707-2" denotes "JET062455A-E" (having a specific gravity of 0.938)

"JET -617-7" is sometimes used to denote "Unitol S" High Rosin Tall Oil Fatty Acid

"EC-1" is also used to denote Citric acid solution (50% w/w in water)

"ENCAP 90706 [21% COATING]" denotes an encapsulated tetraethylenepentamine in which the tetraethylenepentamine is absorbed in diatomaceous earth. This diatomaceous earth/tetraethylenepentamine material is then coated with a styrenated acrylic paint. The 21% designates the weight percent acrylic paint present on the diatomaceous earth/tetraethylenepentamine material. This product is available from Fritz Industries of Dallas, Texas.

"TOL:HRTOFA" denotes a toluene/"Unitol S" high rosin tall oil solution (mixed at 50% w/w).

"ENCAP MGO" denotes encapsulated magnesium oxide dispersed in aliphatic hydrocarbon insoluble resin known as "VINSOL RESIN" (oil soluble resin available from Hercules, Incorporated). Same type material could be made with another oil soluble resin, such as described in US Patent 5,497,830, incorporated herein by reference. Vinsol resin has the property that it is more soluble in oil containing aromatics than only containing aliphatics.

"OB-1" is an imidazoline-based emulsifier available from BJ Services.

"AC12" and "ACM16AM" are examples of reactive calcined alumina (available from Alchem) that may be employed as first or second metal source in the practice of the disclosed method and compositions.

A composite reaction sample suitable for use in the disclosed methods and compositions may be formulated using 100 ppt aluminum octoate and 60 gpt oleic acid from vegetable oil (available from Acme-Hardesty).

It will be understood with benefit of this disclosure that the procedures of the examples given herein may be employed by those of skill in the art to select appropriate components, for example from those components disclosed elsewhere herein, so as to vary characteristics (*e.g.,* gel time, rheology, temperature stability, *etc.*) of the disclosed non-phosphate gelled organic fluids. In this regard, fluid characteristics may be tailored to achieve gelled fluids meeting requirements or conditions for individual or specific applications. It will also be understood that, with benefit of this disclosure, other rheological and fluid testing methods known in the art may also be employed for this purpose.

While the invention may be adaptable to various modifications and alternative forms, specific embodiments have been shown by way of example and described herein. However, it should be understood that the invention is not intended to be limited to the particular forms disclosed. Rather, the invention is to cover all modifications, equivalents, and alternatives falling within the spirit and scope of the invention as defined by the appended claims. Moreover, the different aspects of the disclosed compositions and methods may be utilized in various combinations and/or independently. Thus the invention is not limited to only those combinations shown herein, but rather may include other combinations. Further, although exemplary embodiments are described herein, it will be understood with benefit of this disclosure that the disclosed compositions and method may be beneficially employed in any other application where gelation of liquid organics and resulting compositions may be suitably employed (such as for gelled fuels, *etc.*).

REFERENCES

The following references, to the extent that they provide exemplary procedural or other details supplementary to those set forth herein, are specifically incorporated herein by reference.

United States Patent Application Serial No. 60/148,274 filed on August 11, 1999, entitled "Gelled Hydrocarbon Compositions and Methods for Use Thereof";

United States Patent Application Serial No. 60/129,770 filed on April 15, 1999, entitled "Gelled Hydrocarbon Compositions and Methods for Use Thereof";

United States Patent Application Serial No. 60/127,298 filed on March 30, 1999, entitled "Gelled Hydrocarbon Compositions and Methods for Use Thereof";

United States Patent Application Serial No. 09/151,169, filed September 10, 1998, entitled "Surfactant Compositions and Uses Therefor."

United States Patent No. 2,793,966

United States Patent No. 2,965,566

United States Patent No. 3,505,374

United States Patent No. 3,511,820

United States Patent No. 3,528,939

United States Patent No. 3,625,286

United States Patent No. 3,650,970

United States Patent No. 3,654,990

United States Patent No. 3,654,991

United States Patent No. 3,654,992

United States Patent No. 3,657,123

United States Patent No. 3,719,711

United States Patent No. 3,725,547

United States Patent No. 3,741,943

United States Patent No. 3,755,189

United States Patent No. 3,757,864

United States Patent No. 3,764,571

United States Patent No. 3,819,386

United States Patent No. 3,821,109

United States Patent No. 3,839,300

United States Patent No. 3,852,441

United States Patent No. 3,883,404

United States Patent No. 3,887,508

United States Patent No. 3,900,070

United States Patent No. 3,904,541

United States Patent No. 3,905,909

United States Patent No. 3,960,514

United States Patent No. 3,969,087

United States Patent No. 3,969,233

United States Patent No. 4,008,264

United States Patent No. 4,003,393

United States Patent No. 4,049,858

United States Patent No. 4,053,428

United States Patent No. 4,084,089

United States Patent No. 4,096,071

United States Patent No. 4,142,978

United States Patent No. 4,147,643

United States Patent No. 4,152,289

United States Patent No. 4,153,649

United States Patent No. 4,156,678

United States Patent No. 4,171,268

United States Patent No. 4,174,283

United States Patent No. 4,186,802

United States Patent No. 4,200,540

United States Patent No. 4,238,529

United States Patent No. 4,242,377

United States Patent No. 4,259,428

United States Patent No. 4,273,891

United States Patent No. 4,284,414

United States Patent No. 4,301,868

United States Patent No. 4,312,765

United States Patent No. 4,316,807

United States Patent No. 4,316,810

United States Patent No. 4,316,852

United States Patent No. 4,404,112

United States Patent No. 4,440,674

United States Patent No. 4,450,261

United States Patent No. 4,446,039

United States Patent No. 4,517,115

United States Patent No. 4,517,115

United States Patent No. 4,557,842

United States Patent No. 4,566,977

United States Patent No. 4,576,819

United States Patent No. 4,579,671

United States Patent No. 4,615,393

United States Patent No. 4,622,155

United States Patent No. 4,647,603

United States Patent No. 4,658,036

United States Patent No. 4,665,982

United States Patent No. 4,668,439

United States Patent No. 4,720,576

United States Patent No. 4,751,011

United States Patent No. 4,780,221

United States Patent No. 4,781,845

United States Patent No. 4,787,994

United States Patent No. 4,877,894

United States Patent No. 4,909,923

United States Patent No. 4,962,271

United States Patent No. 5,015,793

United States Patent No. 5,021,170

United States Patent No. 5,045,220

United States Patent No. 5,057,233

United States Patent No. 5,076,852

United States Patent No. 5,082,059

United States Patent No. 5,132,271

United States Patent No. 5,190,675

United States Patent No. 5,256,320

United States Patent No. 5,276,231

United States Patent No. 5,271,464

United States Patent No. 5,278,203

United States Patent No. 5,283,235

United States Patent No. 5,296,164

United States Patent No. 5,300,715

United States Patent No. 5,330,588

United States Patent No. 5,330,662

United States Patent No. 5,346,943

United States Patent No. 5,362,409

United States Patent No. 5,381,864

United States Patent No. 5,382,411

United States Patent No. 5,384,421

United States Patent No. 5,403,501

United States Patent No. 5,411,091

United States Patent No. 5,417,287

United States Patent No. 5,426,137

United States Patent No. 5,449,470

United States Patent No. 5,486,300

United States Patent No. 5,487,838

United States Patent No. 5,492,178

United States Patent No. 5,497,830

United States Patent No. 5,514,645

United States Patent No. 5,519,063

United States Patent No. 5,529,722

United States Patent No. 5,534,609

United States Patent No. 5,552,377

United States Patent No. 5,609,207

United States Patent No. 5,620,946

United States Patent No. 5,637,557

United States Patent No. 5,641,890

United States Patent No. 5,674,936

United States Patent No. 5,679,280

United States Patent No. 5,700,767

United States Patent No. 5,773,706

United States Patent No. 5,826,669

United States Patent No. 5,843,873

United States Patent No. 5,858,929

Japanese Patent No. 03097781A

Japanese Patent No. 06087968

Japanese Patent No. 08048965A

Japanese Patent No. 08183249

Japanese Patent No. 56022739A

Japanese Patent No. 58154758A

Japanese Patent No. 8484933

European Patent No. 0004353A2

European Patent No. 0202940A2

European Patent No. 0207787A2

European Patent No. 0225661A2

European Patent No. 0271362B1

European Patent No. 0295877A3

European Patent No. 0326155A2

European Patent No. 0338738A1

European Patent No. 0390280A1

European Patent No. 0449257A2

European Patent No. 0551021A1

European Patent No. 0580246A1

European Patent No. 0582928A2

European Patent No. 0604988A2

European Patent No. 0682940A1

European Patent No. 0691454A1

European Patent No. 0739619A1

European Patent No. 0785225A2

European Patent No. 0835647A1

European Patent No. 0848029A2

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George et al., "Low Temperature Rheology of Greases: Functionalized Polymer Systems" Nat'l Lubricating Grease Institute, 9808.

Hole et al., "The Enhancement of Grease Structure through the use of Functionalised Polymer Systems" The Lubrizol Corporation.

A

A-1

Log number
12188

Temperature
200 F

Customer
J. THOMPSON

Location
BJSSTTC

Fluid System
NPHGS ((FROM COMPOSITE REACTION SAMPLE #2)) P299-0972, 32.4 GMS/250 MLS 200°F
SAMPLE HEATED @ 150°F (65°C) FOR 24 HRS. [SAMPLE # 02-0406 OLEIC-VEG SYSTEM]

Additives
OFF ROAD DIESEL, 32.4 GMS COMPOSITE REACTION SAMPLE # 2

Breaker
NONE

Initial pH
N/A

Final pH

Comments
P299-0972

A.2

						Rate 1	Rate 2	Rate 3
						40	100	170
Time	Temp	n	K	Kv	Corr			
Min	°F		Lbf*s^n/ft^n	Lbf*s^n/ft^2		CentiPoise	CentiPoise	CentiPoise
2.10	76	0.2282	0.56094	0.61713	0.8644	1558	768	510
19.10	180	0.3339	0.18412	0.20053	0.9978	755	410	288
36.10	194	0.3929	0.11837	0.12807	1.0000	604	346	251
53.10	196	0.3957	0.10549	0.11410	0.9997	544	312	227
70.10	197	0.3928	0.10132	0.10962	0.9998	517	296	215
87.10	197	0.3951	0.09714	0.10507	0.9998	499	287	208
104.10	197	0.3970	0.09434	0.10202	0.9997	488	281	204
121.10	197	0.4018	0.09027	0.09756	0.9998	476	275	200
138.10	197	0.4035	0.08862	0.09575	1.0000	470	272	198
155.10	197	0.4072	0.08614	0.09304	0.9999	463	269	196
172.10	197	0.4120	0.08339	0.09002	0.9999	456	266	195
189.10	197	0.4103	0.08312	0.08974	0.9998	452	263	193
206.10	197	0.4150	0.08060	0.08698	0.9999	446	261	191
223.10	197	0.4176	0.07871	0.08490	0.9998	440	258	189
240.10	197	0.4181	0.07758	0.08368	0.9999	434	255	187
257.10	197	0.4221	0.07509	0.08096	0.9999	426	251	185
274.10	197	0.4188	0.07557	0.08151	0.9999	424	249	183
291.10	197	0.4199	0.07426	0.08009	0.9999	418	246	181
308.10	197	0.4272	0.07162	0.07717	0.9998	415	245	181
325.10	197	0.4186	0.07315	0.07890	0.9999	410	241	177
342.10	197	0.4286	0.06954	0.07492	0.9999	405	240	177
359.10	197	0.4243	0.07043	0.07591	0.9999	403	238	175
376.10	197	0.4274	0.06880	0.07413	0.9999	398	236	174
393.10	197	0.4240	0.06978	0.07522	0.9999	399	235	173
410.10	197	0.4241	0.06868	0.07403	1.0000	393	232	171
427.10	197	0.4302	0.06650	0.07163	1.0000	389	231	171
444.10	197	0.4257	0.06731	0.07254	0.9999	387	229	169
461.10	197	0.4344	0.06392	0.06881	0.9999	380	226	168
478.10	197	0.4373	0.06331	0.06813	0.9999	380	227	168
495.10	197	0.4376	0.06251	0.06727	0.9998	376	225	167
512.10	197	0.4416	0.06093	0.06554	0.9999	372	223	166
529.10	197	0.4387	0.06156	0.06624	1.0000	372	222	165
546.10	197	0.4395	0.06041	0.06500	0.9996	366	219	163
563.10	197	0.4402	0.06000	0.06455	0.9998	364	218	162
580.10	197	0.4423	0.05950	0.06400	0.9994	364	218	162
597.10	197	0.4413	0.05878	0.06323	0.9999	358	215	160
614.10	197	0.4420	0.05862	0.06305	0.9999	358	215	160
631.10	197	0.4555	0.05324	0.05717	0.9998	342	208	156
648.10	197	0.4601	0.05174	0.05553	0.9999	338	206	155
665.10	197	0.4603	0.05192	0.05572	0.9999	340	207	155

						Rate 1	Rate 2	Rate 3
						40	100	170
Time	Temp	n	K	Kv	Corr			
Min	°F		Lbf*s^n/ft^n	Lbf*s^n/ft^2		CentiPoise	CentiPoise	CentiPoise
682.10	197	0.4573	0.05197	0.05579	0.9998	336	204	153
699.10	197	0.4607	0.05106	0.05480	0.9997	334	204	153
716.10	197	0.4595	0.05125	0.05501	0.9997	334	204	153
733.10	197	0.4637	0.04948	0.05308	0.9997	328	200	151
750.10	197	0.4649	0.04937	0.05295	0.9999	328	201	151
767.10	197	0.4638	0.04932	0.05291	0.9999	327	200	150
784.10	197	0.4676	0.04828	0.05177	0.9999	324	199	150
801.10	197	0.4678	0.04835	0.05184	0.9999	325	200	150
818.10	197	0.4676	0.04748	0.05091	0.9997	319	196	148
835.10	197	0.4693	0.04733	0.05073	0.9999	320	197	148
852.10	197	0.4683	0.04748	0.05090	0.9997	320	196	148
869.10	197	0.4703	0.04667	0.05003	0.9994	317	195	147
886.10	197	0.4715	0.04654	0.04987	0.9998	317	195	148
903.10	197	0.4726	0.04563	0.04889	0.9999	312	193	146
920.10	197	0.4739	0.04537	0.04861	0.9998	312	193	146
937.10	197	0.4678	0.04646	0.04981	0.9999	312	192	145
954.10	197	0.4741	0.04457	0.04775	1.0000	307	189	143
971.10	197	0.4797	0.04394	0.04705	1.0000	309	192	145
988.10	197	0.4780	0.04386	0.04696	0.9999	306	190	144
1005.10	197	0.4796	0.04336	0.04642	0.9998	304	189	143
1022.10	197	0.4780	0.04379	0.04689	0.9998	306	189	144
1039.10	197	0.4862	0.04191	0.04484	0.9996	302	188	143
1056.10	197	0.4783	0.04300	0.04604	1.0000	300	186	141
1073.10	197	0.4807	0.04255	0.04555	1.0000	300	186	142
1090.10	197	0.4882	0.04109	0.04394	1.0000	298	186	142

Log number
P2990972-18

Temperature
200°F

Customer
J. THOMPSON

Location
BJS TTC

Fluid System
NPHGS [REACTIVE ALUMINA [AC16AM] ALUCHEM INC, ONE LANDY LANE, READING OHIO 45215)], AWD/W.E. 200°F
[SAMPLE # 04-0406, 75°F]

Additives
OFF ROAD DIESEL, 100 PPT AL 2-ETHYL HEXANOATE, 40 PPT REACTIVE ALUMINA [AC 16AM], 60 GPT
SYLFAT-1 FA-1, 4 GPT PETROSURF XL

Breaker
N/A

Initial pH
N/A

Final pH

Comments
R1B5HC/FAMN #1HC

						Rate 1	Rate 2	Rate 3
						40	100	170
Time	Temp	n	K	Kv	Corr			
Min	°F		Lbf*s^n/ft^n	Lbf*s^n/ft^2		CentiPoise	CentiPoise	CentiPoise
2.12	88	0.2453	0.43526	0.47820	0.9988	1288	645	432
19.12	184	0.5581	0.09480	0.10049	0.9968	889	593	469
36.12	197	0.4521	0.11281	0.12119	0.9992	716	433	324
53.12	199	0.4045	0.12416	0.13415	0.9983	661	383	279
70.12	199	0.3793	0.13393	0.14513	0.9996	650	368	265
87.12	199	0.3737	0.13296	0.14417	0.9996	632	356	255
104.12	199	0.3657	0.13384	0.14526	0.9997	617	345	247
121.12	199	0.3589	0.13522	0.14686	0.9996	608	338	241
138.12	199	0.3596	0.13323	0.14469	0.9999	601	334	238
155.12	199	0.3585	0.13217	0.14356	1.0000	594	330	235
172.12	199	0.3508	0.13467	0.14640	0.9998	588	324	230
189.12	199	0.3456	0.13612	0.14806	0.9998	583	320	226
206.12	199	0.3431	0.13605	0.14803	0.9998	577	316	223
223.12	199	0.3424	0.13522	0.14713	0.9999	572	313	221
240.12	199	0.3405	0.13482	0.14673	0.9999	567	310	218
257.12	199	0.3335	0.13785	0.15014	0.9998	565	307	215
274.12	199	0.3362	0.13488	0.14686	0.9999	558	304	214
291.12	199	0.3361	0.13367	0.14554	0.9997	553	301	212
308.12	199	0.3313	0.13541	0.14752	0.9997	550	298	209
325.12	199	0.3305	0.13496	0.14704	0.9999	547	296	208
342.12	199	0.3322	0.13345	0.14536	1.0000	544	295	207
359.12	198	0.3270	0.13544	0.14762	0.9999	542	292	205
376.12	198	0.3272	0.13427	0.14634	0.9999	537	290	203
393.12	198	0.3265	0.13431	0.14639	0.9999	536	289	202
410.12	198	0.3245	0.13415	0.14626	0.9999	532	286	200
427.12	198	0.3249	0.13341	0.14544	0.9999	529	285	199
444.12	198	0.3223	0.13410	0.14623	1.0000	527	283	198
461.12	198	0.3253	0.13167	0.14353	0.9999	523	282	197
478.12	198	0.3279	0.12969	0.14134	0.9998	520	281	197
495.12	198	0.3199	0.13334	0.14544	0.9999	519	279	194
512.12	198	0.3263	0.12914	0.14076	0.9999	515	278	194
529.12	198	0.3271	0.12851	0.14007	0.9997	514	277	194
546.12	198	0.3268	0.12819	0.13972	0.9997	512	276	193
563.12	198	0.3256	0.12810	0.13964	0.9998	510	275	192
580.12	198	0.3252	0.12781	0.13933	0.9999	508	274	191
597.12	198	0.3222	0.12875	0.14040	1.0000	506	272	190
614.12	198	0.3230	0.12823	0.13983	0.9999	505	272	190
631.12	198	0.3264	0.12554	0.13683	0.9996	501	270	189
648.12	198	0.3240	0.12629	0.13769	0.9998	499	269	188
665.12	198	0.3220	0.12690	0.13838	0.9999	498	268	187

						Rate 1	Rate 2	Rate 3
						40	100	170
Time	Temp	n	K	Kv	Corr			
Min	°F		Lbf*s^n/ft^n	Lbf*s^n/ft^2		CentiPoise	CentiPoise	CentiPoise
682.12	198	0.3210	0.12661	0.13808	1.0000	495	266	185
699.12	198	0.3272	0.12294	0.13400	0.9999	492	266	186
716.12	198	0.3275	0.12247	0.13347	0.9997	491	265	185
733.12	198	0.3273	0.12208	0.13305	0.9997	489	264	185
750.12	198	0.3276	0.12121	0.13211	0.9998	486	262	184
767.12	198	0.3255	0.12193	0.13292	0.9999	485	261	183
784.12	198	0.3270	0.12085	0.13171	0.9996	483	261	183
801.12	198	0.3264	0.12074	0.13160	0.9997	482	260	182
818.12	198	0.3281	0.11967	0.13042	0.9997	480	260	182
835.12	198	0.3232	0.12173	0.13273	1.0000	480	258	180
852.12	198	0.3249	0.12009	0.13092	0.9998	477	257	179
869.12	198	0.3258	0.11929	0.13004	0.9998	475	256	179
886.12	198	0.3260	0.11881	0.12951	0.9999	473	255	179
903.12	198	0.3321	0.11550	0.12582	0.9999	471	255	179
920.12	198	0.3231	0.11949	0.13029	0.9997	471	253	177
937.12	199	0.3266	0.11728	0.12783	0.9995	468	253	177
954.12	198	0.3360	0.11294	0.12298	0.9992	467	254	179
971.12	198	0.3321	0.11416	0.12436	0.9997	465	252	177
988.12	198	0.3312	0.11434	0.12457	0.9998	464	252	176
1005.12	198	0.3303	0.11433	0.12456	0.9998	463	251	176
1022.12	198	0.3303	0.11391	0.12411	0.9997	461	250	175
1039.12	198	0.3300	0.11332	0.12347	0.9997	458	248	174
1056.12	197	0.3386	0.10907	0.11873	0.9994	455	248	175
1073.12	197	0.3114	0.12158	0.13274	0.9997	459	244	169
1090.12	198	0.3378	0.11068	0.12049	0.9995	461	251	177
1107.12	198	0.3418	0.10845	0.11801	0.9995	458	251	177
1124.12	198	0.3383	0.10972	0.11944	0.9996	457	249	176
1141.12	198	0.3367	0.11025	0.12003	0.9997	457	249	175
1158.12	198	0.3394	0.10879	0.11841	0.9993	455	249	175
1175.12	198	0.3400	0.10865	0.11825	0.9995	456	249	175
1192.12	198	0.3362	0.11025	0.12005	0.9994	456	248	175
1209.12	198	0.3384	0.10917	0.11884	0.9994	455	248	175
1226.12	199	0.3427	0.10711	0.11655	0.9993	454	249	175
1243.12	199	0.3396	0.10826	0.11783	0.9994	453	248	174
1260.12	199	0.3381	0.10827	0.11787	0.9994	451	246	173
1277.12	199	0.3354	0.10967	0.11943	0.9996	452	246	173
1294.12	199	0.3340	0.10988	0.11967	0.9996	451	245	172
1311.12	199	0.3357	0.10930	0.11902	0.9994	451	246	173
1328.12	199	0.3357	0.10875	0.11842	0.9996	449	244	172
1345.12	199	0.3384	0.10734	0.11685	0.9996	448	244	172

						Rate 1	Rate 2	Rate 3
						40	100	170
Time	Temp	n	K	Kv	Corr			
Min	°F		Lbf*s^n/ft^n	Lbf*s^n/ft^2		CentiPoise	CentiPoise	CentiPoise
1362.12	199	0.3353	0.10855	0.11821	0.9997	448	243	171

Log number
12193

Temperature
200°F

Customer
J. THOMPSON

Location
BJS TTC

Fluid System
NPHGS (W/AC11AM), AWD/W.E., ALUCHEM INC. ALUMINA, 200 °F

Additives
OFF ROAD DIESEL, 100 PPT AL 2-ETHYLHEXANOATE, 40 PPT AC 16 AM, 60 GPT SYLFAT FA-1, 4 GPT PETROSURF XL.

Breaker
NONE

Initial pH
N/A

Final pH

Comments
P2990972-19

						Rate 1	Rate 2	Rate 3
						40	100	170
Time	Temp	n	K	Ky	Corr			
Min	°F		Lbf*s^n/ft^n	Lbf*s^n/ft^2		CentiPoise	CentiPoise	CentiPoise
2.10	76	0.4187	0.22839	0.24634	0.9966	1281	752	552
19.10	186	0.4536	0.12191	0.13093	0.9995	778	471	353
36.10	200	0.4382	0.10662	0.11473	1.0000	643	384	285
53.10	202	NaN	NaN	NaN	NaN	NaN	NaN	NaN
70.10	202	0.4314	0.10265	0.11055	0.9998	603	358	265
87.10	202	0.4221	0.10458	0.11276	0.9998	594	350	257
104.10	202	0.4249	0.10146	0.10935	0.9998	582	344	253
121.10	202	0.4265	0.09904	0.10673	0.9998	572	338	249
138.10	202	0.4197	0.10032	0.10820	0.9999	565	332	244
155.10	202	0.4127	0.10175	0.10983	0.9999	558	326	239
172.10	202	0.4229	0.09591	0.10339	0.9998	546	322	237
189.10	202	0.4197	0.09579	0.10331	0.9999	539	317	233
206.10	202	0.4199	0.09442	0.10182	0.9998	532	313	230
223.10	202	0.4124	0.09633	0.10398	1.0000	528	308	226
240.10	202	0.4243	0.09051	0.09755	0.9998	518	306	225
257.10	202	0.4171	0.09227	0.09954	0.9999	514	302	221
274.10	202	0.4178	0.09094	0.09810	1.0000	508	298	219
291.10	202	0.4253	0.08713	0.09390	0.9998	501	296	218
308.10	202	0.4172	0.08932	0.09636	0.9998	498	292	214
325.10	202	0.4215	0.08660	0.09337	0.9998	491	289	212
342.10	202	0.4187	0.08700	0.09384	0.9998	488	286	210
359.10	202	0.4215	0.08511	0.09177	0.9998	482	284	209
376.10	202	0.4184	0.08518	0.09188	0.9999	477	280	206
393.10	202	0.4212	0.08367	0.09022	0.9998	474	279	205
410.10	202	0.4283	0.08028	0.08649	0.9996	467	276	204
427.10	202	0.4217	0.08209	0.08851	0.9996	466	274	202
444.10	202	0.4240	0.08062	0.08690	0.9996	461	272	200
461.10	202	0.4274	0.07869	0.08478	0.9993	456	270	199
478.10	202	0.4215	0.08026	0.08654	0.9999	455	268	197
495.10	202	0.4289	0.07703	0.08298	0.9994	449	266	196
512.10	202	0.4261	0.07734	0.08335	0.9995	446	263	194
529.10	202	0.4249	0.07722	0.08323	0.9997	443	262	193
546.10	202	0.4237	0.07675	0.08273	0.9993	438	259	190
563.10	202	0.4251	0.07567	0.08155	0.9994	435	257	189
580.10	202	0.4231	0.07598	0.08191	0.9993	433	255	188
597.10	202	0.4306	0.07286	0.07847	0.9992	427	253	187
614.10	202	0.4256	0.07384	0.07957	0.9991	425	251	185
631.10	202	0.4269	0.07307	0.07874	0.9997	422	250	184
648.10	202	0.4294	0.07188	0.07743	0.9994	419	249	184
665.10	202	0.4264	0.07207	0.07767	0.9994	416	246	181

Log number
12194

Temperature
200°F

Customer
J. THOMPSON

Location
BJS TTC

Fluid System
NPHGS (W/ AC12 -325SG, CALCINED ALUMINA SUPERGROUND) AWD/W.E., 200°F

Additives
OFF ROAD DIESEL, 100 PPT AL 2-ETHYLHEXANOATE, 40 PPT AC12 -325SG, 60 GPT SYLFAT FA-1, 4 GPT PETROSURF XL

Breaker
NONE

Initial pH
N/A

Final pH
N/A

Comments
P2980972-19

						Rate 1	Rate 2	Rate 3
						40	100	170
Time	Temp	n	K	Kv	Corr			
Min	°F		Lbf*s^n/ft^n	Lbf*s^n/ft^2		CentiPoise	CentiPoise	CentiPoise
682.10	202	0.4355	0.06888	0.07414	0.9993	411	245	182
699.10	202	0.4301	0.07021	0.07562	0.9994	411	244	180
716.10	202	0.4291	0.06994	0.07534	0.9993	408	242	178
733.10	202	0.4330	0.06820	0.07343	0.9990	403	240	178
750.10	202	0.4341	0.06746	0.07263	0.9990	400	238	177
767.10	202	0.4291	0.06860	0.07389	0.9991	400	237	175
784.10	202	0.4263	0.06880	0.07414	0.9993	397	235	173
801.10	202	0.4342	0.06615	0.07122	0.9992	393	234	173
818.10	202	0.4323	0.06630	0.07140	0.9993	391	232	172
835.10	202	0.4305	0.06655	0.07168	0.9993	390	231	171
852.10	202	0.4326	0.06545	0.07048	0.9995	386	230	170
869.10	202	0.4446	0.06163	0.06627	0.9992	380	229	170
886.10	202	0.4406	0.06241	0.06714	0.9991	380	227	169
903.10	202	0.4390	0.06257	0.06732	0.9995	378	226	168
920.10	202	0.4411	0.06149	0.06614	0.9992	375	224	167
937.10	202	0.4434	0.06067	0.06525	0.9993	373	224	167
954.10	202	0.4359	0.06243	0.06720	0.9995	373	223	165
971.10	202	0.4407	0.06066	0.06526	0.9995	369	221	164
988.10	202	0.4455	0.05917	0.06361	0.9994	366	220	164
1005.10	202	0.4283	0.06355	0.06847	0.9995	369	219	161
1022.10	202	0.4401	0.05985	0.06439	0.9996	363	217	162
1039.10	202	0.4427	0.05885	0.06329	0.9992	361	216	161
1056.10	202	0.4365	0.06012	0.06470	0.9995	360	215	159

						Rate 1	Rate 2	Rate 3
						40	100	170
Time	Temp	n	K	Ky	Corr			
Min	'F		Lbf*s^n/ft^n	Lbf*s^n/ft^2		CentiPoise	CentiPoise	CentiPoise
2.10	182	0.4888	0.10114	0.10816	0.9962	735	460	351
19.10	199	0.4227	0.10002	0.10783	0.9996	569	335	247
36.10	202	0.4174	0.09253	0.09981	0.9997	517	303	222
53.10	202	0.4069	0.09245	0.09985	0.9999	496	288	210
70.10	202	0.4040	0.09130	0.09864	1.0000	485	281	205
87.10	201	0.4022	0.08983	0.09706	0.9999	474	274	200
104.10	201	0.3996	0.08840	0.09557	1.0000	462	267	194
121.10	201	0.4003	0 08646	0.09348	1.0000	453	262	190
138.10	201	0.4058	0.08185	0.08842	1.0000	438	254	185
155.10	201	0.4017	0.08204	0.08866	1.0000	432	250	182
172.10	202	0.4056	0.07835	0.08464	1.0000	419	243	177
189.10	201	0.4082	0.07651	0.08262	1.0000	413	240	175
206.10	202	0.4081	0.07443	0.08038	0.9999	401	233	170
223.10	201	0.4082	0.07374	0.07963	0.9999	398	231	169
240.10	201	0.4064	0.07290	0.07875	0.9996	391	227	166
257.10	202	0.4146	0.06906	0.07462	0.9999	382	223	164
274.10	201	0.4182	0.06771	0.07304	0.9999	379	222	163
291.10	201	0.4183	0.06631	0.07152	0.9999	371	218	160
308.10	202	0.4293	0.06252	0.06755	0.9998	365	216	160
325.10	201	0.4217	0.06403	0.06904	0.9998	363	214	157
342.10	202	0.4217	0.06284	0.06775	0.9997	356	210	154
359.10	202	0.4182	0.06380	0.06882	0.9998	357	210	154
376.10	202	0.4227	0.06163	0.06644	0.9997	351	207	152
393.10	202	0.4301	0.05935	0.06392	0.9995	347	206	152
410.10	201	0.4245	0.06035	0.06505	0.9997	346	204	150
427.10	202	0.4356	0.05706	0.06144	0.9987	341	203	151
444.10	202	0.4348	0.05661	0.06094	0.9998	337	201	149
461.10	201	0.4273	0.05834	0.06286	0.9997	338	200	147
478.10	202	0.4384	0.05475	0.05891	0.9998	330	197	147
495.10	202	0.4397	0.05453	0.05867	0.9997	330	198	147
512.10	201	0.4342	0.05532	0.05955	0.9995	329	196	145
529.10	202	0.4365	0.05422	0.05835	0.9996	325	194	144
546.10	202	0.4406	0.05282	0.05682	0.9998	321	192	143
563.10	201	0.4339	0.05457	0.05876	0.9997	324	193	143
580.10	201	0.4370	0.05323	0.05729	0.9999	319	191	141
597.10	202	0.4413	0.05152	0.05542	0.9999	314	188	140
614.10	202	0.4455	0.05085	0.05468	0.9997	315	189	141
631.10	201	0.4407	0.05182	0.05574	0.9998	315	189	140
648.10	202	0.4466	0.04971	0.05342	0.9996	311	188	140
665.10	202	0.4510	0.04868	0.05230	0.9998	308	186	139

						Rate 1	Rate 2	Rate 3
						40	100	170
Time	Temp	n	K	Ky	Corr			
Min	°F		Lbf*s^n/ft^n	Lbf*s^n/ft^2		CentiPoise	CentiPoise	CentiPoise
682.10	202	0.4519	0.04871	0.05233	1.0000	308	187	140
699.10	201	0.4469	0.04962	0.05334	0.9999	309	188	139
716.10	202	0.4534	0.04785	0.05140	0.9998	305	185	138
733.10	202	0.4614	0.04592	0.04927	0.9997	301	184	138
750.10	202	0.4644	0.04560	0.04891	0.9998	303	185	139
767.10	202	0.4529	0.04768	0.05121	0.9998	303	184	137
784.10	202	0.4574	0.04634	0.04975	0.9995	300	182	137
801.10	202	0.4670	0.04431	0.04751	0.9997	297	182	137
818.10	202	0.4532	0.04713	0.05063	0.9999	300	182	136
835.10	202	0.4531	0.04677	0.05023	1.0000	298	180	135
852.10	202	0.4646	0.04417	0.04737	0.9999	293	180	135
869.10	202	0.4557	0.04623	0.04954	0.9999	297	181	135
886.10	201	0.4580	0.04544	0.04878	1.0000	295	178	134
903 10	202	0.4674	0.04331	0.04644	0.9997	291	178	135
920.10	202	0.4625	0.04441	0.04765	0.9999	293	179	135
937.10	201	0.4632	0.04414	0.04735	0.9998	292	178	134
954.10	202	0.4684	0.04267	0.04575	0.9997	287	177	133
971.10	201	0.4652	0.04337	0.04652	0.9997	289	177	133
988.10	202	0.4702	0.04216	0.04521	0.9998	286	176	133

Log number
12195

Temperature
200°F

Customer
J. THOMPSON

Location
BJS TTC

Fluid System
NPHGS (W/ AC12 -325SG, CALCINED ALUMINA SUPERGROUND) AWD/W.E., 200°F

Additives
OFF ROAD DIESEL, 100 PPT AL 2-ETHYLHEXANOATE, 40 PPT AC12 -325SG, 60 GPT SYLFAT FA-1, 4 GPT PETROSURF XL

Breaker
NONE

Initial pH
N/A

Final pH
N/A

Comments
P2900972-19 (CONTINUATION)

						Rate 1	Rate 2	Rate 3
						40	100	170
Time	Temp	n	K	Kv	Corr			
Min	°F		Lbf*s^n/ft^n	Lbf*s^n/ft^2		CentiPoise	CentiPoise	CentiPoise
2.10	182	0.4888	0.10114	0.10816	0.9962	735	460	351
19.10	199	0.4227	0.10002	0.10783	0.9996	569	335	247
36.10	202	0.4174	0.09253	0.09981	0.9997	517	303	222
53.10	202	0.4069	0.09245	0.09985	0.9999	496	288	210
70.10	202	0.4040	0.09130	0.09864	1.0000	485	281	205
87.10	201	0.4022	0.08983	0.09708	0.9999	474	274	200
104.10	201	0.3996	0.08840	0.09557	1.0000	462	267	194
121.10	201	0.4003	0.08646	0.09346	1.0000	453	262	190
138.10	201	0.4058	0.08185	0.08842	1.0000	438	254	185
155.10	201	0.4017	0.08204	0.08866	1.0000	432	250	182
172.10	202	0.4056	0.07835	0.08464	1.0000	419	243	177
189.10	201	0.4082	0.07651	0.08262	1.0000	413	240	175
206.10	202	0.4081	0.07443	0.08038	0.9999	401	233	170
223.10	201	0.4082	0.07374	0.07963	0.9999	398	231	169
240.10	201	0.4064	0.07290	0.07875	0.9996	391	227	166
257.10	202	0.4146	0.06906	0.07452	0.9999	382	223	164
274.10	201	0.4182	0.06771	0.07304	0.9999	379	222	163
291.10	201	0.4183	0.06631	0.07152	0.9999	371	218	160
308.10	202	0.4293	0.06252	0.06735	0.9998	365	216	160
325.10	201	0.4217	0.06403	0.06904	0.9998	363	214	157
342.10	202	0.4217	0.06284	0.06775	0.9997	356	210	154
359.10	202	0.4182	0.06380	0.06882	0.9998	357	210	154
376.10	202	0.4227	0.06163	0.06644	0.9997	351	207	152
393.10	202	0.4301	0.05935	0.06392	0.9995	347	206	152
410.10	201	0.4245	0.06035	0.06505	0.9997	346	204	150
427.10	202	0.4356	0.05708	0.06144	0.9987	341	203	151
444.10	202	0.4348	0.05661	0.06094	0.9998	337	201	149
461.10	201	0.4273	0.05834	0.06286	0.9997	338	200	147
478.10	202	0.4384	0.05475	0.05891	0.9998	330	197	147
495.10	202	0.4397	0.05453	0.05867	0.9997	330	198	147
512.10	201	0.4342	0.05532	0.05955	0.9995	329	196	145
529.10	202	0.4365	0.05422	0.05835	0.9996	325	194	144
546.10	202	0.4406	0.05282	0.05682	0.9998	321	192	143
563.10	201	0.4339	0.05457	0.05876	0.9997	324	193	143
580.10	201	0.4370	0.05323	0.05729	0.9999	319	191	141
597.10	202	0.4413	0.05152	0.05542	0.9999	314	188	140
614.10	202	0.4455	0.05085	0.05466	0.9997	315	189	141
631.10	201	0.4407	0.05182	0.05574	0.9998	315	189	140
648.10	202	0.4486	0.04971	0.05342	0.9996	311	188	140
665.10	202	0.4510	0.04868	0.05230	0.9998	308	186	139

						Rate 1	Rate 2	Rate 3
						40	100	170
Time	Temp	n	K	Kv	Corr			
Min	°F		Lbf*s^n/ft^n	Lbf*s^n/ft^2		CentiPoise	CentiPoise	CentiPoise
682.10	202	0.4519	0.04871	0.05233	1.0000	309	187	140
699.10	201	0.4469	0.04962	0.05334	0.9999	309	186	139
716.10	202	0.4534	0.04785	0.05140	0.9998	305	185	138
733.10	202	0.4614	0.04592	0.04927	0.9997	301	184	138
750.10	202	0.4644	0.04560	0.04891	0.9998	303	185	139
767.10	202	0.4529	0.04768	0.05121	0.9998	303	184	137
784.10	202	0.4574	0.04634	0.04975	0.9995	300	182	137
801.10	202	0.4670	0.04431	0.04751	0.9997	297	182	137
818.10	202	0.4532	0.04713	0.05063	0.9999	300	182	136
835.10	202	0.4531	0.04677	0.05023	1.0000	298	180	135
852.10	202	0.4646	0.04417	0.04737	0.9999	293	180	135
869.10	202	0.4557	0.04623	0.04964	0.9999	297	181	135
886.10	201	0.4580	0.04544	0.04878	1.0000	295	179	134
903.10	202	0.4674	0.04331	0.04644	0.9997	291	178	135
920.10	202	0.4625	0.04441	0.04765	0.9999	293	179	135
937.10	201	0.4632	0.04414	0.04735	0.9998	292	178	134
954.10	202	0.4684	0.04267	0.04575	0.9997	287	177	133
971.10	201	0.4652	0.04337	0.04652	0.9997	289	177	133
988.10	202	0.4702	0.04218	0.04521	0.9998	286	176	133

Log number
P2988972-15

Temperature
200°F

Customer
J. THOMPSON

Location
BJS TTC

Fluid System
NPHGS (COMPOSITE SAMPLE [# 03-0406, OLEIC-VEG SYSTEM]), AWD/W.E. 200°F
[SAMPLE # 03-0406, 75°F]

Additives
OFF ROAD DIESEL, 32.4 GMS COMPOSITE SAMPLE

Breaker
N/A

Initial pH
N/A

Final pH

Comments
R1B5HC/FANN #1HC

						Rate 1	Rate 2	Rate 3
						40	100	170
Time	Temp	n	K	Kv	Corr			
Min	°F		Lbf*s^n/ft^n	Lbf*s^n/ft^2		CentiPoise	CentiPoise	CentiPoise
2.12	96	0.3043	1.16474	1.27254	0.9410	4283	2264	1565
19.12	185	0.3901	0.32545	0.35221	0.9996	1643	939	680
36.12	199	0.3613	0.31604	0.34316	0.9986	1434	799	569
53.12	201	0.3816	0.28054	0.30391	0.9997	1372	779	561
70.12	201	0.3765	0.27650	0.29971	0.9999	1327	750	539
87.12	200	0.3770	0.26987	0.29251	0.9998	1298	733	527
104.12	200	0.3746	0.26676	0.28921	0.9997	1272	717	515
121.12	200	0.3745	0.26270	0.28482	0.9994	1252	706	506
138.12	200	0.3724	0.26163	0.28372	0.9993	1237	696	499
155.12	200	0.3753	0.25518	0.27663	0.9992	1220	688	494
172.12	199	0.3762	0.25104	0.27213	0.9993	1204	680	488
189.12	200	0.3802	0.24398	0.26434	0.9994	1187	673	484
206.12	200	0.3797	0.24169	0.26188	0.9996	1174	665	478
223.12	200	0.3786	0.24065	0.26079	0.9989	1164	659	474
240.12	200	0.3819	0.23505	0.25462	0.9995	1151	653	471
257.12	199	0.3746	0.24014	0.26036	0.9996	1145	645	463
274.12	199	0.3882	0.22576	0.24438	0.9993	1132	646	467
291.12	199	0.3779	0.23289	0.25240	0.9997	1124	635	457
308.12	199	0.3777	0.23168	0.25109	0.9999	1117	632	454
325.12	199	0.3902	0.21831	0.23626	0.9991	1102	630	456
342.12	199	0.3879	0.21787	0.23584	0.9994	1091	622	450
359.12	199	0.3886	0.21527	0.23301	0.9994	1080	617	446
376.12	199	0.3907	0.21183	0.22924	0.9995	1072	613	444
393.12	199	0.3948	0.20757	0.22452	0.9987	1066	612	444
410.12	199	0.3909	0.20886	0.22602	0.9995	1057	605	438
427.12	199	0.3934	0.20533	0.22212	0.9994	1049	602	436
444.12	199	0.3935	0.20403	0.22072	0.9993	1043	598	434
461.12	199	0.3967	0.20060	0.21693	0.9989	1037	597	433
478.12	199	0.3998	0.19675	0.21269	0.9988	1029	594	432
495.12	199	0.3991	0.19591	0.21180	0.9996	1022	589	429
512.12	199	0.3918	0.20084	0.21731	0.9993	1020	584	423
529.12	199	0.3955	0.19747	0.21357	0.9995	1017	584	424
546.12	199	0.3932	0.19835	0.21458	0.9996	1012	581	421
563.12	199	0.3958	0.19506	0.21096	0.9996	1006	578	420
580.12	199	0.4002	0.19140	0.20690	0.9992	1003	579	421
597.12	199	0.4002	0.19023	0.20564	0.9993	997	575	418
614.12	199	0.3996	0.18987	0.20526	0.9995	992	572	416
631.12	199	0.3990	0.18921	0.20456	0.9995	987	569	414
648.12	199	0.3944	0.19173	0.20740	0.9991	983	565	409
665.12	199	0.4045	0.18375	0.19852	0.9990	978	567	413

						Rate 1	Rate 2	Rate 3
						40	100	170
Time	Temp	n	K	Kv	Corr			
Min	°F		Lbf*s^n/ft^n	Lbf*s^n/ft^2		CentiPoise	CentiPoise	CentiPoise
682.12	199	0.4046	0.18250	0.19718	0.9995	972	563	411
699.12	199	0.3927	0.19072	0.20634	0.9996	972	557	404
716.12	199	0.3949	0.18832	0.20370	0.9995	968	556	403
733.12	199	0.3989	0.18490	0.19990	0.9993	964	556	404
750.12	199	0.4066	0.17884	0.19318	0.9992	959	557	407
767.12	199	0.4055	0.17894	0.19331	0.9992	956	554	404
784.12	199	0.4090	0.17595	0.18999	0.9990	952	554	405
801.12	199	0.4002	0.18153	0.19623	0.9994	951	549	399
818.12	199	0.4036	0.17854	0.19292	0.9993	947	548	400
835.12	199	0.4073	0.17611	0.19021	0.9989	947	550	402
852.12	199	0.3991	0.18103	0.19571	0.9993	945	545	396
869.12	199	0.4014	0.17853	0.19296	0.9993	940	543	395
886.12	199	0.4018	0.17822	0.19261	0.9991	939	543	395
903.12	199	0.4061	0.17465	0.18866	0.9990	935	543	396
920.12	199	0.4088	0.17232	0.18608	0.9988	932	542	396
937.12	199	0.4024	0.17620	0.19041	0.9993	931	538	392
954.12	199	0.4066	0.17309	0.18696	0.9992	928	539	393
971.12	199	0.4043	0.17442	0.18846	0.9994	928	537	392
988.12	199	0.4008	0.17617	0.19042	0.9995	925	534	389
1005.12	199	0.3999	0.17673	0.19104	0.9994	925	534	388
1022.12	199	0.4021	0.18237	0.19709	0.9993	962	556	405
1039.12	199	0.4015	0.18304	0.19783	0.9992	963	557	405
1056.12	199	0.3775	0.21671	0.23487	0.9994	1044	590	424
1073.12	199	0.3753	0.22256	0.24127	0.9995	1064	600	431

B

CA 02303465 2000-03-29

B-1

Log Number 12259
Temperature 250°F
Customer = J. THOMPSON
Location = BJS TTC
Fluid System NPHGS (CRUDE), SAMPLE 98-12-0808 250°F
Additives = FIELD CRUDE, 100 PPT AL OCTOATE, 40 GPT Sylfat FA-1 TOFA, 10 GPT XYLENE, 5 GPT VISCOMASTER 2100
4 GPT PETROSU F XL, 4 GPT AL TRI-SEC-BUTOXIDE, 150 PPT SMA.X-31980
Breaker = NONE
Final pH = N/A
Initial pH = N/A
Comments = R1B5 FANN #1

Time Min	Temp. Deg. F	n	K Lbf*s^n/ft^2	Corr.	Vis@ 40/s cP	Vis@ 100/s cP	Vis@ 170/s cP
2.1	90	0.8914	0.00113	1	36	33	31
34.1	252	0.2732	1.57501	0.9936	5164	2653	1804
66.1	252	0.179	2.12914	0.9503	4932	2324	1504
98.1	251	0.4704	0.4121	0.9659	2797	1721	1300
130.1	251	0.5468	0.21312	0.7489	1917	1266	995
162.1	250	0.4751	0.24573	0.7461	1697	1049	794
194.1	251	0.8071	0.06595	0.8903	1550	1299	1172
226.1	250	0.3816	0.38157	0.9403	1866	1059	763
258.1	250	0.5309	0.20305	0.9588	1723	1121	874
290.1	250	0.5759	0.16487	0.8171	1651	1120	894
322.1	250	0.588	0.13028	0.97	1364	935	752
354.1	250	0.8315	0.05391	0.945	1386	1188	1086
386.1	250	0.8838	0.05665	0.9942	1767	1588	1493
418.1	250	1.1129	0.01941	0.8637	1409	1563	1659
450.1	250	0.8671	0.05143	0.9797	1508	1335	1244
482.1	250	0.5389	0.18191	0.9893	1589	1042	816
514.1	250	0.7153	0.09402	0.7739	1575	1213	1043
546.1	249	0.7714	0.06523	0.9724	1344	1090	965
578.1	249	0.7493	0.07129	0.9629	1354	1076	942
610.1	250	0.6458	0.125	0.9568	1620	1171	970
642.1	249	0.8239	0.0693	0.9975	1733	1474	1343
674.1	250	0.65	0.11543	0.9798	1519	1103	916
706.1	249	0.4158	0.26151	0.9166	1451	850	623
738.1	250	0.5608	0.159	0.8936	1506	1007	798
770.1	250	0.9596	0.03594	0.9799	1482	1428	1398
802.1	251	1.3072	0.00888	0.9197	1320	1749	2059
834.1	251	0.8376	0.06015	0.951	1582	1363	1251

B-2

Log Number 12300
Temperature 200°F
Customer = J. THOMPSON
Location = BJS TTC
Fluid System NPHGS (BJS SYS.), W/ CO2 200°F
Additives = OFF-ROAD DIESEL, 100 PPT AL 2 ETHYLHEXANOATE, 60 GPT G-20, 5 GPT PETROSURF XL
Breaker = N/A
Final pH = N/A
Initial pH = N/A
Comments = R1B5HC/FANN #4

Time Min	Temp. Deg. F	n	K Lbf*s^n/ft^2	Corr.	Vis@ 40/s cP	Vis@ 100/s cP	Vis@ 170/s cP
2.1	75	0.0888	1.43116	0.8134	2377	1031	636
19.1	141	0.1953	1.07212	0.9977	2637	1262	823
36.1	198	0.121	1.25436	1	2346	1048	658
53.1	209	0.1158	1.21695	1	2233	993	621
70.1	207	0.1096	1.24349	0.9999	2230	986	615
87.1	205	0.1073	1.25056	1	2224	981	611
104.1	203	0.1051	1.25931	1	2221	978	608
121.1	202	0.1033	1.26623	1	2218	975	606
138.1	202	0.1031	1.26476	1	2214	973	605
155.1	202	0.1025	1.26457	1	2209	971	603
172.1	202	0.1006	1.27171	1	2206	968	600
189.1	202	0.1005	1.26832	1	2199	965	598
206.1	202	0.1015	1.25927	1	2192	962	597
223.1	202	0.1011	1.25855	0.9999	2187	960	596
240.1	202	0.0996	1.26363	1	2184	957	594
257.1	201	0.0999	1.25988	1	2180	955	593
274.1	202	0.1002	1.25633	1	2176	954	592
291.1	202	0.0925	1.30083	0.9881	2190	953	589
308.1	202	0.0995	1.25761	1	2173	952	590
325.1	202	0.099	1.25679	0.9999	2167	949	588
342.1	201	0.098	1.26142	1	2167	948	588
359.1	202	0.0982	1.2567	1	2161	946	586
376.1	202	0.0973	1.26517	0.9999	2168	948	587
393.1	201	0.0982	1.25477	1	2157	944	585
410.1	202	0.0985	1.25056	0.9999	2153	942	584
427.1	201	0.0969	1.25783	0.9999	2152	941	583
444.1	202	0.0979	1.24943	1	2146	939	582
461.1	201	0.0966	1.25637	0.9999	2147	938	581
478.1	202	0.0972	1.24963	0.9999	2141	936	580
495.1	201	0.0963	1.25455	0.9999	2142	936	579
512.1	202	0.0963	1.25237	1	2138	934	578
529.1	201	0.1052	1.31608	0.9959	2322	1023	636
546.1	202	0.0781	1.5368	0.8962	2453	1054	646
563.1	202	0.3778	0.28424	0.8953	1371	775	557
580.1	202	0.446	0.23227	0.5192	1441	867	646
597.1	202	0.3036	0.29556	0.6834	1084	573	396
614.1	201	0.2705	0.15332	0.179	498	255	173
631.1	202	0.2799	0.06061	0.86	204	105	72
648.1	201	0.266	0.03935	1	126	64	43
665.1	202	0.2674	0.03751	0.9965	120	62	42
682.1	201	0.2664	0.03855	0.9999	123	63	43
699.1	202	0.2838	0.03458	0.9991	118	61	42
716.1	202	0.2704	0.0359	0.9996	117	60	41
733.1	202	0.2988	0.02897	0.9999	104	55	38
750.1	202	0.266	0.03733	0.9948	119	61	41
767.1	201	0.2642	0.03548	0.9995	113	57	39
784.1	202	0.2796	0.03304	0.9988	111	57	39
801.1	201	0.3881	0.01647	0.9968	83	47	34

818.1	202	0.3443	0.01968	0.9971	84	46	32
835.1	201	0.3549	0.01889	0.9973	84	46	33
852.1	202	0.3572	0.01816	0.9994	81	45	32
869.1	202	0.3501	0.01919	0.9965	84	46	33
886.1	201	0.3573	0.0178	0.9992	80	44	31
903.1	201	0.3709	0.01679	0.9998	79	44	32
920.1	202	0.3621	0.01748	0.9994	80	44	32
937.1	202	0.3608	0.01772	0.9997	80	45	32
954.1	201	0.3578	0.01766	0.9996	79	44	31
971.1	202	0.3675	0.0169	0.9996	78	44	31
988.1	202	0.3655	0.01703	0.9997	78	44	31

Log Number 12400
Temperature 212°F
Customer = J. THOMPSON, SR. FR-9961
Location = BJS TTC
Fluid System NPHGS (JET-28AE / GBO-5L)
Additives = OFF-ROAD DIESEL, 1 GPT HOH, 30 GPT JET-55AE (SMA 3840), 4 GPT PXL [LOT 990489, 1 GPT ACTIVATOR (2)
Breaker = NONE
Final pH = N/A
Initial pH = N/A
Comments = R1B5HC/FANN #2

Time Min	Temp. Deg. F	n	K Lbf*s^n/ft^2	Corr.	Vis@ 40/s cP	Vis@ 100/s cP	Vis@ 170/s cP
19.1	202	0.0343	1.89528	0.928	2574	1063	637
36.1	216	0.0381	1.61549	0.9825	2225	922	553
53.1	217	0.0454	1.43893	0.992	2036	849	512
70.1	217	0.0458	1.35619	0.9798	1922	802	483
87.1	216	0.0398	1.35322	0.9907	1876	778	468
104.1	216	0.043	1.29787	0.9791	1820	757	456
121.1	216	0.0425	1.29088	0.9883	1807	752	452
138.1	216	0.0331	1.33917	0.9717	1811	747	447
155.1	216	0.0379	1.29386	0.9836	1781	738	443
172.1	216	0.0281	1.36011	0.9562	1806	741	442
189.1	216	0.0381	1.29933	0.9596	1790	741	445
206.1	216	0.0326	1.33916	0.9793	1808	745	446
223.1	216	0.0366	1.30416	0.9593	1787	739	443
240.1	216	0.0359	1.30627	0.9909	1785	738	442
257.1	216	0.0384	1.29005	0.9877	1779	737	442
274.1	216	0.0438	1.25164	0.9597	1761	733	441
291.1	216	0.0301	1.33322	0.9665	1783	733	438
308.1	216	0.0292	1.3346	0.9983	1779	731	437
325.1	216	0.0306	1.3171	0.8776	1765	726	434
342.1	216	0.0308	1.31552	0.9488	1764	726	434
359.1	216	0.0221	1.37458	0.7882	1785	729	434
376.1	216	0.0285	1.32162	0.8652	1757	721	431
393.1	215	0.0251	1.34356	0.8632	1764	722	430
410.1	215	0.0215	1.36757	0.8958	1772	723	430
427.1	216	0.0252	1.33265	0.8648	1750	716	427
444.1	215	0.023	1.34665	0.88	1754	717	427
461.1	215	0.0169	1.38803	0.7076	1768	718	426
478.1	215	0.0168	1.38483	0.6595	1763	716	425
495.1	215	0.02	1.35813	0.8355	1750	713	424
512.1	215	0.0158	1.38154	0.7328	1753	711	422
529.1	215	0.0188	1.35892	0.7487	1743	709	421
546.1	215	0.0218	1.33636	0.9598	1733	707	421
563.1	215	0.0157	1.38348	0.9063	1755	712	422
580.1	215	0.0166	1.37066	0.6954	1744	708	420
597.1	215	0.0169	1.36427	0.8453	1738	706	419
614.1	215	0.0131	1.39414	0.821	1751	709	420
631.1	215	0.0092	1.42391	0.5981	1763	711	420
648.1	215	0.0185	1.34573	0.9752	1724	702	417
665.1	215	0.0084	1.42714	0.5089	1762	710	420
682.1	215	0.0098	1.41512	0.7689	1756	709	419
699.1	215	0.0071	1.4387	0.5565	1768	712	420
716.1	215	0.0169	1.34922	0.7571	1719	698	414
733.1	215	0.0091	1.41498	0.5701	1751	706	418
750.1	215	0.0133	1.37689	0.7653	1731	701	415
767.1	215	0.0117	1.38661	0.837	1733	701	415
784.1	215	0.01	1.40154	0.6996	1740	703	415
801.1	215	0.0168	1.34182	0.8893	1709	694	412

818.1	215	0.0147	1.36088	0.8154	1720	697	413
835.1	215	0.0098	1.39832	0.6496	1735	700	414
852.1	215	0.0122	1.38138	0.6895	1729	700	414
869.1	215	0.0088	1.41277	0.3599	1747	704	416
886.1	215	0.0056	1.4379	0.4184	1757	706	417
903.1	215	0.0123	1.37862	0.863	1727	698	414
920.1	215	0.0112	1.38503	0.7473	1728	698	413
937.1	215	0.0116	1.37684	0.6901	1720	695	412
954.1	215	0.0123	1.37418	0.6368	1721	696	412
971.1	215	0.0053	1.43752	0.2416	1754	705	416
988.1	215	0.0097	1.40008	0.6491	1737	701	414
1005.1	215	0.0159	1.34437	0.9042	1706	692	411
1022.1	215	0.0087	1.40731	0.9041	1739	701	414
1039.1	215	0.0105	1.39462	0.4813	1735	701	415
1056.1	215	0.0101	1.39799	0.5868	1737	701	415
1073.1	215	0.0081	1.41335	0.4972	1743	702	415

Log Number 12401
Temperature 250°F
Customer = J. THOMPSON, SR. FR-9961
Location = BJS TTC
Fluid System NPHGS (JET-55AE), 250°F
Additives = OFF-ROAD DIESEL, 1 GPT HOH, 30 GPT JET-55AE, 4 GPT PXL [LOT 990489], 1 ACTIVATOR (2)
Breaker = NONE
Final pH = N/A
Initial pH = N/A
Comments = R1B5HC/FANN #5

Time Min	Temp. Deg. F	n	K Lbf*s^n/ft^2	Corr.	Vis@ 40/s cP	Vis@ 100/s cP	Vis@ 170/s cP
19.1	231	0.8406	0.03639	0.9488	968	836	768
36.1	253	0.3838	0.27654	0.9908	1364	775	559
53.1	255	0.3974	0.27238	0.9456	1412	813	590
70.1	254	0.3104	0.40425	0.9385	1520	808	561
87.1	254	0.2218	0.59991	0.9368	1627	798	528
104.1	254	0.0998	1.03724	0.9651	1794	786	488
121.1	254	0.0342	1.43932	0.9126	1954	807	483
138.1	254	0.0266	1.50508	0.8572	1987	814	486
155.1	254	0.0262	1.50262	0.9751	1981	812	484
172.1	254	0.0247	1.50632	0.9786	1975	808	482
189.1	253	0.0163	1.56228	0.8058	1986	806	478
206.1	253	0.0215	1.50778	0.8657	1954	797	474
223.1	253	0.0205	1.49736	0.9755	1933	788	468
240.1	253	0.0001	1.68981	0.01	2023	809	476
257.1	253	0.0105	1.55375	0.9329	1933	781	462
274.1	253	0.0172	1.4765	0.9347	1883	765	454
291.1	253	0.008	1.54237	0.6092	1901	766	453
308.1	253	0.0078	1.52811	0.6324	1882	758	448
325.1	253	0.01	1.49376	0.789	1855	749	443
342.1	253	0.0059	1.52317	0.8732	1863	749	442
359.1	253	0.007	1.49659	0.6816	1838	740	437
376.1	253	0.0015	1.54449	0.2685	1859	745	438
393.1	253	0.01	1.45394	0.9512	1806	729	431
410.1	253	0.0015	1.53053	0.3132	1842	738	434
427.1	253	0.0008	1.52897	0.1193	1835	735	432
444.1	253	0.0059	1.4653	0.5168	1792	721	425
478.1	252	0.0018	1.4942	0.1875	1800	721	425
495.1	252	0.0017	1.49808	0.2022	1804	723	426
512.1	252	0.0013	1.49339	0.1367	1796	719	423
529.1	252	0.0009	1.49446	0.1116	1795	718	423
580.1	252	0.0054	1.41936	0.8352	1733	697	411
597.1	252	0.0007	1.46998	0.1296	1764	706	415
631.1	252	0.0028	1.43669	0.2978	1737	697	410
682.1	252	0.0024	1.42902	0.5199	1726	692	407
699.1	252	0.0013	1.4338	0.9801	1724	691	406
767.1	252	0.0007	1.42941	0.1711	1715	687	404
852.1	252	0.0027	1.39404	0.8444	1685	676	398
954.1	252	0.0002	1.4184	0.0356	1699	680	400
971.1	252	0.003	1.37975	0.4416	1670	670	395
1005.1	252	0.0015	1.389	0.4304	1672	670	394
1022.1	252	0.0019	1.38139	0.3543	1665	667	393

Log Number 12409
Temperature 200°F
Customer = J. THOMPSON, SR. FR-9961
Location = BJS TTC
Fluid System NPHGS (JET-28AE) PXL LOT 970141 200°F
Additives = OFF-ROAD DIESEL, 1 GPT HOH, 30 GPT JET-55AE (SMA 3840), 5 GPT PXL [LOT 970141].
Breaker = NONE
Final pH = N/A
Initial pH = N/A
Comments = R1B5HC/FANN #2

Time Min	Temp. Deg. F	n	K Lbf*s^n/ft^2	Corr.	Vis@ 40/s cP	Vis@ 100/s cP	Vis@ 170/s cP
2.1	94	0.7814	0.04904	0.9979	1048	858	764
19.1	189	0.8633	0.01888	0.9998	546	482	448
36.1	202	0.996	0.01384	0.9994	653	650	649
53.1	204	1.0559	0.01114	0.9994	655	690	711
70.1	204	1.0749	0.01037	0.9992	654	701	729
87.1	204	1.087	0.00982	0.9993	648	702	735
104.1	203	1.0925	0.0095	0.9991	640	696	731
121.1	203	1.0993	0.00919	0.9993	635	695	733
138.1	203	1.1074	0.00882	0.9993	628	692	733
155.1	203	1.1165	0.00836	0.9994	615	684	728
172.1	203	1.1185	0.00822	0.9995	609	679	723
189.1	203	1.1229	0.00781	0.9994	588	658	703
206.1	203	1.1109	0.00796	0.9993	574	635	674
223.1	203	1.1177	0.00758	0.9992	560	624	664
240.1	203	1.1106	0.00755	0.9992	544	602	638
257.1	203	1.1042	0.00753	0.999	529	582	616
274.1	203	1.087	0.00795	0.9991	525	568	595
291.1	203	1.0898	0.00775	0.9988	517	561	588
308.1	203	1.0881	0.00776	0.9988	514	557	584
325.1	203	1.0926	0.00751	0.999	506	551	578
342.1	203	1.098	0.00725	0.999	498	545	574
359.1	203	1.0895	0.00741	0.9989	494	536	562
376.1	203	1.0954	0.00735	0.9991	500	546	574
393.1	203	1.1054	0.0072	0.9991	508	560	592
410.1	203	1.1086	0.00729	0.9991	521	575	610
427.1	203	1.1168	0.00717	0.9992	528	588	625
444.1	203	1.1237	0.00704	0.9993	532	596	636
461.1	203	1.1271	0.00705	0.9993	539	606	648
478.1	203	1.1251	0.00716	0.9993	544	610	652
495.1	203	1.1372	0.00688	0.9994	546	620	666
512.1	203	1.1372	0.0069	0.9994	548	621	668
529.1	203	1.1391	0.00685	0.9993	548	622	670
546.1	203	1.1362	0.00694	0.9993	549	622	669
563.1	203	1.1423	0.00677	0.9994	548	624	673
580.1	203	1.1431	0.00675	0.9992	548	625	674
597.1	203	1.1371	0.00693	0.9993	550	624	671
614.1	203	1.1392	0.0069	0.9993	552	627	675
631.1	203	1.1403	0.00689	0.9993	553	629	678
648.1	203	1.1432	0.0069	0.9992	560	639	689
665.1	203	1.1436	0.00699	0.9991	568	648	700
682.1	203	1.1536	0.00676	0.9991	570	657	712
699.1	203	1.1481	0.00689	0.999	570	652	706
716.1	203	1.1534	0.00677	0.9989	571	657	713
733.1	203	1.154	0.00673	0.9992	569	655	711
750.1	203	1.1537	0.00678	0.9991	572	659	715
767.1	203	1.1622	0.00653	0.9992	569	660	719
784.1	203	1.1527	0.00682	0.999	573	660	715

801.1	203	1.1505	0.00692	0.9986	577	663	718
818.1	203	1.1518	0.00689	0.9992	577	664	719
835.1	203	1.1506	0.00701	0.9988	585	671	727
852.1	203	1.1501	0.00704	0.9988	586	673	729
869.1	203	1.152	0.00699	0.999	586	674	730
886.1	203	1.144	0.0072	0.9988	586	669	722
903.1	203	1.1465	0.00712	0.9989	585	669	723
920.1	203	1.1484	0.00705	0.9991	583	668	723
937.1	203	1.1573	0.00676	0.9993	578	668	726
954.1	203	1.1544	0.00684	0.9993	579	667	724
971.1	203	1.1506	0.00693	0.999	578	664	719
988.1	203	1.1523	0.00686	0.999	576	662	718
1005.1	203	1.151	0.00687	0.9991	574	659	714
1022.1	203	1.1539	0.00675	0.9993	570	656	712

Log Number 123070
Temperature 150°F
Customer =
Location =
Fluid System NPHGS (JET061334A-E) ETHOX CHEMICALS @ 150°F
Additives = OFF-ROAD DIESEL, 1 GPT HOH, 40 GPT JET061334A-E, 5 GPT PXL
Breaker = N/A
Final pH =
Initial pH =
Comments = R1B5HC/FANN #2

Time Min	Temp. Deg. F	n	K Lbf*s^n/ft^2	Corr.	Vis@ 40/s cP	Vis@ 100/s cP	Vis@ 170/s cP
19.1	140	0.0228	4.6434	0.8036	6045	2469	1470
36.1	152	0.0981	3.07367	0.984	5283	2312	1433
53.1	154	0.1003	2.95246	0.9723	5116	2243	1392
70.1	154	0.083	2.97352	0.9901	4834	2086	1282
87.1	154	0.1121	2.59306	0.9613	4693	2080	1299
104.1	154	0.1679	2.02045	0.9962	4492	2096	1348
121.1	154	0.1898	1.88026	0.9861	4532	2157	1403

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Log Number 12371
Temperature 200°F
Customer =
Location =
Fluid System NPHGS (JET061334A-E) ETHOX CHEMICALS @ 200°F
Additives = OFF-ROAD DIESEL, 1 GPT HOH, 40 GPT JET061334A-E, 5 GPT PXL
Breaker = N/A
Final pH =
Initial pH =
Comments = R1B5HC/FANN #3

Time Min	Temp. Deg. F	n	K Lbf*s^n/ft^2	Corr.	Vis@ 40/s cP	Vis@ 100/s cP	Vis@ 170/s cP
19.1	184	0.0971	2.8046	0.9778	4803	2100	1300
36.1	200	0.2067	1.62057	0.951	4158	2010	1319
53.1	203	0.2662	1.25987	0.9424	4026	2055	1392
70.1	203	0.2665	1.26287	0.9828	4040	2063	1398
87.1	203	0.2721	1.24635	0.9229	4070	2089	1420
104.1	203	0.2291	1.48654	0.9904	4142	2044	1358
121.1	203	0.1439	1.89588	0.9786	3858	1761	1118
138.1	203	0.0712	2.79609	0.9248	4352	1858	1135
155.1	203	0.0912	2.64404	0.6762	4430	1926	1189
172.1	203	0.0914	2.52794	0.9141	4239	1844	1138

Log Number 12385
Temperature 250°F
Customer =
Location =
Fluid System NPHGS (JET061334A) ETHOX CHEMICAL
Additives = OFF-ROAD DIESEL, 1 GPT HOH, 30 GPT JET061334A, 5 GPT PXL
Breaker = N/A
Final pH =
Initial pH =
Comments = R1B5HC/FANN #5

Time Min	Temp. Deg. F	n	K Lbf*s^n/ft^2	Corr.	Vis@ 40/s cP	Vis@ 100/s cP	Vis@ 170/s cP
19.1	211	0.164	0.74147	0.9736	1625	755	485
36.1	250	0.4011	0.30867	0.979	1622	937	682
53.1	250	0.3181	0.45404	0.991	1757	941	655
70.1	250	0.3133	0.46762	0.9872	1778	948	658
87.1	250	0.2757	0.55695	0.9907	1843	949	646
104.1	250	0.2091	0.74203	0.988	1921	931	612
121.1	250	0.1904	0.81482	0.9937	1968	937	610
138.1	250	0.1597	0.94449	0.9942	2037	943	604
155.1	250	0.1018	1.22684	0.9454	2138	939	583
172.1	250	0.0522	1.52476	0.997	2212	928	561
223.1	250	0.0199	1.78403	0.6177	2298	936	556
240.1	250	0.0718	1.29495	0.7687	2020	863	527
257.1	250	0.0532	1.49544	0.9097	2178	915	553

Log Number 12386
Temperature 250°F
Customer =
Location =
Fluid System NPHGS (JET061334A) ETHOX CHEMICAL
Additives = OFF-ROAD DIESEL, 1 GPT HOH, 30 GPT JET061334A, 5 GPT PXL, 2 GPT JET0617-7
Breaker = N/A
Final pH =
Initial pH =
Comments = R1B5HC/FANN #2

Time Min	Temp. Deg. F	n	K Lbf*s^n/ft^2	Corr.	Vis@ 40/s cP	Vis@ 100/s cP	Vis@ 170/s cP
19.1	227	0.0278	3.15091	0.7819	4178	1714	1024
53.1	254	0.0173	3.7752	0.5222	4816	1957	1162
70.1	254	0.0218	3.68533	0.9275	4780	1951	1161
87.1	254	0.0268	3.54565	0.5844	4685	1920	1146
104.1	254	0.0281	3.46557	0.7682	4601	1888	1127
121.1	254	0.0133	3.65886	0.2303	4599	1862	1103
138.1	254	0.0759	2.55899	0.6211	4052	1738	1064
155.1	254	0.0935	2.35843	0.8145	3985	1737	1074
172.1	254	0.0779	2.48102	0.8533	3958	1700	1042
189.1	254	0.0989	2.24211	0.8504	3865	1693	1049
206.1	254	0.1053	2.17354	0.9177	3836	1690	1051
223.1	254	0.1103	2.08676	0.9187	3752	1660	1035
240.1	254	0.0183	3.19045	0.6944	4085	1662	987
257.1	254	0.1207	1.96439	0.922	3670	1640	1028
274.1	254	0.0651	2.52448	0.6692	3842	1631	993
291.1	254	0.0768	2.35568	0.8702	3743	1606	984
308.1	254	0.0711	2.38735	0.9972	3714	1586	969
325.1	253	0.0861	2.28365	0.9774	3755	1625	1001
342.1	253	0.067	2.47307	0.8133	3790	1612	982
359.1	253	0.0491	2.6344	0.6321	3779	1581	955
376.1	254	0.0209	3.03217	0.6503	3920	1598	951
393.1	254	0.0336	2.82544	0.669	3828	1579	946
427.1	253	0.0009	3.4718	0.0077	4169	1669	982
478.1	253	0.0108	3.22896	0.1574	4022	1625	961
495.1	253	0.033	2.89286	0.8468	3911	1612	965
512.1	253	0.024	3.03765	0.5863	3972	1624	968
529.1	253	0.0247	3.03023	0.5689	3973	1625	969
546.1	253	0.0029	3.48849	0.0904	4220	1693	997
563.1	253	0.0128	3.19261	0.2192	4006	1621	960
580.1	253	0.0356	2.7609	0.4332	3768	1557	933
597.1	253	0.0267	2.97	0.4167	3923	1608	959
699.1	253	0.0077	3.36566	0.5887	4144	1669	986
716.1	253	0.0086	3.35762	0.773	4148	1672	988
767.1	253	0.0038	3.45892	0.2987	4198	1685	993
869.1	253	0.0049	3.45119	0.149	4206	1690	997
886.1	253	0.0066	3.40127	0.1259	4171	1679	991
903.1	253	0.0101	3.35161	0.3263	4164	1681	994
920.1	253	0.0032	3.50595	0.1242	4246	1703	1004
937.1	253	0.0458	2.74938	0.8719	3896	1625	980
1005.1	253	0.0233	3.07695	0.7877	4013	1640	977
1022.1	253	0.031	2.96422	0.9183	3978	1637	979
1039.1	253	0.032	2.96223	0.3453	3990	1643	983
1073.1	253	0.0222	3.0784	0.4951	3999	1632	972
1107.1	253	0.0036	3.41347	0.107	4140	1661	979
1124.1	253	0.0362	2.87494	0.8057	3932	1626	975
1141.1	253	0.0097	3.26369	0.2073	4048	1634	966
1158.1	253	0.0089	3.31129	0.3904	4095	1652	976

Log Number 12373
Temperature 300°F
Customer =
Location =
Fluid System NPHGS (JET061334A-E) ETHOX CHEMICALS @ 300°F
Additives = OFF-ROAD DIESEL, 1 GPT HOH, 40 GPT JET061334A-E, 5 GPT PXL
Breaker = N/A
Final pH =
Initial pH =
Comments = R1B5HC/FANN #5

Time Min	Temp. Deg. F	n	K Lbf*s^n/ft^2	Corr.	Vis@ 40/s cP	Vis@ 100/s cP	Vis@ 170/s cP
19.1	270	0.0595	2.96746	0.9128	4423	1868	1134
36.1	303	0.091	3.11026	0.912	5207	2264	1398
53.1	305	0.1606	2.13387	0.9779	4618	2140	1371
70.1	304	0.1279	2.25184	0.9531	4320	1943	1223
87.1	305	0.1141	2.34946	0.9948	4284	1902	1189
104.1	306	0.0371	3.15287	0.2794	4327	1791	1074
121.1	305	0.1135	2.46699	0.9469	4488	1992	1244
138.1	304	0.0973	2.18164	0.7889	3739	1635	1013
155.1	304	0.1358	1.93981	0.7898	3831	1736	1097
172.1	304	0.1352	1.96107	0.7864	3865	1750	1106

Log Number 12475
Temperature 212°F
Customer = J. THOMPSON, SR. FR 9961
Location = BJS TTC
Fluid System NPHGS (JET062455A-E), With CITRIC ACID 212°F
Additives = OFF-ROAD DIESEL, 2 GPT EC-1, 2.5 GPT "Petrosurf XL", 30 GPT JET062455A-E
Breaker = NONE
Final pH = N/A
Initial pH = N/A
Comments = R1B5HC/ FANN# 5 (HC BS)

Time Min	Temp. Deg. F	n	K Lbf*s^n/ft^2	Corr.	Vis@ 40/s cP	Vis@ 100/s cP	Vis@ 170/s cP
16.7	189	0.192	0.94097	0.991	2287	1091	710
32.5	190	0.2398	0.74169	0.9909	2150	1071	716
48.3	184	0.2075	0.8811	0.9871	2267	1097	720
64.1	188	0.1626	1.13062	0.9865	2465	1145	734
79.9	198	0.1567	1.11424	0.9274	2377	1098	702
95.7	205	0.131	1.31764	0.9912	2557	1153	727
111.5	208	0.1578	1.09263	0.9655	2341	1082	692
127.3	210	0.1458	1.16374	0.9726	2385	1090	693
143.1	210	0.1271	1.21371	0.9738	2322	1043	657
158.9	210	0.1513	1.14812	0.9552	2401	1103	703
174.7	210	0.0929	1.45507	0.8477	2453	1069	660
190.5	210	0.0968	1.44849	0.9993	2478	1083	671
206.3	210	0.1377	1.18999	0.9548	2367	1074	680
222.1	210	0.1102	1.27377	0.9478	2289	1013	632
237.9	210	0.0857	1.41059	0.9033	2316	1002	617
253.7	210	0.1164	1.23424	0.9291	2269	1010	632
269.5	210	0.1103	1.2573	0.9313	2260	1000	624
285.3	210	0.0293	1.84642	0.5752	2462	1012	604
301.1	210	0.0816	1.46504	0.9979	2369	1021	627
316.9	209	0.0721	1.52942	0.9442	2388	1021	624
332.7	209	0.0775	1.48337	0.976	2363	1015	622
348.5	210	0.0827	1.44714	0.9612	2350	1014	623
364.3	209	0.073	1.4829	0.8713	2323	994	608
380.1	209	0.0921	1.3639	0.978	2293	998	616
395.9	209	0.0453	1.63395	0.826	2311	964	581
411.7	209	0.0557	1.54714	0.7427	2274	957	580
427.5	209	0.0465	1.63034	0.9543	2316	967	583
443.3	209	0.0735	1.37498	0.7745	2158	923	565
459.1	209	0.0843	1.37019	0.9809	2238	967	595
474.9	209	0.0882	1.33046	0.9973	2205	956	589
490.7	209	0.0809	1.36107	0.9225	2195	946	581
506.5	209	0.0838	1.35319	0.971	2206	953	586
522.3	209	0.1083	1.21149	0.9626	2162	955	595
538.1	209	0.1564	0.95871	0.9566	2043	943	603
553.9	209	0.1074	1.19497	0.9615	2125	938	584
569.7	209	0.1018	1.21545	0.8908	2118	930	577
585.5	209	0.1003	1.23181	0.9499	2134	936	581
601.3	209	0.0795	1.3357	0.9659	2143	922	566
617.1	209	0.0904	1.25731	0.9185	2100	913	563
632.9	209	0.105	1.16845	0.8233	2060	907	564
648.7	209	0.091	1.25319	0.9303	2098	912	563
664.5	209	0.0959	1.22516	0.9758	2089	912	565
680.3	209	0.1045	1.17135	0.8696	2061	907	564
696.1	209	0.1025	1.19155	0.9418	2081	915	568
711.9	209	0.1125	1.13431	0.9448	2056	912	569
727.7	209	0.1019	1.19048	0.9749	2075	911	566
743.5	209	0.1001	1.19329	0.9467	2066	906	562

759.3	209	0.0883	1.24905	0.9886	2071	898	554
775.1	209	0.118	1.081	0.8896	1999	891	558
790.9	209	0.1142	1.11373	0.9612	2031	902	564
806.7	209	0.1049	1.15945	0.9766	2043	900	560
822.5	209	0.1386	1.00214	0.984	2000	908	575
838.3	209	0.1029	1.1675	0.9642	2042	898	558
854.1	209	0.1044	1.16115	0.9394	2043	899	559
869.9	209	0.1047	1.14891	0.8974	2023	891	554
885.7	209	0.1013	1.16771	0.9446	2031	891	553
901.5	209	0.1031	1.16067	0.9589	2032	893	555
917.3	209	0.1043	1.15284	0.9849	2027	892	555
933.1	209	0.1003	1.17258	0.9516	2032	891	553
948.9	209	0.0943	1.21013	0.975	2051	894	553
964.7	209	0.0945	1.19862	0.9291	2033	887	548
980.5	209	0.1088	1.12767	0.9508	2016	891	555
996.3	209	0.0932	1.20661	0.9603	2037	887	548
1012.1	209	0.0922	1.21288	0.9111	2040	888	548

Log Number 12487
Temperature 212°F
Customer = J. THOMPSON, SR. FR 9961
Location = BJS TTC
Fluid System NPHGS (JET-31890), W/ CRUDE SAMPLE 98-12-0808 (TTC#10 w/ 1% Asphaltenes)
Additives = CRUDE SAMPLE 98-12-0808, 2 GPT "EC-1" (50:50 W/W Citric Acid in Water), 1 GPT NE-118, 30 GPT JET061334A-E, 5
Breaker = NONE
Final pH = N/A
Initial pH = N/A
Comments = R1B5HC/ FANN# 3 (Hastelloy C Bobshaft)

Time Min	Temp. Deg. F	n	K Lbf*s^n/ft^2	Corr.	Vis@ 40/s cP	Vis@ 100/s cP	Vis@ 170/s cP
2.1	88	0.3468	0.08995	0.9935	387	213	150
19.1	205	0.1414	0.86435	0.9937	1743	794	503
36.1	212	0.2432	0.35669	0.9972	1047	523	350
53.1	212	0.4477	0.09679	0.9775	604	364	272
70.1	212	0.7128	0.02208	0.9802	366	282	242
87.1	211	0.9864	0.0051	0.9811	232	229	228
104.1	211	1.1824	0.00176	0.9866	165	195	215
121.1	211	1.3242	0.00078	0.9918	123	166	197
138.1	211	1.3731	0.00052	0.9969	99	139	169
155.1	211	1.4013	0.00039	0.9992	82	119	147
172.1	211	1.4089	0.00034	0.9997	74	107	133
189.1	211	1.3864	0.00033	0.9992	66	94	115
206.1	211	1.4079	0.00028	0.9989	60	88	109
223.1	211	1.3929	0.00032	0.9997	65	94	115
240.1	211	1.3335	0.00054	0.9976	88	120	143
257.1	211	1.2461	0.00094	0.9932	112	140	159
274.1	211	1.1165	0.00181	0.991	133	148	158
291.1	211	1.0267	0.0029	0.9888	153	157	159
308.1	211	0.9374	0.00456	0.9863	173	164	158
325.1	211	0.8785	0.00628	0.9848	192	172	161
342.1	211	0.8234	0.00837	0.9847	209	178	162
359.1	211	0.7516	0.01207	0.9832	231	184	161
376.1	211	0.6844	0.01683	0.9836	252	188	159
393.1	211	0.6306	0.02227	0.9818	273	195	160
410.1	211	0.5688	0.03	0.9802	293	197	157
427.1	212	0.549	0.03401	0.9813	308	204	161
444.1	212	0.5115	0.04095	0.9828	323	207	160
461.1	212	0.4981	0.04494	0.9808	338	213	163
478.1	212	0.4947	0.04584	0.9826	340	214	164
495.1	212	0.4655	0.0543	0.9833	362	222	167
512.1	212	0.4529	0.05829	0.9884	371	225	168
529.1	212	0.4215	0.06872	0.992	389	229	169
546.1	212	0.3978	0.07775	0.991	404	232	169
563.1	212	0.3859	0.0831	0.9911	413	235	170
580.1	212	0.3633	0.09354	0.9934	428	239	170
597.1	212	0.3507	0.09971	0.996	435	240	170
614.1	212	0.3364	0.10894	0.9971	451	246	173
631.1	212	0.3143	0.12091	0.9974	461	246	171
648.1	212	0.2963	0.13438	0.9996	480	252	173
665.1	212	0.2942	0.13695	0.9999	485	254	175
682.1	212	0.2902	0.14141	0.9998	494	258	177
699.1	212	0.2648	0.15838	0.9995	503	257	174
716.1	212	0.2789	0.15118	0.9997	506	261	178
733.1	212	0.266	0.16205	1	517	264	179
750.1	212	0.2732	0.15776	0.9999	517	266	181
767.1	212	0.2629	0.16803	0.9991	530	270	183
784.1	213	0.2532	0.17392	0.9998	530	267	180

801.1	212	0.261	0.17185	0.9998	539	274	185
818.1	213	0.2657	0.16982	0.9979	542	276	187
835.1	213	0.2619	0.17425	0.9987	548	279	188
852.1	213	0.2566	0.17966	1	554	280	189
869.1	213	0.2612	0.17832	0.999	559	284	192
886.1	213	0.2619	0.17996	0.999	566	288	195
903.1	213	0.2597	0.18111	0.9996	565	287	194
920.1	213	0.2498	0.19113	0.9977	575	289	194
937.1	212	0.7446	0.01514	0.9735	283	224	195
954.1	212	0.7109	0.01832	0.9766	302	232	199
971.1	212	0.6371	0.0263	0.9773	330	237	195
988.1	212	0.5377	0.04302	0.9797	374	245	192
1005.1	212	0.5042	0.05039	0.9812	387	246	189
1022.1	212	0.4558	0.06351	0.9813	408	248	186
1039.1	212	0.7116	0.01774	0.9741	293	225	193
1056.1	212	0.5841	0.03373	0.9757	348	238	191
1073.1	212	0.4501	0.06528	0.9858	411	248	186
1090.1	212	0.3788	0.09422	0.9829	456	258	186
1107.1	212	0.3368	0.1181	0.9925	490	267	188

212°F
PT PXL (LOT 990489)

Log Number 12260
Temperature 200°F
Customer = J. THOMPSON
Location = BJS TTC
Fluid System NPHGS (CRUDE) SAMPLE 98-12-0808 (TTC #10 -- 1% Asphaltenes) 205°F
Additives = FIELD CRUDE # 98-12-0808, 100 PPT AL OCTOATE, 40 GPT "Sylfat FA-1" TOFA, VISCOMASTER 2100, 10 GPT XYL
Breaker = NONE
Final pH = N/A
Initial pH = N/A
Comments = FANN# 1SC, R1B5HC,

Time Min	Temp. Deg. F	n	K Lbf*s^n/ft^2	Corr.	Vis@ 40/s cP	Vis@ 100/s cP	Vis@ 170/s cP
2.1	87	1.0411	0.00052	0.9998	29	30	31
34.1	195	0.1347	4.00791	0.9871	7884	3568	2254
66.1	200	0.0424	6.27844	0.8556	8787	3654	2198

NE, 150 PPT SMA.X-31890

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Log Number 12261
Temperature 250°F
Customer = J. THOMPSON
Location = BJS TTC
Fluid System NPHGS (CRUDE), SAMPLE 98-12-0808 250°F
Additives = FIELD CRUDE, 100 PPT AL OCTOATE, 40 GPT "Sylfat FA-1" TOFA, 10 GPT XYLENE, 5 GPT "VISCOMASTER 2100" Al
Breaker = NONE
Final pH = N/A
Initial pH = N/A
Comments = R1B5 FANN #1

Time Min	Temp. Deg. F	n	K Lbf*s^n/ft^2	Corr.	Vis@ 40/s cP	Vis@ 100/s cP	Vis@ 170/s cP
2.1	90	0.8914	0.00113	1	36	33	31
34.1	252	0.2732	1.57501	0.9936	5164	2653	1804
66.1	252	0.179	2.12914	0.9503	4932	2324	1504
98.1	251	0.4704	0.4121	0.9659	2797	1721	1300
130.1	251	0.5468	0.21312	0.7489	1917	1266	995
162.1	250	0.4751	0.24573	0.7461	1697	1049	794
194.1	251	0.8071	0.06595	0.8903	1550	1299	1172
226.1	250	0.3816	0.38157	0.9403	1866	1059	763
258.1	250	0.5309	0.20305	0.9588	1723	1121	874
290.1	250	0.5759	0.16487	0.8171	1651	1120	894
322.1	250	0.588	0.13028	0.97	1364	935	752
354.1	250	0.8315	0.05391	0.945	1386	1188	1086
386.1	250	0.8838	0.05665	0.9942	1767	1588	1493
418.1	250	1.1129	0.01941	0.8637	1409	1563	1659
450.1	250	0.8671	0.05143	0.9797	1508	1335	1244
482.1	250	0.5389	0.18191	0.9893	1589	1042	816
514.1	250	0.7153	0.09402	0.7739	1575	1213	1043
546.1	249	0.7714	0.06523	0.9724	1344	1090	965
578.1	249	0.7493	0.07129	0.9629	1354	1076	942
610.1	250	0.6458	0.125	0.9568	1620	1171	970
642.1	249	0.8239	0.0693	0.9975	1733	1474	1343
674.1	250	0.65	0.11543	0.9798	1519	1103	916
706.1	249	0.4158	0.26151	0.9166	1451	850	623
738.1	250	0.5608	0.159	0.8936	1506	1007	798
770.1	250	0.9596	0.03594	0.9799	1482	1428	1398
802.1	251	1.3072	0.00888	0.9197	1320	1749	2059

B-22

Isopropoxide, 4 GPT PETROSURF XL, 4 GPT AL TRI-SECONDARY-BUTOXIDE, 150 PPT SMA.X-31890

Log Number 12435
Temperature 212°F
Customer = J. THOMPSON, SR. FR9166
Location = BJS TTC
Fluid System NPHGS (JET061334A-E, @ 3%), W/ KCITRATE 212°F
Additives = OFF-ROAD DIESEL, 2 GPT Potassium CITRATE salt of citric acid [50:50,W/W K Citrate:Water], 1 GPT "NE-118", 5 GPT Petr
Breaker = NONE
Final pH = N/A
Initial pH = N/A
Comments = R1B5HC/ FANN3 3 (HC BS)

Time Min	Temp. Deg. F	n	K Lbf*s^n/ft^2	Corr.	Vis@ 40/s cP	Vis@ 100/s cP	Vis@ 170/s cP
4.1	91	0.1557	0.71166	0.9866	1513	698	446
23.1	189	0.0979	1.82778	0.9696	3139	1373	851
42.1	204	0.0682	1.76169	0.9746	2712	1155	704
61.1	207	0.0447	1.65508	0.9356	2336	973	586
99.1	208	0.01	1.71903	0.7856	2135	862	510
954.1	207	0.0023	1.26122	0.2147	1522	610	359
1011.1	207	0.0072	1.21745	0.6958	1496	602	356
1049.1	207	0.0042	1.25079	0.1763	1520	610	360
1087.1	206	0.0024	1.26284	0.0877	1525	611	360
1106.1	207	0.0103	1.19666	0.4654	1488	601	355
1125.1	207	0.0088	1.21005	0.5165	1496	603	357
1144.1	207	0.0049	1.24893	0.1969	1522	612	361
1163.1	207	0.0125	1.18995	0.5639	1491	603	357
1182.1	207	0.0143	1.17683	0.6793	1485	602	357
1201.1	207	0.0141	1.1766	0.7163	1483	601	356
1220.1	207	0.0227	1.12177	0.8166	1460	596	355
1239.1	207	0.0224	1.12563	0.737	1463	597	356
1258.1	207	0.0222	1.12776	0.8015	1465	598	356
1277.1	207	0.0231	1.12376	0.7165	1465	598	356
1296.1	207	0.0244	1.11957	0.9186	1466	600	357
1315.1	207	0.0224	1.1324	0.7664	1472	601	358
1334.1	207	0.0292	1.09637	0.9399	1461	600	359
1353.1	207	0.0243	1.124	0.8053	1471	602	359
1372.1	207	0.0306	1.09003	0.9055	1460	601	359
1391.1	207	0.0348	1.07034	0.8861	1457	601	360
1410.1	207	0.0314	1.0885	0.7874	1463	602	360

surf XL, 30 GPT JET061334A-E

Log Number 12423
Temperature 212°F
Customer = J. THOMPSON, FR9166
Location = BJS TTC
Fluid System NPHGS (JET 062455A-E) BLANK 212°F
Additives = OFF-ROAD DIESEL, 1 GPT HOH, 1 GPT NE-118, 30 GPT JET062455A-E, 5 GPT Petrosurf XL, 1GPT JET-0617-7
Breaker = NONE
Final pH = N/A
Initial pH = N/A
Comments = R1B5HC/ FANN# 2 (HC BS)

Time Min	Temp. Deg. F	n	K Lbf*s^n/ft^2	Corr.	Vis@ 40/s cP	Vis@ 100/s cP	Vis@ 170/s cP
19.1	187	0.3578	0.52419	0.9937	2348	1304	927
36.1	208	0.492	0.27749	0.9998	2039	1280	978
53.1	211	0.6425	0.12687	0.9995	1625	1171	968
70.1	211	0.6588	0.11252	0.9976	1530	1119	934
87.1	211	0.6368	0.13305	0.9977	1668	1196	986
104.1	211	0.6742	0.1126	0.9972	1621	1202	1011
121.1	211	0.5914	0.15864	0.9994	1682	1157	931
138.1	211	0.6477	0.12011	0.998	1568	1135	942
155.1	211	0.5606	0.18855	0.9972	1785	1193	945
172.1	211	0.5688	0.18106	0.9996	1767	1190	947
189.1	211	0.5814	0.17472	0.999	1786	1217	974
206.1	210	0.554	0.19895	0.9996	1838	1221	964
223.1	210	0.5558	0.18479	0.9995	1718	1144	904
240.1	210	0.5209	0.23175	0.9989	1895	1222	947
257.1	210	0.4885	0.27375	0.9981	1986	1243	948
274.1	211	0.4949	0.2605	0.9988	1935	1218	932
291.1	211	0.4438	0.31999	0.9942	1969	1183	880
308.1	211	0.4563	0.31559	0.9997	2033	1235	926
325.1	210	0.4977	0.27213	0.9997	2042	1289	987
342.1	210	0.4416	0.34198	0.9962	2087	1251	930
359.1	210	0.4764	0.30502	0.9999	2116	1310	992
376.1	210	0.482	0.28732	0.9996	2035	1266	962
393.1	210	0.4767	0.29588	0.9985	2055	1272	964
410.1	210	0.4555	0.32755	0.9997	2104	1278	957
427.1	210	0.4568	0.32875	0.9991	2122	1290	967
444.1	210	0.4374	0.35439	0.9964	2129	1272	943
461.1	210	0.4718	0.31118	0.9978	2123	1308	989
478.1	210	0.4501	0.34191	0.9991	2153	1301	972
495.1	210	0.4238	0.38361	0.9988	2192	1293	952
512.1	210	0.4685	0.31596	0.9986	2129	1308	987
529.1	210	0.3976	0.42494	0.9993	2205	1269	922
546.1	210	0.4509	0.34158	0.9981	2157	1304	975
563.1	210	0.4307	0.37477	0.9981	2197	1304	964
580.1	210	0.439	0.36426	0.9975	2202	1317	978
597.1	210	0.4285	0.3815	0.9977	2218	1314	970
614.1	210	0.4496	0.34711	0.998	2182	1318	984
631.1	210	0.4345	0.37147	0.9981	2208	1315	974
648.1	210	0.4368	0.36637	0.9964	2197	1311	972
665.1	210	0.4347	0.38088	0.9978	2266	1350	1000
682.1	210	0.3882	0.45891	0.998	2300	1313	949
699.1	210	0.4316	0.38166	0.9985	2245	1333	986
716.1	210	0.4178	0.39651	0.9968	2216	1300	955
733.1	210	0.4274	0.38661	0.9991	2239	1325	978
750.1	210	0.4165	0.40589	0.9989	2258	1323	971
767.1	210	0.4077	0.40647	0.9966	2189	1272	929
784.1	210	0.4192	0.39771	0.9985	2235	1312	964
801.1	210	0.4121	0.41893	0.999	2293	1338	979

818.1	210	0.4155	0.4083	0.9965	2263	1325	971
835.1	210	0.421	0.40179	0.998	2273	1337	983
852.1	210	0.4149	0.41358	0.9991	2287	1338	981
869.1	210	0.4082	0.42677	0.998	2302	1339	978
886.1	210	0.4302	0.38737	0.9976	2267	1345	994
903.1	210	0.4244	0.39744	0.999	2276	1343	990
920.1	210	0.4119	0.41668	0.9975	2279	1330	973
937.1	210	0.4196	0.40169	0.9974	2260	1328	976
954.1	210	0.4138	0.41102	0.9986	2264	1323	969
971.1	210	0.4183	0.40764	0.9973	2283	1340	984
988.1	210	0.4235	0.39478	0.9985	2254	1329	979
1005.1	210	0.4139	0.40582	0.9983	2236	1307	958
1022.1	210	0.423	0.398	0.9962	2268	1337	984
1039.1	210	0.4152	0.40376	0.9953	2235	1308	959
1056.1	210	0.4095	0.42244	0.999	2290	1333	975
1073.1	210	0.4077	0.42364	0.9986	2281	1326	968
1090.1	210	0.4115	0.42011	0.999	2294	1338	979
1107.1	210	0.4135	0.40921	0.9965	2251	1315	964
1124.1	210	0.4042	0.43483	0.9981	2312	1339	976

Log Number 12426
Temperature 212°F
Customer = J. THOMPSON, SR. FR9166
Location = BJ TTC
Fluid System NPHGS (JET0707-2), BASELINE, BLANK Q.C. 212°F
Additives = OFF-ROAD DIESEL, 1 GPT HOH, 1 GPT JET -617-7, 1 GPT NE-118, 5 GPT Petrosurf XL, 30 GPT JET0707-2
Breaker = NONE
Final pH = N/A
Initial pH = N/A
Comments = R1B5HC/ FANN# 5 (HC BS)

Time Min	Temp. Deg. F	n	K Lbf*s^n/ft^2	Corr.	Vis@ 40/s cP	Vis@ 100/s cP	Vis@ 170/s cP
2.1	73	0.5873	0.0189	0.9985	197	135	109
19.1	189	0.32	0.36195	0.9983	1410	756	527
36.1	206	0.3304	0.35064	0.9954	1420	769	539
53.1	209	0.3346	0.35162	0.9964	1446	786	552
70.1	209	0.2936	0.42163	0.9982	1491	780	536
87.1	209	0.294	0.42049	0.9957	1489	780	536
104.1	209	0.3007	0.41243	0.9958	1497	789	544
121.1	209	0.2662	0.46685	0.9935	1492	762	516
138.1	209	0.2949	0.41695	0.9945	1481	776	534
155.1	209	0.2771	0.44724	0.9943	1488	767	523
172.1	209	0.2721	0.4562	0.9945	1490	765	520
189.1	209	0.2769	0.44603	0.9938	1483	764	521
206.1	209	0.2546	0.48265	0.9858	1478	746	503
223.1	209	0.265	0.46451	0.9953	1478	754	510
240.1	209	0.2343	0.52048	0.9608	1478	733	488
257.1	209	0.2367	0.51775	0.9947	1484	737	492
274.1	209	0.2347	0.52088	0.9949	1482	735	490
291.1	209	0.2191	0.55001	0.9961	1477	722	477
308.1	209	0.2232	0.53982	0.9984	1472	722	478
325.1	209	0.23	0.51592	0.9862	1442	712	473
342.1	209	0.207	0.57407	0.9974	1474	713	468
359.1	209	0.2269	0.5275	0.9888	1458	718	476
376.1	209	0.2161	0.54621	0.9979	1451	707	467
393.1	209	0.1978	0.58635	0.9824	1456	698	456
410.1	209	0.1984	0.58531	0.9872	1456	699	457
427.1	209	0.195	0.59288	0.9982	1457	697	455
444.1	209	0.2123	0.55332	0.9874	1449	704	464
461.1	209	0.214	0.54535	0.9884	1437	699	461
478.1	209	0.1827	0.61206	0.9878	1437	680	441
495.1	209	0.1513	0.69817	0.9468	1460	671	428
512.1	209	0.159	0.6714	0.9957	1445	668	428
529.1	209	0.1662	0.65309	0.9934	1443	672	432
546.1	209	0.1783	0.6213	0.9881	1435	676	437
563.1	209	0.1744	0.63193	0.9888	1439	675	436
580.1	209	0.1588	0.66461	0.9855	1429	661	423
597.1	209	0.2064	0.5461	0.9916	1400	676	444
614.1	209	0.1611	0.65934	0.9931	1430	663	425
631.1	209	0.1507	0.67696	0.9523	1413	649	413
648.1	209	0.1629	0.65378	0.9712	1427	663	425
665.1	209	0.1699	0.62661	0.9869	1404	656	422
682.1	209	0.1693	0.63456	0.9907	1418	662	426
699.1	209	0.1528	0.67085	0.9908	1411	649	414
716.1	209	0.1935	0.5193	0.9848	1269	606	395
733.1	209	0.1665	0.62958	0.9738	1393	649	417
750.1	209	0.1567	0.65983	0.9965	1408	650	416
767.1	209	0.1518	0.66004	0.9803	1383	636	405
784.1	209	0.1819	0.57964	0.957	1357	641	415

801.1	209	0.2131	0.50229	0.9807	1319	642	423
818.1	209	0.1711	0.60875	0.9596	1370	641	413
835.1	209	0.1502	0.66127	0.947	1377	632	403
852.1	209	0.1431	0.67311	0.9197	1366	623	395
869.1	209	0.1892	0.54645	0.9723	1314	625	407
886.1	209	0.1393	0.68849	0.9956	1378	626	397
903.1	209	0.1612	0.6289	0.9792	1364	633	405
920.1	209	0.1343	0.70143	0.9545	1378	623	394
937.1	209	0.1504	0.64315	0.8679	1341	615	392
954.1	209	0.1428	0.67415	0.9918	1366	623	395
971.1	209	0.159	0.62834	0.9914	1352	626	400
988.1	209	0.1531	0.64582	0.988	1360	626	399
1005.1	209	0.1412	0.67283	0.9306	1356	617	391

Log Number 12437
Temperature 212°F
Customer = J. THOMPSON, SR. FR9166
Location = BJ TTC
Fluid System NPHGS (JET0707-1), With Potassium Citrate ("K CITRATE") + HEXA 212°F
Additives = OFF-ROAD DIESEL, 2 GPT K CITRATE [50:50,W/W], 1 GPT NE-118, 5 GPT Petrosurf XL, 10 PPT HEXA, 20 GPT JET0
Breaker = 2 GPT POTASSIUM CITRATE [50:50, W/W IN WATER], 10 PPT HEXAMETHYLENETETRAMINE
Final pH = N/A
Initial pH = N/A
Comments = R1B5HC/ FANN# 5 (HC BS)

Time Min	Temp. Deg. F	n	K Lbf*s^n/ft^2	Corr.	Vis@ 40/s cP	Vis@ 100/s cP	Vis@ 170/s cP
4.1	86	0.137	0.5375	0.9739	1066	484	306
23.1	195	0.0907	1.15654	0.9939	1934	841	519
42.1	203	0.261	0.16352	0.9987	513	260	176
61.1	205	0.4843	0.0251	0.9978	179	112	85
80.1	205	0.3984	0.01418	0.9943	74	43	31
99.1	205	0.2661	0.01526	0.9933	49	25	17
118.1	205	0.1619	0.01819	0.9848	40	18	12
137.1	205	0.1225	0.01963	0.9782	37	17	10
156.1	205	0.2171	0.01188	0.9981	32	15	10
175.1	205	0.3043	0.00701	0.9395	26	14	9
194.1	205	0.2054	0.00942	0.9306	24	12	8
213.1	205	0.1287	0.01237	0.9557	24	11	7
232.1	205	0.1832	0.00955	0.9912	22	11	7
251.1	205	0.154	0.01089	0.9829	23	11	7
270.1	205	0.1614	0.01105	0.9122	24	11	7
289.1	205	0.1502	0.01139	0.9533	24	11	7
308.1	205	0.1945	0.00943	0.9899	23	11	7
327.1	205	0.1684	0.01038	0.9926	23	11	7
346.1	205	0.1715	0.01042	0.9629	23	11	7
365.1	205	0.1308	0.0121	0.9345	23	11	7
384.1	205	0.1749	0.01005	0.9793	23	11	7
403.1	205	0.1877	0.00964	0.9908	23	11	7
422.1	205	0.1971	0.00917	0.9976	23	11	7
441.1	205	0.1838	0.00999	0.971	24	11	7
460.1	205	0.2329	0.0086	0.9679	24	12	8
479.1	205	0.1593	0.01089	0.9729	23	11	7
498.1	205	0.2055	0.00873	0.9993	22	11	7
517.1	205	0.211	0.00905	0.9152	24	11	8
536.1	205	0.239	0.00836	0.9085	24	12	8
555.1	205	0.2456	0.00812	0.9026	24	12	8
574.1	205	0.2454	0.0082	0.9251	24	12	8
593.1	205	0.2009	0.00926	0.9664	23	11	7
612.1	205	0.2324	0.00821	0.9459	23	11	8
631.1	205	0.2381	0.00798	0.9761	23	11	8
650.1	205	0.2292	0.0084	0.9431	23	12	8
669.1	205	0.2739	0.00696	0.9561	23	12	8
688.1	205	0.2161	0.00895	0.8915	24	12	8
707.1	205	0.2486	0.00815	0.954	24	12	8
726.1	205	0.253	0.0078	0.8814	24	12	8
745.1	205	0.2545	0.00773	0.9247	24	12	8
764.1	205	0.2431	0.00804	0.9125	24	12	8
783.1	205	0.2378	0.00829	0.9447	24	12	8
802.1	205	0.2549	0.00781	0.9459	24	12	8
821.1	205	0.249	0.00801	0.9095	24	12	8
840.1	205	0.3028	0.00671	0.9842	25	13	9
859.1	205	0.2743	0.00737	0.9794	24	12	8
878.1	205	0.281	0.00711	0.9777	24	12	8

897.1	205	0.2606	0.00772	0.959	24	12	8
916.1	205	0.2652	0.00756	0.9589	24	12	8
935.1	205	0.2428	0.00811	0.9201	24	12	8
954.1	205	0.2584	0.0078	0.9466	24	12	8
973.1	205	0.3471	0.00568	0.981	24	13	10
992.1	205	0.3086	0.00649	0.97	24	13	9
1011.1	205	0.2733	0.00739	0.9849	24	12	8
1030.1	205	0.3006	0.00655	0.9774	24	13	9
1049.1	205	0.289	0.00691	0.9765	24	13	9
1068.1	205	0.2737	0.0072	0.9361	24	12	8
1087.1	205	0.2863	0.00691	0.9688	24	12	8
1106.1	205	0.3401	0.00562	0.9897	24	13	9
1125.1	205	0.2864	0.00697	0.9759	24	12	9
1144.1	205	0.3328	0.00588	0.9685	24	13	9
1163.1	205	0.3024	0.00657	0.9658	24	13	9
1182.1	205	0.3225	0.00621	0.9793	24	13	9
1201.1	205	0.3167	0.00629	0.9755	24	13	9
1220.1	205	0.356	0.00548	0.9846	24	14	10
1239.1	205	0.3783	0.00501	0.973	24	14	10
1258.1	205	0.3464	0.00566	0.9811	24	13	9
1277.1	205	0.426	0.0042	0.9729	24	14	11
1296.1	205	0.4254	0.00421	0.9728	24	14	11
1315.1	205	0.4247	0.00422	0.9725	24	14	11
1334.1	205	0.4252	0.00421	0.9727	24	14	11
1353.1	173	0.4224	0.00449	0.9952	26	15	11

707-1,

B-33

Log Number 12436
Temperature 212°F
Customer = J. THOMPSON, SR. FR9961
Location = BJS TTC
Fluid System NPHGS (JET0707-1, 3%), W/ K CITRATE + HEXA 212°F
Additives = OFF-ROAD DIESEL, 2 GPT K CITRATE, 5 PPT HEXA, 1 GPT NE-118, 5 GPT PXL, 30 GPT JET0707-1 [SP GR. .948]
Breaker = 2 GPT KCITRATE [50:50, W/W] + 5 PPT HEXA
Final pH = N/A
Initial pH = N/A
Comments = R1B5HC/FANN #4

Time Min	Temp. Deg. F	n	K Lbf*s^n/ft^2	Corr.	Vis@ 40/s cP	Vis@ 100/s cP	Vis@ 170/s cP
4.1	72	0.147	0.40681	0.9867	837	383	244
23.1	180	0.0289	2.35656	0.7133	3138	1289	770
61.1	206	0.0688	0.92982	0.9215	1434	611	373
80.1	205	0.1657	0.40011	0.9774	882	411	264
99.1	205	0.3412	0.08864	0.9977	374	204	144
118.1	204	0.8557	0.00292	0.9943	82	72	67

B-34

Log Number 12477
Temperature 212°F
Customer = J. THOMPSON, SR. FR9961
Location = BJS TTC
Fluid System NPHGS (JET 31890, W/ ENCAP MGO 212°F
Additives = OFF-ROAD DIESEL, 1 GPT EC-1, 1 GPT NE-118, 30 GPT JET31890, [PILOT LAB SAMPLE], 5 GPT Petrosurf XL (LOT

Breaker = 20 PPT ENCAP MGO

Final pH = N/A
Initial pH = N/A
Comments = R1B5HC/ FANN# 3 (HC BS)

Time Min	Temp. Deg. F	n	K Lbf*s^n/ft^2	Corr.	Vis@ 40/s cP	Vis@ 100/s cP	Vis@ 170/s cP
19.1	203	0.0804	2.04383	0.9832	3291	1417	870
53.1	215	0.2141	0.43273	0.7842	1141	555	366
70.1	214	0.3309	0.2841	0.79	1152	624	438
87.1	213	0.2485	0.36703	0.7906	1099	552	370
104.1	213	0.1651	0.49796	0.8364	1096	510	327
121.1	213	0.035	0.72581	0.2539	988	408	245
138.1	213	0.235	0.27976	0.9394	797	395	263
155.1	213	0.0539	0.62089	0.5174	907	381	231
172.1	213	0.2275	0.25177	0.9429	697	344	228
189.1	213	0.0198	0.6848	0.1446	882	359	213
240.1	212	0.1395	0.41943	0.8155	840	382	242
257.1	212	0.3452	0.16095	0.897	688	378	267
274.1	212	0.1422	0.40788	0.513	825	376	238
291.1	212	0.2963	0.21738	0.7109	776	407	280
308.1	212	0.3601	0.15809	0.8207	714	397	283
325.1	212	0.5151	0.07946	0.9819	636	408	315
342.1	212	0.5327	0.0698	0.9818	596	388	303
359.1	212	0.5792	0.05435	0.99	551	375	300
376.1	212	0.5998	0.04723	0.9881	517	358	290
393.1	212	0.6208	0.04053	0.9927	479	338	277
410.1	212	0.638	0.03533	0.993	445	319	264
427.1	212	0.6553	0.03093	0.9918	415	303	252
444.1	212	0.6873	0.02516	0.9918	380	285	242
461.1	212	0.7065	0.02169	0.9944	352	269	230
478.1	212	0.7467	0.01684	0.9935	317	251	220
495.1	212	0.746	0.01597	0.9942	300	237	207
512.1	212	0.7639	0.01357	0.9921	272	219	193
529.1	212	0.7846	0.01158	0.9944	250	206	183
546.1	212	0.8175	0.00935	0.9947	228	193	175
563.1	212	0.8614	0.00709	0.9934	204	179	167
580.1	212	0.8746	0.00616	0.9948	186	166	155
597.1	212	0.9105	0.00487	0.9974	168	154	147
614.1	212	0.9114	0.00441	0.9972	152	140	134
631.1	212	0.9118	0.00405	0.9989	140	129	123
648.1	212	0.931	0.00337	0.9993	125	117	113
665.1	212	0.9513	0.00287	0.9994	115	110	107
682.1	212	0.959	0.00254	0.9995	105	101	99
699.1	212	0.9473	0.00245	0.9998	97	92	89
716.1	212	0.9491	0.00221	0.9999	88	84	81
733.1	212	0.9274	0.00222	1	81	76	73
750.1	212	0.9465	0.00186	1	73	70	68
767.1	212	0.916	0.00199	0.9996	70	65	62
784.1	212	0.9359	0.00168	1	63	60	58
801.1	212	0.9063	0.00179	0.9994	61	56	53
818.1	212	0.9062	0.00163	1	55	51	48

835.1	212	0.8746	0.00178	0.9997	54	48	45
852.1	212	0.9158	0.00132	0.9999	46	43	41
869.1	212	0.8865	0.00144	0.999	45	41	38
886.1	212	0.9381	0.00106	0.9996	40	38	37
903.1	212	0.9427	0.00098	0.9999	38	36	35
920.1	212	0.8695	0.00127	1	38	33	31
937.1	212	0.9216	0.00094	0.9995	34	31	30
954.1	212	0.8442	0.0013	0.9996	35	30	28
971.1	212	0.881	0.00102	0.9993	31	28	27
988.1	212	0.96	0.00068	0.9992	28	27	27
1005.1	212	0.9073	0.00081	0.999	28	25	24
1022.1	212	0.917	0.00074	0.9998	26	24	23
1039.1	186	0.8273	0.00155	0.9999	39	33	31
1056.1	150	0.8071	0.00276	0.9992	65	54	49
1073.1	128	0.6873	0.00643	0.9974	97	73	62
1090.1	112	0.5935	0.0119	0.9994	127	88	71

70141)

Log Number 12475
Temperature 212°F
Customer = J. THOMPSON, SR. FR 9961
Location = BJS TTC
Fluid System NPHGS (JET062455A-E), W CITRIC(OH) 212°F
Additives = OFF-ROAD DIESEL, 2 GPT EC-1, 2.5 GPT Petrosurf XL, 30 GPT JET062455A-E
Breaker = NONE
Final pH = N/A
Initial pH = N/A
Comments = R1B5HC/ FANN# 5 (HC BS)

Time Min	Temp. Deg. F	n	K Lbf*s^n/ft^2	Corr.	Vis@ 40/s cP	Vis@ 100/s cP	Vis@ 170/s cP
16.7	189	0.192	0.94097	0.991	2287	1091	710
32.5	190	0.2398	0.74169	0.9909	2150	1071	716
48.3	184	0.2075	0.8811	0.9871	2267	1097	720
64.1	188	0.1626	1.13062	0.9865	2465	1145	734
79.9	198	0.1567	1.11424	0.9274	2377	1098	702
95.7	205	0.131	1.31764	0.9912	2557	1153	727
111.5	208	0.1578	1.09263	0.9655	2341	1082	692
127.3	210	0.1458	1.16374	0.9726	2385	1090	693
143.1	210	0.1271	1.21371	0.9738	2322	1043	657
158.9	210	0.1513	1.14812	0.9552	2401	1103	703
174.7	210	0.0929	1.45507	0.8477	2453	1069	660
190.5	210	0.0968	1.44849	0.9993	2478	1083	671
206.3	210	0.1377	1.18999	0.9548	2367	1074	680
222.1	210	0.1102	1.27377	0.9478	2289	1013	632
237.9	210	0.0857	1.41059	0.9033	2316	1002	617
253.7	210	0.1164	1.23424	0.9291	2269	1010	632
269.5	210	0.1103	1.2573	0.9313	2260	1000	624
285.3	210	0.0293	1.84642	0.5752	2462	1012	604
301.1	210	0.0816	1.46504	0.9979	2369	1021	627
316.9	209	0.0721	1.52942	0.9442	2388	1021	624
332.7	209	0.0775	1.48337	0.976	2363	1015	622
348.5	210	0.0827	1.44714	0.9612	2350	1014	623
364.3	209	0.073	1.4829	0.8713	2323	994	608
380.1	209	0.0921	1.3639	0.978	2293	998	616
395.9	209	0.0453	1.63395	0.826	2311	964	581
411.7	209	0.0557	1.54714	0.7427	2274	957	580
427.5	209	0.0465	1.63034	0.9543	2316	967	583
443.3	209	0.0735	1.37498	0.7745	2158	923	565
459.1	209	0.0843	1.37019	0.9809	2238	967	595
474.9	209	0.0882	1.33046	0.9973	2205	956	589
490.7	209	0.0809	1.36107	0.9225	2195	946	581
506.5	209	0.0838	1.35319	0.971	2206	953	586
522.3	209	0.1083	1.21149	0.9626	2162	955	595
538.1	209	0.1564	0.95871	0.9566	2043	943	603
553.9	209	0.1074	1.19497	0.9615	2125	938	584
569.7	209	0.1018	1.21545	0.8908	2118	930	577
585.5	209	0.1003	1.23181	0.9499	2134	936	581
601.3	209	0.0795	1.3357	0.9659	2143	922	566
617.1	209	0.0904	1.25731	0.9185	2100	913	563
632.9	209	0.105	1.16845	0.8233	2060	907	564
648.7	209	0.091	1.25319	0.9303	2098	912	563
664.5	209	0.0959	1.22516	0.9758	2089	912	565
680.3	209	0.1045	1.17135	0.8696	2061	907	564
696.1	209	0.1025	1.19155	0.9418	2081	915	568
711.9	209	0.1125	1.13431	0.9448	2056	912	569
727.7	209	0.1019	1.19048	0.9749	2075	911	566
743.5	209	0.1001	1.19329	0.9467	2066	906	562

759.3	209	0.0883	1.24905	0.9886	2071	898	554
775.1	209	0.118	1.081	0.8896	1999	891	558
790.9	209	0.1142	1.11373	0.9612	2031	902	564
806.7	209	0.1049	1.15945	0.9766	2043	900	560
822.5	209	0.1386	1.00214	0.984	2000	908	575
838.3	209	0.1029	1.1675	0.9642	2042	898	558
854.1	209	0.1044	1.16115	0.9394	2043	899	559
869.9	209	0.1047	1.14891	0.8974	2023	891	554
885.7	209	0.1013	1.16771	0.9446	2031	891	553
901.5	209	0.1031	1.16067	0.9589	2032	893	555
917.3	209	0.1043	1.15284	0.9849	2027	892	555
933.1	209	0.1003	1.17258	0.9516	2032	891	553
948.9	209	0.0943	1.21013	0.975	2051	894	553
964.7	209	0.0945	1.19862	0.9291	2033	887	548
980.5	209	0.1088	1.12767	0.9508	2016	891	555
996.3	209	0.0932	1.20661	0.9603	2037	887	548
1012.1	209	0.0922	1.21288	0.9111	2040	888	548

Log Number 12467
Temperature 150°F
Customer = J. THOMPSON, SR. FR9961
Location = BJS TTC
Fluid System NOPHGS (JETN 062455A-E, PILOT PLANT), W/ ENCAP 90706 [21% Acrylic COATING] 150°F
Additives = OFF-ROAD DIESEL, 1 GPT HOH, 1 GPT NE-118, 1 GPT ACT (2), 30 GPT JET062455A-E [PILOT PLANT], 5 GPT Petros 20 PPT ENCAP 90706 [21% COATING]
Breaker = 20 GPT ENCAP 90706 [21% COATING, 07159-1]
Final pH = N/A
Initial pH = N/A
Comments = R1B5HC/ FANN# 3 (HC BS)

Time Min	Temp. Deg. F	n	K Lbf*s^n/ft^2	Corr.	Vis@ 40/s cP	Vis@ 100/s cP	Vis@ 170/s cP
2.1	72	0.2866	0.28355	0.9435	977	508	348
19.1	141	0.0565	1.18269	0.9253	1744	734	445
36.1	149	0.161	0.42871	0.9974	929	431	276
53.1	149	0.2498	0.14094	0.9981	424	213	143
70.1	149	0.257	0.10095	0.9997	312	158	106
87.1	149	0.503	0.02034	0.9995	156	99	76
104.1	149	0.3357	0.02106	0.9911	87	47	33
121.1	149	0.2373	0.02889	0.9961	83	41	28
138.1	149	0.224	0.0294	0.9838	80	39	26
155.1	149	0.1751	0.03524	0.9825	80	38	24
172.1	149	0.1561	0.03772	0.99	80	37	24
189.1	149	0.1581	0.03667	0.9744	79	36	23
206.1	149	0.147	0.03823	0.9764	79	36	23
223.1	149	0.1249	0.04227	0.9499	80	36	23
240.1	149	0.1235	0.04251	0.945	80	36	23
257.1	149	0.1287	0.0415	0.9494	80	36	23
274.1	149	0.1263	0.04172	0.9748	80	36	22

rf XL

Log Number 12466
Temperature 150°F
Customer = J. THOMPSON, SR. FR9961
Location = BJS TTC
Fluid System NPHGS (JET 062455A-E, PILOT PLANT), W/ ENCAP 90706 [21% Acrylic COATIONG] 150°F
Additives = OFF ROAD DIESEL, 1 GPT HOH, 1 GPT NE-118, 1 GPT ACT (2), 30 GPT JET 062455 A-E [PILOT PLANT], 5 GPT Petro
Breaker = 10 PPT ENCAP 90706 [21% Acrylic COATING, 07159-1]
Final pH = N/A
Initial pH = N/A
Comments = R1B5HC FANN# 2 (HC BS)

Time Min	Temp. Deg. F	n	K Lbf*s^n/ft^2	Corr.	Vis@ 40/s cP	Vis@ 100/s cP	Vis@ 170/s cP
2.1	70	0.3742	0.20663	0.9738	983	554	398
19.1	130	0.1082	1.10766	0.9628	1976	873	544
36.1	139	0.0553	1.23365	0.854	1811	762	462
53.1	146	0.0262	1.2459	0.8681	1642	673	401
70.1	149	0.0586	0.93313	0.9643	1386	585	355
87.1	150	0.0798	0.70699	0.9986	1136	489	300
104.1	150	0.1022	0.52803	0.9868	921	405	251
121.1	150	0.1187	0.39197	0.9973	727	324	203
138.1	150	0.1304	0.31331	0.9967	607	273	172
155.1	150	0.1226	0.27645	0.9821	520	233	146
172.1	150	0.16	0.19799	0.9968	428	198	127
189.1	150	0.2116	0.12911	0.9921	337	164	108
206.1	149	0.3043	0.06856	0.9903	252	133	92
223.1	150	0.3966	0.03386	0.997	175	101	73
240.1	150	0.6564	0.00834	0.9968	112	82	68
257.1	150	0.8097	0.00317	0.9988	75	63	57
274.1	150	0.7791	0.00274	0.9999	58	47	42

urf XL, 10 PPT ENCAP 90706

Log Number 12464
Temperature 150°F
Customer = J. THOMPSON, FR9961
Location = BJS TTC
Fluid System NPHGS (JET 0707-2, SP GR.= 0.938), W/ ENCAP magnesium oxide ("MGO")
Additives = OFF-ROAD DIESEL, 1 GPT HOH, 1 GPT TOL:HRTOFA, 1 GPT NE-118, 30 GPT JET0707-2 [SP GR. 0.938]
Breaker = 20 PPT ENCAP MGO
Final pH = N/A
Initial pH = N/A
Comments = R1B5HC/ FANN# 5 (HC BS)

Time Min	Temp. Deg. F	n	K Lbf*s^n/ft^2	Corr.	Vis@ 40/s cP	Vis@ 100/s cP	Vis@ 170/s cP
0.9	72	0.6578	0.0549	0.9959	744	544	453
16.7	134	0.3563	0.32906	0.9989	1466	813	578
32.5	146	0.3122	0.39034	0.9956	1478	787	546
48.3	149	0.2877	0.40942	0.994	1416	737	505
64.1	150	0.2792	0.40739	0.9937	1366	706	481
79.9	150	0.258	0.43171	0.9928	1338	678	457
95.7	150	0.2375	0.45589	0.9935	1310	652	435
111.5	151	0.2206	0.47429	0.9916	1281	627	415
127.3	151	0.2094	0.48553	0.9914	1258	610	401
143.1	151	0.191	0.50841	0.9799	1231	587	382
158.9	151	0.1802	0.51807	0.985	1205	569	368
174.7	151	0.1708	0.52571	0.9821	1181	553	356
190.5	151	0.1566	0.54898	0.9849	1171	541	346
206.3	151	0.1428	0.55975	0.9885	1135	517	328
222.1	151	0.1325	0.57146	0.9863	1115	504	318
237.9	151	0.1197	0.58676	0.9613	1092	487	306
253.7	151	0.1144	0.57957	0.9842	1058	470	294
269.5	151	0.1039	0.58868	0.9804	1034	455	283
285.3	151	0.099	0.5806	0.9722	1001	439	272
301.1	151	0.0864	0.59649	0.9619	982	425	262
316.9	151	0.0957	0.56054	0.9602	955	417	258
332.7	151	0.085	0.56978	0.9792	933	403	248
348.5	151	0.0768	0.57463	0.9518	913	392	240
364.3	151	0.0779	0.55676	0.9532	888	382	234
380.1	151	0.0602	0.59032	0.9418	882	373	226
395.9	151	0.0611	0.57143	0.8812	857	362	220
411.7	151	0.0518	0.58299	0.8923	845	354	214
427.5	151	0.0633	0.53687	0.9401	812	344	209
443.3	151	0.0596	0.53788	0.9424	802	339	206
459.1	151	0.068	0.50489	0.9621	777	331	202
474.9	151	0.0624	0.51027	0.9843	769	326	198
490.7	151	0.0535	0.5203	0.8661	759	319	193
506.5	151	0.0542	0.5131	0.9002	750	315	191
522.3	151	0.069	0.47186	0.9114	728	310	189
538.1	151	0.0687	0.4924	0.9142	759	323	197
553.9	150	0.096	0.43713	0.9669	746	326	202
569.7	151	0.0909	0.44839	0.974	750	326	201
585.5	150	0.0977	0.43576	0.9628	748	327	203
601.3	151	0.0834	0.46553	0.9499	758	327	201
617.1	150	0.0886	0.44125	0.9556	732	318	196
632.9	151	0.0787	0.46038	0.9364	737	317	194
648.7	151	0.0829	0.44726	0.9709	727	314	193
664.5	150	0.077	0.45539	0.9559	724	311	190
680.3	151	0.0651	0.47402	0.9176	721	306	186
696.1	151	0.0767	0.44402	0.9693	705	303	185
711.9	150	0.0744	0.44116	0.9312	695	298	182

727.7	151	0.077	0.43197	0.9873	687	295	181
743.5	151	0.074	0.43313	0.9422	681	292	178
759.3	150	0.0835	0.40939	0.9158	667	288	177
775.1	151	0.084	0.40214	0.9683	656	283	174
790.9	151	0.0778	0.41041	0.9593	654	281	172
806.7	150	0.0797	0.40276	0.9696	647	278	171
822.5	151	0.0874	0.38338	0.9864	633	274	169
838.3	151	0.0777	0.3978	0.9649	634	272	167
854.1	150	0.067	0.41423	0.9074	635	270	165
869.9	150	0.0792	0.38587	0.9508	619	266	163
885.7	150	0.0666	0.40618	0.9516	622	264	161
901.5	151	0.0632	0.40558	0.9727	613	260	158
917.3	150	0.0877	0.3622	0.9086	599	260	160
933.1	150	0.0834	0.36694	0.9451	597	258	159
948.9	150	0.0685	0.38673	0.926	596	254	155
964.7	150	0.0678	0.38609	0.922	593	253	154
980.5	150	0.0715	0.37615	0.9783	586	250	153
996.3	150	0.0844	0.35051	0.931	573	248	152
1012.1	150	0.0633	0.38088	0.951	576	244	148
1027.9	150	0.0744	0.3557	0.918	560	240	147
1043.7	150	0.0647	0.37109	0.8812	564	239	146
1059.5	150	0.0643	0.36766	0.9277	558	237	144
1075.3	150	0.0809	0.33655	0.9313	543	234	144
1091.1	150	0.0911	0.31829	0.9891	533	232	143
1106.9	150	0.0982	0.305	0.9894	524	230	142
1122.7	150	0.0577	0.36388	0.9713	539	227	138
1138.5	150	0.0695	0.34213	0.936	529	226	138
1154.3	150	0.0956	0.30067	0.9823	512	224	138
1170.1	150	0.0834	0.31281	0.9503	509	220	135
1185.9	150	0.0916	0.29955	0.9864	503	219	135
1201.7	150	0.0955	0.29033	0.9462	494	216	134
1217.5	150	0.0835	0.30141	0.9413	491	212	130
1233.3	150	0.0734	0.31624	0.9773	496	212	130
1249.1	150	0.0966	0.27976	0.9865	478	209	129
1264.9	150	0.091	0.28324	0.9463	474	206	127
1280.7	150	0.104	0.26773	0.9798	470	207	129

`150°F

B-46

Log Number 12463
Temperature 150°F
Customer = J. THOMPSON, SR., FR 9961
Location = BJS TTC
Fluid System NPHGS (JET0707-2 SP GR.=0.938), W/ BREAKER ENCAP MGO 150°F
Additives = OFF-ROAD DIESEL, 1 GPT HOH, 1 GPT TOL:HRTOFA, 1 GPT NE-118, 30 GPT JET0707-2 SP GR.= 0.938, 15 PPT EN
Breaker = 40 PPT ENCAP MGO
Final pH = N/A
Initial pH = N/A
Comments = R1B5HC/ FANN# 3 (HC BS)

Time Min	Temp. Deg. F	n	K Lbf*s^n/ft^2	Corr.	Vis@ 40/s cP	Vis@ 100/s cP	Vis@ 170/s cP
2.1	75	0.9062	0.02318	0.9988	785	720	685
19.1	138	0.3293	0.33781	0.9888	1362	737	516
36.1	147	0.2569	0.43885	0.9806	1355	686	462
53.1	149	0.225	0.47361	0.9788	1300	639	424
70.1	150	0.1943	0.51385	0.9839	1259	602	393
87.1	150	0.1783	0.52507	0.9819	1213	571	369
104.1	150	0.1472	0.57672	0.9678	1188	544	346
121.1	150	0.1324	0.59192	0.9752	1155	521	329
138.1	150	0.1223	0.59706	0.9656	1122	502	315
155.1	150	0.109	0.60733	0.9732	1087	480	299
172.1	150	0.0845	0.65568	0.9565	1072	463	285
189.1	150	0.0508	0.73749	0.8364	1065	446	270
206.1	150	0.0356	0.76744	0.9082	1047	433	259
223.1	150	0.0268	0.64449	0.805	852	349	208
376.1	150	0.0107	0.3934	0.6358	490	198	117
393.1	150	0.0159	0.35349	0.4738	449	182	108
410.1	150	0.0237	0.31271	0.8248	408	167	99
427.1	150	0.022	0.2916	0.6434	379	154	92
444.1	150	0.0367	0.2508	0.822	344	142	85
461.1	150	0.0568	0.20937	0.9428	309	130	79
478.1	150	0.0765	0.17792	0.9378	282	121	74
495.1	150	0.0861	0.15821	0.9301	260	113	69
512.1	150	0.0934	0.14234	0.9221	240	105	65
529.1	150	0.1153	0.12105	0.9228	222	99	62
546.1	150	0.1231	0.10848	0.9375	204	92	57
563.1	150	0.1598	0.0871	0.9601	188	87	56
580.1	150	0.1712	0.07757	0.9406	175	82	53
597.1	150	0.2018	0.06408	0.9819	161	78	51
614.1	150	0.2372	0.05133	0.983	147	73	49
631.1	150	0.2659	0.04251	0.9828	136	69	47
648.1	150	0.2994	0.03444	0.9969	124	65	45
665.1	150	0.3339	0.02823	0.9976	116	63	44
682.1	150	0.3734	0.02225	0.9982	106	59	43
699.1	150	0.419	0.01688	0.998	95	56	41
716.1	150	0.4383	0.01485	0.999	90	54	40
733.1	150	0.4528	0.01287	0.9942	82	50	37
750.1	150	0.5113	0.00925	0.9957	73	47	36
767.1	150	0.5483	0.00756	0.999	68	45	36
784.1	150	0.6186	0.00502	0.9991	59	41	34
801.1	150	0.6715	0.00376	0.9999	54	40	33
818.1	150	0.7059	0.00308	0.9994	50	38	33
835.1	150	0.795	0.00194	0.9992	44	36	32
852.1	150	0.9021	0.00112	0.9998	37	34	32
869.1	150	1.0435	0.00056	0.9963	31	33	34
886.1	150	1.0729	0.00048	0.9975	30	32	33
903.1	150	1.1907	0.00026	0.9987	25	30	33
920.1	150	1.2747	0.00017	0.9956	22	29	33

937.1	150	1.5977	0.00004	0.9949	17	30	41
954.1	150	1.8721	0.00001	0.9881	12	27	42
971.1	150	2.1741	0	0.9824	0	0	0
988.1	150	2.7928	0	0.9654	0	0	0

212°F

AP MGO

Log Number 12491
Temperature 212°F
Customer = J. THMPSON, SR. FR 9961
Location = BJS TTC
Fluid System NPHGS (JET.31890), With Carbon Dioxide BASELINE 212°F
Additives = OFF-ROAD DIESEL, 2 GPT EC-1, 1 GPT NE-118, 30 GPT JET.31890,
Breaker = NONE
Final pH = N/A
Initial pH = N/A
Comments = R1B5HC/FANN #5

Time Min	Temp. Deg. F	n	K Lbf*s^n/ft^2	Corr.	Vis@ 40/s cP	Vis@ 100/s cP	Vis@ 170/s cP
92.1	210	0.0086	2.33036	0.6963	2879	1161	686
122.1	209	0.0032	2.36003	0.4836	2858	1147	676
362.1	209	0.012	1.88892	0.8112	2363	956	566
392.1	209	0.0179	1.79439	0.8209	2294	933	554
422.1	209	0.0241	1.71158	0.9279	2239	916	546
452.1	209	0.0231	1.7152	0.9844	2235	913	544
482.1	209	0.029	1.6418	0.9546	2187	898	537
512.1	209	0.0232	1.68781	0.985	2201	899	535
542.1	209	0.0402	1.53077	0.9224	2125	882	530
572.1	209	0.0353	1.55676	0.9492	2122	877	526
602.1	209	0.032	1.54486	0.647	2081	857	513
632.1	209	0.0312	1.53812	0.6929	2065	850	508
662.1	209	0.03	1.55144	0.9416	2074	853	510
692.1	209	0.0454	1.4381	0.9836	2035	849	511
722.1	209	0.0345	1.50615	0.9767	2047	845	506
752.1	209	0.0411	1.46365	0.9406	2039	847	509
782.1	209	0.041	1.44692	0.9125	2015	837	503
812.1	209	0.053	1.35612	0.9692	1974	829	501
842.1	209	0.0342	1.47072	0.8244	1997	824	494
872.1	208	0.038	1.44765	0.8457	1993	826	496
902.1	208	0.025	1.53375	0.9666	2013	824	491
932.1	209	0.044	1.39956	0.9101	1970	821	494
962.1	208	0.0386	1.43432	0.8601	1979	820	492
992.1	208	0.0393	1.42372	0.935	1970	817	491
1022.1	209	0.0171	1.5976	0.8781	2037	827	491
1052.1	208	0.0232	1.54723	0.9126	2017	824	491
1082.1	209	0.0382	1.41022	0.895	1943	805	483
1112.1	208	0.0295	1.49129	0.9437	1990	818	489
1142.1	208	0.0287	1.48347	0.9469	1974	811	484
1172.1	208	0.0304	1.47622	0.9311	1976	813	486
1202.1	208	0.0468	1.3581	0.9557	1932	807	486
1232.1	208	0.0536	1.31704	0.9621	1921	807	488
1262.1	208	0.0553	1.30633	0.9992	1917	807	489
1292.1	208	0.0311	1.48086	0.9289	1988	818	489
1322.1	208	0.0674	1.2457	0.9873	1912	813	496
1352.1	208	0.0407	1.40202	0.8605	1950	810	487
1382.1	208	0.0496	1.3312	0.8837	1913	801	484
1412.1	208	0.0409	1.38693	0.9384	1930	802	482
1442.1	208	0.0501	1.31889	0.8803	1899	795	480

Log Number 12425
Temperature 212°f
Customer = J. THOMPSON, SR., FR9166
Location = BJS TTC
Fluid System NPHGS (JET0707-1), BASE LINE, BLANK 212°F
Additives = OFF-ROAD DIESEL, 1 GPT HOH, 1 GPT NE-118, 1 GPT JET-617-7, 5 GPT Petrosurf XL, 30 GPT JET0707-1
Breaker = NONE
Final pH = N/A
Initial pH = N/A
Comments = R1B5HC/ FANN#4 (HC BS)

Time Min	Temp. Deg. F	n	K Lbf*s^n/ft^2	Corr.	Vis@ 40/s cP	Vis@ 100/s cP	Vis@ 170/s cP
19.1	185	0.4029	0.40536	0.9965	2145	1241	904
36.1	206	0.4927	0.24895	0.9998	1834	1152	880
53.1	210	0.5446	0.18973	0.9998	1693	1115	876
70.1	210	0.5072	0.23624	0.9992	1836	1169	900
87.1	210	0.4789	0.27247	0.9973	1908	1184	898
104.1	210	0.4654	0.29269	0.9971	1950	1195	900
121.1	209	0.4597	0.30011	0.9988	1958	1193	896
138.1	209	0.4592	0.31022	0.9976	2020	1231	924
155.1	209	0.4691	0.30248	0.9959	2043	1256	948
172.1	209	0.4582	0.31575	0.9976	2049	1247	935
189.1	209	0.4518	0.32071	0.9968	2032	1230	919
206.1	209	0.4436	0.33815	0.9971	2079	1249	929
223.1	209	0.3805	0.42651	0.9953	2078	1178	848
240.1	209	0.4289	0.36504	0.996	2126	1260	930
257.1	209	0.4193	0.37943	0.9973	2133	1253	920
274.1	209	0.4193	0.37591	0.9966	2113	1241	912
291.1	209	0.4048	0.40016	0.9958	2132	1236	901
308.1	209	0.377	0.44921	0.9915	2160	1221	877
325.1	209	0.4008	0.40978	0.9968	2151	1242	904
342.1	209	0.4025	0.40831	0.9961	2157	1248	909
359.1	209	0.4008	0.4077	0.9949	2140	1236	899
376.1	209	0.3443	0.50889	0.9886	2169	1189	840
393.1	209	0.3983	0.41261	0.9965	2146	1237	899
410.1	209	0.3673	0.4733	0.9953	2196	1230	879
427.1	209	0.3826	0.43824	0.9968	2151	1222	881
444.1	209	0.3791	0.4427	0.9953	2145	1215	874
461.1	209	0.3866	0.42917	0.9951	2138	1219	880
478.1	209	0.3297	0.53327	0.9997	2154	1165	817
495.1	209	0.3687	0.46133	0.9932	2151	1206	863
512.1	209	0.3722	0.45383	0.9946	2144	1206	864
529.1	209	0.3733	0.4504	0.994	2136	1203	863
546.1	209	0.372	0.45199	0.9954	2134	1200	860
563.1	209	0.3684	0.46123	0.996	2149	1205	862
580.1	209	0.3706	0.4567	0.9943	2145	1205	863
597.1	209	0.361	0.47296	0.9961	2144	1194	850
614.1	209	0.3628	0.46824	0.9951	2137	1192	850
631.1	209	0.3624	0.46993	0.9953	2141	1194	851
648.1	209	0.3663	0.46119	0.9943	2132	1193	852
665.1	209	0.3384	0.51503	0.9871	2148	1171	825
682.1	209	0.3533	0.48433	0.9951	2134	1180	837
699.1	209	0.3615	0.46507	0.9946	2112	1177	838
716.1	209	0.3568	0.47584	0.9935	2124	1178	837
733.1	209	0.317	0.55018	0.998	2120	1134	789
750.1	209	0.3393	0.51492	0.9929	2155	1176	828
767.1	209	0.3573	0.47283	0.9966	2114	1173	834
784.1	209	0.3661	0.43895	0.9978	2028	1134	810
801.1	209	0.3535	0.47573	0.9948	2098	1160	823

818.1	209	0.3705	0.43598	0.9925	2047	1150	823
835.1	209	0.3466	0.48945	0.9957	2104	1156	817
852.1	209	0.3112	0.55636	0.9998	2099	1116	775
869.1	209	0.352	0.47886	0.995	2100	1160	822
886.1	209	0.3215	0.54355	0.9986	2130	1144	798
903.1	209	0.3444	0.4899	0.9953	2089	1146	809
920.1	209	0.2817	0.61693	0.9823	2087	1081	738
937.1	209	0.3002	0.57956	0.9919	2099	1106	763
954.1	209	0.2977	0.58902	0.9908	2114	1111	765
971.1	209	0.2793	0.62992	0.9944	2112	1091	745
988.1	209	0.2987	0.58224	0.9958	2097	1103	760
1005.1	209	0.2908	0.60531	0.9894	2118	1106	759
1022.1	209	0.2737	0.64475	0.9958	2118	1089	740

B-52

Log Number 12393
Temperature 200°F
Customer = FR-9961
Location =
Fluid System NAPHGS (JET-28AE - BLANK)
Additives = OFF-ROAD DIESEL, 1 GPT HOH, 40 GPT JET-28AE, 5 GPT PXL, 1 GPT JET0617-7
Breaker = N/A
Final pH =
Initial pH =
Comments = R1B5HC/FANN #3

Time Min	Temp. Deg. F	n	K Lbf*s^n/ft^2	Corr.	Vis@ 40/s cP	Vis@ 100/s cP	Vis@ 170/s cP
19.1	191	0.1752	0.79591	0.8096	1818	854	551
36.1	198	0.3585	0.34476	0.9937	1548	860	612
53.1	198	0.329	0.37618	0.9436	1515	819	574
70.1	198	0.5277	0.15977	0.9879	1339	869	676
87.1	198	0.3177	0.38512	0.9819	1488	796	554
104.1	198	0.5589	0.14092	0.9974	1326	885	700
121.1	198	0.4116	0.26832	0.9798	1466	855	626
138.1	198	0.2692	0.47294	0.9427	1528	782	531
155.1	198	0.3752	0.30895	0.9964	1476	833	598
172.1	198	0.372	0.30088	0.9844	1420	799	572
189.1	198	0.3369	0.35519	0.9393	1473	802	564
206.1	198	0.3122	0.39837	0.9927	1508	803	558
223.1	198	0.4024	0.27675	0.9975	1461	845	616
240.1	198	0.355	0.34341	0.9464	1523	843	599
257.1	198	0.2963	0.4325	0.9682	1544	810	558
274.1	198	0.2856	0.44604	0.9643	1531	796	545
291.1	198	0.3266	0.3868	0.9413	1544	833	583
308.1	198	0.3177	0.4043	0.9659	1562	836	582
325.1	198	0.3551	0.33783	0.9614	1498	830	589
342.1	198	0.4314	0.24562	0.955	1444	857	634
359.1	198	0.4101	0.27346	0.9782	1486	865	633
376.1	198	0.4893	0.19397	0.9595	1411	884	674
393.1	198	0.3727	0.327	0.9782	1548	871	624
410.1	198	0.3446	0.35649	0.9681	1521	834	589
427.1	198	0.3766	0.31969	0.9784	1535	867	623
444.1	198	0.29	0.46525	0.9265	1623	847	581
461.1	198	0.4186	0.25875	0.9931	1451	851	625
478.1	198	0.4426	0.24574	0.9672	1505	903	672
495.1	198	0.4194	0.2706	0.9418	1521	894	657
512.1	198	0.4639	0.22391	0.9647	1484	908	683
529.1	198	0.4146	0.26988	0.9063	1491	872	639
546.1	198	0.3398	0.38369	0.9805	1608	878	619
563.1	198	0.3744	0.32633	0.8672	1554	876	629
580.1	198	0.3223	0.39828	0.9158	1565	841	587
597.1	198	0.3825	0.31437	0.9969	1543	876	631
614.1	198	0.2789	0.49131	0.8615	1645	850	580
631.1	198	0.4843	0.2111	0.9249	1508	940	715
648.1	198	0.2977	0.47391	0.976	1701	894	616
665.1	198	0.4031	0.30569	0.9537	1618	937	682
682.1	198	0.5594	0.15691	0.948	1479	988	782
699.1	198	0.4451	0.25077	0.946	1550	932	695
716.1	198	0.4013	0.30412	0.8835	1600	924	673
733.1	198	0.5337	0.17388	0.8808	1490	972	759
750.1	198	0.2102	0.67321	0.7721	1750	848	558
767.1	198	0.438	0.26942	0.9553	1622	969	719
784.1	198	0.3773	0.33908	0.8814	1632	923	663
801.1	198	0.3165	0.42135	0.7925	1621	866	603
818.1	198	0.4106	0.30021	0.933	1634	952	696

835.1	198	0.4177	0.29658	0.9702	1657	972	714
852.1	198	0.4444	0.25597	0.9244	1578	949	706
869.1	198	0.2523	0.57352	0.957	1741	878	590
886.1	198	0.4119	0.30186	0.9755	1651	963	705
903.1	198	0.4485	0.25527	0.921	1598	964	719
920.1	198	0.4385	0.27065	0.9287	1633	976	725
937.1	198	0.1293	0.95555	0.4982	1843	830	523
954.1	198	0.4768	0.23948	0.9154	1664	1030	781
971.1	198	0.3571	0.38622	0.8508	1726	957	681
988.1	198	0.2783	0.51571	0.755	1723	889	606
1005.1	198	0.3441	0.41164	0.8359	1753	961	679
1022.1	198	0.225	0.67503	0.8522	1853	911	604
1039.1	198	0.4126	0.30937	0.9526	1696	990	725
1056.1	198	0.259	0.57857	0.7849	1800	913	616
1073.1	198	0.2587	0.59115	0.7693	1837	932	629
1090.1	198	0.2416	0.64362	0.8042	1878	937	627
1107.1	198	0.3407	0.43629	0.9316	1835	1003	707
1124.1	198	0.3644	0.40504	0.968	1859	1038	741
1141.1	198	0.2517	0.61478	0.7372	1862	938	631
1158.1	198	0.4167	0.30949	0.9456	1723	1010	741
1175.1	198	0.3804	0.3768	0.9412	1835	1040	749
1192.1	198	0.2487	0.65043	0.9277	1948	979	657
1209.1	198	0.1654	0.88237	0.6125	1944	905	581
1226.1	198	0.2406	0.66158	0.7185	1923	959	641
1243.1	198	0.3736	0.39165	0.906	1860	1048	751
1260.1	198	0.1867	0.80766	0.6965	1925	914	593
1277.1	198	0.2367	0.67042	0.698	1921	955	637

Log Number 12423
Temperature 212°F
Customer = J. THOMPSON, FR9166
Location = BJS TTC
Fluid System NPHGS (JET 062455A-E) BLANK 212°F
Additives = OFF-ROAD DIESEL, 1 GPT HOH, 1 GPT NE-118, 30 GPT JET062455A-E, 5 GPT PXXL, 1GPT JET-0617-7
Breaker = NONE
Final pH = N/A
Initial pH = N/A
Comments = R1B5HC/ FANN# 2 (HC BS)

Time Min	Temp. Deg. F	n	K Lbf*s^n/ft^2	Corr.	Vis@ 40/s cP	Vis@ 100/s cP	Vis@ 170/s cP
19.1	187	0.3578	0.52419	0.9937	2348	1304	927
36.1	208	0.492	0.27749	0.9998	2039	1280	978
53.1	211	0.6425	0.12687	0.9995	1625	1171	968
70.1	211	0.6588	0.11252	0.9976	1530	1119	934
87.1	211	0.6368	0.13305	0.9977	1668	1196	986
104.1	211	0.6742	0.1126	0.9972	1621	1202	1011
121.1	211	0.5914	0.15864	0.9994	1682	1157	931
138.1	211	0.6477	0.12011	0.998	1568	1135	942
155.1	211	0.5606	0.18855	0.9972	1785	1193	945
172.1	211	0.5688	0.18106	0.9996	1767	1190	947
189.1	211	0.5814	0.17472	0.999	1786	1217	974
206.1	210	0.554	0.19895	0.9996	1838	1221	964
223.1	210	0.5558	0.18479	0.9995	1718	1144	904
240.1	210	0.5209	0.23175	0.9989	1895	1222	947
257.1	210	0.4885	0.27375	0.9981	1986	1243	948
274.1	211	0.4949	0.2605	0.9988	1935	1218	932
291.1	211	0.4438	0.31999	0.9942	1969	1183	880
308.1	211	0.4563	0.31559	0.9997	2033	1235	926
325.1	210	0.4977	0.27213	0.9997	2042	1289	987
342.1	210	0.4416	0.34198	0.9962	2087	1251	930
359.1	210	0.4764	0.30502	0.9999	2116	1310	992
376.1	210	0.482	0.28732	0.9996	2035	1266	962
393.1	210	0.4767	0.29588	0.9985	2055	1272	964
410.1	210	0.4555	0.32755	0.9997	2104	1278	957
427.1	210	0.4568	0.32875	0.9991	2122	1290	967
444.1	210	0.4374	0.35439	0.9964	2129	1272	943
461.1	210	0.4718	0.31118	0.9978	2123	1308	989
478.1	210	0.4501	0.34191	0.9991	2153	1301	972
495.1	210	0.4238	0.38361	0.9988	2192	1293	952
512.1	210	0.4685	0.31596	0.9986	2129	1308	987
529.1	210	0.3976	0.42494	0.9993	2205	1269	922
546.1	210	0.4509	0.34158	0.9981	2157	1304	975
563.1	210	0.4307	0.37477	0.9981	2197	1304	964
580.1	210	0.439	0.36426	0.9975	2202	1317	978
597.1	210	0.4285	0.3815	0.9977	2218	1314	970
614.1	210	0.4496	0.34711	0.998	2182	1318	984
631.1	210	0.4345	0.37147	0.9981	2208	1315	974
648.1	210	0.4368	0.36637	0.9964	2197	1311	972
665.1	210	0.4347	0.38088	0.9978	2266	1350	1000
682.1	210	0.3882	0.45891	0.998	2300	1313	949
699.1	210	0.4316	0.38166	0.9985	2245	1333	986
716.1	210	0.4178	0.39651	0.9968	2216	1300	955
733.1	210	0.4274	0.38661	0.9991	2239	1325	978
750.1	210	0.4165	0.40589	0.9989	2258	1323	971
767.1	210	0.4077	0.40647	0.9966	2189	1272	929
784.1	210	0.4192	0.39771	0.9985	2235	1312	964
801.1	210	0.4121	0.41893	0.999	2293	1338	979
818.1	210	0.4155	0.4083	0.9965	2263	1325	971

835.1	210	0.421	0.40179	0.998	2273	1337	983
852.1	210	0.4149	0.41358	0.9991	2287	1338	981
869.1	210	0.4082	0.42677	0.998	2302	1339	978
886.1	210	0.4302	0.38737	0.9976	2267	1345	994
903.1	210	0.4244	0.39744	0.999	2276	1343	990
920.1	210	0.4119	0.41668	0.9975	2279	1330	973
937.1	210	0.4196	0.40169	0.9974	2260	1328	976
954.1	210	0.4138	0.41102	0.9986	2264	1323	969
971.1	210	0.4183	0.40764	0.9973	2283	1340	984
988.1	210	0.4235	0.39478	0.9985	2254	1329	979
1005.1	210	0.4139	0.40582	0.9983	2236	1307	958
1022.1	210	0.423	0.398	0.9962	2268	1337	984
1039.1	210	0.4152	0.40376	0.9953	2235	1308	959
1056.1	210	0.4095	0.42244	0.999	2290	1333	975
1073.1	210	0.4077	0.42364	0.9986	2281	1326	968
1090.1	210	0.4115	0.42011	0.999	2294	1338	979
1107.1	210	0.4135	0.40921	0.9965	2251	1315	964
1124.1	210	0.4042	0.43483	0.9981	2312	1339	976

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Log Number 12425
Temperature 212°f
Customer = J. THOMPSON, SR., FR9166
Location = BJS TTC
Fluid System NPHGS (JET0707-1), BASE LINE, BLANK 212°F
Additives = OFF-ROAD DIESEL, 1 GPT HOH, 1 GPT NE-118, 1 GPT JET-617-7, 5 GPT PXL, 30 GPT JET0707-1
Breaker = NONE
Final pH = N/A
Initial pH = N/A
Comments = R1B5HC/ FANN#4 (HC BS)

Time Min	Temp. Deg. F	n	K Lbf*s^n/ft^2	Corr.	Vis@ 40/s cP	Vis@ 100/s cP	Vis@ 170/s cP
19.1	185	0.4029	0.40536	0.9965	2145	1241	904
36.1	206	0.4927	0.24895	0.9998	1834	1152	880
53.1	210	0.5446	0.18973	0.9998	1693	1115	876
70.1	210	0.5072	0.23624	0.9992	1836	1169	900
87.1	210	0.4789	0.27247	0.9973	1908	1184	898
104.1	210	0.4654	0.29269	0.9971	1950	1195	900
121.1	209	0.4597	0.30011	0.9988	1958	1193	896
138.1	209	0.4592	0.31022	0.9976	2020	1231	924
155.1	209	0.4691	0.30248	0.9959	2043	1256	948
172.1	209	0.4582	0.31575	0.9976	2049	1247	935
189.1	209	0.4518	0.32071	0.9968	2032	1230	919
206.1	209	0.4436	0.33815	0.9971	2079	1249	929
223.1	209	0.3805	0.42651	0.9953	2078	1178	848
240.1	209	0.4289	0.36504	0.996	2126	1260	930
257.1	209	0.4193	0.37943	0.9973	2133	1253	920
274.1	209	0.4193	0.37591	0.9966	2113	1241	912
291.1	209	0.4048	0.40016	0.9958	2132	1236	901
308.1	209	0.377	0.44921	0.9915	2160	1221	877
325.1	209	0.4008	0.40978	0.9968	2151	1242	904
342.1	209	0.4025	0.40831	0.9961	2157	1248	909
359.1	209	0.4008	0.4077	0.9949	2140	1236	899
376.1	209	0.3443	0.50889	0.9886	2169	1189	840
393.1	209	0.3983	0.41261	0.9965	2146	1237	899
410.1	209	0.3673	0.4733	0.9953	2196	1230	879
427.1	209	0.3826	0.43824	0.9968	2151	1222	881
444.1	209	0.3791	0.4427	0.9953	2145	1215	874
461.1	209	0.3866	0.42917	0.9951	2138	1219	880
478.1	209	0.3297	0.53327	0.9997	2154	1165	817
495.1	209	0.3687	0.46133	0.9932	2151	1206	863
512.1	209	0.3722	0.45383	0.9946	2144	1206	864
529.1	209	0.3733	0.4504	0.994	2136	1203	863
546.1	209	0.372	0.45199	0.9954	2134	1200	860
563.1	209	0.3684	0.46123	0.996	2149	1205	862
580.1	209	0.3706	0.4567	0.9943	2145	1205	863
597.1	209	0.361	0.47296	0.9961	2144	1194	850
614.1	209	0.3628	0.46824	0.9951	2137	1192	850
631.1	209	0.3624	0.46993	0.9953	2141	1194	851
648.1	209	0.3663	0.46119	0.9943	2132	1193	852
665.1	209	0.3384	0.51503	0.9871	2148	1171	825
682.1	209	0.3533	0.48433	0.9951	2134	1180	837
699.1	209	0.3615	0.46507	0.9946	2112	1177	838
716.1	209	0.3568	0.47584	0.9935	2124	1178	837
733.1	209	0.317	0.55018	0.998	2120	1134	789
750.1	209	0.3393	0.51492	0.9929	2155	1176	828
767.1	209	0.3573	0.47283	0.9966	2114	1173	834
784.1	209	0.3661	0.43895	0.9978	2028	1134	810
801.1	209	0.3535	0.47573	0.9948	2098	1160	823
818.1	209	0.3705	0.43598	0.9925	2047	1150	823

835.1	209	0.3466	0.48945	0.9957	2104	1156	817
852.1	209	0.3112	0.55636	0.9998	2099	1116	775
869.1	209	0.352	0.47886	0.995	2100	1160	822
886.1	209	0.3215	0.54355	0.9986	2130	1144	798
903.1	209	0.3444	0.4899	0.9953	2089	1146	809
920.1	209	0.2817	0.61693	0.9823	2087	1081	738
937.1	209	0.3002	0.57956	0.9919	2099	1106	763
954.1	209	0.2977	0.58902	0.9908	2114	1111	765
971.1	209	0.2793	0.62992	0.9944	2112	1091	745
988.1	209	0.2987	0.58224	0.9958	2097	1103	760
1005.1	209	0.2908	0.60531	0.9894	2118	1106	759
1022.1	209	0.2737	0.64475	0.9958	2118	1089	740

Log Number 12426
Temperature 212°F
Customer = J. THOMPSON, SR. FR9166
Location = BJ TTC
Fluid System NPHGS (JET0707-2), BASELINE, BLANK Q.C. 212°F
Additives = OFF-ROAD DIESEL, 1 GPT HOH, 1 GPT JET -617-7, 1 GPT NE-118, 5 GPT PXL, 30 GPT JET0707-2
Breaker = NONE
Final pH = N/A
Initial pH = N/A
Comments = R1B5HC/ FANN# 5 (HC BS)

Time Min	Temp. Deg. F	n	K Lbf*s^n/ft^2	Corr.	Vis@ 40/s cP	Vis@ 100/s cP	Vis@ 170/s cP
2.1	73	0.5873	0.0189	0.9985	197	135	109
19.1	189	0.32	0.36195	0.9983	1410	756	527
36.1	206	0.3304	0.35064	0.9954	1420	769	539
53.1	209	0.3346	0.35162	0.9964	1446	786	552
70.1	209	0.2936	0.42163	0.9982	1491	780	536
87.1	209	0.294	0.42049	0.9957	1489	780	536
104.1	209	0.3007	0.41243	0.9958	1497	789	544
121.1	209	0.2662	0.46685	0.9935	1492	762	516
138.1	209	0.2949	0.41695	0.9945	1481	776	534
155.1	209	0.2771	0.44724	0.9943	1488	767	523
172.1	209	0.2721	0.4562	0.9945	1490	765	520
189.1	209	0.2769	0.44603	0.9938	1483	764	521
206.1	209	0.2546	0.48265	0.9858	1478	746	503
223.1	209	0.265	0.46451	0.9953	1478	754	510
240.1	209	0.2343	0.52048	0.9608	1478	733	488
257.1	209	0.2367	0.51775	0.9947	1484	737	492
274.1	209	0.2347	0.52088	0.9949	1482	735	490
291.1	209	0.2191	0.55001	0.9961	1477	722	477
308.1	209	0.2232	0.53982	0.9984	1472	722	478
325.1	209	0.23	0.51592	0.9862	1442	712	473
342.1	209	0.207	0.57407	0.9974	1474	713	468
359.1	209	0.2269	0.5275	0.9888	1458	718	476
376.1	209	0.2161	0.54621	0.9979	1451	707	467
393.1	209	0.1978	0.58635	0.9824	1456	698	456
410.1	209	0.1984	0.58531	0.9872	1456	699	457
427.1	209	0.195	0.59288	0.9982	1457	697	455
444.1	209	0.2123	0.55332	0.9874	1449	704	464
461.1	209	0.214	0.54535	0.9884	1437	699	461
478.1	209	0.1827	0.61206	0.9878	1437	680	441
495.1	209	0.1513	0.69817	0.9468	1460	671	428
512.1	209	0.159	0.6714	0.9957	1445	668	428
529.1	209	0.1662	0.65309	0.9934	1443	672	432
546.1	209	0.1783	0.6213	0.9881	1435	676	437
563.1	209	0.1744	0.63193	0.9888	1439	675	436
580.1	209	0.1588	0.66461	0.9855	1429	661	423
597.1	209	0.2064	0.5461	0.9916	1400	676	444
614.1	209	0.1611	0.65934	0.9931	1430	663	425
631.1	209	0.1507	0.67696	0.9523	1413	649	413
648.1	209	0.1629	0.65378	0.9712	1427	663	425
665.1	209	0.1699	0.62661	0.9869	1404	656	422
682.1	209	0.1693	0.63456	0.9907	1418	662	426
699.1	209	0.1528	0.67085	0.9908	1411	649	414
716.1	209	0.1935	0.5193	0.9848	1269	606	395
733.1	209	0.1665	0.62958	0.9738	1393	649	417
750.1	209	0.1567	0.65983	0.9965	1408	650	416
767.1	209	0.1518	0.66004	0.9803	1383	636	405
784.1	209	0.1819	0.57964	0.957	1357	641	415
801.1	209	0.2131	0.50229	0.9807	1319	642	423

818.1	209	0.1711	0.60875	0.9596	1370	641	413
835.1	209	0.1502	0.66127	0.947	1377	632	403
852.1	209	0.1431	0.67311	0.9197	1366	623	395
869.1	209	0.1892	0.54645	0.9723	1314	625	407
886.1	209	0.1393	0.68849	0.9956	1378	626	397
903.1	209	0.1612	0.6289	0.9792	1364	633	405
920.1	209	0.1343	0.70143	0.9545	1378	623	394
937.1	209	0.1504	0.64315	0.8679	1341	615	392
954.1	209	0.1428	0.67415	0.9918	1366	623	395
971.1	209	0.159	0.62834	0.9914	1352	626	400
988.1	209	0.1531	0.64582	0.988	1360	626	399
1005.1	209	0.1412	0.67283	0.9306	1356	617	391

Log Number 12428
Temperature 212°F
Customer = J. THOMPSON, FR9961
Location = BJS TTC
Fluid System NPHGS (JET 062455A-E) PILOT PLANT SAMPLE 212°F
Additives = OFF-ROAD DIESEL, 2 GPT FE-300L, 1 GPT NE-118, 30 GPT JET062455A-E, 5 GPT PXL, 1GPT JET-0617-7, 10 PPT HEX
Breaker = 20 PPT HEXA
Final pH = N/A
Initial pH = N/A
Comments = R1B5HC/ FANN# 2 (HC BS)

Time Min	Temp. Deg. F	n	K Lbf*s^n/ft^2	Corr.	Vis@ 40/s cP	Vis@ 100/s cP	Vis@ 170/s cP
19.1	191	0.0683	3.16129	0.9842	4868	2073	1264
36.1	210	0.0733	3.12483	0.9892	4901	2097	1282
53.1	212	0.066	3.23574	0.9768	4940	2099	1279
70.1	211	0.0628	3.24047	0.9679	4889	2072	1260
87.1	211	0.0759	2.99855	0.9961	4748	2036	1247
104.1	210	0.068	3.08863	0.9921	4751	2022	1233
121.1	210	0.06	3.17329	0.9619	4739	2003	1216
138.1	210	0.0621	3.12629	1	4705	1992	1211
155.1	210	0.0515	3.26329	0.9954	4723	1980	1197
172.1	210	0.0447	3.36359	0.9827	4747	1978	1192
189.1	210	0.0591	3.12617	0.9811	4653	1965	1193
206.1	210	0.0628	3.04914	0.9867	4601	1949	1185
223.1	210	0.0582	3.08627	0.9923	4578	1932	1172
240.1	210	0.0464	3.27885	0.9861	4657	1944	1172
257.1	210	0.0569	3.10721	0.9849	4587	1933	1172
274.1	210	0.0523	3.16483	0.9861	4594	1928	1166
291.1	210	0.0553	3.07817	0.9966	4518	1901	1152
308.1	210	0.0554	3.04873	0.9999	4476	1884	1141
325.1	210	0.0529	3.09017	0.994	4495	1887	1142
342.1	210	0.0459	3.21473	0.9877	4557	1901	1146
359.1	210	0.0542	3.08864	0.9986	4515	1898	1149
376.1	207	0.0525	3.07903	0.9903	4473	1877	1135
393.1	211	0.0427	3.2544	0.9832	4560	1897	1141
410.1	211	0.0498	3.13054	0.9743	4502	1885	1139
427.1	211	0.0469	3.13906	0.9859	4467	1865	1125
444.1	210	0.0618	2.92027	0.9943	4390	1858	1130
461.1	210	0.0577	2.99185	0.9617	4430	1868	1133
478.1	210	0.0366	3.22328	0.9547	4415	1826	1095
495.1	210	0.0293	3.36176	0.9877	4483	1842	1100
512.1	210	0.0447	3.08954	0.9948	4361	1817	1095
529.1	210	0.0426	3.11436	0.9525	4362	1814	1092
546.1	210	0.0445	3.06677	0.981	4325	1802	1085
563.1	210	0.0423	3.09649	0.9399	4332	1801	1084
580.1	210	0.0462	3.02636	0.9972	4295	1792	1080
597.1	210	0.032	3.23143	0.8556	4352	1793	1073
614.1	210	0.0283	3.28912	0.9509	4370	1794	1071
631.1	210	0.0437	3.02697	0.9862	4257	1772	1067
648.1	210	0.0312	3.24049	0.9802	4351	1791	1071
665.1	210	0.0376	3.15555	0.9784	4339	1796	1078
682.1	210	0.0418	3.06929	0.9626	4286	1781	1071
699.1	210	0.0422	3.0167	0.9667	4219	1754	1055
716.1	210	0.0213	3.36797	0.8581	4360	1779	1058
733.1	210	0.045	2.95994	0.8848	4182	1743	1050
750.1	210	0.0208	3.34261	0.8602	4320	1761	1047
767.1	210	0.0435	2.98312	0.9268	4192	1745	1050
784.1	210	0.0363	3.09426	0.9937	4234	1751	1050
801.1	210	0.0333	3.14684	0.8414	4259	1756	1051
818.1	210	0.0384	3.04139	0.9894	4194	1738	1043

835.1	210	0.0258	3.25908	0.4939	4290	1757	1048
852.1	210	0.0323	3.07411	0.4273	4145	1708	1022
869.1	210	0.0513	2.76446	0.7798	3998	1676	1013
886.1	210	0.0527	2.70458	0.8518	3932	1650	998
903.1	210	0.0546	2.76382	0.9149	4046	1701	1030
937.1	210	0.0073	3.46348	0.0804	4258	1715	1013
954.1	210	0.0285	3.10629	0.7397	4130	1696	1013
971.1	210	0.0236	3.13717	0.4008	4096	1674	997
988.1	210	0.0566	2.6693	0.7656	3937	1658	1005
1005.1	210	0.0394	2.93311	0.6291	4060	1684	1011
1022.1	210	0.067	2.54534	0.8873	3901	1659	1011

Log Number 12429
Temperature 212°F
Customer = J. THOMPSON, SR. FR9166
Location = BJS TTC
Fluid System NPHGS (JET0707-3), W/ BREAKER 212°F
Additives = OFF-ROAD DIESEL, 2 GPT FE-300L, 1 GPT NE-118, 1 GPT JET-617-7, 5 GPT PXL, 30 GPT JET0707-3, 28.5 PPT ENCA
Breaker = 28.5 PPT ENCAP 80715
Final pH = N/A
Initial pH = N/A
Comments = R1B5HC/ FANN3 3 (HC BS)

Time Min	Temp. Deg. F	n	K Lbf*s^n/ft^2	Corr.	Vis@ 40/s cP	Vis@ 100/s cP	Vis@ 170/s cP
19.1	193	0.0576	3.19026	0.9836	4722.20089	1991.25002	1207.67682
36.1	208	0.0284	3.57041	0.8322	4745.21963	1948.12942	1163.35868
53.1	210	0.0219	3.63921	0.8248	4722.06494	1927.11145	1146.84505
70.1	210	0.0538	3.03512	0.9885	4430.02746	1861.55376	1126.74285
87.1	210	0.0659	2.83214	0.9515	4322.45216	1836.59938	1118.79907
104.1	210	0.0361	3.2349	0.7283	4423.18343	1828.77626	1096.55611
121.1	210	0.0563	2.92813	0.9916	4313.46279	1816.72867	1101.07125
138.1	210	0.091	2.41274	0.9632	4039.5939	1756.34666	1084.25684
155.1	210	0.0665	2.61991	0.8746	4007.40362	1703.6724	1038.15457
172.1	209	0.081	2.40529	0.9948	3881.27155	1672.11892	1026.79703
189.1	209	0.0728	2.47962	0.9041	3881.99366	1659.91116	1014.87512
206.1	209	0.0969	2.15172	0.8409	3681.84155	1609.47958	996.705951
223.1	209	0.0838	2.30015	0.9928	3750.14889	1619.77941	996.135855
240.1	209	0.1009	2.07334	0.7727	3600.46094	1579.68408	980.332988
274.1	209	0.0606	2.47031	0.6627	3697.22615	1563.33184	949.65849
291.1	209	0.0684	2.36756	0.7954	3646.88125	1553.10461	947.358801
308.1	209	0.0374	2.67132	0.8594	3670.14044	1519.23736	911.581493
325.1	209	0.0424	2.64214	0.906	3697.62525	1537.64309	925.076512
342.1	209	0.0604	2.39196	0.5567	3577.32222	1512.35459	918.59446
359.1	209	0.0764	2.20561	0.8187	3499.17634	1501.16503	919.572158
376.1	208	0.0268	2.82832	0.8071	3736.83117	1531.89239	914.019307
393.1	208	0.0865	2.05061	0.6703	3376.76614	1462.11922	900.466783
410.1	209	0.0582	2.34606	0.69	3480.31642	1468.38125	890.844773
427.1	209	0.0736	2.20239	0.8791	3458.16385	1479.76906	905.119791
444.1	209	0.0425	2.58822	0.9587	3623.50164	1506.95715	906.663353
461.1	209	0.0724	2.2136	0.9437	3460.41363	1479.10451	904.137416
478.1	209	0.0913	2.01301	0.827	3374.06724	1467.39031	906.017764
495.1	209	0.1001	1.87983	0.8184	3254.80148	1426.98133	885.191647
512.1	209	0.0949	1.92346	0.9341	3267.06952	1425.55138	881.867943
529.1	209	0.0847	2.03161	0.8974	3323.33826	1436.61388	883.914299
546.1	209	0.1163	1.77107	0.9901	3255.33005	1448.55651	906.332869
563.1	209	0.0947	1.92614	0.931	3269.20877	1426.22343	882.190054
580.1	209	0.0708	2.12574	0.9602	3303.51069	1409.96996	861.145869
597.1	209	0.0788	2.04343	0.7638	3270.70833	1406.24011	862.521509
614.1	209	0.0904	1.94607	0.9279	3251.05566	1412.72676	871.850125
631.1	209	0.0432	2.46565	0.7886	3460.82902	1440.22765	866.83735
648.1	209	0.102	1.83894	0.9497	3206.39781	1408.20952	874.428177
665.1	209	0.116	1.72899	0.991	3174.46954	1412.18696	883.436524
682.1	209	0.0381	2.52078	0.8988	3472.26733	1438.25092	863.308153
699.1	209	0.0602	2.24525	0.9827	3355.43199	1418.28797	861.367585
716.1	209	0.0648	2.20442	0.884	3350.79265	1422.30933	865.92091
733.1	209	0.0887	1.95036	0.9329	3237.85374	1404.79999	866.176496
750.1	209	0.0707	2.12234	0.9354	3297.01046	1407.06667	859.327069
767.1	209	0.0755	2.06675	0.9767	3268.00867	1400.83719	857.704392
784.1	209	0.0942	1.91511	0.9765	3244.49791	1414.79475	874.888698
801.1	209	0.0814	2.09868	0.9136	3391.51413	1461.65858	897.750302
818.1	209	0.1168	1.75012	0.9931	3222.76144	1434.72129	897.914647
835.1	209	0.0753	2.09902	0.9829	3316.58718	1421.39994	870.202195

852.1	209	0.0931	1.91284	0.9179	3227.52901	1405.97747	868.928883
869.1	209	0.0948	1.93339	0.9673	3282.72482	1432.25116	885.965519
886.1	209	0.0609	2.24958	0.951	3370.59537	1425.61139	866.136969
903.1	209	0.0996	1.89926	0.9931	3282.3835	1438.41478	892.047393
920.1	209	0.0854	2.01577	0.9602	3305.95262	1430.01533	880.181243
937.1	209	0.0965	1.90944	0.9652	3262.455	1425.62641	882.663425
954.1	209	0.0754	2.13015	0.9083	3367.01642	1443.14478	883.561592
971.1	209	0.0949	1.92732	0.9938	3273.62588	1428.41218	883.637676
988.1	209	0.1082	1.8136	0.9614	3235.37125	1429.02959	890.280528
1005.1	209	0.0603	2.27798	0.964	3405.60166	1439.6258	874.373065
1022.1	209	0.1105	1.79291	0.9934	3225.71388	1427.76984	890.581951

80715 (30%)

Log Number 12432
Temperature 212°F
Customer = J. THOMPSON, SR. FR9166
Location = BJS TTC
Fluid System NPHGS (JET28A-E), W/ ECA-2, 3% 212°F
Additives = OFF-ROAD DIESEL, 2 GPT ECA-2, 1 GPT NE-118, 1 GPT , 4 GPT PXL, 30 GPT JET28A-E
Breaker = NONE
Final pH = N/A
Initial pH = N/A
Comments = R1B5HC/ FANN3 3 (HC BS)
Number of c 1
PL/YPL-B = FALSE
US/M "B" = FALSE
Temp "B" = FALSE

Time Min	Temp. Deg. F	Stress Dyne/cm^2	Rate Sec^-1	Viscosity CentiPoise	n	K Lbf*s^n/ft^2	Corr.	Kv Lbf*s^n/ft^2	Kp Lbf*s^n/ft^2
0.6	80	1310.12	104.82	1250					
1.1	80	1391.74	83.13	1674					
1.6	80	1399.22	61.59	2272					
2.1	80	1429.48	39.82	3590					
						3.31791	0.8745	4.01581	NaN
7.1	160	533.83	104.98	509					
12.1	187	598.44	104.52	573					
17.1	196	463.57	104.99	442					
17.6	196	462.76	104.77	442					
18.1	196	372.15	83.18	447					
18.6	197	295.7	61.65	480					
19.1	197	290.04	39.8	729					
						0.4777	0.09059	0.9066	0.09701	0.10167
24.1	202	557.26	104.76	532					
29.1	205	505.57	105.13	481					
34.1	207	468.42	104.88	447					
34.6	207	465.19	105.02	443					
35.1	207	377.1	83.21	453					
35.6	207	294.46	61.9	476					
36.1	207	209.76	39.77	527					
						0.8174	0.02087	0.9993	0.02139	0.02182
41.1	208	416.73	104.59	398					
46.1	208	392.5	105.06	374					
51.1	209	377.16	105.12	359					
51.6	209	376.83	104.81	360					
52.1	209	309.42	83.15	372					
52.6	209	244.87	61.54	398					
53.1	209	177.94	39.78	447					
						0.7712	0.02089	0.9995	0.02154	0.02207
58.1	209	349.7	104.77	334					
63.1	209	332.74	105	317					
68.1	209	319.01	104.61	305					
68.6	209	317.77	104.82	303					
69.1	209	262.58	83.17	316					
69.6	209	209.33	61.63	340					
70.1	209	154.85	39.74	390					
						0.7383	0.02042	0.9992	0.02114	0.02174
75.1	209	298.82	104.66	286					
80.1	209	290.74	105.04	277					

85.1	209	281.05	104.73	268					
85.6	209	281.37	104.77	269					
86.1	209	234.32	83.14	282					
86.6	209	189.79	61.7	308					
87.1	209	141.82	39.73	357					
					0.7026	0.02126	0.9993	0.02212	0.02281
92.1	209	269.74	104.65	258					
97.1	209	264.9	104.7	253					
102.1	209	259.25	104.77	247					
102.6	209	258.87	104.77	247					
103.1	209	217.84	83.08	262					
103.6	208	177.94	61.6	289					
104.1	208	132.4	39.74	333					
					0.6884	0.02096	0.9998	0.02185	0.02256
109.1	208	251.17	104.62	240					
114.1	209	248.75	105.07	237					
119.1	209	243.09	105.04	231					
119.6	209	242.93	104.79	232					
120.1	209	204.76	83.17	246					
120.6	208	167.45	61.55	272					
121.1	208	125.23	39.8	315					
					0.6811	0.02032	0.9998	0.0212	0.02191
126.1	208	235.82	104.76	225					
131.1	208	232.59	104.42	223					
136.1	209	222.9	104.44	213					
136.6	209	223.17	104.76	213					
137.1	209	190.01	83.13	229					
137.6	208	154.04	61.74	249					
138.1	208	115.27	39.77	290					
					0.6827	0.01861	0.9999	0.01941	0.02006
143.1	208	221.29	104.54	212					
148.1	208	218.86	105.03	208					

Kf Lbf*s^n/ft^2
NaN
0.10509
0.02213
0.02247
0.02217

0.02332

0.02309

0.02243

0.02053

Log Number 12434
Temperature 212°F
Customer = J. THOMPSON, FR9961
Location = BJS TTC
Fluid System NPHGS (JET0707-1A-E) PILOT PLANT SAMPLE 212°F
Additives = OFF-ROAD DIESEL, ,1 GPT HOH, 1 GPT J-01617-7, 1 GPT NE-118, 20 GPT JET0707-1A-E, 4.0 GPT PXL, ,
Breaker = NONE
Final pH = N/A
Initial pH = N/A
Comments = R1B5HC/ FANN# 2 (HC BS)

Time Min	Temp. Deg. F	n	K Lbf*s^n/ft^2	Corr.	Vis@ 40/s cP	Vis@ 100/s cP	Vis@ 170/s cP
2.1	90	0.7028	0.00922	1	147	112	96
19.1	181	0.0715	0.58545	0.8715	912	390	238
36.1	204	0.0697	0.53062	0.9275	821	350	214
53.1	207	0.0662	0.50105	0.9272	766	325	198
70.1	206	0.0458	0.51276	0.966	727	303	183
87.1	205	0.049	0.46786	0.8837	671	281	169
104.1	205	0.0465	0.40432	0.9244	574	240	145
121.1	205	0.0395	0.39283	0.8557	544	226	136
138.1	205	0.0358	0.37572	0.8174	513	212	127
155.1	205	0.0116	0.41252	0.38	515	208	123
172.1	205	0.0231	0.36696	0.7581	478	195	116
189.1	205	0.0145	0.36948	0.3559	467	189	112
206.1	205	0.0179	0.34878	0.5581	446	181	108
223.1	205	0.0322	0.30944	0.649	417	172	103
240.1	205	0.0198	0.31875	0.5845	410	167	99
257.1	205	0.0086	0.3315	0.604	410	165	98
274.1	205	0.0252	0.28916	0.72	380	155	93
291.1	205	0.0498	0.24396	0.9443	351	147	89
308.1	205	0.0261	0.26718	0.7718	352	144	86
325.1	205	0.0289	0.25651	0.7917	342	140	84
342.1	205	0.0542	0.21857	0.9629	319	134	81
359.1	205	0.0475	0.21955	0.8773	313	131	79
376.1	205	0.0444	0.21652	0.924	305	127	77
393.1	205	0.0568	0.19907	0.8043	294	124	75
410.1	204	0.0471	0.2024	0.9652	288	120	73
427.1	205	0.0559	0.19115	0.964	281	118	72
444.1	205	0.0502	0.19068	0.9697	275	115	69
461.1	205	0.0605	0.17758	0.9494	266	112	68
478.1	205	0.0553	0.17942	0.9887	263	111	67
495.1	205	0.0486	0.18023	0.9852	258	108	65
512.1	205	0.0677	0.16228	0.9331	249	106	65
529.1	205	0.0659	0.16054	0.9662	245	104	63
546.1	205	0.0544	0.16623	0.9173	243	102	62
563.1	205	0.072	0.14867	0.9622	232	99	61
580.1	204	0.0779	0.14241	0.9855	227	98	60
597.1	205	0.0642	0.14683	0.9911	223	94	57
614.1	204	0.0695	0.14303	0.9848	221	94	58
631.1	205	0.0758	0.13682	0.8919	217	93	57
648.1	205	0.0713	0.13666	0.9866	213	91	56
665.1	205	0.0778	0.12966	0.9723	207	89	54
682.1	204	0.0837	0.12389	0.9845	202	87	54
699.1	205	0.0884	0.11858	0.9509	197	85	53
716.1	205	0.0721	0.12601	0.8263	197	84	51
733.1	205	0.0867	0.11637	0.9915	192	83	51
750.1	205	0.085	0.11517	0.9615	189	82	50
767.1	205	0.1028	0.10427	0.9568	182	80	50
784.1	205	0.115	0.09703	0.9483	177	79	49
801.1	205	0.101	0.10056	0.922	175	77	48

818.1	204	0.1029	0.09644	0.9743	169	74	46
835.1	205	0.107	0.09411	0.9559	167	74	46
852.1	205	0.0996	0.09561	0.9917	165	72	45
869.1	205	0.1244	0.08393	0.9807	159	71	45
886.1	205	0.1224	0.08323	0.9627	156	70	44
903.1	205	0.1156	0.08373	0.9639	154	68	43
920.1	205	0.107	0.0828	0.9605	147	65	40
937.1	205	0.1174	0.08001	0.9569	148	66	41
954.1	205	0.1309	0.07368	0.9717	143	64	41
971.1	205	0.1603	0.06343	0.9641	137	64	41
988.1	205	0.1816	0.05633	0.988	132	62	40
1005.1	205	0.1446	0.06623	0.9571	135	62	39
1022.1	205	0.1574	0.06138	0.9795	131	61	39
1039.1	205	0.1444	0.06389	0.9853	130	59	38
1056.1	205	0.1839	0.05169	0.9605	122	58	37
1073.1	205	0.1473	0.06038	0.9948	124	57	36
1090.1	205	0.1833	0.05006	0.9864	118	56	36
1107.1	205	0.157	0.0555	0.9833	119	55	35
1124.1	205	0.1769	0.05039	0.9624	116	54	35
1141.1	205	0.1703	0.05096	0.997	114	53	34
1158.1	205	0.2104	0.04214	0.9728	110	53	35
1175.1	205	0.232	0.03648	0.9898	103	51	34
1192.1	205	0.1856	0.04449	0.989	106	50	33
1209.1	205	0.2301	0.036	0.9969	101	50	33
1226.1	205	0.2338	0.03488	0.9755	99	49	33
1243.1	205	0.2294	0.03421	0.9815	95	47	31
1260.1	205	0.2819	0.02669	0.9942	90	47	32
1277.1	205	0.2597	0.02898	0.9669	90	46	31
1294.1	205	0.274	0.02652	0.9801	87	45	31
1311.1	205	0.2815	0.02547	0.991	86	45	30
1328.1	205	0.2726	0.026	0.9801	85	44	30
1345.1	205	0.2623	0.02651	0.9559	83	42	29
1362.1	205	0.2889	0.02295	0.9848	80	42	28
1379.1	205	0.249	0.02668	0.9747	80	40	27
1396.1	205	0.347	0.01709	0.9713	74	40	29
1413.1	205	0.3125	0.01967	0.987	75	40	28
1430.1	205	0.3519	0.01597	0.9762	70	39	27
1447.1	205	0.3031	0.01972	0.9837	72	38	26
1464.1	205	0.314	0.01815	0.9872	69	37	26
1481.1	205	0.3486	0.0155	0.9777	67	37	26
1498.1	205	0.4167	0.0111	0.9851	62	36	27

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Log Number 12435
Temperature 212°F
Customer = J. THOMPSON, SR. FR9166
Location = BJS TTC
Fluid System NPHGS (JET0707-1, @ 3%), W/ KCITRATE 212°F
Additives = OFF-ROAD DIESEL, 2 GPT K CITRATE [50:50,W/W], 1 GPT NE-118, 5 GPT PXL, 30 GPT JET0707-1
Breaker = NONE
Final pH = N/A
Initial pH = N/A
Comments = R1B5HC/ FANN3 3 (HC BS)

Time Min	Temp. Deg. F	n	K Lbf*s^n/ft^2	Corr.	Vis@ 40/s cP	Vis@ 100/s cP	Vis@ 170/s cP
4.1	91	0.1557	0.71166	0.9866	1513	698	446
23.1	189	0.0979	1.82778	0.9696	3139	1373	851
42.1	204	0.0682	1.76169	0.9746	2712	1155	704
61.1	207	0.0447	1.65508	0.9356	2336	973	586
99.1	208	0.01	1.71903	0.7856	2135	862	510
954.1	207	0.0023	1.26122	0.2147	1522	610	359
1011.1	207	0.0072	1.21745	0.6958	1496	602	356
1049.1	207	0.0042	1.25079	0.1763	1520	610	360
1087.1	206	0.0024	1.26284	0.0877	1525	611	360
1106.1	207	0.0103	1.19666	0.4654	1488	601	355
1125.1	207	0.0088	1.21005	0.5165	1496	603	357
1144.1	207	0.0049	1.24893	0.1969	1522	612	361
1163.1	207	0.0125	1.18995	0.5639	1491	603	357
1182.1	207	0.0143	1.17683	0.6793	1485	602	357
1201.1	207	0.0141	1.1766	0.7163	1483	601	356
1220.1	207	0.0227	1.12177	0.8166	1460	596	355
1239.1	207	0.0224	1.12563	0.737	1463	597	356
1258.1	207	0.0222	1.12776	0.8015	1465	598	356
1277.1	207	0.0231	1.12376	0.7165	1465	598	356
1296.1	207	0.0244	1.11957	0.9186	1466	600	357
1315.1	207	0.0224	1.1324	0.7664	1472	601	358
1334.1	207	0.0292	1.09637	0.9399	1461	600	359
1353.1	207	0.0243	1.124	0.8053	1471	602	359
1372.1	207	0.0306	1.09003	0.9055	1460	601	359
1391.1	207	0.0348	1.07034	0.8861	1457	601	360
1410.1	207	0.0314	1.0885	0.7874	1463	602	360

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Log Number 12437
Temperature 212°F
Customer = J. THOMPSON, SR. FR9961
Location = BJS TTC
Fluid System NPHGS (JET0707-1, 3%), W/ K CITRATE + HEXA 212°F
Additives = OFF-ROAD DIESEL, 2 GPT K CITRATE, 5 PPT HEXA, 1 GPT NE-118, 5 GPT PXL, 30 GPT JET0707-1 [SP GR. .948]
Breaker = 2 GPT KCITRATE [50:50, W/W] + 5 PPT HEXA
Final pH = N/A
Initial pH = N/A
Comments = R1B5HC/FANN #4

Time Min	Temp. Deg. F	n	K Lbf*s^n/ft^2	Corr.	Vis@ 40/s cP	Vis@ 100/s cP	Vis@ 170/s cP
4.1	72	0.147	0.40681	0.9867	837	383	244
23.1	180	0.0289	2.35656	0.7133	3138	1289	770
61.1	206	0.0688	0.92982	0.9215	1434	611	373
80.1	205	0.1657	0.40011	0.9774	882	411	264
99.1	205	0.3412	0.08864	0.9977	374	204	144
118.1	204	0.8557	0.00292	0.9943	82	72	67
137.1	204	1.5805	0.00004	0.9968	16	28	38

Log Number 12437
Temperature 212°F
Customer = J. THOMPSON, SR. FR9166
Location = BJ TTC
Fluid System NPHGS (JET0707-1), W/ K CUITRATE + HEXA 212°F
Additives = OFF-ROAD DIESEL, 2 GPT K CITRATE [50:50,W/W], 1 GPT NE-118, 5 GPT PXL, 10 PPT HEXA, 20 GPT JET0707-1,
Breaker = 2 GPT K CIOTRATE [50:50, W/W], 10 PPT HEXA
Final pH = N/A
Initial pH = N/A
Comments = R1B5HC/ FANN# 5 (HC BS)

Time Min	Temp. Deg. F	n	K Lbf*s^n/ft^2	Corr.	Vis@ 40/s cP	Vis@ 100/s cP	Vis@ 170/s cP
4.1	86	0.137	0.5375	0.9739	1066	484	306
23.1	195	0.0907	1.15654	0.9939	1934	841	519
42.1	203	0.261	0.16352	0.9987	513	260	176
61.1	205	0.4843	0.0251	0.9978	179	112	85
80.1	205	0.3984	0.01418	0.9943	74	43	31
99.1	205	0.2661	0.01526	0.9933	49	25	17
118.1	205	0.1619	0.01819	0.9848	40	18	12
137.1	205	0.1225	0.01963	0.9782	37	17	10
156.1	205	0.2171	0.01188	0.9981	32	15	10
175.1	205	0.3043	0.00701	0.9395	26	14	9
194.1	205	0.2054	0.00942	0.9306	24	12	8
213.1	205	0.1287	0.01237	0.9557	24	11	7
232.1	205	0.1832	0.00955	0.9912	22	11	7
251.1	205	0.154	0.01089	0.9829	23	11	7
270.1	205	0.1614	0.01105	0.9122	24	11	7
289.1	205	0.1502	0.01139	0.9533	24	11	7
308.1	205	0.1945	0.00943	0.9899	23	11	7
327.1	205	0.1684	0.01038	0.9926	23	11	7
346.1	205	0.1715	0.01042	0.9629	23	11	7
365.1	205	0.1308	0.0121	0.9345	23	11	7
384.1	205	0.1749	0.01005	0.9793	23	11	7
403.1	205	0.1877	0.00964	0.9908	23	11	7
422.1	205	0.1971	0.00917	0.9976	23	11	7
441.1	205	0.1838	0.00999	0.971	24	11	7
460.1	205	0.2329	0.0086	0.9679	24	12	8
479.1	205	0.1593	0.01089	0.9729	23	11	7
498.1	205	0.2055	0.00873	0.9993	22	11	7
517.1	205	0.211	0.00905	0.9152	24	11	8
536.1	205	0.239	0.00836	0.9085	24	12	8
555.1	205	0.2456	0.00812	0.9026	24	12	8
574.1	205	0.2454	0.0082	0.9251	24	12	8
593.1	205	0.2009	0.00926	0.9664	23	11	7
612.1	205	0.2324	0.00821	0.9459	23	11	8
631.1	205	0.2381	0.00798	0.9761	23	11	8
650.1	205	0.2292	0.0084	0.9431	23	12	8
669.1	205	0.2739	0.00696	0.9561	23	12	8
688.1	205	0.2161	0.00895	0.8915	24	12	8
707.1	205	0.2486	0.00815	0.954	24	12	8
726.1	205	0.253	0.0078	0.8814	24	12	8
745.1	205	0.2545	0.00773	0.9247	24	12	8
764.1	205	0.2431	0.00804	0.9125	24	12	8
783.1	205	0.2378	0.00829	0.9447	24	12	8
802.1	205	0.2549	0.00781	0.9459	24	12	8
821.1	205	0.249	0.00801	0.9095	24	12	8
840.1	205	0.3028	0.00671	0.9842	25	13	9
859.1	205	0.2743	0.00737	0.9794	24	12	8
878.1	205	0.281	0.00711	0.9777	24	12	8
897.1	205	0.2606	0.00772	0.959	24	12	8

916.1	205	0.2652	0.00756	0.9589	24	12	8
935.1	205	0.2428	0.00811	0.9201	24	12	8
954.1	205	0.2584	0.0078	0.9466	24	12	8
973.1	205	0.3471	0.00568	0.981	24	13	10
992.1	205	0.3086	0.00649	0.97	24	13	9
1011.1	205	0.2733	0.00739	0.9849	24	12	8
1030.1	205	0.3006	0.00655	0.9774	24	13	9
1049.1	205	0.289	0.00691	0.9765	24	13	9
1068.1	205	0.2737	0.0072	0.9361	24	12	8
1087.1	205	0.2863	0.00691	0.9688	24	12	8
1106.1	205	0.3401	0.00562	0.9897	24	13	9
1125.1	205	0.2864	0.00697	0.9759	24	12	9
1144.1	205	0.3328	0.00588	0.9685	24	13	9
1163.1	205	0.3024	0.00657	0.9658	24	13	9
1182.1	205	0.3225	0.00621	0.9793	24	13	9
1201.1	205	0.3167	0.00629	0.9755	24	13	9
1220.1	205	0.356	0.00548	0.9846	24	14	10
1239.1	205	0.3783	0.00501	0.973	24	14	10
1258.1	205	0.3464	0.00566	0.9811	24	13	9
1277.1	205	0.426	0.0042	0.9729	24	14	11
1296.1	205	0.4254	0.00421	0.9728	24	14	11
1315.1	205	0.4247	0.00422	0.9725	24	14	11
1334.1	205	0.4252	0.00421	0.9727	24	14	11
1353.1	173	0.4224	0.00449	0.9952	26	15	11

B-75

Log Number 12374
Temperature 150°F
Customer =
Location =
Fluid System NPHGS (JET060428A-E) ETHOX CHEMICAL
Additives = OFF-ROAD DIESEL, 1 GPT HOH, 40 GPT JET060428A-E, 5 GPT PXL
Breaker = N/A
Final pH =
Initial pH =
Comments = R1B5HC/FANN #2

Time Min	Temp. Deg. F	n	K Lbf*s^n/ft^2	Corr.	Vis@ 40/s cP	Vis@ 100/s cP	Vis@ 170/s cP
2.1	72	0.3958	0.21755	0.9953	1121	645	468
19.1	140	0.2938	0.23704	0.9997	839	439	302
36.1	151	0.2839	0.29671	0.9998	1012	525	359
53.1	153	0.2912	0.31423	0.9993	1101	575	395
70.1	153	0.304	0.31275	0.9991	1149	607	420
87.1	153	0.3177	0.30463	0.9989	1177	630	439
104.1	153	0.3279	0.29837	0.9984	1197	647	453
121.1	153	0.3428	0.28456	0.9992	1206	661	466
138.1	153	0.347	0.28273	0.9994	1217	669	473
155.1	153	0.3433	0.29078	0.9982	1235	676	477
172.1	153	0.3529	0.28168	0.9984	1239	685	486
189.1	153	0.3657	0.26941	0.9987	1243	695	496
206.1	153	0.3619	0.27587	0.9988	1255	699	498
223.1	154	0.3697	0.26905	0.9985	1259	707	506
240.1	153	0.3727	0.26834	0.9985	1270	715	512
257.1	153	0.3827	0.25903	0.9987	1272	723	521
274.1	154	0.3871	0.25596	0.9987	1278	729	526
291.1	153	0.3849	0.2612	0.9984	1293	736	531
308.1	153	0.3865	0.26109	0.9977	1300	741	535
325.1	153	0.392	0.25697	0.9972	1306	748	542
342.1	153	0.3901	0.26032	0.9981	1314	751	544
359.1	154	0.3967	0.25413	0.9978	1314	756	549
376.1	153	0.3952	0.25686	0.9978	1321	759	551
393.1	153	0.4091	0.24361	0.9982	1319	767	561
410.1	154	0.4122	0.2411	0.998	1320	770	564
427.1	152	0.4225	0.23426	0.9984	1332	785	578
444.1	153	0.4269	0.23062	0.9981	1333	788	582
461.1	153	0.4225	0.23577	0.9982	1341	790	581
478.1	153	0.4619	0.18307	0.9997	1204	735	553
495.1	153	0.4885	0.16593	0.9987	1204	753	574
512.1	153	0.5069	0.15611	0.9993	1212	771	594
529.1	153	0.4953	0.16422	0.9991	1222	769	589
546.1	153	0.5082	0.15695	0.9973	1225	780	601
563.1	153	0.5041	0.16076	0.9987	1235	784	603
580.1	153	0.5208	0.1508	0.998	1233	795	616
597.1	153	0.4776	0.17231	0.9982	1201	744	564
614.1	153	0.4798	0.17098	0.9969	1201	746	566
631.1	153	0.4891	0.16448	0.9975	1196	749	571
648.1	153	0.4793	0.17151	0.9988	1203	746	566
665.1	153	0.4841	0.16964	0.9976	1211	755	574
682.1	153	0.4828	0.17014	0.9987	1209	752	572
699.1	153	0.497	0.16253	0.9986	1217	767	588
716.1	153	0.486	0.16987	0.9976	1221	762	580
733.1	153	0.4977	0.16285	0.9968	1222	771	591
750.1	153	0.4597	0.18491	0.9964	1206	735	552
767.1	153	0.4566	0.18574	0.994	1198	728	546
784.1	153	0.5015	0.15864	0.998	1207	765	587
801.1	153	0.4923	0.16347	0.9984	1203	755	577

818.1	153	0.4853	0.1684	0.9996	1207	753	573
835.1	153	0.4965	0.15935	0.9982	1191	751	575

C

C-1

Log Numb: 123870
Temperatu 150°F
Customer =
Location =
Fluid Syste NPHGS (JET061334A-E) ETHOX CHEMICALS @ 150°F
Additives = OFF-ROAD DIESEL, 1 GPT HOH, 40 GPT JET061334A-E, 5 GPT PXL
Breaker = N/A
Final pH =
Initial pH =
Comments R1B5HC/FANN #2

Time Min	Temp. Deg. F	n	K Lbf*s^n/ft^2	Corr.	Vis@ 40/s cP	Vis@ 100/: cP	Vis@ 170/s cP
19.1	140	0.0228	4.6434	0.8036	6045	2489	1470
36.1	152	0.0981	3.07367	0.984	5283	2312	1433
53.1	154	0.1003	2.95246	0.9723	5116	2243	1392
70.1	154	0.083	2.97352	0.9901	4834	2086	1282
87.1	154	0.1121	2.59306	0.9813	4693	2080	1299
104.1	154	0.1679	2.02045	0.9982	4492	2096	1348
121.1	154	0.1898	1.88026	0.9861	4532	2157	1403

C-2

Log Numbi 12371
Temperatu 200°F
Customer =
Location =
Fluid Syste NPHGS (JET061334A-E) ETHOX CHEMICALS @ 200°F
Additives = OFF-ROAD DIESEL, 1 GPT HOH, 40 GPT JET061334A-E, 5 GPT PXL
Breaker = N/A
Final pH =
Initial pH =
Comments R1B5HC/FANN #3

Time Min	Temp. Deg. F	n	K Lbf*s^n/ft^2	Corr.	Vis@ 40/s cP	Vis@ 100/s cP	Vis@ 170/s cP
19.1	184	0.0971	2.8046	0.9778	4803	2100	1300
36.1	200	0.2067	1.62057	0.951	4158	2010	1319
53.1	203	0.2662	1.25987	0.9424	4026	2055	1392
70.1	203	0.2665	1.26287	0.9828	4040	2063	1398
87.1	203	0.2721	1.24635	0.9229	4070	2089	1420
104.1	203	0.2291	1.48654	0.9904	4142	2044	1358
121.1	203	0.1439	1.89588	0.9786	3858	1761	1118
138.1	203	0.0712	2.79609	0.9248	4352	1858	1135
155.1	203	0.0912	2.64404	0.6782	4430	1926	1188
172.1	203	0.0914	2.52794	0.9141	4239	1844	1138

C-3

Log Numb: 12385
Temperatu 250°F
Customer =
Location =
Fluid Syste NPHGS (JET061334A) ETHOX CHEMICAL
Additives = OFF-ROAD DIESEL, 1 GPT HOH, 30 GPT JET061334A, 5 GPT PXL
Breaker = N/A
Final pH =
Initial pH =
Comments R1B5HC/FANN #5

Time Min	Temp. Deg. F	n	K Lbf*s^n/ft^2	Corr.	Vis@ 40/s cP	Vis@ 100/: cP	Vis@ 170/s cP
19.1	211	0.164	0.74147	0.9736	1625	755	485
36.1	250	0.4011	0.30867	0.979	1622	937	682
53.1	250	0.3181	0.45404	0.991	1757	941	655
70.1	250	0.3133	0.46762	0.9872	1778	948	658
87.1	250	0.2757	0.55695	0.9907	1843	949	646
104.1	250	0.2091	0.74203	0.988	1921	931	612
121.1	250	0.1904	0.81482	0.9937	1968	937	610
138.1	250	0.1587	0.94449	0.9942	2037	943	604
155.1	250	0.1018	1.22884	0.9454	2136	939	583
172.1	250	0.0522	1.52476	0.997	2212	928	561
223.1	250	0.0199	1.78403	0.6177	2298	936	556
240.1	250	0.0718	1.29495	0.7687	2020	883	527
257.1	250	0.0532	1.49544	0.9097	2178	915	553

C-4

Log Numb: 12373
Temperatu 300°F
Customer =
Location =
Fluid Syste NPHGS (JET061334A-E) ETHOX CHEMICALS @ 300°F
Additives = OFF-ROAD DIESEL, 1 GPT HOH, 40 GPT JET061334A-E, 5 GPT PXL
Breaker = N/A
Final pH =
Initial pH =
Comments R1B5HC/FANN #5

Time Min	Temp. Deg. F	n	K Lbf*s^n/ft^2	Corr.	Vis@ 40/s cP	Vis@ 100/: cP	Vis@ 170/s cP
19.1	270	0.0595	2.98746	0.9128	4423	1868	1134
36.1	303	0.091	3.11028	0.912	5207	2264	1398
53.1	305	0.1606	2.13387	0.9779	4618	2140	1371
70.1	304	0.1279	2.25184	0.9531	4320	1943	1223
87.1	305	0.1141	2.34946	0.9848	4284	1902	1189
104.1	306	0.0371	3.15287	0.2794	4327	1791	1074
121.1	305	0.1135	2.46699	0.9469	4488	1992	1244
138.1	304	0.0973	2.18164	0.7889	3739	1635	1013
155.1	304	0.1358	1.93981	0.7898	3831	1736	1097
172.1	304	0.1352	1.96107	0.7864	3865	1750	1106

D

D-1

Log Numb 12423
Temperatu 212°F
Customer : J. THOMPSON, FR9166
Location = BJS TTC
Fluid Syste NPHGS (JET 062455A-E) BLANK
Additives = OFF-ROAD DIESEL, 1 GPT HOH, 1 GPT NE-118, 30 GPT JET062455A-E, 5 GPT PXXL,
Breaker = NONE
Final pH = N/A
Initial pH = N/A
Comments R1B5HC/ FANN# 2 (HC BS)

Time Min	Temp. Deg. F	n	K Lbf*s^n/ft^2	Corr.	Vis@ 40/s cP	Vis@ 100/s cP	Vis@ 170/s cP
19.1	187	0.3578	0.52419	0.9837	2348	1304	927
36.1	208	0.492	0.27749	0.9988	2039	1280	978
53.1	211	0.6425	0.12687	0.9985	1625	1171	988
70.1	211	0.6588	0.11252	0.9976	1530	1119	934
87.1	211	0.6368	0.13305	0.9977	1668	1196	986
104.1	211	0.6742	0.1126	0.9972	1621	1202	1011
121.1	211	0.5914	0.15864	0.9994	1682	1157	931
138.1	211	0.6477	0.12011	0.998	1568	1135	942
155.1	211	0.5806	0.16855	0.9972	1785	1193	945
172.1	211	0.5686	0.18106	0.9996	1767	1190	947
189.1	211	0.5814	0.17472	0.999	1786	1217	974
206.1	210	0.554	0.19895	0.9996	1838	1221	964
223.1	210	0.5558	0.18479	0.9995	1718	1144	904
240.1	210	0.5209	0.23175	0.9989	1895	1222	947
257.1	210	0.4885	0.27375	0.9981	1988	1243	948
274.1	211	0.4949	0.2805	0.9988	1935	1218	932
291.1	211	0.4436	0.31999	0.9942	1969	1183	880
308.1	211	0.4563	0.31559	0.9997	2033	1235	926
325.1	210	0.4977	0.27213	0.9997	2042	1289	987
342.1	210	0.4416	0.34198	0.9982	2087	1251	930
359.1	210	0.4764	0.30502	0.9999	2116	1310	992
376.1	210	0.482	0.28732	0.9998	2035	1288	962
393.1	210	0.4767	0.29588	0.9985	2055	1272	964
410.1	210	0.4555	0.32755	0.9997	2104	1278	957
427.1	210	0.4588	0.32875	0.9991	2122	1290	967
444.1	210	0.4374	0.35439	0.9964	2129	1272	943
461.1	210	0.4718	0.31118	0.9978	2123	1308	989
478.1	210	0.4501	0.34191	0.9991	2153	1301	972
495.1	210	0.4238	0.38361	0.9988	2192	1293	952
512.1	210	0.4685	0.31596	0.9986	2129	1308	987
529.1	210	0.3978	0.42494	0.9993	2205	1289	922
546.1	210	0.4509	0.34158	0.9981	2157	1304	975
563.1	210	0.4307	0.37477	0.9981	2197	1304	984
580.1	210	0.439	0.36426	0.9975	2202	1317	978

597.1	210	0.4285	0.3815	0.9977	2218	1314	970
614.1	210	0.4498	0.34711	0.998	2182	1318	984
631.1	210	0.4345	0.37147	0.9981	2208	1315	974
648.1	210	0.4368	0.36637	0.9984	2197	1311	972
665.1	210	0.4347	0.38088	0.9978	2266	1350	1000
682.1	210	0.3882	0.45891	0.998	2300	1313	949
699.1	210	0.4316	0.38168	0.9985	2245	1333	986
716.1	210	0.4178	0.39651	0.9968	2216	1300	955
733.1	210	0.4274	0.38661	0.9991	2239	1325	978
750.1	210	0.4165	0.40589	0.9989	2258	1323	971
767.1	210	0.4077	0.40647	0.9966	2189	1272	929
784.1	210	0.4192	0.39771	0.9985	2235	1312	964
801.1	210	0.4121	0.41893	0.999	2293	1338	979
818.1	210	0.4155	0.4083	0.9965	2263	1325	971
835.1	210	0.421	0.40179	0.998	2273	1337	983
852.1	210	0.4149	0.41358	0.9991	2287	1338	981
869.1	210	0.4082	0.42677	0.998	2302	1339	978
886.1	210	0.4302	0.38737	0.9976	2267	1345	984
903.1	210	0.4244	0.39744	0.999	2276	1343	980
920.1	210	0.4119	0.41668	0.9975	2279	1330	973
937.1	210	0.4196	0.40169	0.9974	2280	1328	976
954.1	210	0.4138	0.41102	0.9986	2264	1323	969
971.1	210	0.4183	0.40764	0.9973	2283	1340	984
988.1	210	0.4235	0.39478	0.9965	2254	1329	979
1005.1	210	0.4139	0.40582	0.9983	2236	1307	958
1022.1	210	0.423	0.398	0.9962	2268	1337	984
1039.1	210	0.4152	0.40376	0.9953	2235	1308	959
1056.1	210	0.4095	0.42244	0.999	2290	1333	975
1073.1	210	0.4077	0.42364	0.9986	2281	1326	968
1090.1	210	0.4115	0.42011	0.999	2294	1338	979
1107.1	210	0.4135	0.40921	0.9965	2251	1315	964
1124.1	210	0.4042	0.43483	0.9981	2312	1339	976

D-3

212°F
1GPT JET-0617-7

D-4

Log Numb 12401
Temperatu 250°F
Customer : J. THOMPSON, SR. FR-9961
Location = BJS TTC
Fluid Syste NPHGS (JET-55AE), 250°F
Additives = OFF-ROAD DIESEL, 1 GPT HOH, 30 GPT JET-55AE, 4 GPT PXL [LOT 990489], 1 ACI
Breaker = NONE
Final pH = N/A
Initial pH = N/A
Comments R1B5HC/FANN #5

Time Min	Temp. Deg. F	n	K Lbf*s^n/ft^2	Corr.	Vis@ 40/s cP	Vis@ 100/: cP	Vis@ 170/s cP
19.1	231	0.8408	0.03839	0.9488	968	836	768
36.1	253	0.3838	0.27854	0.9908	1364	775	559
53.1	255	0.3974	0.27238	0.9456	1412	813	590
70.1	254	0.3104	0.40425	0.9385	1520	808	581
87.1	254	0.2218	0.59991	0.9368	1627	798	528
104.1	254	0.0998	1.03724	0.9651	1794	786	488
121.1	254	0.0342	1.43932	0.9126	1954	807	483
138.1	254	0.0286	1.50508	0.8572	1987	814	486
155.1	254	0.0262	1.50262	0.9751	1981	812	484
172.1	254	0.0247	1.50632	0.9786	1975	808	482
189.1	253	0.0163	1.56228	0.8058	1986	806	478
206.1	253	0.0215	1.50778	0.8857	1954	797	474
223.1	253	0.0205	1.49736	0.9755	1933	788	468
240.1	253	0.0001	1.68981	0.01	2023	809	476
257.1	253	0.0105	1.55375	0.9329	1933	781	462
274.1	253	0.0172	1.4785	0.9347	1883	765	454
291.1	253	0.008	1.54237	0.8092	1901	766	453
308.1	253	0.0078	1.52811	0.8324	1882	758	448
325.1	253	0.01	1.49376	0.789	1855	749	443
342.1	253	0.0058	1.52317	0.8732	1883	749	442
359.1	253	0.007	1.49659	0.8816	1838	740	437
376.1	253	0.0015	1.54449	0.2685	1859	745	438
393.1	253	0.01	1.45394	0.9512	1808	729	431
410.1	253	0.0015	1.53053	0.3132	1842	738	434
427.1	253	0.0008	1.52897	0.1193	1835	735	432
444.1	253	0.0059	1.4853	0.5168	1792	721	425
478.1	252	0.0018	1.4942	0.1875	1800	721	425
495.1	252	0.0017	1.49808	0.2022	1804	723	426
512.1	252	0.0013	1.49339	0.1367	1798	719	423
529.1	252	0.0009	1.49446	0.1116	1795	718	423
580.1	252	0.0054	1.41936	0.8352	1733	697	411
597.1	252	0.0007	1.46998	0.1298	1764	706	415
631.1	252	0.0028	1.43669	0.2978	1737	697	410
682.1	252	0.0024	1.42902	0.5199	1728	692	407

699.1	252	0.0013	1.4338	0.9801	1724	691	405
767.1	252	0.0007	1.42941	0.1711	1715	687	404
852.1	252	0.0027	1.39404	0.8444	1685	676	398
954.1	252	0.0002	1.4184	0.0356	1699	680	400
971.1	252	0.003	1.37975	0.4416	1670	670	395
1005.1	252	0.0015	1.389	0.4304	1672	670	394
1022.1	252	0.0019	1.38139	0.3543	1665	667	393

D-6

ΠVATOR (2)

CA 02303465 2000-03-29

E

CA 02303465 2000-03-29

		Generic Name	Appearance	Composition % Fatty Acid	Rosin	Unsaps	Iodine Value	Acid Number	Color (Gardner)
UNITOL®	ACD-Special	Tall Oil Fatty Acid	Straw Colored Liquid	97.4	0.3	2.3	130	193	3
	AFL	Tall Oil Fatty Acid	Straw Colored Liquid	96.6	1.2	2.2	130	193	4
	A1-55	Tall Oil Fatty Acid	Straw Colored Liquid	96.0	1.8	2.5	148	193	4
	LFA	Tall Oil Fatty Acid	Straw Colored Liquid	95.3	1.9	2.8	130	191	5
	DSR	Tall Oil Fatty Acid	Yellow Liquid	92.8	4.0	3.2	130	191	5
	DSR-90	Tall Oil Fatty Acid	Yellow Liquid	91.9	4.7	3.4	132	190	6
	DT-22	Distilled Tall Oil	Yellow Liquid	71.0	25.5	3.5	133	169	8
	D25	Distilled Tall Oil	Yellow Liquid	71.0	20.0	3.0	148	183	5
→	PDT	Distilled Tall Oil	Yellow Liquid	66.5	27.2	3.5	134	170	8
	D28	Distilled Tall Oil	Yellow Liquid	66.0	28.0	3.0	148	181	6
	DT-30	Distilled Tall Oil	Yellow Liquid	62.9	33.0	3.5	133	175	8
→	AR-40	Specialty Tall Oil	Amber Liquid	57.5	38.0	4.5	n/a	152	12
	AR-60	Specialty Tall Oil	Amber Liquid	58.0	38.0	4.5	n/a	151	12
	R 60	Tall Oil Rosin	Yellow Solid	5.0	81.0	8.0	n/a	164	M(USDA)
	NCY	Tall Oil Rosin	Yellow Solid	3.2	84.0	5.0	n/a	164	X(USDA)
→	DPX		Dark Liquid	83	13	4		145	

E-1

WHAT IS CLAIMED IS:

1. A method of forming a gelled organic-based fluid, comprising:

combining at least one organic base fluid with a solid reaction product of at least one carboxylic acid and at least one first metal source compound to form said gelled organic fluid.

2. The method of claim 1, wherein said combining further comprises combining at least one MSMA-based compound with said organic base fluid, said solid reaction product, and said first metal source compound to form said gelled organic fluid.

3. The method of claim 1, wherein said metal of said first metal source has a valence of +3.

4. The method of claim 3, wherein said first metal source compound comprises at least one of carboxylic acid salt, metal oxide, metal halide, metal hydroxide, metal alkoxide, metal sulfate, and wherein said metal of said first metal source compound is aluminum, iron, or a mixture thereof.

5. The method of claim 1, wherein said combining further comprises combining a second metal source compound with said organic base fluid and said solid reaction product.

6. The method of claim 5, wherein said metal of said first metal source has a valence of +3; and wherein said metal of said second metal source has a valence of +3.

7. The method of claim 6, wherein said first metal source compound comprises salt of carboxylic acid; wherein said second metal source compound comprises at least one of metal oxide, metal halide, metal hydroxide, metal alkoxide, metal sulfate or a mixture thereof; and wherein said metal of said first and second metal source compounds is aluminum, iron, or a mixture thereof.

8. The method of claim 1, wherein said solid reaction product comprises a reaction product of at least one carboxylic acid, said first metal source compound and a second metal source compound.

9. A method of forming and using a gelled organic-based fluid, comprising:

combining at least one organic base fluid, at least one carboxylic acid, at least one first metal source compound, and at least one second metal source compound to form said gelled organic fluid; and

introducing said gelled organic fluid into a wellbore, pipeline interior or fluid processing facility;

wherein said first and second metal source compounds are different compounds; and

wherein said metal of said first metal source has a valence of +3; and wherein said metal of said second metal source has a valence of +3.

10. The method of claim 9, wherein said combining further comprises combining at least one MSMA-based compound with said organic base fluid, said solid reaction product, and said first metal source compound to form said gelled organic fluid.

11. The method of claim 9, wherein said first metal source compound comprises salt of carboxylic acid; wherein said second metal source compound comprises at least one of metal oxide, metal hydroxide, metal halide, metal alkoxide, metal sulfate or a mixture thereof; and wherein said metal of said first and second metal source compounds is aluminum, iron, or a mixture thereof.

12. The method of claim 9, wherein said carboxylic acid comprises at least one fatty acid having from about 6 to about 24 carbon atoms; wherein said carboxylic acid salt comprises aluminum octoate, aluminum stearate, iron octoate, aluminum 2,4-pentadione, iron 2,4-pentadione, or a mixture thereof; and wherein said second metal source compound comprises at least one of aluminum oxide, iron hydroxide, aluminum hydroxide, aluminum isopropoxide, aluminum chloride, ferric ammonium sulfate, or a mixture thereof.

13. The method of any of claim 12, further comprising combining with said organic base fluid a breaker material.

14. The method of any of claim 13, wherein said gelled organic-based fluid is introduced into a wellbore, a pipeline interior, or a fluid processing facility.

15. The method of claim 13, wherein said gelled organic-based fluid is introduced into a subterranean formation at a pressure above a fracturing pressure of said subterranean formation

16. A method of forming a gelled organic-based fluid, comprising combining the following components to form said gelled organic fluid:

at least one organic base fluid;

at least one MSMA-based compound; and

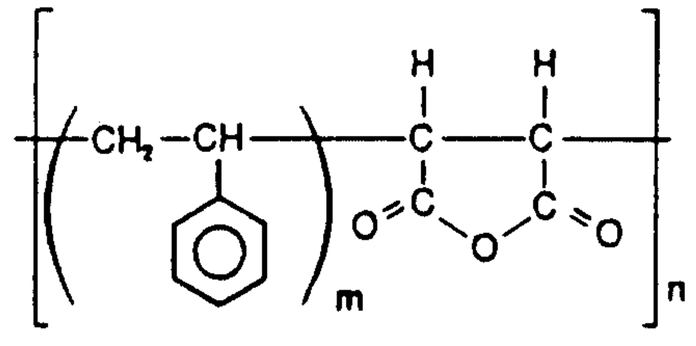
at least one first metal source compound.

17. The method of claim 16, wherein said combining comprises first combining said MSMA-based compound and said first metal source compound to form a reaction product; and then combining said reaction product with said organic base fluid to form said gelled organic-based fluid.

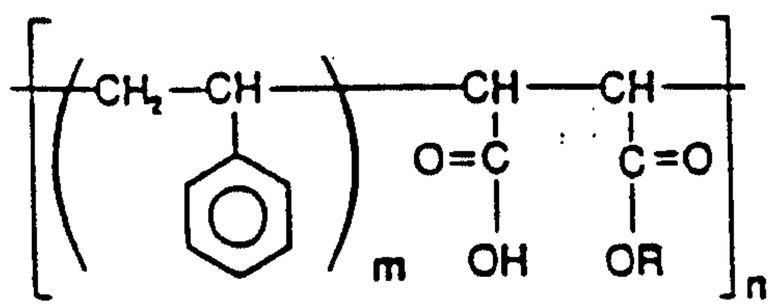
18. The method of claim 17, wherein said metal of said first metal source compound has a valence of +3.

19. The method of claim 18, wherein said reaction product comprises the reaction product of at least one carboxylic acid, said at least one MSMA-based compound, and said at least one first metal source compound.

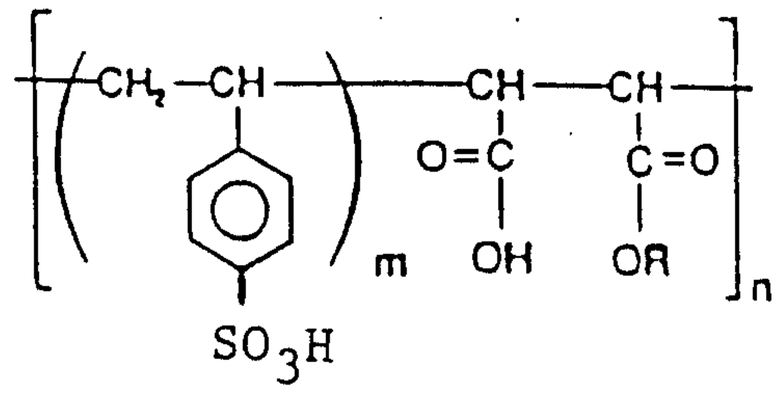
20. The method of claim 19, wherein said MSMA-based compound has at least one of the following structures, or a mixture thereof:

(A) 

wherein m = from about 1 to about 3; and n = from about 6 to about 8;

(B) 

wherein m = from about 1 to about 3; n = from about 6 to about 8; and ROH represents a fatty alcohol in which R is a branched or straight carbon chain that may be saturated or unsaturated, and which has from about 8 to about 20 carbon atoms; or

(C) 

wherein m = from about 1 to about 3; n = from about 6 to about 8; and ROH represents a fatty alcohol in which R is a branched or straight carbon chain that may be saturated or unsaturated, and which has from about 8 to about 20 carbon atoms.

21. The method of claim 20, wherein said first metal source compound comprises at least one of carboxylic acid salt, metal oxide, metal halide, metal hydroxide, metal alkoxide, metal sulfate, or mixture thereof; and wherein said metal of said first metal source compound is aluminum, iron, or a mixture thereof.

22. The method of claim 20, wherein said combining further comprises combining a second metal source compound with said organic base fluid, said at least one MSMA-based compound, and said at least one first metal source compound.

23. The method of claim 22, wherein said first metal source compound comprises salt of carboxylic acid; and wherein said second metal source compound comprises at least one of metal oxide, metal halide, metal hydroxide, metal alkoxide, metal sulfate or a mixture thereof; and wherein said metal of said first and second metal source compounds is aluminum, iron, or a mixture thereof.

24. The method of claim 19, wherein said carboxylic acid comprises at least one fatty acid having from about 6 to about 24 carbon atoms; and wherein said first metal source compound comprises aluminum octoate, aluminum stearate, iron octoate, aluminum 2,4-pentadione, iron 2,4-pentadione, aluminum oxide, iron hydroxide, aluminum hydroxide, aluminum isopropoxide, aluminum chloride, sodium hydroxide, ferric ammonium sulfate, or a mixture thereof.

25. The method of claim 23, wherein said carboxylic acid comprises at least one fatty acid having from about 6 to about 24 carbon atoms; wherein said carboxylic acid salt comprises aluminum octoate, aluminum stearate, iron octoate, aluminum 2,4-pentadione,

iron 2,4-pentadione, or a mixture thereof; and wherein said second metal source compound comprises at least one of aluminum oxide, iron hydroxide, aluminum hydroxide, aluminum isopropoxide, aluminum chloride, sodium hydroxide, ferric ammonium sulfate, or a mixture thereof.

26. The method of claim 17, wherein said combining further comprises combining at least one phosphate ester with said other components to form said gelled organic fluid.

27. The method of claim 17, further comprising combining with said organic base fluid a breaker material.

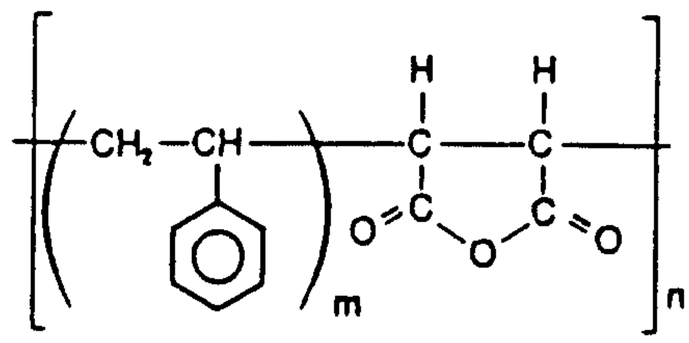
28. The method of claim 17, further comprising introducing said gelled organic-based fluid into a wellbore, a pipeline interior, or a fluid processing facility.

29. The method of claim 17, wherein said gelled organic-based fluid is introduced into a subterranean formation at a pressure above a fracturing pressure of said subterranean formation.

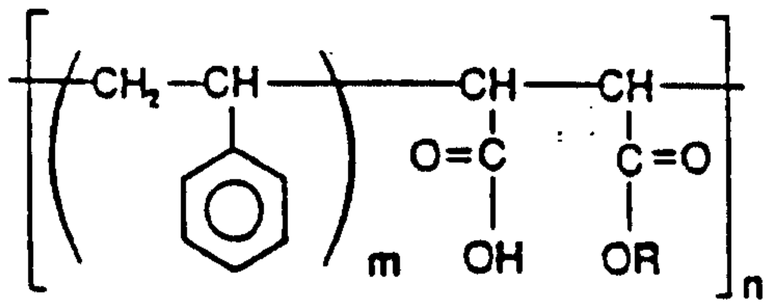
30. A reaction product of at least one carboxylic acid, at least one metal source compound, and at least one MSMA-based compound.

31. The reaction product of claim 30 wherein said carboxylic acid comprises at least one fatty acid having from about 6 to about 24 carbon atoms; wherein said at least one metal source compound comprises aluminum octoate, aluminum stearate, iron octoate,

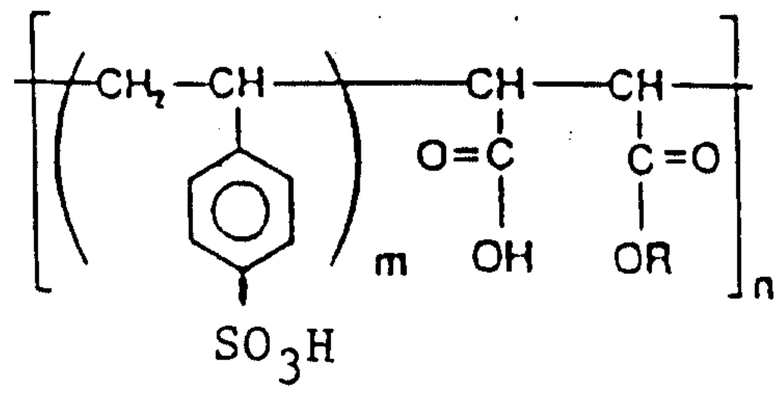
aluminum 2,4-pentadione, iron 2,4-pentadione, aluminum oxide, iron hydroxide, aluminum hydroxide, aluminum isopropoxide, aluminum chloride, ferric ammonium sulfate, or a mixture thereof; and wherein said MSMA-based compound has at least one of the following structures, or a mixture thereof:

(A) 

wherein m = from about 1 to about 3; and n = from about 6 to about 8;

(B) 

wherein m = from about 1 to about 3; n = from about 6 to about 8; and ROH represents a fatty alcohol in which R is a branched or straight carbon chain that may be saturated or unsaturated, and which has from about 8 to about 20 carbon atoms; or

(C) 

wherein m = from about 1 to about 3; n = from about 6 to about 8; and ROH represents a fatty alcohol in which R is a branched or straight carbon chain that may be saturated or unsaturated, and which has from about 8 to about 20 carbon atoms.

32. The reaction product of claim 30, wherein said at least one metal source compound comprises a first and a second metal source compound, said first and second metal source compounds being different compounds.

33. The reaction product of claim 31, wherein said reaction product comprises a solid reaction product having a particle size of from about 100 mesh to about 325 mesh.

34. A reaction product of at least one carboxylic acid, at least one first metal source compound, and at least one second metal source compound; said first and second metal source compounds being different compounds.

35. The reaction product of claim 34 wherein said carboxylic acid comprises at least one fatty acid having from about 6 to about 24 carbon atoms; wherein said at least one first metal source compound comprises a carboxylic acid salt that is at least one of aluminum octoate, aluminum stearate, iron octoate, aluminum 2,4-pentadione, iron 2,4-pentadione, or a mixture thereof; and wherein said at least one second metal source compound comprises at least one of aluminum oxide, iron hydroxide, aluminum hydroxide, aluminum isopropoxide, aluminum chloride, ferric ammonium sulfate, or a mixture thereof.

36. The reaction product of claim 35, wherein said reaction product comprises a solid reaction product having a particle size of from about 100 mesh to about 325 mesh.

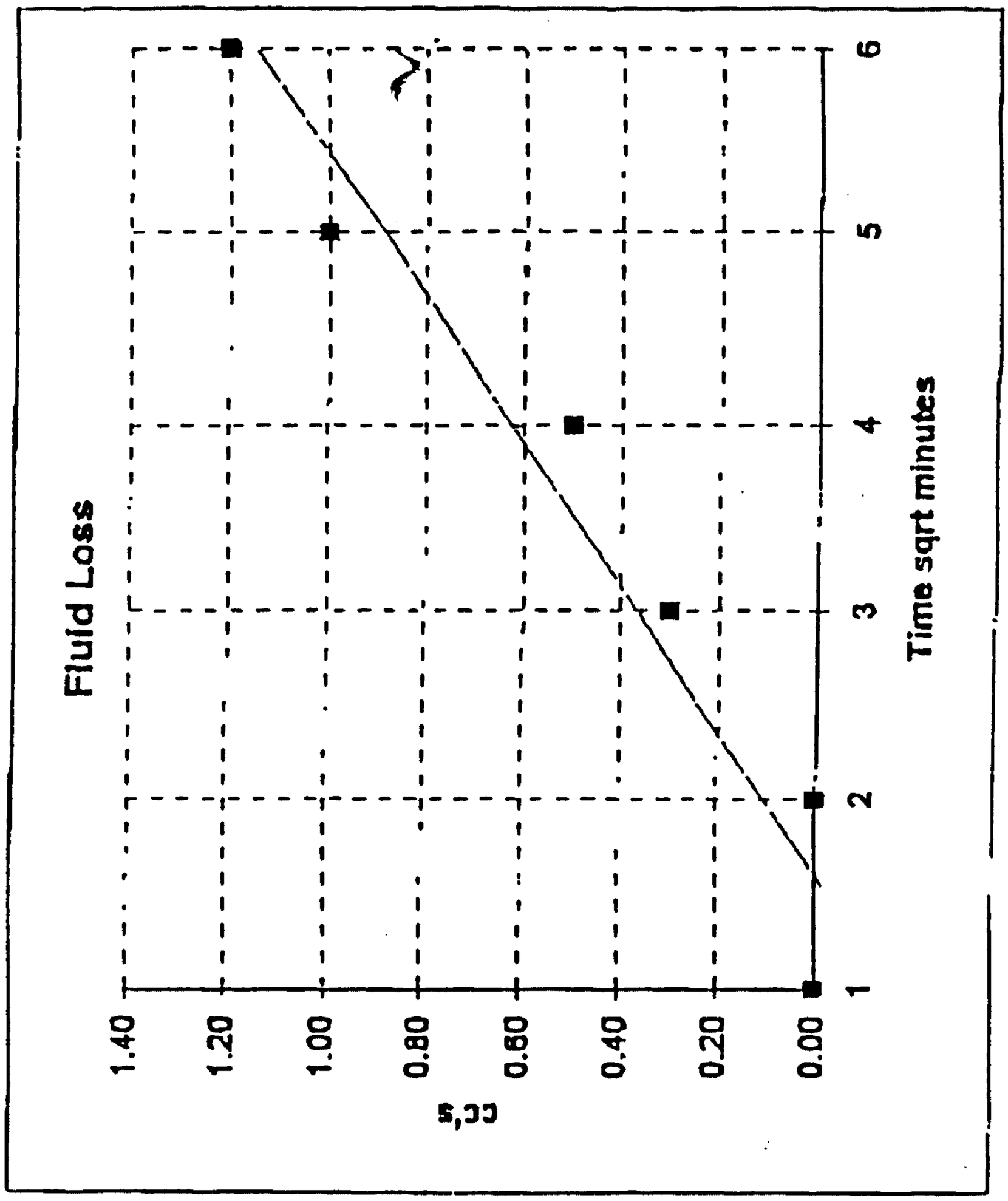
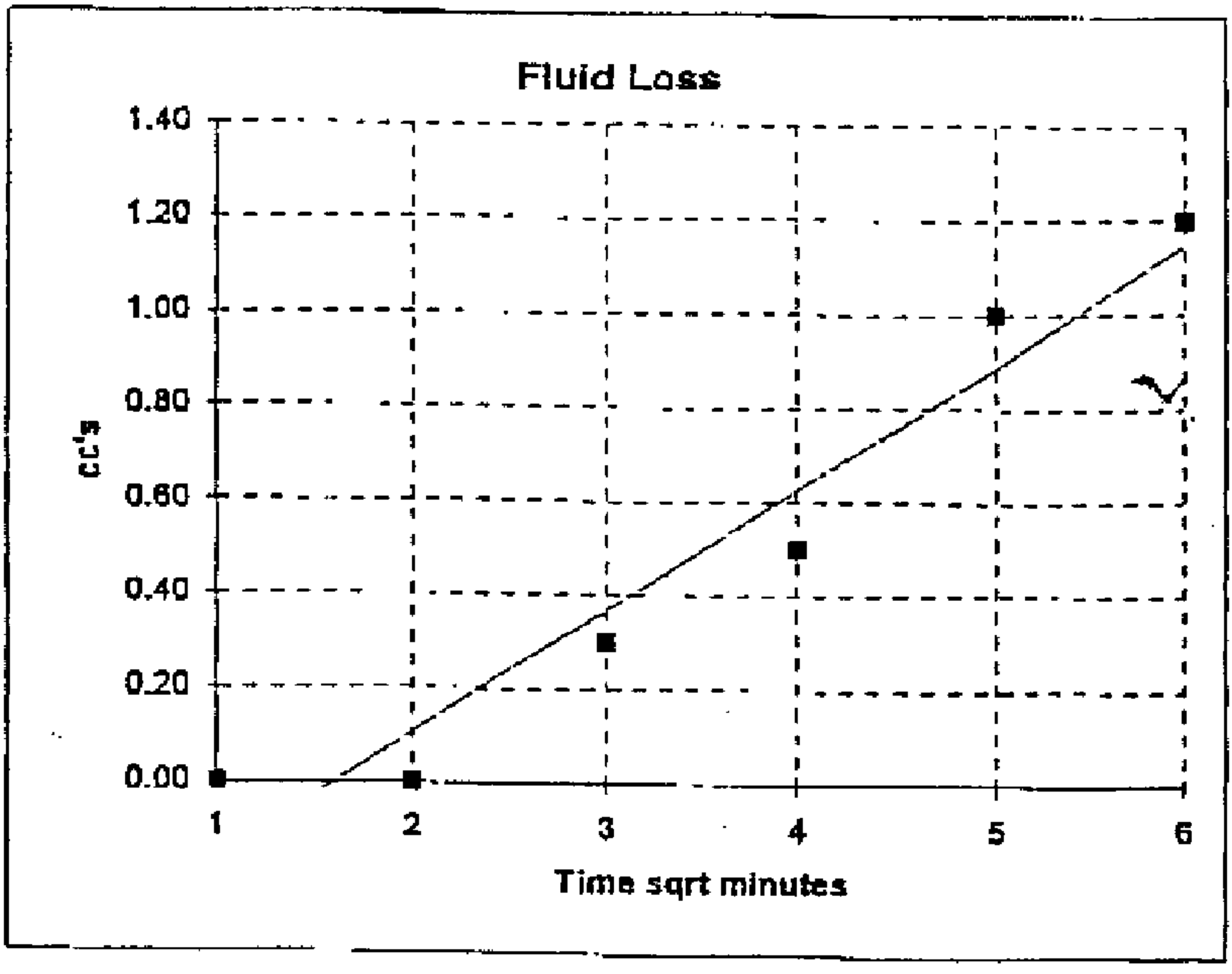

Fluid Loss
cc's
1.40
1.20
1.00
0.80
0.60
0.40
0.20
0.00
1
2
3
4
5
6
Time sqrt minutes

FIG. 1


Fluid Loss
1.40
1.20
1.00
0.80
0.60
0.40
0.20
0.00
cc's
1
2
3
4
5
6
Time sqrt minutes