ABSTRACT

Methods of treating a subterranean formation are disclosed that include contacting a paste including a liquid chemical and a lightweight fiber having a high aspect ratio with a treatment fluid, and placing the treatment fluid into a subterranean formation. Also disclosed is an additive for treating a subterranean formation comprising a paste including a liquid chemical and a lightweight fiber having a high aspect ratio.
**FIG. 3**

- **1000 PPT 12.7mm PLA FIBER IN GLYCEROL**
- **500 PPT 12.7mm PLA FIBER IN GLYCEROL**
- **GLYCEROL**

**Shear rate (1/s)**

**Viscosity (cp)**
FIBER PASTE AND METHODS FOR TREATING A SOUTERRANEAN FORMATION WITH THE FIBER PASTE

CROSS-REFERENCE TO RELATED APPLICATION(S)


BACKGROUND

[0002] Hydrocarbons (oil, natural gas, etc.) may be obtained from a souterranean geologic formation (a “reservoir”) by drilling a well that penetrates the hydrocarbon-bearing formation. Well treatment methods often are used to increase hydrocarbon production by using a treatment fluid to interact with a souterranean formation in a manner that ultimately increases oil or gas flow from the formation to the wellbore for removal to the surface.

[0003] Many of such treatment fluids use fibers. For example, wellbore treatments that employ treatment fluids containing fibers may include, for example, drilling, reservoir stimulation, and cementing, among others. A variety of fibers may be incorporated into the treatment fluid, with different physical and chemical properties as bulk materials. However, the physical handling of these uses of fibers can be very challenging particularly for fiber-like materials that are lightweight and have a high aspect ratio. Unlike heavy spherical solids (proppants, such as sand), fibers tend to bridge very easily due to the high aspect ratio. Bridging may occur where individual strands or groups of strands tend to aggregate, agglomerate and/or form clumps with each other. This makes dispensing and metering very challenging. Also, due to its lightweight nature, fibers may tend to “fly around” and get carried away easily by air, complicating transport and use thereof.

SUMMARY

[0004] This summary is provided to introduce a selection of concepts that are further described below in the detailed description. This summary is not intended to identify key or essential features of the claimed subject matter, nor is it intended to be used as an aid in limiting the scope of the claimed subject matter. Furthermore, the concepts described below are not necessarily limited to oilfield and/or oilfield service applications and may be employed in any suitable industry, such as, for example, the construction industry (insulation, concrete mixers, etc.), fabric manufacturing and plastic manufacturing.

[0005] In some embodiments, the present disclosure relates to a method for treating a souterranean formation that include in no particular order contacting a treatment fluid with a paste comprising a liquid chemical and lightweight fibers having a high aspect ratio, wherein the lightweight fibers are uniformly distributed in the paste. The treatment fluid may then be placed into a souterranean formation via a wellbore; wherein the lightweight fibers are present in the paste at a concentration in a range of from about 500 ppt to about 10,000 ppt.

BRIEF DESCRIPTION OF DRAWINGS

[0006] FIG. 1 is an image of the fiber paste, according to an embodiment of the disclosure.

[0007] FIG. 2 is an image of the fiber paste, according to an embodiment of the disclosure.

[0008] FIG. 3 is a graphical representation of a rheology profile, according to an embodiment of the disclosure.

DETAILED DESCRIPTION

[0009] In the following description, numerous details are set forth to provide an understanding of the present disclosure. However, it may be understood by those skilled in the art that the methods of the present disclosure may be practiced without these details and that numerous variations or modifications from the described embodiments may be possible.

[0010] At the outset, it should be noted that in the development of any such actual embodiment, numerous implementation-specific decisions may be made to achieve the developer’s specific goals, such as compliance with system related and business related constraints, which will vary from one implementation to another. Moreover, it will be appreciated that such a development effort might be complex and time consuming but would nevertheless be a routine undertaking for those of ordinary skill in the art having the benefit of this disclosure. In addition, the composition used/disclosed herein can also comprise some components other than those cited. In the summary and this detailed description, each numerical value should be read once as modified by the term “about” (unless already expressly so modified), and then read again as not so modified unless otherwise indicated in context. The term about should be understood as any amount or range within 10% of the recited amount or range (for example, a range from about 1 to about 10 encompasses a range from 0.9 to 11). Also, in the summary and this detailed description, it should be understood that a range listed or described as being useful, suitable, or the like, is intended to include support for any conceivable sub-range within the range at least because every point within the range, including the end points, is to be considered as having been stated. For example, “a range of from 1 to 10” is to be read as indicating each possible number along the continuum between about 1 and about 10. Furthermore, one or more of the data points in the present examples may be combined together, or may be combined with one of the data points in the specification to create a range, and thus include each possible value or number within this range. Thus, (1) even if numerous specific data points within the range are explicitly identified, (2) even if reference is made to a few specific data points within the range, or (3) even when no data points within the range are explicitly identified, it is to be understood (i) that the inventors appreciate and understand that any conceivable data point within the range is to be considered to have been specified, and (ii) that the inventors possessed knowledge of the entire range, each conceivable sub-range within the range, and each conceivable point within the range. Furthermore, the subject matter of this application illustratively disclosed herein suitably may be practiced in the absence of any element(s) that are not specifically disclosed herein.

[0011] Fibers are well known to be used for various purposes in oilfield treatment operations. For example, methods such as fiber assisted transport have been used to improve particle transport in fracturing and wellbore cleanout operations while reducing the amount of other fluid viscosifiers
employed. The methods of the present disclosure employ a paste comprising lightweight fibers with a high aspect ratio for ease of fiber delivery. [0012] In embodiments, the methods of the present disclosure use chemical liquids to fluidize a lightweight fiber into a paste with predetermined desired properties in order to circumvent the challenges of bulk handling of lightweight fiber in its original dry form. [0013] The term “paste” refers to a composition comprising lightweight fibers having a high aspect ratio mixed with a liquid chemical. In embodiments, the lightweight fibers are readily dispersible into the paste so that the lightweight fibers are separated from one another and distributed evenly throughout the entire volume of the paste. The paste of the present disclosure allows for the lightweight fibers to be stored, and/or transported to and around a field or an oilfield location in an inert form that is easy to transport, handle in bulk, dispense and meter. [0014] The term “liquid chemical” means any fluid with sufficient viscosity to keep a lightweight fiber entrained and uniformly suspended within a paste (formed by mixing the lightweight fiber with the liquid chemical). The liquid chemical may be selected to be compatible with the lightweight fibers. In some embodiments, the liquid chemical neither chemically alters (by inducing decomposition) the light-weight fiber nor affects the lightweight fiber chemical properties (such as by swelling) of the lightweight fiber during the shelf life of, or the utilization of, the paste (including the steps from manufacturing up to usage at the well site). In embodiments, the liquid chemical used in the methods of the present disclosure possesses consistent flow properties in liquid form (and in paste form, when mixed with the lightweight fiber), low friction rate, and compatibility with other chemicals used in the treatment operation. In embodiments, the liquid chemical is easily dispersible or soluble in water or aqueous fluids and may assist in the uniform distribution of fibers in the treatment fluid. In embodiments, the liquid chemical is selected to allow pumping the paste as a liquid additive into the treatment fluid. The liquid chemical can be a combination of one or more of chemicals listed below. [0015] In embodiments, the liquid chemical possesses a sufficient viscosity to keep the fiber entrained and suspended within itself. The viscosity of the liquid chemical may be at least about 40 cP at 25°C at a shear rate of about 5 s⁻¹ to about 100 s⁻¹, such as, for example, from about 40 cP to about 5000 cP from about 100 cP to about 2500 cP and from about 250 cP to about 1000 cP, at the above shear rate and temperature. [0016] In some embodiments, the liquid chemical is selected such that it is easily dispersible or soluble in the treatment fluid (such as water) to provide uniform distribution of the liquid chemical in treatment fluid (which aids in the distribution of the fibers in the treatment fluid). For example, in some embodiments the liquid chemical may disperse or dissolve in the treatment fluid (such as water) in less than about 10 minutes from the time the paste contacts the treatment fluid (such as water), or the liquid chemical may disperse or dissolve in the treatment fluid (such as water) in less than about thirty seconds from the time the paste contacts the treatment fluid (such as water), or the liquid chemical may disperse or dissolve in the treatment fluid (such as water) in less than about 10 seconds from the time the paste contacts the treatment fluid (such as water). [0017] Suitable examples of liquid chemicals include alcohols, such as, for example, glycerol; solutions (aqueous or organic) of polymers, such as polyacrylamide, guar, polyethylene oxides, poly ethylene glycols; and other water soluble and degradable polymers listed in the table below (Table 1) and combinations thereof, as well as crosslinked (partially, or reversibly crosslinked) versions of the mentioned polymers.

<table>
<thead>
<tr>
<th>Water-soluble polymers</th>
<th>Degradable polymers</th>
</tr>
</thead>
<tbody>
<tr>
<td>Polyvinyl alcohol</td>
<td>Polyethylene</td>
</tr>
<tr>
<td>Polyethylene oxide</td>
<td>Polyhydroxyalkanotes: poly[R-3-hydroxybutyrate], poly[R-3-hydroxybutyrate-co-3-hydroxyvalerate], poly[R-3-hydroxybutyrate-co-4-hydroxyvalerate], etc.</td>
</tr>
<tr>
<td>Polyvinylpyrrolidone</td>
<td>Starch-based polymers</td>
</tr>
<tr>
<td>Polysaccharides:</td>
<td>Polyactic acid and copolymers</td>
</tr>
<tr>
<td>Starch, chitosan, guar gum, hydroxyethyl guar, hydroxypropyl guar, hydroxybutyl guar, carboxymethylhydroxypropyl guar, hydroxyethyl cellulose, carboxymethyl cellulose, carboxymethyl hydroxyethyl cellulose, xanthan gum, diutan, camgumenan polymer polymers</td>
<td>Aliphatic-aromatic polymers: poly(ε-caprolactone), polyethylene terephthalate, polybutylene terephthalate, etc.</td>
</tr>
<tr>
<td>Polyacrylamide, polyacrylic acid, partially hydrolyzed polyacrylamide, co- and ter-polymers containing acrylamide, acryic acid, vinylpyrolidene, acrylamidopropene sulfonic acid (AMPS) or phosphonate monomers</td>
<td>Polyacrylamide, polyacrylic acid, partially hydrolyzed polyacrylamide, co- and ter-polymers containing acrylamide, acryic acid, vinylpyrolidene, acrylamidopropene sulfonic acid (AMPS) or phosphonate monomers</td>
</tr>
<tr>
<td>Polynylimidazole</td>
<td>Proteins: gelatin, wheat and maize gluten, cottonseed flour, whey proteins, myosin fibrillar</td>
</tr>
<tr>
<td>Polynylacrylic acid</td>
<td>Proteins: caseins etc.</td>
</tr>
<tr>
<td>Polynylamine</td>
<td></td>
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<tr>
<td>Polynylpyridine</td>
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</table>

[0018] Additional liquid chemicals may be oil-based fluids, hydrocarbon based fluids, including aromatic hydrocarbons, such as, for example, o-xylene, m-xylene, p-xylene, ethyl benzene, wax and paraffinic hydrocarbons. Further liquid chemicals may include solvents and solvent systems, such as, for example, nitrogen containing solvent systems, methyl isobutyl ketone, formamide, mutual solvent gel, petroleum jelly, gelatin, agar; alcohol solvents, such as, for example, methanol, ethanol, 1-propanol, 2-propanol, 1-butanol, 3-methyl-1-butanol and the like; ether solvents, such as, for example, n-butyl acetate, ethyl lactate and the like; ether solvents, such as, for example, isopropyl ether and the like. [0019] In some embodiments, the liquid chemical may be a liquid phase represented by an emulsion. For example, emulsions with mineral or vegetable oil capable of inversion and subsequent dispersion may be used. In some embodiments, the emulsion may contain a minimum amount of additives such that it may not have an impact on the composition/ formulation of the treatment fluid or the effectiveness of the treatment fluid (such as a fracturing fluid).

[0020] In embodiments, the liquid chemical (either in the liquid form or in paste form—when mixed with the lightweight fiber) and the lightweight fiber are dispersible in the treatment fluid. In embodiments, the liquid chemical (either in the liquid form or in paste form—when mixed with the lightweight fiber) is dissolvable and/or miscible in the treatment fluid, and the lightweight fiber is dispersible in the treatment fluid (either in the liquid form or in paste form—
when mixed with the lightweight fiber). In some embodiments, both the lightweight fiber and the liquid chemical are chemically inert while in the form of a paste.

[0021] In its original form, the lightweight fibers may exist as individual particles (or strands) or in bunches of two or more individual particles (or strands) stuck together as a consequence of a coating; sizing; and/or manufacturing process. The fibers can be bent; crimped; straight or a combination thereof. In some embodiments, the lightweight fiber employed by the methods of the present disclosure are generally straight. Curved, crimped, spiral-shaped, branched, irregular-shaped, and other three dimensional geometries, or combinations thereof, may be used in the methods of the present disclosure. The lightweight fibers may be a mixture of one or more fibers described below.

[0022] The fibers herein are lightweight and have a high-aspect ratio. Fibers herein are considered to have a high-aspect ratio when they possess an aspect ratio greater than about 100:1, such as an aspect ratio greater than about 1,000:1, or an aspect ratio greater than about 10,000:1, or an aspect ratio greater than about 1,000,000:1. As used herein, the aspect ratio of a lightweight fiber is defined as the ratio of its length (that is, its longest dimension) to its diameter (that is, its shortest dimension, such as the average diameter of a fiber over the length of the entire fiber). The fibers are considered to be lightweight when they possess a specific gravity of about 2.0 or lower, such as a specific gravity in the range of from about 2.0 to about 0.5, or a specific gravity in the range of from about 1.8 to about 0.8, or a specific gravity in the range of from about 1.6 to about 1.0, or a specific gravity in the range of from about 1.5 to about 1.1. The specific gravity may be measured according to the ASTM D792 standard “Standard test methods for density and specific gravity (relative density) of plastics by displacement.”

[0023] In embodiments, the lightweight fibers may have a diameter of about 1 mm or less. In some embodiments, the lightweight fibers may have a diameter in the range of from about 1 µm to about 1 mm, such as a diameter in the range of from about 100 µm to about 500 µm. In embodiments, the lightweight fibers may have a length in the range of from about 1 mm to about 100 mm, such as a length in the range of from about 10 mm to about 50 mm, and from about 25 mm to about 45 mm.

[0024] In embodiments, the lightweight fibers may have a diameter of about 2 mm or less. In some embodiments, the lightweight fibers may have an average diameter in the range of from about 10 µm to about 1 mm, such as an average diameter in the range of from about 100 µm to about 500 µm.

[0025] Selection of the lightweight fiber concentration for use in the methods of the present disclosure may depend on many factors, such as the anticipated changes to the paste and/or treatment fluid parameters and/or composition during a treatment operation in order to induce the paste to disperse as desired in the treatment fluid. Additional factors include the specific treatment operation and/or the way in which the lightweight fiber will be used. In some embodiments, the selection of the concentration of lightweight fiber in the methods of the present disclosure may also take into account the nature of the subterranean operation, for example, whether or not fluid loss control is desired, the temperature, the nature of the formation, and the time desired before complete dispersion of the lightweight fiber from the paste occurs. In embodiments, the paste used in the methods of the present disclosure may contain the lightweight fiber in any desired amount that is sufficient to form the desired concentration of the lightweight fiber downhole.

[0026] In embodiments, the lightweight fiber may be selected such that it decomposes in the treatment fluid (such as after a predetermined time of being exposed to treatment fluid) under downhole conditions, or may be triggered to decompose by being exposed to a predetermined condition, such as temperature, pH, salinity, ionic concentration, solvent composition and combinations thereof.

[0027] Suitable fibers may be selected from the group consisting of substituted and unsubstituted lactide, glycolide, oily lactic acid and polyglycolic acid, copolymers of glycolic acid with other hydroxy-, carboxylic acid-, or hydroxyxarboxylic acid-containing moieties, and mixtures thereof, polyethylene, polyethylene terephthalate, cellulose, glass fibers, phenol formaldehyde fibers among others.

[0028] In embodiments, the paste of the present disclosure possesses consistent flow properties at low shear rate such as, for example, from 5 s⁻¹ to 500 s⁻¹, compatibility with other chemicals used in the treatment operation, reduces fiber scattering, and decreases the risk of airborne fibers being breathed in by the personnel on site.

[0029] In some embodiments, the paste comprising lightweight fibers with a high aspect ratio can be handled at the desired location (for example, the wellbore site) as a liquid additive. In embodiments, the paste of the present disclosure comprising lightweight fibers with a high aspect ratio may be used in conjunction with an automated feeding apparatus that conveys the paste through a liquid additive feeder or other automated device. In embodiments, the paste of the present disclosure comprising lightweight fibers with a high aspect ratio may be precisely dosed and/or metered, such as when used in conjunction with an automated feeding apparatus that conveys the paste through a liquid additive feeder or other automated device.

[0030] In some embodiments, the paste comprising a liquid chemical and a lightweight fiber having a high aspect ratio is stable (after a uniform mixture of the paste is prepared) as a uniform mixture for a predetermined amount of storage time. For example, in some embodiments, the paste comprising a liquid chemical and a lightweight fiber having a high aspect ratio is able to be stored as a substantially uniform or uniform mixture at a temperature in the range of from about 0° to about 60° C. at atmospheric pressure for a period of at least about 4 weeks, or the paste comprising a liquid chemical and a lightweight fiber having a high aspect ratio is able to be stored as a substantially uniform or uniform mixture at a temperature in the range of from about 10° to about 40° C. at atmospheric pressure for a period of at least about 8 weeks, or the paste comprising a liquid chemical and a lightweight fiber having a high aspect ratio is able to be stored as a substantially uniform or uniform mixture at a temperature in the range of from about 20° to about 30° C. at atmospheric pressure for a period of at least about 20 weeks. In such embodiments (in conjunction with the above-mentioned conditions and storage times), the lightweight fiber may not substantially separate out of the paste, such as less than about 10% by weight of the lightweight fiber (based on the total weight of the lightweight fiber in the paste separates or filters itself out of the paste, or less than about 2% by weight of the lightweight fiber (based on the total weight of the lightweight fiber in the paste) separates or filters itself out of the paste, or less than about 1% by weight of the lightweight fiber (based on the total weight of the
lightweight fiber in the paste) separates or filters itself out of the paste (under the above-mentioned conditions and storage times). In embodiments, the paste of the present disclosure may be dispersible, dissolvable, or partially dissolvable in the treatment fluid. In some embodiments, the paste may disintegrate, degrade or decompose by hydrolysis, chemical trigger, temperature trigger, pH trigger or mechanical trigger upon contacting the treatment fluid, or at a predetermined time after contacting the treatment fluid.

[0031] In embodiments, the components of the paste may be selected for fiber delivery under predetermined conditions or in a predetermined environment, for handling specific type of surface equipment, for assisting fiber inclusion and dispersion in the treatment fluid, and for protection of the fiber and other treatment fluid constituents during the well site delivery and fluid mixing procedures.

[0032] In embodiments, the paste may be formulated to facilitate rapid fiber dispersion with minimal mixing energy. This can be accomplished by using any of the appropriate surfactants as part of the paste formulation as described below.

[0033] In embodiments, the paste of the present disclosure may comprise uniformly distributed lightweight fibers having a high aspect ratio at a concentration in a range of from about 500 pounds per one thousand gallons of water (ppg) to about 10,000 ppg, such as a concentration in a range of from about 750 pp to about 9,000 pp, a concentration in a range of from about 1,000 pp to about 9,000 pp, a concentration in a range of from about 1,500 pp to about 7,500 pp, a concentration in a range of from about 1,500 pp to about 5,000 pp, a concentration in a range of from about 1,500 pp to about 3,000 pp or a concentration in a range of from about 2,000 pp to about 2,500 pp. In embodiments, the paste of the present disclosure may possess a viscosity in the range of from about 1 cp to 500,000 cp at 25° C. at a shear rate of 1 s⁻¹ to 200 s⁻¹, such as a viscosity in the range of from about 1 cp to 100,000 cp at 25° C. at a shear rate of 1 s⁻¹ to 200 s⁻¹, or a viscosity in the range of from about 10,000 cp to 50,000 cp at 25° C. at a shear rate of 1 s⁻¹ to 200 s⁻¹.

[0034] The dispersion time of the paste and thus the release time of the lightweight fibers (into the treatment fluid) having a high aspect ratio from the paste may be tailored by adjusting the type and grade of the liquid chemical, the amount and concentration of the liquid chemical, the type of treatment fluid, the composition of the treatment fluid, the pH, the temperature, and the amount of impurities in the paste or treatment fluid. The paste dispersion time in the treatment fluid may also be influenced by conditions such as agitation rate, and the turbulence experienced by the treatment fluid.

[0035] In some embodiments, the paste is easily dispersible or soluble in treatment fluid (such as water) to provide uniform distribution of the lightweight fibers in the treatment fluid. For example, in some embodiments the paste may disperse or dissolve upon contact with the treatment fluid (such as water) in less than about 1 hour (60 minutes) from the time the paste contacts the treatment fluid (such as water), in less than about 10 minutes from the time the paste contacts the treatment fluid (such as water), or the paste may disperse or dissolve upon contact with the treatment fluid (such as water) in less than about 30 seconds from the time the paste contacts the treatment fluid (such as water), or the paste may disperse or dissolve in treatment fluid (such as water) in less than about 10 seconds from the time the paste contacts the treatment fluid (such as water).

[0036] In some embodiments, the lightweight fibers of the paste may uniformly disperse in treatment fluid (such as water) in less than about 10 minutes from the time the paste contacts the treatment fluid (such as water), or the lightweight fibers of the paste may uniformly disperse in treatment fluid (such as water) in less than about thirty seconds from the time the paste contacts the treatment fluid (such as water), or the lightweight fibers of the paste may disperse in treatment fluid (such as water) in less than about 10 seconds from the time the paste contacts the treatment fluid (such as water).

[0037] In some embodiments, the paste may disintegrate, degrade or decompose by hydrolysis, chemical trigger, temperature trigger, pH trigger or mechanical trigger at a predetermined time after contacting the treatment fluid (as opposed to immediately after contacting the treatment fluid, which occurs in some embodiments). For example, in some embodiments, the components of the paste may be selected such that the paste may disintegrate, degrade or decompose by hydrolysis, chemical trigger, temperature trigger, pH trigger or mechanical trigger at a time no less than about one hour from the time the paste contacts the treatment fluid (such as water), or the components of the paste may be selected such that the paste may disintegrate, degrade or decompose by hydrolysis, chemical trigger, temperature trigger, pH trigger or mechanical trigger at a time no less than about six hours from the time the paste contacts the treatment fluid (such as water), or the components of the paste may be selected such that the paste may disintegrate, degrade or decompose by hydrolysis, chemical trigger, temperature trigger, pH trigger or mechanical trigger at a time no less than about two days from the time the paste contacts the treatment fluid (such as water).

[0038] In some embodiments, the components of the paste may be selected such that the paste may disintegrate, degrade or decompose by hydrolysis, chemical trigger, temperature trigger, pH trigger or mechanical trigger at a time less than about one week from the time the paste contacts the treatment fluid (such as water), or the components of the paste may be selected such that the paste may disintegrate, degrade or decompose by hydrolysis, chemical trigger, temperature trigger, pH trigger or mechanical trigger at a time less than about one day from the time the paste contacts the treatment fluid (such as water).

[0039] In embodiments, the paste of the present disclosure may be effective as a means of transporting lightweight fiber having a high aspect ratio to the well site. In embodiments, the paste may be fed into the treatment fluid as a liquid additive (as an extruded paste).

[0040] In some embodiments, the paste comprising a liquid chemical and a lightweight fiber having a high aspect ratio is pumpable as a uniform mixture, such as through conduits or lines having a diameter in the range of from about 0.5 inches to about 10 inches, such as through conduits or lines having a diameter in the range of from about 1 inch to about 4 inches, or through conduits or lines having a diameter in the range of from about 1 inch to about 6 inches. For example, in some embodiments, such as where the conduits or lines (through which the paste flows or is pumped) has a diameter in the range of from about 0.5 to about 2 inches the flow rate of the paste may be in the range of from about 0.1 gallons per min (gpm) to about 300 gpm, such as a flow rate in the range of from about 1 gpm to about 200 gpm, or a flow rate in the range of from about 10 gpm to about 170 gpm. In some embodiments, such as where the conduits or lines (through which the
paste flows or is pumped) has a diameter in the range of from about 2 to about 10 inches the flow rate of the paste may be in the range of from about 1 gpm to about 5000 gpm, such as a flow rate in the range of from about 10 gpm to about 2000 gpm, or a flow rate in the range of from about 50 gpm to about 1000 gpm. In such embodiments (in conjunction with the above-mentioned conduit or line diameters and flow rates), the lightweight fiber may not substantially separate or filter itself out of the paste, such as less than about 10% by weight of the lightweight fiber (based on the total weight of the fiber in the paste separates or filters itself out of the paste (during transport), or less than about 2% by weight of the lightweight fiber (based on the total weight of the fiber in the paste) separates or filters itself out of the paste (during transport), or less than about 1% by weight of the lightweight fiber (based on the total weight of the fiber in the paste) separates or filters itself out of the paste (during transport).

[0041] In embodiments, the paste comprising a liquid chemical and a lightweight fiber having a high aspect ratio may be premixed at the location of use or at the manufacturing site. The shelf life of the paste can be tailored by manipulating the storage conditions, type of additives and nature of liquid chemical used. In embodiments, the paste can be prepared by one or combination of several of the commonly known mixing techniques at the well site, manufacturing site, bulk plant or at the location which utilizes a combination of tanks and paddles. In some embodiments, a continuous mixing technique may be employed to prepare the paste of the present disclosure.

[0042] Forming the paste of the present disclosure, which comprises lightweight fibers having a high aspect ratio mixed with a liquid chemical, allows for the reduction of fiber scattering observed during conventional methods in which lightweight fibers having a high aspect ratio are used. In addition, the paste of the present disclosure may allow for the elimination of the current practice of manually opening bags of fibers and feeding fiber in to the treatment fluid at the location of use (for example, the wellbore site). In embodiments, the paste of the present disclosure can be delivered in a truck and fed automatically. In embodiments, dosing the lightweight fibers having a high aspect ratio in the form of a paste also improves metering accuracy, and thus the overall quality of treatment operation with the preselected treatment fluid.

[0043] As used herein, the term “treatment fluid,” refers to any pumpable and/or flowable fluid used in a subterranean operation in conjunction with a desired function and/or for a desired purpose. Such fluids may be modified to contain a paste comprising lightweight fibers with a high aspect ratio and a liquid chemical. For example, the treatment fluid may be at the surface or downhole when it is contacted with a paste of the present disclosure. In some embodiments, the paste of the present disclosure may be incorporated into treatment fluids that are either aqueous or organic.

[0044] The term “treatment,” or “treating,” does not imply any particular action by the fluid. For example, a treatment fluid (to which the paste comprising lightweight fibers with a high aspect ratio has been added) may be placed or introduced into a subterranean formation subsequent to a leading-edge fluid may be a hydraulic fracturing fluid, an acidizing fluid (acid fracturing, acid diverting fluid), a stimulation fluid, a sand control fluid, a completion fluid, a wellbore consolidation fluid, a remediation treatment fluid, a cementing fluid, a driller fluid, a frac-packing fluid, or gravel packing fluid. The methods of the present disclosure include forming a paste comprising lightweight fibers with a high aspect ratio. The treatment fluids to which the paste comprising lightweight fibers with a high aspect ratio may be added, may be used in full-scale operations, pills, or any combination thereof. As used herein, a “pill” is a type of relatively small volume of specially prepared treatment fluid placed or circulated in the wellbore.

[0045] The term “fracturing” refers to the process and methods of breaking down a geological formation and creating a fracture, such as the rock formation around a wellbore, by pumping fluid at very high pressures (pressure above the determined closure pressure of the formation), in order to increase production rates from or injection rates into a hydrocarbon reservoir. The fracturing methods of the present disclosure may include a treatment fluid to which the paste comprising lightweight fibers with a high aspect ratio has been added, but otherwise use conventional techniques known in the art.

[0046] In embodiments, the methods of the present disclosure may include the following actions, in any order: contacting a treatment fluid with a paste comprising lightweight fibers with a high aspect ratio and a liquid chemical; placing the treatment fluid in a subterranean formation to perform its desired function and/or for a desired purpose. The terms “placing” or “placed” refer to the addition of a treatment fluid to a subterranean formation by any suitable means and, unless stated otherwise, do not imply any order by which the actions occur.

[0047] In some embodiments, the treatment fluid may act as a vehicle that contains, and optionally chemically isolates, the paste of the present disclosure while it is being transported into the subterranean formation until the conditions are achieved or triggered to allow the lightweight fibers in the paste to be dispersed into the treatment fluid.

[0048] The treatment fluids of the present disclosure (to which a paste comprising lightweight fibers with a high aspect ratio either has been added, or to which a paste comprising lightweight fibers with a high aspect ratio either will be added) may be introduced during methods that may be applied at any time in the life cycle of a reservoir, field, or oilfield. For example, the methods and treatment fluids of the present disclosure may be employed in any desired downhole application (such as, for example, stimulation) at any time in the life cycle of a reservoir, field, or oilfield.

[0049] In embodiments, the paste comprising lightweight fibers with a high aspect ratio of the present disclosure may be placed or introduced into a wellbore. A “wellbore” may be any type of well, including, a producing well, a non-producing well, an injection well, a fluid disposal well, an experimental well, an exploratory deep well, and the like. Wellbores may be vertical, horizontal, deviated some angle between vertical and horizontal, and combinations thereof, for example a vertical well with a non-vertical component.

[0050] The term “field” includes land-based (surface and sub-surface) and sub-seabed applications. The term “oilfield,” as used herein, includes hydrocarbon oil and gas reservoirs, and formations or portions of formations where hydrocarbon oil and gas are expected but may additionally contain other materials such as water, brine, or some other composition.

[0051] In some embodiments, the paste, which comprises lightweight fibers having a high aspect ratio mixed with a liquid chemical, for use in the methods of the present disclosure may be selected such that paste may have predetermined condition, such as temperature, pH, salinity, ionic concentra-
tion, solvent composition, etc., at which the lightweight fiber disperses out of the paste and into the treatment fluid. In other words, the paste, which comprises lightweight fibers having a high aspect ratio mixed with a liquid chemical, for use in the methods of the present disclosure may be selected to have defined chemical and/or physical conditions under which it releases the lightweight fibers from the paste into the treatment fluid.

[0052] In embodiments, the paste of the present disclosure, which comprises lightweight fibers having a high aspect ratio mixed with a liquid chemical, may be selected to avoid premature dispersion of the lightweight fiber. Then, when it is desired to disperse the lightweight fibers, conditions may be altered, such as by placing a solvent or treatment fluid, and/or and additional component, to modify the paste such that conditions under which lightweight fibers will become free from the paste are generated.

[0053] In embodiments, after the lightweight fiber has been released from the paste into the treatment fluid, the treatment fluids used in the methods of the present disclosure may contain the lightweight fiber in a concentration of from about 1 ppt to about 200 ppt, such as, for example, from about 1 ppt to about 50 ppt, from about 5 ppt to about 40 ppt, from about 10 ppt to about 35 ppt and from about 25 ppt to about 35 ppt. In some embodiments, the paste (which comprises lightweight fibers having a high aspect ratio mixed with a liquid chemical) may be added to the treatment fluid downhole, and thus the concentration of the lightweight fiber in the surface prepared treatment fluid is zero (until the paste is added at a downhole location).

[0054] In some embodiments, most or a substantial portion of the lightweight fiber used to prepare the paste arrives at the target treatment zone or target subterranean formation after being dispersed in the treatment fluid, for example, at least about 50% by weight of the lightweight fiber at least about 60% by weight of the lightweight fiber, at least about 70% by weight of the lightweight fiber, at least about 80% by weight of the lightweight fiber, at least about 90% by weight of the lightweight fiber, at least about 95% by weight of the lightweight fiber, at least about 98% by weight of the lightweight fiber, or at least about 99% by weight of the lightweight fiber, or at least about 99.9% by weight of the lightweight fiber, may arrive at the target treatment zone or target subterranean formation.

[0055] In some embodiments, the paste (which comprises lightweight fibers having a high aspect ratio mixed with a liquid chemical) may be added to the treatment fluid after the treatment fluid has been pumped downhole.

[0056] In some embodiments (such as when the paste is added to the treatment fluid downhole, or where the paste is added to the treatment fluid at the surface) a substantial portion of the lightweight fiber present in the paste arrives at the target treatment zone or target subterranean formation after being uniformly dispersed in the treatment fluid, for example, at least about 95% by weight of the lightweight fiber is uniformly dispersed in the treatment fluid, or at least about 99% by weight of the lightweight fiber is uniformly dispersed in the treatment fluid, or at least about 99.9% by weight of the lightweight fiber uniformly dispersed in the treatment fluid, before the lightweight fiber arrives at the target treatment zone or target subterranean formation.

[0057] While the pastes, methods and treatment fluids of the present disclosure are described herein as comprising the above-mentioned components, it should be understood that the pastes, methods and fluids of the present disclosure may optionally comprise other additional materials, such as the materials and additional components discussed below.

[0058] Optionally other chemical agents can be premixed with fibers and added into the paste to regulate viscosity, flow properties, dispersion rate, reduce friction, etc. For example, chemicals useful for the treatment application may also be included in the paste. Such chemicals or additives that may be included in the paste (or the treatment fluid) may include scale inhibitors, corrosion inhibitors, clay stabilizers, surfactants, fluid loss additives, polymer breaking agents such as enzymes or oxidizers and encapsulated forms of the breakers, polymers, crosslinkers, thermal stabilizers, defoamers, dye or biocides. Additionally dispersing additives can be premixed into the paste, such as, for example superabsorbents, surfactant, inert materials and other.

[0059] After the lightweight fiber is dispersed into the treatment fluid, it may perform its intended function and/or application, for example, as a fiber-like component in a drilling fluid, a fracturing fluid, cement slurry, or a completion fluid. Such materials are described in U.S. Pat. Nos. 5,330,005, 5,439,055; 5,501,275; 6,172,011; and 6,419,019, the disclosures of which are hereby incorporated by reference in their entirety. Furthermore, any additives normally used in such treatments may be included in the treatment fluid (and/or paste), provided that they are compatible with the other components and the desired results of the treatment operation. Such additives may include those identified above, as well as anti-oxidants, crosslinkers, delay agents, buffers, fluid loss additives, etc.

[0060] As discussed above, the treatment fluid into which the lightweight fibers of the paste are distributed may be any well treatment fluid, such as a fluid loss control pill, a water control treatment fluid, a scale inhibition treatment fluid, a fracturing fluid, a gravel packing fluid, a drilling fluid, and a drill-in fluid. The carrier solvent (as one of the components of the treatment fluid) may be a pure solvent or a mixture. Suitable carrier solvents or use with the methods of the present disclosure, such as for forming the treatment fluids disclosed herein, may be aqueous or organic based. Aqueous carrier solvents may include at least one of fresh water, sea water, brine, mixtures of water and water-soluble organic compounds and mixtures thereof. Organic carrier solvents may include any organic solvent that is able to dissolve or suspend the various components, such as the chemical entities and/or components of the treatment fluid. The carrier solvent may be the same or different than the liquid chemical described above.

[0061] Suitable organic carrier solvents may include, for example, alcohols, glycols, esters, ketones, nitrites, amides, amines, cyclic ethers, glycol ethers, acetone, acetonitrile, 1-butanol, 2-butanol, 2-butanol, t-butyl alcohol, cyclohexane, diethyl ether, diethylene glycol, diethylene glycol dimethyl ether, 1,2-dimethoxy-ethane (DME), dimethylether, dibutyl ether, dimethyl sulfoxide (DMSO), dioxane, ethanol, ethyl acetate, ethylene glycol, glycerin, heptanes, hexamethylphosphoramide (HMP), hexane, methanol, methyl t-butyl ether (MTBE), N-methyl-2-pyrrolidone (NMP), nitromethane, pentane, petroleum ether (ligroine), 1-propanol, 2-propanol, pyridine, tetrahydrofuran (THF), toluene, triethylamine, o-xylene, m-xylene, p-xylene, ethylene glycol monobutyl ether, polyglycol ethers, pyridones, N-(alkyl or cycloalkyl)-2-pyrrolidones, N-alkyl pyrrolidones, N,N-diethyl alkanolamides, N,N,N',N'-tetra alkyl ureas, dialkylsil-
The treatment fluids described herein also may include one or more inorganic salts. Examples of such salts include water-soluble potassium, sodium, and ammonium salts, such as potassium chloride, ammonium chloride, chlorine chloride, or tetramethyl ammonium chloride (TMAC). Additionally, sodium chloride, calcium chloride, potassium chloride, sodium bromide, calcium bromide, potassium bromide, sodium sulfate, calcium sulfate, sodium phosphate, calcium phosphate, sodium nitrate, calcium nitrate, cesium chloride, cesium sulfate, cesium phosphate, cesium nitrate, cesium bromide, potassium sulfate, potassium phosphate, potassium nitrate salts may also be used. Any mixtures of the inorganic salts may be used as well. The inorganic salt may be added to the fluid in an amount of from about 1 wt% to about 99 wt% based upon total weight of the treatment fluid.

In other embodiments, the surfactant is a blend of two or more of the surfactants described above, or a blend of any of the surfactant or surfactants described above with one or more nonionic surfactants. Examples of suitable nonionic surfactants include, but are not limited to, alkyl alcohol ethoxylates, alkyl phenol ethoxylates, alkyl acid ethoxylates, alkyl amine ethoxylates, sorbitan alkanoates and ethoxylated sorbitan alkanoates. Any effective amount of surfactant or blend of surfactants may be used in aqueous energized fluids.

Friction reducers may also be incorporated in any fluid embodiment. Any suitable friction reducer polymer, such as polyacrylamide and co-polymers, partially hydrolyzed polyacrylamide, poly(2-acrylamido-2-methyl-1-propane sulfonic acid) (polyAMPS), and polyethylene oxide may be used. Commercial drag reducing chemicals such as those sold by Conoco Inc. under the trademark “CDR” as described in U.S. Pat. No. 3,692,676 or drag reducers such as those sold by Chemlink designated under the trademarks FLO1003, FLO1004, FLO1005 and FLO1008 have also been found to be effective. These polymeric species added as friction reducers or viscosity index improvers may also act as excellent fluid loss additives reducing or even eliminating the use of conventional fluid loss additives. Latex resins or polymer emulsions may be incorporated as fluid loss additives. Shear recovery agents may also be used in embodiments.

The above fluids may also comprise a breaker. The purpose of this component is to “break” or diminish the viscosity of the fluid so that this fluid is more easily recovered from the formation during cleanup. With regard to breaking down viscosity, inorganic or organic oxidizers, enzymes, or acids may be used. Breakers reduce the polymer’s molecular weight by the action of an acid or an acid precursor such as polyacrylic acid (PLA) or polyglycolic acid (PGA), an oxidizer, an enzyme, or some combination of these on the polymer itself. In the case of borate-crosslinked gels, increasing the pH and therefore increasing the effective concentration of the active crosslinker, the borate anion, reversibly create the
borate crosslinks. Lowering the pH can just as easily remove the borate/polymer bonds. At a high pH above 8, the borate ion exists and is available to crosslink and cause gelling. At lower pH, the borate is tied up by hydrogen and is not available for crosslinking, thus gelation by borate ion is reversible. [0069] Embodiments may also include proppant particles that are substantially insoluble in the fluids of the formation. Proppant particles carried by the treatment fluid remain in the fracture created, thus propping open the fracture when the fracturing pressure is released and the well is put into production. Proppant particles can have any shape, including but not limited to spherical and rod-like. Proppant particles might be filled entirely with a solid substance or contain hollow spaces within. Suitable proppant materials include, but are not limited to, sand, walnut shells, sintered bauxite, glass beads, ceramic materials, nanocomposite beads, naturally occurring materials, or similar materials. Mixtures of proppant can be used as well. If sand is used, it may be from about 20 to about 100 U.S. Standard Mesh in size, although other sizes above and below this range can be used. With synthetic proppants, mesh sizes about 8 or greater may be used. Naturally occurring materials may be underdried and/or unprocessed naturally occurring materials, as well as materials based on naturally occurring materials that have been processed and/or derived. Suitable examples of naturally occurring particulate materials for use as proppants include: ground or crushed shells of nuts such as walnut, coconut, pecan, almond, ivory nut, brazil nut, etc.; ground or cracked seed shells (including fruit pits) of seeds of fruits such as plum, olive, peach, cherry, apricot, etc.; ground or crushed seed shells of other plants such as maize (e.g., corn cobs or corn kernels), etc.; processed wood materials such as those derived from woods such as oak, hickory, walnut, poplar, mahogany, etc. including such woods that have been processed by grinding, chipping, or other form of particulation, processing, etc. [0070] The concentration of proppant in the fluid can be any concentration known in the art. For example, the concentration of proppant in the fluid may be in the range of from about 0.03 to about 3 kilograms of proppant added per liter of liquid phase. Also, any of the proppant particles can further be coated with a resin to potentially improve the strength, clustering ability, and flow back properties of the proppant. [0071] Embodiments may further use fluids containing other additives and chemicals that are known to be commonly used in oilfield applications by those skilled in the art. These include, materials such as surfactants in addition to those mentioned hereinabove, breaker aids in addition to those mentioned hereinabove, oxygen scavengers, alcohols, stabilizers, scale inhibitors, corrosion inhibitors, fluid-loss additives, bactericides and biocides such as 2,2-dihromo-3-nitriopropionime or glutaraldehyde, and the like. Also, they may include a co-surfactant to optimize viscosity or to minimize the formation of stable emulsions that contain components of crude oil. [0072] As used herein, the term “alcohol stabilizer” is used in reference to a certain group of organic molecules substantially or completely soluble in water containing at least one hydroxyl group, which are susceptible of providing thermal stability and long term shelf life stability to aqueous zirconium complexes. Examples of organic molecules referred as “alcohol stabilizers” include but are not limited to methanol, ethanol, n-propanol, isopropanol, n-butanol, tert-butanol, ethyleneglycol monomethyl ether, and the like. Furthermore, one or more of the chemicals identified above may be encapsulated to provide a delayed release of the oilfield chemicals into the surrounding fluid or material such that the oilfield chemical is liberateted after entering the formation (or the fracture). Additional details regarding encapsulation are described in U.S. Patent Application Pub. Nos. 2010/0307744; 2010/0270031 and 2008/0109490, the disclosure of which are incorporated by reference herein in their entirety. [0074] In this regard, the treatment fluid may include components independently selected from any solids, liquids, gases, and combinations thereof such as slurries, gas-saturated or non-gas-saturated liquids, mixtures of two or more miscible or immiscible liquids, and the like, as long as such additional components allow for the dispersion of the lightweight fiber into the treatment fluid. For example, the treatment fluid may comprise organic chemicals, inorganic chemicals, and any combinations thereof. Organic chemicals may be monomeric, oligomeric, polymeric, crosslinked, and combinations, while polymers may be thermoplastic, thermosetting, moisture setting, elastomeric, and the like. Inorganic chemicals may be metals, alkaline and alkaline earth chemicals, minerals, and the like. [0075] Various other fibrous materials may also be included in the treatment fluid. Suitable fibrous materials may be woven or nonwoven, and may be comprised of organic fibers, inorganic fibers, mixtures thereof and combinations thereof. [0076] In embodiments, the method of the present disclosure may utilize a pumping system that pumps one or more treatment fluids, and/or one or more of the pastes into the wellbore. The pumping systems may include mixing or combining devices, wherein various components, such as fluids, solids, and/or gases may be mixed or combined prior to being pumped into the wellbore. The mixing or combining device may be controlled in a number of ways, including, but not limited to, using data obtained either downhole from the wellbore, surface data, or some combination thereof. [0077] In embodiments, also described is a method of delivering a solid to a wellsite, that includes forming a paste, wherein a concentration of the solid to liquid is in the range described herein above. The paste may then be transported to the wellsite by any suitable transportation means, such as a truck, trailer, boat or tanker or railcar. The paste may then be diluting such that the concentration of the diluted paste in the manner described above. The dilution may occur at the wellsite. The paste composition may include or not include any cementsitious materials such as those described in U.S. Patent Application Pub. Nos. 2010/0065273, 2005/0274516 and 2004/0188090, the disclosures of which are incorporated herein by reference in their entireties. The forming of the paste may occur at the wellsite, a location adjacent to the wellsite or a location that is remote from the wellsite. The paste may be diluted at the wellsite. [0078] In embodiments, the device used to form the paste can be a batch mix tank, or a continuous mixer using a vertical auger. Furthermore, the dilution of the paste may employ a dilution device, such as, for example, a positive displacement pump. Examples of positive displacement pumps include a progressive cavity pump, gear pump, vane pump, or lobe pump. [0079] The foregoing is further illustrated by reference to the following examples, which are presented for purposes of illustration and are not intended to limit the scope of the present disclosure.
EXAMPLES

Example 1

[0080] 120 grams of polylactic acid (PLA) fibers having an average length 5-7 mm were mixed with 500 mL of vegetable glycerol (food grade, 99.7 wt%) to form a flowable paste. The concentration of the PLA fibers in the glycerol was 2 pounds per gallon water (ppg) or 2,000 ppt. Drops of the paste were added to water. The drops were seen to disperse and release the fibers within 60 seconds, to create a uniform distribution of fiber in water. Example 1 is represented in FIG. 1.

Example 2

[0081] 90 grams of polylactic acid (PLA) fibers (having an average length 5-7 mm) were mixed with 500 mL of 80 ppt of unmodified guar (supplied by Lamberti) in water to form flowable paste. The concentration of the PLA fibers in the guar was 1.5 pounds per gallon of water (ppg) or 1,500 ppt. Example 2 is represented in FIG. 2.

Example 3

[0082] 120 grams of polylactic acid (PLA) fibers having an average length 5-7 mm were mixed with 500 mL of polycrylamide solution to form a flowable paste. The concentration of the PLA fibers in the polycrylamide was 2.0 ppg or 2000 ppt.

Example 4

[0083] 12 grams of polylactic acid (PLA) fibers having an average length 12.7 mm were mixed with 100 mL of glycerol to form a flowable paste as shown below. The concentration of the PLA fibers in the glycerol was 1.0 ppg or 1,000 ppt. The viscosity of Example 4 is shown below in FIG. 3.

Example 5

[0084] 6 grams of polylactic acid (PLA) fibers having an average length 12.7 mm were mixed with 100 mL of glycerol to form a flowable paste as shown below. The concentration of the PLA fibers in the glycerol was 0.5 ppg or 500 ppt. The viscosity of Example 5 is shown in FIG. 3. The data presented in FIG. 3 was obtained with the Bohlin Parallel plate rheometer, the experimental conditions under which the data was collected were as follows: Instrument: Bohlin C-VOR 150 rotational rheometer; a temperature of 22°C ± 0.5°C; a PLA Fiber with a 12.7 mm length; a plate of 40 mm with a 1 mm gap.

[0085] The measurement of viscosity of fluid with fibers can be a problematic task, especially with long fibers, such as one used in Examples 4 and 5 (e.g., 12.7 mm). For example, a coaxial cylinder rheometers, such as, for example, the Chandler 5550 High Pressure High Temperature (HPHT), that have been used in the oilfield are not suitable for this task. As discussed above, the data presented in FIG. 3 was obtained with the Bohlin Parallel plate rheometer. During this measurement, fiber accumulation was ongoing due to rotation motion of the plates, thus resulting in high viscosity values. Thus, the values presented may provide at least a general understanding of the level of viscosity for concentrated fiber paste as disclosed in the present embodiments.

[0086] Although the preceding description has been described herein with reference to particular means, materials and embodiments, it is not intended to be limited to the particulars disclosed herein; rather, it extends to all functionally equivalent structures, methods and uses, such as are within the scope of the appended claims. Furthermore, although only a few example embodiments have been described in detail above, those skilled in the art will readily appreciate that many modifications are possible in the example embodiments without materially departing from the disclosure of FIBER PASTE AND METHODS FOR TREATING A SUBTERRANEAN FORMATION INCLUDING THE FIBER PASTE. Accordingly, all such modifications are intended to be included within the scope of this disclosure as defined in the following claims. In the claims, means-plus-function clauses are intended to cover the structures described herein as performing the recited function and not only structural equivalents, but also equivalent structures. Thus, although a nail and a screw may not be structural equivalents in that a nail employs a cylindrical surface to secure wooden parts together, whereas a screw employs a helical surface, in the environment of fastening wooden parts, a nail and a screw may be equivalent structures. It is the express intention of the applicant not to invoke 35 U.S.C. §112(f) for any limitations of any of the claims herein, except for those in which the claim expressly uses the words "means for" together with an associated function.

What is claimed is:

1. A method for treating a subterranean formation comprising, in any order:
   contacting a treatment fluid with a paste comprising a liquid chemical and lightweight fibers having a high aspect ratio, wherein the lightweight fibers are uniformly distributed in the paste; and
   placing the treatment fluid into a subterranean formation via a wellbore; wherein the lightweight fibers are present in the paste at a concentration in a range of from about 500 ppt to about 10,000 ppt.

2. The method of claim 1, wherein the liquid chemical is selected from the group consisting of include glycerol, a solutions of a polymer, a solution of polycrylamide, a solution of guar, a solution of polyethylene oxide, a solution of polyethylene glycol, and a solution of a water soluble polymer, a solution of a degradable polymer, an oil-based fluid, a hydrocarbon based fluid, an aromatic hydrocarbon, α-xyylene, m-xyylene, p-xyylene, ethyl benzene, nitrogen containing solvent systems, methyl iso-butyl ketone, formamide, petroleum jelly, gelatin, agar, alcohol solvents, methanol, ethanol, 1-propanol, 2-propanol, 1-butanol, 3-methyl-1-butanol, ester solvents, n-butyl acetate, ethyl lactate, ether solvents, isopropyl ether, an emulsion, emulsions containing mineral oil, and an emulsions containing vegetable oil.

3. The method of claim 1, wherein the lightweight fibers have a specific gravity of about 2.0 or lower, the high-aspect ratio of the lightweight fiber being an aspect ratio greater than about 100:1, and the paste has a viscosity in the range of from about 1 cp to 500,000 cp at 25°C at a shear rate of 1 s⁻¹ to 200 s⁻¹.

4. The method of claim 1, wherein the lightweight fibers are at least one member selected from the group consisting of substituted and unsubstituted lactide fibers, glycolide fibers, oily lactide fibers, polyglycolic acid fibers, fibers of copolymers of glycolic acid with hydroxy containing moieties, fibers of copolymers of glycolic acid with carboxylic acid containing moieties, fibers of copolymers of glycolic acid with hydroxy-carboxylic acid containing moieties, polyethylene fibers, polyethylene terephthalate fibers, cellulose fibers, glass fibers, and phenol formaldehyde fibers.
5. The method of claim 1, wherein contacting a treatment fluid with a paste comprises transporting the paste via a conduit at a flow rate in the range of from about 2 gallons per hour to about 40 gallons per hour; wherein a diameter of the conduit is in the range of from about 0.5 to about 2 inches, and less than about 2% by weight of the lightweight fibers, based on the total weight of the fiber in the paste, separates or filters out of the paste during transport of the paste through the conduit.

6. The method of claim 1, wherein the treatment fluid is contacted with the paste at a surface of the wellbore before the treatment fluid is placed into the wellbore.

7. The method of claim 1, wherein the treatment fluid is contacted with the paste after the treatment fluid has been placed into the wellbore.

8. The method of claim 1, wherein contacting the treatment fluid with the paste occurs at one or more underground locations selected from the group consisting of the wellbore and the subterranean formation.

9. The method of claim 1, wherein the treatment fluid is selected from the group consisting of a fluid loss control pill, a water control treatment fluid, a scale inhibition treatment fluid, a fracturing fluid, a gravel packing fluid, a drilling fluid, and a drill-in fluid.

10. A method of delivering a solid to a wellsite, comprising:
forming a paste, wherein a concentration of the solid to liquid is in the range of 500 ppt to 10,000 ppt;
transporting the paste to the wellsite; and
diluting the paste such that a concentration of the solid to liquid is in the range of 1 ppt to 200 ppt.

11. The method of claim 10, wherein the forming the concentration occurs at a location remote from the wellsite.

12. The method of claim 10, wherein the diluting the paste occurs at the wellsite.

13. The method of claim 10, wherein the forming of the paste employs a mixing device, the mixing device being a batch mixing tank, or a continuous mixer using a vertical auger.

14. The method of claim 10, wherein the diluting of the paste employs a dilution device, the dilution device being a positive displacement pump.

15. The method of claim 14, wherein the positive displacement pump is a progressive cavity pump, gear pump, vane pump, or lobe pump.

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