



(51) International Patent Classification:
C10C 3/00 (2006.01)

(21) International Application Number:
PCT/US2012/071087

(22) International Filing Date:
20 December 2012 (20.12.2012)

(25) Filing Language: English

(26) Publication Language: English

(30) Priority Data:
61/700,090 12 September 2012 (12.09.2012) US

(71) Applicant: **THE UNIVERSITY OF WYOMING RESEARCH CORPORATION D/B/A/ WESTERN RESEARCH INSTITUTE** [US/US]; 365 North 9th Street, Laramie, WY 82072-3380 (US).

(72) Inventors: **SCHABRON, John, F.**; 1805 Arnold Street, Laramie, WY 82070 (US). **ADAMS, Jeramie, J.**; 1813 Skyline Road, Laramie, WY 82070 (US). **ROVANI, Joseph, F.**; 3337 Aspen Lane, Laramie, WY 82070 (US). **PLANCHE, Jean-Pascal**; 4231 Bobolink Lane, Laramie, WY 82070 (US).

(74) Agent: **WIEDMANN, Alfred, K.**; Santangelo Law Offices, P.C., 125 South Howes, Third Floor, Fort Collins, CO 80521 (US).

(81) Designated States (unless otherwise indicated, for every kind of national protection available): AE, AG, AL, AM, AO, AT, AU, AZ, BA, BB, BG, BH, BN, BR, BW, BY, BZ, CA, CH, CL, CN, CO, CR, CU, CZ, DE, DK, DM, DO, DZ, EC, EE, EG, ES, FI, GB, GD, GE, GH, GM, GT, HN, HR, HU, ID, IL, IN, IS, JP, KE, KG, KM, KN, KP, KR, KZ, LA, LC, LK, LR, LS, LT, LU, LY, MA, MD, ME, MG, MK, MN, MW, MX, MY, MZ, NA, NG, NI, NO, NZ, OM, PA, PE, PG, PH, PL, PT, QA, RO, RS, RU, RW, SC, SD, SE, SG, SK, SL, SM, ST, SV, SY, TH, TJ, TM, TN, TR, TT, TZ, UA, UG, US, UZ, VC, VN, ZA, ZM, ZW.

(84) Designated States (unless otherwise indicated, for every kind of regional protection available): ARIPO (BW, GH, GM, KE, LR, LS, MW, MZ, NA, RW, SD, SL, SZ, TZ, UG, ZM, ZW), Eurasian (AM, AZ, BY, KG, KZ, RU, TJ, TM), European (AL, AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI, FR, GB, GR, HR, HU, IE, IS, IT, LT, LU, LV, MC, MK, MT, NL, NO, PL, PT, RO, RS, SE, SI, SK, SM, TR), OAPI (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, ML, MR, NE, SN, TD, TG).

Declarations under Rule 4.17:

— of inventorship (Rule 4.17(iv))

Published:

— with international search report (Art. 21(3))

(54) Title: METHODS FOR CHANGING STABILITY OF WATER AND OIL EMULSIONS

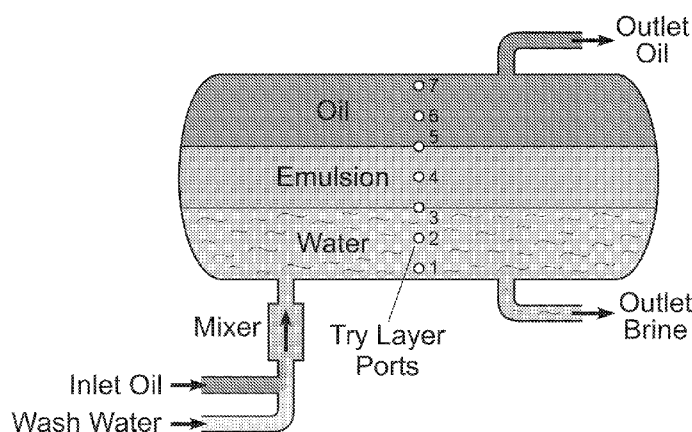


Fig. 2

(57) Abstract: At least one embodiment of the inventive technology may involve the intentional changing of the stability of an emulsion from a first stability to a more desired, second stability upon the addition of a more aromatic asphaltene subfraction (perhaps even a most aromatic asphaltene subfraction), or a less aromatic asphaltene subfraction (perhaps even a least aromatic asphaltene subfraction) to a emulsion hydrocarbon of an oil emulsion, thereby increasing emulsion stability or decreasing emulsion stability, respectively. Precipitation and redis solution or sorbent-based techniques may be used to isolate a selected asphaltene subfraction before its addition to an emulsion hydrocarbon when that hydrocarbon is part of an emulsion or an ingredient of a yet-to-be-formed emulsion.

METHODS FOR CHANGING STABILITY OF WATER AND OIL EMULSIONS

This application is an international application and claims priority to and benefit of United States Provisional Application serial number 61/700,090, filed September 12, 2012, said provisional application incorporated herein in its entirety.

5

BACKGROUND

The most aromatic asphaltenic components from oil, which may be the most polar and pericondensed aromatic asphaltenic components, may play a major role in stabilizing emulsions (a term including foams). The emulsions can be water-in-oil or oil-in-water emulsions, or complex (mixed) emulsions. Asphalt foams are water vapor in oil foams which utilize non-foam emulsions with small amounts of water to make foams by heating the mixture to vaporize the dispersed water. The inventive technology described herein presents a new process for monitoring, predicting, formulating, controlling, stabilizing, and destabilizing water and oil emulsions or foams by evaluating or more generally, utilizing the subfractions of asphaltenes that affect emulsion stability. Particular embodiments may involve use of an on-column precipitation and re-dissolution analysis technique, and/or a sorbent-based technique for separating/isolating oil components. The inventive technology also describes new compositions and applications based on this new process, particularly in the field of asphalt workability.

Solubility separations can be used to isolate the most or more aromatic asphaltenic materials from oils, which can often then can be used to stabilize emulsions or foams in controlled formulations. Emulsions can be made more stable by adding such highly aromatic (which are often highly pericondensed and polar) components or surrogates thereof. Alternatively, emulsions can be destabilized by selectively removing such components from emulsions using sorbents. Such sorbents can include but at not limited to metals, ceramics, zeolites, clays, silica, limestone, glass, quartz, sand, alumina, or high surface energy carbonaceous materials such as petroleum coke, coal, charcoal, activated carbon, acids, bases, salts, or similar materials.

An adsorptive process can be used to isolate the most polar and aromatic components from oils. Portions of these materials can be selectively adsorbed onto high surface energy solid sorbents such as metals, ceramics, zeolites, clays, silica, limestone, glass, quartz, sand, alumina,

or high surface energy carbonaceous materials such as petroleum coke, coal, charcoal, activated carbon, acids, bases, salts, or similar materials. They can then be desorbed by using a variety of solvents such as but not limited to aromatic hydrocarbons, acids or bases, carboxylic acids, pyrroles, aldehyde, ketones, alcohols, water, amines, pyridines, carbon disulfide, dimethyl
5 sulfoxide or halogenated solvents. Emulsions and foams can be made more stable by adding such highly pericondensed and aromatic components or surrogates thereof. Less aromatic subfractions (which may be referred to as first asphaltene subfractions) can be isolated and used to destabilize emulsions, as desired. Generally, asphaltene subfractions of differing aromaticity may be used to change emulsion stability as desired; less aromatic asphaltene subfraction(s) (of
10 sufficiently low aromaticity) may have an emulsion destabilizing effect while more aromatic asphaltenes of sufficiently high aromaticity may have an emulsion stabilizing effect.

Emulsions and foams can be used to significantly lower the temperature of application of asphalt-aggregate mixtures through warm mix or cold mix processes. Being able to produce asphalt emulsion or foams from an appropriately selected crude oil origin is an important stake
15 for the highway industry which is trying to lower those application temperatures in order to reduce its energy consumption, its carbon footprint, fume emission and to improve its workers' safety and comfort. Embodiments of the inventive technology disclosed herein may offer a tool to predict the emulsion or foam ability of a given asphalt and relate it to its parent crude oil. It also provides a tool to formulate the emulsion or the foam itself.

20 Methods based on a new breakthrough on-column precipitation and re-dissolution separation technique developed at WRI offer significant advancement for the characterization of the pericondensed aromatic and polar materials and waxes in petroleum and residua. The methods provide solubility profiles for oil components. The development work and example separations with representative materials have been described in detail in U.S. patent 7,875,464,
25 (an "Asphaltene DeterminatorTM" patent), Schabron and Rovani 2008, Goual et al. 2008, and Schabron et al. 2010, each of which is incorporated herein in its entirety. The separations, in particular embodiments, are performed using an inert stationary phase consisting of ground polytetrafluoroethylene (PTFE). Although high-performance liquid chromatography (HPLC) instrumentation and detectors are used, there are no chromatographic interactions between the
30 material being separated and the stationary phase. It is solubility based.

The WRI Asphaltene DeterminatorTM method which is based on the recently invented technique separates oils into four solubility fractions using step gradient solvent changes at 30 °C: heptane, cyclohexane, toluene, and methylene chloride:methanol (98:2 v:v) (Schabron et al. 2010). Other methods based on the technique such as re-dissolution with a continuous increase in solvent polarity/strength are possible also. The Asphaltene Determinator method allows for the measurement of the most polar and aromatic components in oil. In one example, these are the materials that elute with the last, or strongest solvent, methylene chloride:methanol (98:2 v:v). This method was used to evaluate emulsions involving petroleum materials. The results show that the most aromatic, including the most polar and pericondensed material in oil asphaltenes play a significant role in stabilizing water and oil emulsions, and that they are enriched in the emulsions (Schabron et al. 2012). Asphaltene Determinator technology may refer to technologies described herein, and/or disclosed and/or claimed in any one or more of the following: US 7,875,464; US 8,273,581; US Pat. App. No. 13/490,307; US Pat. App. No. 13/490,316; and US Pat. App. No. 13/600,039, each of which is incorporated herein in its entirety.

Asphaltene Component Adsorption and Deposition

Asphaltenes are defined as a solubility class of associated chemical complexes which precipitate when petroleum is dissolved in a low polarity paraffinic solvent such as heptane, pentane, or isooctane, for example. A wide variety of polar and highly pericondensed aromatic molecules containing sulfur, nitrogen, and oxygen as well as metal complexes containing nickel, vanadium, and iron are concentrated in the asphaltenes. Asphaltenes can stabilize water and oil emulsions. These can be water-in-oil or oil-in-water emulsions, or mixed (complex) emulsions. Asphaltenes act as the major viscosity builders in oil. In catalytic upgrading processes such as hydrotreating, the presence of these materials can shorten catalyst life. The petroleum industry has developed various deasphalting processes that involve dissolving oil in an excess of hydrocarbon solvent available in the refinery such as compressed propane, or a liquid aliphatic solvent stream, resulting in asphaltene precipitation. The disadvantage of such processes is the high cost of operation resulting from gas compression or solvent removal.

In prior work we have shown that asphaltene components of petroleum residua can adsorb onto on metal surfaces when the oil is heated to temperatures below the temperature at

which pyrolysis cracking reactions begin ($< 340\text{ }^{\circ}\text{C}$). More deposits were observed on aluminum metal surfaces as the temperature of residua was increased from $100\text{ }^{\circ}\text{C}$ to $300\text{ }^{\circ}\text{C}$ (Schabron et al. 2001). The resulting asphaltenic material enriched in Ni and V was observed to deposit as dark spots on stainless steel and aluminum surfaces, but not on a non-polar polytetrafluoroethylene (PTFE) surface. This phenomenon appears to be due to the partitioning of the intermediate polarity material surrounding the aromatic asphaltene component molecules into the oil matrix solution, exposing the highly pericondensed aromatic or polar material. The pericondensed aromatic or polar material can flocculate and/or adhere to the polar metal surface. This is a cause of heat-induced fouling of pipes and heat exchangers in refineries.

The Asphaltene Determinator on-column precipitation and re-dissolution method, in embodiments, involves analytical scale precipitation of asphaltene components from oil within a column packed with ground inert PTFE using a heptane mobile phase (Schabron et al. 2010). The precipitated material may be re-dissolved in three steps using solvents of increasing solubility parameter: cyclohexane, toluene, and methylene chloride:methanol (98:2 v:v). The amount of asphaltenes (heptane insolubles) and the Total Pericondensed Aromatic (TPA) content can be determined in less than an hour. It was observed in the development work for the method that glass wool or glass beads strongly adsorbed asphaltene component molecules once they are separated from other peptizing molecules in the oil (Schabron and Rovani 2008). This observation of an undesired effect in the analytical method reinforced the concept of the possibility of asphaltene component molecule removal by adsorption onto a sorbent. In addition, the Asphaltene Determinator method also is ideally suited to evaluate the efficiency of removal of pericondensed aromatic molecules in sorbent-based asphaltene removal technology.

It is generally assumed that highly aromatic, polar and pericondensed material in oils are solubilized by intermediate polarity peptizing molecules present in the oils, but that when these structures are disrupted using heat, sorbents, or chemical treatments, the highly aromatic (perhaps also highly pericondensed molecules) become depeptized and they can then self-associate to form large insoluble pre-coke and coke complexes. The surface energy of the pericondensed material is the highest of any component in oil (Pauli et al. 2005). This and other observations related to heat-induced deposition have led us to discover that the most pericondensed, viscosity building aromatic structures could be selectively removed from oil by, in certain embodiments, heating or pre-treating the oil and exposing it to high surface energy

polar or highly aromatic sorbent material. The resulting oil would be deficient in the most refractory polar and pericondensed aromatic structures and the product oil is more stable and less viscous than the original oil. The pericondensed material adsorbed to the sorbent can be desorbed by contact with a solvent(s) (e.g., via solvent rinsing), and these non-surfactant highly polar pericondensed aromatic materials can be used to stabilize water and oil emulsions or foams.

BRIEF DESCRIPTION OF DRAWINGS

Figure 1 shows conceptual water droplets in oil with emulsion stabilizing skin.

Figure 2 shows a generic schematic for a refinery desalter unit and tray layers, relative to which at least one embodiment of the inventive technology may find application.

Figure 3 shows a toluene and water mixtures with fractions 1 - 4 material from preparative asphaltene determinator separation of Lloydminster vacuum residuum asphaltenes added. From left to right, toluene and water blank (no emulsion); 5.1 mg of fraction 1 material (heptane soluble); 5.2 mg fraction 2 material (cyclohexane soluble), 5.1 mg fraction 3 material (toluene soluble) 5.1 mg fraction 4 material (methylene chloride soluble).

Figure 4 shows a toluene and water blank mixture on the left and a water in oil emulsion between toluene and water stabilized by adding 5.2 mg of asphaltenic material desorbed from silica gel following sorbent treatment of Canadian Bitumen (Canmet Energy) on the right.

Figure 5 shows toluene and water emulsions created by adding increasing amounts of Peak 3 (toluene soluble) asphaltene subfraction material from Lloydminster vacuum residuum n-heptane asphaltenes. From left to right: toluene/water blank mixture; 5.0 mg, 10.5 mg, 21.0 mg, 42.0 mg, 85.0 mg, 170 mg toluene soluble material added. Note that the oil in water emulsion on left becomes water in oil emulsion at about 43 mg material added.

Figure 6 shows the effect of adding about 100 mg silica gel to a toluene and water emulsion stabilized by 13 mg of the most polar and pericondensed Peak 4 material from a preparative Asphaltene Determinator separation of Lloydminster vacuum residuum asphaltenes: left – no silica gel, right – 100 mg silica gel added.

Figure 7 shows the effect of adding silica gel to a toluene and water emulsion stabilized by 5.1 mg of the most polar and pericondensed aromatic Peak 4 material (methylene chloride soluble

fraction) from a preparative Asphaltene Determinator separation of Lloydminster vacuum residuum asphaltenes: left – toluene and water; middle - no silica gel; right – silica gel added.

BRIEF DESCRIPTION OF THE PREFERRED EMBODIMENTS

As additional background, components in the oil, especially the asphaltenes can affect to
5 the emulsion stability. The emulsions can be water-in-oil, or oil-in-water, or mixed, depending
on the process. Refinery desalter emulsions are believed to be water-in-oil emulsions that
consist of spherical particles of water, each surrounded by a shell which stabilizes the emulsion
structure (Figure 1). Spherical droplet diameters of 1-28 microns have been observed (Ortiz and
Yarranton 2010). Asphaltenes have been shown to stabilize the emulsions, while intermediate
10 polarity resins act as destabilizers (Spieker and Kilpatrick 2004). The emulsions also can be
stabilized by fine inorganic particles such as clays in the oils (Menon and Wasan 1988,
Sztukowski and Yarranton 2005). For enhanced oil or bitumen recovery, ionic surfactants such
as amines and sulfonic acid surfactants as well as non-ionic and surfactants have been used.
These are often oil-in-water emulsions. The emulsions must be destabilized before processing.
15 Chemical demulsifiers are often used. The use of a magnetic field has been described for
destabilizing emulsions (Peng et al. 2012).

Asphalt emulsion technology has been discussed in detail in Circular E-C102 from the
Transportation Research Board (2006). Asphalt emulsions also require the use of surfactants or
emulsifiers that can be classified into anionic, cationic and non ionic depending on the charge
20 their polar portion head has in water and on pH. Those emulsifiers are typically fatty amines,
quaternary ammonium salts, fatty acids or phenols (TRB 2006). In an emulsion break test, silica
flour is blended into an emulsion to cause a break due to a surface area effect (TRB 2006).
Foamed asphalts are usually made directly by injecting water into hot asphalt or occasionally by
adding surfactants in asphalt prior to water.

25 Prior U.S. patent art related to stabilizing and destabilizing petroleum emulsions deals
mainly with various types of surfactants including non-ionic, anionic, cationic, and amphoteric.
Only a few examples are provided here. For stabilizing asphalt and water emulsions, various
types of surfactants are used (U.S. 8,114,927, and 7,700,672). Demulsifier formulations are
found in U.S. patents 5,445,765 and 5,164,116. U.S. 8,124,183 describes the use of calcium
30 chloride, calcium nitrate, aluminum chloride, and ferric chloride to break emulsions.

Asphaltenes and Emulsions

Asphaltenes, more so than any other component within crude oil, have been shown to contribute to the stability of water and crude oil emulsions (Sztukowski et al. 2003, Wu 2003, Hemmingsen et al. 2005, Jestin et al. 2007). Certain surface active asphaltene molecules or
5 supramolecular asphaltene aggregates generate frameworks responsible for the stabilizing of these emulsions (Jestin et al. 2007, Czarnecki 2009, Czarnecki 2012). Upon agitation these networks concentrate at oil and water interfaces to produce either oil-in-water or water-in-oil emulsions. It is known that not all types of asphaltene molecules are responsible for stabilizing emulsion interfaces (Czarnecki and Moran 2005, Czarnecki 2012). The less aromatic resinous
10 material in the oils or the asphaltenes can help solvate the aggregated material back into the oil phase and away from the interface, causing emulsion destabilization (Alvarez et al. 2009).

It is well known that small solids, especially those with high surface energy, concentrate at organic liquid and water interfaces to stabilize emulsions. Those emulsions are also called Pickering emulsions (Hannisdal et al. 2006, Wikipedia 2012). The size of the particles can have
15 a direct effect on the stability of the emulsions: smaller particles create more stable emulsions.

It is also known that the adsorption of asphaltenes on minerals and reservoir rocks decreases when the surfaces are coated with water (water wet) but that asphaltene adsorption continues despite the buildup of several ordered layers of water at the surface (Collins and Melrose 1983). In a previous study designed to investigate enhanced oil recovery methods, a
20 variety of oil/water emulsions were prepared using neat brine and dilutions of brine as the aqueous component of the emulsions to evaluate the effect of salinity on the quality of oil produced after emulsions were created and broken. The emulsion oils were characterized using the Asphaltene Determinator, and the results indicated distinct behavioral trends particularly in the asphaltenes component of the oil (Rovani et al. 2009). The results suggested for the first
25 time that the Asphaltene Determinator could be applied in the design of core flood investigations to help understand the complex chemical interactions that occur in underground oil, water, and rock during secondary oil recovery waterflood operations.

Asphaltene Removal

There is a great deal of prior art in U.S. Patents that describe various approaches for
30 removing asphaltenes from oil. Only a few examples are described here. U.S. 7,981,277 is a

recent one that describes asphaltene removal using solvent precipitation. U.S. 4,888,108 describes the agglomeration of asphaltenes during solvent precipitation. Solvent deasphalting in the presence of inorganic salt flocculating agents is described in U.S. 4,525,269. Asphaltene separation by cooling and crushing the solid frozen oil mixture, oil followed by particle size
5 separation is described in U.S. 4,498,971. U.S. 4,765,885 describes a reaction of oil with sodium silicate for extracting asphaltenes into an aqueous phase, where the agglomerate and complex with metals present in the oil and settle to the bottom of a vessel. U.S. 4,514,287 and 4,424,114 describe the use of acidic compounds such as transition metal oxides to selectively remove the basic components of oil and asphaltenes by catalyst selective adsorption. U.S. 4,006,077
10 describes removal of metal containing compounds from asphaltene-containing oils using sorptive attapulugus clay. PCT App. No. US2012/021317 also describes asphaltene removal technology and, like the other patent documents mentioned herein, is incorporated herein in its entirety.

Refinery Desalter Emulsion Study

The solubility subfractions of asphaltenes that contribute to water/oil emulsion stability
15 were evaluated in a recent study, which is described below (Schabron et al. 2012). This is a major issue in oil production and enhanced oil recovery, where emulsion formation is desired in many cases, followed by deliberate destabilization of emulsions, and in refineries where the oil is washed with a water-based solution to remove salt and sediment, where persistent pudding-like emulsions are undesirable. In the study described below, the components of various oils that
20 appear to stabilize oil and water emulsions were evaluated.

Before an incoming crude oil is distilled in a refinery, the first step is to remove salt and sediment using a fresh water-based wash. The separated salt and sediment emerge from the unit in an aqueous outlet brine bottom layer. A generic diagram of a desalter unit showing “try layer” sample port placement is shown in Figure 2. For some oils and conditions, a large undesired
25 middle emulsion phase forms which interferes with efficient operation of the unit. This results in a rag layer or pudding-like emulsion of oil and water which is persistent and difficult to break.

Experimental

Samples and Solvents Crude oil samples and desalter emulsion samples were from petroleum refineries. Solvents and chemicals used in the study were reagent grade. Isolation of the most
30 polar and aromatic (methylene chloride:methanol soluble) components from Lloydminster

vacuum, residuum heptane asphaltenes is described in Schabron et al. 2010.

Gravimetric Isolation of Asphaltenes To prepare asphaltenes for the preparative Asphaltene Determinator separation, a sample of residuum or oil was weighed and mixed with an excess of heptane. The mixture was stirred overnight to allow full precipitation of asphaltenes. The mixture was then filtered using a medium frit (10 μ m) sintered glass filter with repeated rinsing with heptane, and any residual solvent was removed using a vacuum oven at 110 °C. The precipitate was dried and weighed.

Saturates, Aromatics, and Resins (SARA) Separation Open-column chromatographic separations of maltenes into saturates, aromatics, and resins fractions were conducted using a 400 mm x 19 mm id glass column. The column was slurry packed with 35 g Aldrich grade 62, 60-200 mesh silica gel that had been activated overnight at 120 °C. Sample amounts of 350 mg maltenes in heptane solution (1 wt. % loading) were placed on the top of the column. Saturates, aromatics, and resins fractions were eluted with heptane, toluene, and toluene:methanol (80:20 v:v), respectively. The eluted fractions were rotovapped at 70 °C to near dryness, and then dried in a vacuum oven at 100 °C for 1 hour prior to weighing for gravimetric determination of the amounts in each fraction.

Emulsion Centrifugation Desalter emulsions were centrifuged in a manner similar to ASTM D-4007-02 without adding a demulsifier. The emulsions were centrifuged in an International Centrifuge; Universal Model UV, with 100 mL centrifuge tubes at 2,500 rpm with 16 inches tube tip to tube tip diameter while rotating. The centrifuging was performed in a series of three 10 minute intervals, with volume separations checked between each interval to ensure that there were no changes between the last two intervals.

Analytical Asphaltene Determinator Separation The on-column asphaltene precipitation and redissolution experiments were conducted using a Waters 717plus autosampler, a Waters 60F pump with a model 600 controller, a Waters 2489 ultraviolet/visible absorbance detector, and a Waters 2424 evaporative light scattering detector (ELSD) as described in Schabron et al. (2010b). Solutions of residua and asphaltenes in chlorobenzene were injected onto a 7 mm i.d. x 250 mm stainless steel column packed with 0.25-0.42 mm ground polytetrafluoroethylene (PTFE) (40-60 mesh). The optical absorbance detector in dual wavelength mode at 500 nm and 700 nm was used to monitor the separation profile for a standard reference oil (Lloydminster

vacuum residuum), which was injected daily to detect the possible onset of adsorption effects in the stationary phase. If adsorption is observed, the in-line pre-filter disc (Supelco 5-9271, 0.5 μm) and/or the column PTFE packing material is replaced to restore proper operation. Solvent flow rates were 2 mL/min with step changes between solvents. Peak area integrations were performed using Waters Empower software. ELSD and optical absorbance peak areas were electronically blank subtracted prior to integration to correct for small blank peaks due to the step gradient solvent changes. A 20 μL injection of 10% Lloydminster vacuum residuum is made daily as a QC check sample to ensure that there is no adsorption occurring on the column. Solutions of the sample oils and residua are prepared as 10% (w/v) or less solutions in chlorobenzene. Portions of 20 μL were injected in duplicate for the analytical scale Asphaltene Determinator separation. The optimized separation conditions are as follows:

Column: 7 mm id x 250 mm stainless steel column

15 Packing: 40-60 mesh ground PTFE

Detectors:

Waters 2489 absorbance detector set at 500 nm and 700 nm

Waters 2424 evaporative light scattering detector (ELSD)

60 °C tube, 12 °C nebulizer, 35 psi nitrogen, gain = 1

20 Solutions: Sample and QC solutions are 10% wt/vol in chlorobenzene

Injection amount: 20 μL

Solvents used for step gradient changes: n-heptane, cyclohexane, toluene, methylene chloride:methanol (98:2) (v:v), all at 2 mL/min

Step gradient times:

25 0 min. heptane

	15 min.	cyclohexane
	25 min.	toluene
	35 min.	methylene chloride:methanol (98:2)
	45 min.	heptane
5	60 min.	next injection

All separation profiles are electronically blank subtracted prior to peak integration

10 Three representative sample sets were obtained from petroleum refinery operations. These include incoming feed oils to the desalter, rag layer emulsions taken from the desalter units, and the desalted effluent oils, each set taken on the same day from a refinery desalter unit. One group of samples is for a light crude oil (API gravity ~40), and another group is for a mixture of heavy and light crude oils (API gravity ~25). A third group is for much heavier oil
15 than the first two groups (API gravity ~20). Differences in the Asphaltene Determinator solubility fraction profile distributions of the rag layer oil asphaltenes were observed in the current study when compared to the inlet and outlet oils. Results for the three sample sets are provided below.

Light Oil Sample Set

20 Examples of results from the light oil group are provided in Tables 1 - 4. The incoming oil (Table 1) and desalted outlet oil (Table 2) appear very similar from the Asphaltene Determinator analyses corrected for ELSD volatiles losses. They also are similar in total heptane gravimetric asphaltenes content. However, the gravimetric asphaltenes from the desalted oil contain less toluene soluble and methylene chloride:methanol (98:2 v:v) soluble material than the
25 asphaltenes from the feed oil (Tables 1-2). The gravimetric asphaltenes from the whole rag layer oil water emulsion (Table 3), which has the consistency of pudding, contain more methylene

chloride:methanol (98:2 v:v) soluble asphaltene components than the asphaltenes from the incoming or desalted oils. To illustrate this, the area percent values for the 500 nm methylene chloride:methanol (98:2 v:v) peaks for the oils and 10-micron asphaltenes for the whole oil, the rag layer oil with water, and the desalted oil are summarized in Table 4.

5 The centrifuged emulsion contained 40 % oil by volume, 54% water, and 6% sediment. The centrifuged rag layer supernatant oil (Table 5) contains about 20 times more gravimetric asphaltenes than the inlet feed oil or the desalted oil and these asphaltenes contain significantly higher methylene chloride:methanol (98:2 v:v) soluble asphaltene components than the gravimetric asphaltenes from the incoming oil. These results for an emulsion set with a single
10 oil suggest that the most pericondensed and highest surface energy components of oil could be involved in stabilizing oil / water emulsions.

Medium Oil Sample Set

Results for the two medium oil sets collected from a refinery desalter unit on the same day are provided in Tables 6 - 9. The rag layer emulsions were centrifuged in a manner similar
15 to ASTM D-4007-02 as described above, without adding a demulsifier. The rag layer from Set 1 contains 60 % oil by volume, 38% water, and 2% sediment. The rag layer emulsion for Set 2 contains 80 % oil by volume, 14% water, and 6% sediment. The Asphaltene Determinator characterization data show that the inlet oils (Table 6) and outlet oils (Table 7) are similar in composition. The desalted effluent oil from Set 2 however has about half the amount of
20 gravimetric asphaltenes as the incoming oil (Table 7). The explanation for this is not straightforward. It could be related to the timing of the sampling for the two materials. The gravimetric heptane asphaltenes from the whole rag layer oil / water emulsions, which have the consistency of pudding, contain significantly more methylene chloride:methanol (98:2 v:v) soluble asphaltene components than the incoming oils (Tables 6 and 8). This represents highly
25 pericondensed and polar asphaltene material. The relative amounts of methylene chloride:methanol soluble material for the centrifuged emulsion oils are similar to the values for the inlet and outlet oils (Tables 6, 7 and 9). The supernatant oils from the centrifuged rag layer emulsions contain about half the amount of gravimetric asphaltenes relative to the incoming or effluent oils from Set 1 and about half the incoming oil from Set 2 (Tables 6, 7 and 9).

30 The area percent values for the 500 nm methylene chloride:methanol (98:2 v:v) peaks for

the oils and 10-micron asphaltenes for the whole oil, the rag layer oil with water, and the desalted oil are summarized in Table 10. Enrichment of the most pericondensed and polar material represented by the methylene chloride:methanol soluble material in the rag layer emulsions suggest that the most pericondensed and highest surface energy components of oil could be involved in stabilizing oil / water emulsions.

Heavy Oil Sample Set

For the heavy oil series, we were provided with samples from various try layer ports in a refinery desalter unit, as well as the incoming and desalted oils. The heavy oil sample set was for heavy oil (~20 API gravity) samples collected from the “try layer” ports of a refinery desalter.

As with the light and medium oil sample sets, analyses were conducted using the Asphaltene Determinator separation and by gravimetric asphaltene precipitation followed by the Asphaltene Determinator. The samples that were analyzed included the whole samples shaken as received, the middle emulsion layers drawn from the samples, the oil from the centrifuged emulsions, and oily residue from the water which was evaporated from the centrifuged emulsions. The many tables of analysis results for this sample set are provided in Appendix A. The more significant results are provided in summary tables as described below. The oil, water, and sediment amounts in the emulsions obtained by centrifugation are provided in Table 11.

Data for the area percents of the methylene chloride:methanol (98:2) soluble material peaks detected by 500 nm absorbance are provided in Table 12. The amounts of this most polar and aromatic material are significantly higher in the whole samples containing emulsions and in the emulsions themselves. The try layer 5 and 7 oil samples, which did not contain emulsions, are more similar to the inlet and desalted oils. Relative volatiles-corrected ELSD area percents for the most pericondensed material are provided in Table 13. For the emulsions, the relative ELSD peak areas were corrected for both the water and volatile oils materials. The residues remaining from evaporation of the water layer after centrifuging contain a larger area percent of heptane insoluble material (asphaltenes) than the whole samples or emulsions.

Selected non-volatile component ELSD area percents are provided in Table 14. The material represented by non-volatile ELSD components is in the boiling range slightly above the nominal initial boiling point for atmospheric residua (> 640 °F, >340 °C). The ELSD area

percents of heptane insolubles and the total pericondensed aromatic contents are highest for the evaporated emulsion centrifuged water residue material when compared with the data for the whole oils or emulsions.

The relative 500 nm absorbance detector area percents for the gravimetric asphaltenes from the oils and emulsions are provided in Table 15. The percents for the toluene soluble asphaltene components are for the most part similar for all the oils and emulsions. However, the relative peak areas for the methylene chloride:methanol soluble materials (Peak 4 materials) are significantly higher for the samples that contain emulsions.

These results show that the most polar pericondensed aromatic pre-coke material in the oils, represented by the methylene chloride:methanol soluble peaks, are enriched in the rag layer emulsion samples relative to the incoming oil or outlet desalted oils. The incoming crude and desalted crude oils are similar in composition to each other as expected. The oils from the emulsions after being centrifuged are somewhat similar to the incoming and desalted oils. The results support the hypothesis that the most pericondensed material in the oils contribute to rag layer emulsion stability.

As mentioned earlier, the present invention includes a variety of aspects, which may be combined in different ways. The following descriptions are provided to list elements and describe some of the embodiments of the present invention. These elements are listed with initial embodiments, however it should be understood that they may be combined in any manner and in any number to create additional embodiments. The variously described examples and preferred embodiments should not be construed to limit the present invention to only the explicitly described systems, techniques, and applications. Further, this description should be understood to support and encompass descriptions and claims of all the various embodiments, systems, techniques, methods, devices, and applications with any number of the disclosed elements, with each element alone, and also with any and all various permutations and combinations of all elements in this or any subsequent application.

Applications

Typically various surfactant formulations are used to stabilize or destabilize emulsions. Asphaltene components are not typical surfactants which consist of hydrophobic and hydrophilic

components in the same molecule (Czarnecki et al. 2012). However, some oils may contain carboxylic acids that can act as surfactants. It is known that certain components of asphaltenes can stabilize emulsions, and less polar resins components of oils can destabilize emulsions (Stanford et al. 2007). The work described above and in Schabron et al. (2012) confirms that a relatively small subfraction of asphaltenes, e.g., the more (at times the most) aromatic asphaltene component molecules (which may be very polar and pericondensed), are enriched in water and oil emulsions, and therefore can act a powerful agents for stabilizing emulsions. Conversely, by selectively removing the most polar and aromatic components from an emulsion using sorbents, the emulsion can be destabilized and broken. By developing approaches to apply the new asphaltene solubility profile separation methods to evaluate oil components that contribute to emulsion stability, emulsions can be better made, formulated, or destabilized.

In addition, asphalt paving processes involving warm mix, hot mix, cold mix, and foam emulsion formulations all utilize emulsion chemistry. Understanding the interplay of the asphaltene subfractions on emulsions will help to control foam or emulsion formation and stability, which is a key issue for asphalt emulsion chemistry. The invention is not limited to petroleum oils. Oils can include but are not limited to asphalts, distillation residua, processed oils such as from catalytic hydrotreating, tar sands oils, shale oils, coal oils, synthetic oils, biologically derived oils, modified and unmodified asphalt binders and formulations, roofing shingles, fuel emulsions, caulks, and sealants.

The invention is also not limited to downstream oil refining processes or asphalt emulsion formulations. Because the Asphaltene Determinator technique may also be used to evaluate the quality of oil produced by enhanced oil recovery techniques, the invention may lead to the development or refinement of chemicals such as emulsifiers, surfactants, or additives that may be used to “tune” the quality of the oil produced by water floods. With a better understanding of the complex chemistry that occurs in underground oil, water, and rock formations, it may be possible to use the invention to develop a technique to retain the most polar pericondensed components of the oil underground while producing higher-quality oil that is deficient in these materials.

On the other hand, aspects of the invention also involves adding asphaltenes or subfractions of asphaltenes to product formulations such as, but not limited to, petroleum or asphalts in order to make foams or any type of oil/water emulsions (O/W or W/O or W/O/W).

Obtaining Asphaltene Subfractions

5 There are several ways that the more aromatic asphaltene subfraction (which is sufficiently high in aromaticity to achieve a desired increase in emulsion stability), described elsewhere herein as the second asphaltene subfraction, and which may be the more or most polar and pericondensed subfraction of asphaltenes, can be isolated. The on-column asphaltene precipitation and re-dissolution technology can be used to obtain asphaltenes or asphaltene
10 solubility subfractions for use in stabilizing water-in-oil or oil-in-water emulsions or complex emulsions. They can also be separated further by the solubility separation of asphaltenes using the in-vessel material generation technology described in U.S. patent 7,875,464 and continuations thereof. In certain embodiments, asphaltene are precipitated in an inert stationary phase using a low polarity alkane solvent, for example, and then re-dissolved all at once or in
15 portions with a solvent or solvents of higher polarity. Manual asphaltene precipitation and partial re-dissolution using various solvent mixtures can also be used to isolate asphaltene subfractions for use in stabilizing emulsions. The sufficiently aromatic, perhaps the most polar and pericondensed, portion of asphaltenes can also be isolated by selective adsorption from oil or emulsions onto sorbents which can be desorbed using various strong chromatographic solvents.
20 The isolated asphaltenic material can be used to stabilize water and oil emulsions.

Emulsions

 Addition of asphaltenes or asphaltene subfractions such as the most polar and aromatic components of asphaltenes or surrogates thereof can be used to stabilize water and oil emulsions or foams/froths (the term foam will further be used only). One application of the invention
25 includes adding asphaltenic oil components to emulsion formulations which result in stable emulsion or foam formation. Another application involves treating or removing the asphaltene components by selective adsorption to destabilize or break emulsions in oil production processes. The technology can also be used to predict, monitor, and destabilize undesirable emulsion formation in pipelines or in refinery desalter units. The technology can also be used to formulate
30 emulsions or foams for warm mix or cold mix asphalt paving or overlay operations.

The on-column asphaltene precipitation and re-dissolution technique can be used to evaluate and predict the propensity of an oil to form or resist formation of water-in-oil or oil-in-water emulsions with aqueous phases such as water, salt water, and brine systems. The technique can also be used to monitor the use of additives, asphaltenes, and asphaltene subfractions to create or stabilize, or alternatively to destroy or destabilize emulsions.

The current configuration for the preparative Asphaltene Determinator developed at WRI which uses an inert stationary phase for a solubility separation, allows for the separation and collection of four distinct asphaltene fractions of increasing polarity and aromaticity in certain embodiments. In one study, the fractions were eluted with heptane, cyclohexane, toluene, and methylene chloride, respectively (Schabron et al, 2010). These four solubility defined subfractions of asphaltenes have distinct physicochemical differences. With increasing solubility parameters of the dissolution eluting solvents there is an increase in aromaticity and polarity. Other solvents or combination of solvents can be used to separate similar fractions using the technique

More resinous (less polar and less aromatic) asphaltenes subfractions which may be from the heptanes or cyclohexane fractions and which may be described as a first asphaltene subfraction can be added to emulsions to terminate supramolecular aggregation giving smaller discrete aggregates. These less aromatic resins materials can disrupt the ability of the supramolecular framework to dynamically make and break bonds between other aggregates that stabilize the networks at the oil and water interface. This approach could be useful for treating and destabilizing emulsions in oil production or refinery desalter units. They also could be used at other key points along the production chain which currently use surfactant additives to mitigate unwanted emulsions in oil production operations.

Due to favorable aggregation, adsorption energy, surface energy, and bond forming sites the more polar and pericondensed aromatic asphaltene subfractions - that elute with toluene and methylene chloride, for example - can be used to enhance emulsions. These fractions can be used independently or combined with other additives to be blended in with other asphalt/asphaltene materials to increase emulsion stability.

Another part of the invention is that selective use of asphaltenes or asphaltene subfractions can be used to control the type of emulsion formed (oil-in-water vs. water-in-oil).

This can involve adding different amounts of asphaltene materials, or different polarity and aromatic types of asphaltene subfractions materials.

Road asphalt and sealants, roofing asphalt and sealants, aerosol and non-aerosol sealants, and fuel oil emulsions can be formulated using the most aromatic subfractions (and possibly also the most polar subfractions) of asphaltenes, such as the toluene and/or methylene chloride soluble asphaltene subfractions after removal of the heptane and cyclohexane soluble subfractions, for example. Other similar solvent schemes can be used to separate asphaltenes into less aromatic pericondensed and more aromatic pericondensed aromatic asphaltene molecular constituents.

Sorbents to Destabilize Emulsions

Sorbents can be used to destabilize the water and oil emulsions. Oil and water emulsions can be effectively destabilized by adding particles, preferably with high surface energy or charge, to adsorb asphaltenes from the water-water droplet interface onto the water-solid surface interface. If the particles are sufficiently large, they can adsorb asphaltenes, perhaps adsorbing a more aromatic subfraction, from the emulsion interface, resulting in breaking the emulsion and giving an asphaltene byproduct that can be separated out of the mixture by settling, flotation, or filtered, for example. The adsorbed asphaltenes from the interface can be rinsed off with organic solvents like toluene or methylene chloride regenerating the sorbent for further use. The rinsed asphaltenes can be used as feedstocks for road or roofing asphalt, sealants, fuel oil, or further upgraded by processes such as hydrocracking. They also can be used to stabilize emulsion for other applications. The sorbent can be one with high surface energy that is selective to adsorption of asphaltene component molecules such as highly aromatic (possibly also highly polar and pericondensed) molecules. Examples of the sorbents which may be particularly useful include but not limited to metals, ceramics, zeolites, clays, silica, limestone, glass, quartz, sand, alumina, metal oxides, alumina silicates, metal oxides impregnated on alumina or silica or zeolites or alumina silicates, or high surface energy carbonaceous materials such as petroleum coke, coal, charcoal, activated carbon, or similar materials. Other sorbents such as salts or acids or bases might be useful also.

Experimental Results

To evaluate the emulsion stabilizing ability of the most polar and pericondensed material

in oil, several experiments were conducted using toluene and water in 9-mL vials. Toluene and water are not miscible and they do not form a natural emulsion when shaken or blended together.

Emulsions Stabilized by Preparative Asphaltene Determinator Subfractions

A preparative Asphaltene Determinator separation was conducted on 3.0004 g of n-heptane asphaltenes from Lloydminster vacuum residuum as described in (Schabron et al. 2010). Four solubility subfractions were obtained: Fraction 1 (heptane soluble, 0.1349 g), Fraction 2 (cyclohexane soluble, 0.7363 g), Fraction 3 (toluene soluble, 2.0875 g), and Fraction 4 (methylene chloride, 0.0401 g) soluble subfractions were obtained. These represent increasing polarity and aromaticity subfractions of asphaltenes. Portions of these asphaltene subfractions were added to mixtures of 3.5 mL toluene and 3.5 mL distilled water in 9-mL vials, and then these were agitated using a vortex mixture. The amounts of each of the solubility subfractions added were: Fraction 1, 5.1 mg; Fraction 2, 5.2 mg; Fraction 3, 5.1 mg; and Fraction 4, 5.1 mg. The results are shown in Figure 3. No emulsion formed with the heptane soluble Fraction 1 material. A small amount of emulsion formed with the cyclohexane soluble Fraction 2 material. A larger amount of emulsion was evident with the toluene soluble Fraction 3 material. The greatest amount of emulsion was formed with the methylene chloride soluble Fraction 4 material, which consists of the most polar and pericondensed aromatic material component of the asphaltenes. As evident in Figure 3, a small portion of the Fraction 4 mixture was lost during handling.

Emulsion Stabilized by Desorbed Asphaltene Subfraction

A 25.0 g portion of Canadian Bitumen (Canmet Energy) was mixed with 9.4599 g activated silica Grade 646 (35-60 mesh) at 300 °C in a sealed vessel for 4 hours with agitation. This treatment results in heat-induced adsorption of very polar and pericondensed asphaltene material onto polar surfaces, such as aluminum, steel or silica gel (Schabron et al. 2001). The method that was used to isolate the asphaltene material resulted in the emulsion used in Fig. 4 may be as described in PCT App. No. US2012/021317, said application incorporated herein in its entirety. The asphaltenic material was desorbed from the silica gel. A portion of 5.2 mg of this material was added to a 9-mL vial and suspended in 3.5 mL toluene. The suspension was mechanically shaken for 30 minutes until it dissolved, 3.5 mL distilled water was added, and the mixture was agitated using a vortex mixture for 60 seconds. A significant emulsion resulted

(Figure 4). The results show that heat-induced deposition of asphaltene components on to sorbents can be used to isolate material from oil that can be used to stabilize water and oil emulsions.

Oil-in-water and Water-in-oil Emulsion Formation Control

5 Different portions of the toluene soluble subfraction of asphaltenes from a preparative solubility sub-fractionation separation of n-heptane asphaltenes from Lloydminster vacuum residuum were added to 9-mL vial and suspended in 3.5 mL toluene. The suspensions were mechanically shaken until all of the asphaltenes were dissolved, 3.5 mL distilled water were added to the solution, and then these were agitated using a vortex mixture for 60 seconds. The results are shown in Figure 5 after sitting at ambient temperature for 5 days. The blank toluene/water mixture is on the far left. From left to right, the various portions of the toluene soluble asphaltene Fraction 3 material added are: 5.0 mg, 10.5 mg, 21.0 mg, 42.0 mg, 85.0 mg, and 170.0 mg. It appears that the emulsion on the left, in which the smallest amount of the asphaltene subfraction was added, is an oil-in-water emulsion. At 42 mg, there is a catastrophic phase inversion from oil-in-water to water-in-oil. For the last 170 mg sample, it is possibly a mixed oil-in-water and water-in-oil emulsion. These results show that the type of emulsion (oil-in-water vs. water-in-oil) can be controlled by adding various amounts of asphaltenes or asphaltene subfractions materials.

Emulsion Destabilization Using Sorbents

20 Portions of the most polar and pericondensed material from Lloydminster asphaltenes was added to two toluene and water mixtures in 9-mL vials. This methylene chloride soluble Fraction 4 asphaltene subfraction material was obtained from a preparative Asphaltene Determinator separating of Lloydminster vacuum residuum asphaltenes as described in Schabron et al. (2010). This material represents about 1.75% of the vacuum residuum oil. The two identical mixtures consisted of 4.5 mL of distilled water, 3.5 mL of toluene, and about 13 mg of the Fraction 4 material. They were then shaken for about 30 seconds to form partial emulsions. Stable emulsions were formed. The mixture on the left in Figure 6 is the stable emulsion in the bottom water layer. About 100 mg of activated silica gel Grade 62 was added to the mixture in the vial on the right in Figure 4. After being shaken briefly, the emulsion was broken, and clear water was evident in the bottom layer.

Results of a similar experiment with a different batch of methylene chloride soluble Fraction 4 asphaltene material from Lloydminster vacuum residuum asphaltene are shown in Figure 7. The two identical mixtures consisted of 3.5 mL of distilled water, 3.5 mL of toluene, and about 5.1 mg of the Fraction 4 material. They were then agitated in a vortex mixture for about 60 seconds to form partial emulsions. Stable emulsions were formed. The mixture on the left in Figure 7 is the stable emulsion in the bottom water layer. About 107 mg of activated silica gel Grade 62 was added to the mixture in the vial on the right in Figure 7. After being shaken briefly, the emulsion was broken, and clear water was evident in the bottom layer. These results illustrate the ability of a sorbent to destabilize emulsions by removing some of the most aromatic (perhaps also the most polar and pericondensed) material from the system, possibly from the water droplet walls.

Table 1. Asphaltene Determinator Characterization of Light Desalter Inlet Oil.

Sample:	WRI 1338-82-4		Date: 3/15/11						
	Desalter Inlet Light Oil								
Material/ Amt. Inj.	Wt. % ELSD Volatiles	Asphaltene Determinator Area Percent Detector Heptane CyC ₆ Toluene CH ₂ Cl ₂ :MeOH					Coke Index Ratio Cy/CCl	AD Asphalt Aging Index Ratio T/H	Percent TPA
Whole Oil 2.0016 mg	69.52	ELSD	98.95	0.47	0.43	0.14	3.4	0.55	2.0
		500 nm	47.99	14.08	26.23	11.71	1.2		
		700 nm	32.42	18.18	28.56	20.85	0.9		
		Whole Oil ELSD Area:		2016104	QC ELSD Area:		6615140		
Corrected for Volatiles Loss		ELSD	99.68	0.14	0.13	0.04	3.4	0.55	0.6
		500 nm	47.99	14.08	26.23	11.71	1.2		
		700 nm	32.42	18.18	28.56	20.85	0.9		
Gravimetric Asphaltenes Analysis									
Material/ Amt. Inj.	Wt.% of Whole Oil	Asphaltene Determinator Area Percent Detector Heptane CyC ₆ Toluene CH ₂ Cl ₂ :MeOH					Area Percent Toluene + CH ₂ Cl ₂ :MeOH	Wt. % Toluene + CH ₂ Cl ₂ :MeOH	Total Wt. % Asphaltenes
C7 Asphaltenes 10 μ ~0.6800 mg	0.05	ELSD	10.52	23.22	61.78	4.49	66.27	0.03	0.11
		500 nm	6.68	25.99	61.23	6.11	67.34		
		700 nm	4.44	26.38	62.46	6.72	69.18		
C7 Asphaltenes 0.45 μ ~0.8400 mg	0.06	ELSD	33.96	26.60	37.04	2.40	39.44	0.02	
		500 nm	14.50	35.48	45.88	4.14	50.02		
		700 nm	10.94	37.21	46.97	4.88	51.85		

Table 2. Asphaltene Determinator Characterization of Desalted Light Oil.

Sample:	WRI 1338-82-3								
	Desalted Light Oil								
Material/ Amt. Inj.	Wt. % ELSD Volatiles	Asphaltene Detector	Determinator Heptane	Area CyC ₆	Percent Toluene	Percent CH ₂ Cl ₂ :MeOH	Coke Index Ratio Cy/CCl	AD Asphalt Aging Index Ratio T/H	Percent TPA
Whole Oil 2.0000 mg	70.34	ELSD	99.01	0.41	0.41	0.17	2.4	0.58	1.8
		500 nm	46.38	14.09	26.99	12.53	1.1		
		700 nm	28.72	17.66	30.68	22.94	0.8		
		Whole Oil ELSD Area:		1961945		QC ELSD Area:		6615140	
Corrected for Volatiles Loss		ELSD	99.71	0.12	0.12	0.05	2.4	0.58	0.5
		500 nm	46.38	14.09	26.99	12.53	1.1		
		700 nm	28.72	17.66	30.68	22.94	0.8		
Gravimetric Asphaltenes Analysis							Area Percent	Wt. %	Total
Material/ Amt. Inj.	Wt.% of Whole Oil	Asphaltene Detector	Determinator Heptane	Area CyC ₆	Percent Toluene	Percent CH ₂ Cl ₂ :MeOH	Toluene + CH ₂ Cl ₂ :MeOH	Toluene + CH ₂ Cl ₂ :MeOH	Wt. % Asphaltenes
C7 Asphaltenes 10 μ ~0.9600 mg	0.07	ELSD	20.30	20.68	55.47	3.55	59.02	0.04	0.12
		500 nm	6.29	26.81	61.29	5.61	66.90		
		700 nm	4.07	26.82	63.10	6.01	69.11		
C7 Asphaltenes 0.45 μ ~0.6800 mg	0.05	ELSD	43.78	21.83	31.89	2.50	34.39	0.02	
		500 nm	16.46	32.84	45.66	5.04	50.70		
		700 nm	12.66	34.30	47.07	5.97	53.04		

Table 3. Asphaltene Determinator Characterization of Light Oil Desalter Whole Emulsion, Shaken.

Sample:		WRI 1338-82-5						
		Light Oil Deesalter Emulsion with 40 vol. % Oil, Shaken						
Material/ Amt. Inj.	Wt. % ELSD	Asphaltene Determinator Area Percent					Coke Index	AD Asphalt Aging Index
	Volatiles	Detector	Heptane	CyC₆	Toluene	CH₂Cl₂:MeOH	Ratio Cy/CCI	Ratio T/H
Whole Oil	90.66	ELSD	97.67	1.34	0.62	0.37	3.6	
2.0018 mg		500 nm	Interference due to water turbidity for CH ₂ Cl ₂ :MeOH peak?					na
		700 nm	Interference due to water turbidity for CH ₂ Cl ₂ :MeOH peak?					
		Whole Oil ELSD Area:		617842	QC ELSD Area:		6615140	
Corrected for Volatiles Loss		ELSD	99.78	0.13	0.06	0.03	3.6	na
		500 nm	na	na	na	na	na	na
		700 nm	na	na	na	na	na	
Gravimetric Asphaltenes Analysis								
Material/ Amt. Inj.	Wt.% of Whole Oil	Asphaltene Determinator Area Percent					Area Percent Toluene + CH₂Cl₂:MeOH	Wt. % Toluene + CH₂Cl₂:MeOH
		Detector	Heptane	CyC₆	Toluene	CH₂Cl₂:MeOH		Total Wt. % Asphaltenes
C7 Asphaltenes	0.04	ELSD	17.92	18.35	57.11	6.62	63.73	0.11
10 μ		500 nm	6.40	22.00	62.24	9.37	71.61	
~0.5600 mg		700 nm	4.30	22.00	63.17	10.53	73.70	
C7 Asphaltenes	0.07	ELSD	28.55	25.55	42.86	3.05	45.91	0.03
0.45 μ		500 nm	12.47	32.79	49.71	5.03	54.74	
~1.0000 mg		700 nm	8.90	33.78	51.35	5.97	57.32	

Table 4. Summary Results for the 500 nm Methylene**5 Chloride:methanol Peak Areas for the Light Oil Series.**

Asphaltene Determinator CH₂Cl₂:MeOH (98:2 v:v) Area Percent		
Light Crude API ~40	500 nm Relative Area Percent	
Material	Whole Oil	10 Micron Asphaltenes
Inlet Crude	11.71	6.11
Rag layer Emulsion	na	9.37
Centrifuged Rag Layer Oil	na	31.36
Desalted Outlet Crude	12.53	5.61

Table 5. Asphaltene Determinator Characterization of Light Supernatant Centrifuged Desalter Emulsion Oil.

Sample:		WRI 1338-82-5							
		Light Oil from Emulsion Separated by Centrifugation							
Material/ Amt. Inj.	Wt. % ELSD	Asphaltene Determinator Area Percent					Coke Index	AD Asphalt Aging Index	Percent
	Volatiles	Detector	Heptane	CyC₆	Toluene	CH₂Cl₂:MeOH	Ratio Cy/CCI	Ratio T/H	TPA
Whole Oil	68.21	ELSD	97.95	1.10	0.25	0.70	1.6		na
2.0016 mg		500 nm	Interference due to water turbidity for CH ₂ Cl ₂ :MeOH peak?					na	
		700 nm	Interference due to water turbidity for CH ₂ Cl ₂ :MeOH peak?						
		Whole Oil ELSD Area:				QC ELSD Area:		6373174.0	
Corrected for Volatiles Loss		ELSD	99.35	1.10	0.25	0.70	1.6		na
		500 nm	na	na	na	na	na	na	
		700 nm	na	na	na	na	na		
Gravimetric Asphaltenes Analysis									
Material/ Amt. Inj.	Wt.% of Whole Oil	Asphaltene Determinator Area Percent					Area Percent Toluene + CH₂Cl₂:MeOH	Wt. % Toluene + CH₂Cl₂:MeOH	Total Wt. % Asphaltenes
		Detector	Heptane	CyC₆	Toluene	CH₂Cl₂:MeOH			
C7 Asphaltenes	1.93	ELSD	12.58	28.32	35.61	23.48	59.09	1.14	2.32
10 μ (difficult to filter)		500 nm	5.00	15.02	48.63	31.36	79.99		
0.4007 mg		700 nm	na	14.32	45.70	39.98	85.68		
C7 Asphaltenes	0.39	ELSD	63.05	11.26	17.66	8.03	25.69	0.10	
0.45 μ		500 nm	14.18	22.66	46.18	16.97	63.15		
0.4051 mg		700 nm	9.60	22.71	44.54	23.15	67.69		

Table 6. Asphaltene Determinator Characterization of Medium Desalter Feed Oils

from Sets 1 and 2.

Sample:		WRI 1338-94-21							
		Desalter Inlet Medium Crude Set 1							
Material/ Amt. Inj.	Wt. % ELSD	Asphaltene Determinator Area Percent					Coke Index	AD Asphalt Aging Index	Percent
	Volatiles	Detector	Heptane	CyC ₆	Toluene	CH ₂ Cl ₂ :MeOH	Ratio Cy/CCl	Ratio T/H	TPA
Whole Oil 2.0012 mg	54.33	ELSD	95.26	1.44	2.81	0.49	2.9		7.7
		500 nm	38.64	18.00	34.34	9.02	2.0	0.89	
		700 nm	24.32	21.59	38.85	15.24	1.4		
		Whole Oil ELSD Area:			3096016	QC ELSD Area:		6779303	
Corrected for Volatiles Loss		ELSD	97.84	0.66	1.28	0.22	2.9		3.5
		500 nm	38.64	18.00	34.34	9.02	2.0	0.89	
		700 nm	24.32	21.59	38.85	15.24	1.4		
Gravimetric Asphaltenes Analysis							Area Percent	Wt. %	Total
Material/ Amt. Inj.	Wt.% of	Asphaltene Determinator Area Percent					Toluene +	Toluene +	Wt. %
	Whole Oil	Detector	Heptane	CyC ₆	Toluene	CH ₂ Cl ₂ :MeOH	CH ₂ Cl ₂ :MeOH	CH ₂ Cl ₂ :MeOH	Asphaltenes
C7 Asphaltenes 10 µ 0.4010 mg	4.27	ELSD	18.53	25.10	52.81	3.56	56.37	2.41	4.87
		500 nm	11.68	26.19	55.91	6.21	62.12		
		700 nm	6.48	26.94	58.44	8.14	66.58		
C7 Asphaltenes 0.45 µ 0.4039 mg	0.60	ELSD	22.94	25.25	47.72	4.10	51.82	0.31	
		500 nm	12.86	27.55	53.33	6.26	59.59		
		700 nm	8.53	28.16	55.36	7.95	63.31		

Sample:		WRI 1338-94-22							
		Desalter Inlet Medium Crude Set 2							
Material/ Amt. Inj.	Wt. % ELSD	Asphaltene Determinator Area Percent					Coke Index	AD Asphalt Aging Index	Percent
	Volatiles	Detector	Heptane	CyC ₆	Toluene	CH ₂ Cl ₂ :MeOH	Ratio Cy/CCl	Ratio T/H	TPA
Whole Oil	54.87	ELSD	95.33	1.42	2.81	0.44	3.2		7.6
2.0014 mg		500 nm	38.55	18.06	34.38	9.01	2.0	0.89	
4/15/2011		700 nm	23.93	21.51	39.18	15.38	1.4		
		Whole Oil ELSD Area:			3059784	QC ELSD Area:		6779303	
Corrected for		ELSD	97.89	0.64	1.27	0.20	3.2		3.4
Volatiles Loss		500 nm	38.55	18.06	34.38	9.01	2.0	0.89	
		700 nm	23.93	21.51	39.18	15.38	1.4		
Gravimetric Asphaltenes Analysis							Area Percent	Wt. %	Total
Material/ Amt. Inj.	Wt.% of	Asphaltene Determinator Area Percent					Toluene +	Toluene +	Wt. %
	Whole Oil	Detector	Heptane	CyC ₆	Toluene	CH ₂ Cl ₂ :MeOH	CH ₂ Cl ₂ :MeOH	CH ₂ Cl ₂ :MeOH	Asphaltenes
C7 Asphaltenes	4.32	ELSD	19.02	25.81	51.75	3.41	55.16	2.38	4.82
10 μ		500 nm	11.94	27.16	54.78	6.12	60.90		
0.4008 mg		700 nm	6.45	28.07	57.50	7.98	65.48		
C7 Asphaltenes	0.50	ELSD	20.46	24.31	47.97	7.25	55.22	0.28	
0.45 μ		500 nm	13.49	26.11	52.51	7.89	60.40		
0.4076 mg		700 nm	6.74	26.84	55.43	10.99	66.42		

Table 7. Asphaltene Determinator Characterization of Medium Desalted Outlet Oils from Sets 1 and 2.

Sample: WRI 1338-94-23									
Desalted Medium Crude Set 1									
Material/ Amt. Inj.	Wt. % ELSD Volatiles	Asphaltene Determinator	Area Percent				Coke Index	AD Asphalt Aging Index	Percent
		<u>Detector</u>	<u>Heptane</u>	<u>CyC₆</u>	<u>Toluene</u>	<u>CH₂Cl₂:MeOH</u>	<u>Ratio Cy/CCI</u>	<u>Ratio T/H</u>	<u>TPA</u>
Whole Oil 2.0002 mg	53.58	ELSD	95.27	1.49	2.78	0.45	3.3		7.8
		500 nm	39.06	18.50	33.77	8.67	2.1	0.86	
		700 nm	24.16	21.99	38.53	15.32	1.4		
		Whole Oil ELSD Area: 3147093			QC ELSD Area:		6779303		
Corrected for Volatiles Loss		ELSD	97.80	0.69	1.29	0.21	3.3		3.6
		500 nm	39.06	18.50	33.77	8.67	2.1	0.86	
		700 nm	24.16	21.99	38.53	15.32	1.4		
Gravimetric Asphaltenes Analysis									
Material/ Amt. Inj.	Wt. % Whole Oil	Asphaltene Determinator	Area Percent				Area Percent Toluene + CH ₂ Cl ₂ :MeOH	Wt. % Toluene + CH ₂ Cl ₂ :MeOH	Total Wt. % Asphaltenes
		<u>Detector</u>	<u>Heptane</u>	<u>CyC₆</u>	<u>Toluene</u>	<u>CH₂Cl₂:MeOH</u>			
C7 Asphaltenes 10 μ 0.4004 mg	4.22	ELSD	20.42	26.30	50.09	3.20	53.29	2.25	4.97
		500 nm	11.99	27.51	54.49	6.01	60.50		
		700 nm	6.49	28.42	57.27	7.82	65.09		
C7 Asphaltenes 0.45 μ 0.4019 mg	0.75	ELSD	28.76	21.24	45.82	4.18	50.00	0.38	
		500 nm	13.01	24.80	55.31	6.87	62.18		
		700 nm	7.42	25.43	58.17	8.98	67.15		

Sample: WRI 1338-94-24									
Desalted Medium Crude Set 2									
Material/ Amt. Inj.	Wt. % ELSD Volatiles	Asphaltene Determinator	Area Percent				Coke Index	AD Asphalt Aging Index	Percent
		<u>Detector</u>	<u>Heptane</u>	<u>CyC₆</u>	<u>Toluene</u>	<u>CH₂Cl₂:MeOH</u>	<u>Ratio Cy/CCI</u>	<u>Ratio T/H</u>	<u>TPA</u>
Whole Oil 2.0006 mg	53.40	ELSD	95.60	1.47	2.48	0.45	3.3		7.4
		500 nm	40.90	19.91	31.76	7.42	2.7	0.78	
		700 nm	26.69	24.00	37.83	11.48	2.1		
		Whole Oil ELSD Area: 2723177			QC ELSD Area:		5843181		
Corrected for Volatiles Loss		ELSD	97.95	0.69	1.16	0.21	3.3		3.5
		500 nm	40.90	19.91	31.76	7.42	2.7	0.78	
		700 nm	26.69	24.00	37.83	11.48	2.1		
Gravimetric Asphaltenes Analysis									
Material/ Amt. Inj.	Wt. % Whole Oil	Asphaltene Determinator	Area Percent				Area Percent Toluene + CH ₂ Cl ₂ :MeOH	Wt. % Toluene + CH ₂ Cl ₂ :MeOH	Total Wt. % Asphaltenes
		<u>Detector</u>	<u>Heptane</u>	<u>CyC₆</u>	<u>Toluene</u>	<u>CH₂Cl₂:MeOH</u>			
C7 Asphaltenes 10 μ 0.4002 mg	2.27	ELSD	10.93	23.33	62.27	3.46	65.73	1.49	2.6
		500 nm	8.51	24.60	61.87	5.03	66.90		
		700 nm	4.78	24.89	64.05	6.28	70.33		
C7 Asphaltenes 0.45 μ 0.4120 mg	0.31	ELSD	23.69	21.36	51.98	2.97	54.95	0.17	
		500 nm	11.10	25.55	58.25	5.10	63.35		
		700 nm	6.46	26.31	60.68	6.55	67.23		

Table 8. Asphaltene Determinator Characterization of Medium Oil Desalter Emulsions from Sets 1 and 2.

Sample:		WRI 1338-94-25							
		Medium Crude Emulsion Shaken (Contains 60 vol. % Oil) Set 1						AD Asphalt	
Material/	Wt. % ELSD	Asphaltene Determinator Area Percent					Coke Index	Aging Index	Percent
Amt. Inj.	Volatiles	Detector	Heptane	CyC ₆	Toluene	CH ₂ Cl ₂ :MeOH	Ratio Cy/CCl	Ratio T/H	TPA
Whole Oil 2.0000 mg	89.38	ELSD	93.87	1.61	3.21	1.31	1.2	1.36	8.7
		500 nm	29.28	17.15	39.90	13.67	1.3		
		700 nm	14.85	18.09	45.02	22.04	0.8		
		Whole Oil ELSD Area:		620678	QC ELSD Area:		5843181		
Corrected for Volatiles Loss		ELSD	99.35	0.17	0.34	0.14	1.2	1.36	0.9
		500 nm	29.28	17.15	39.90	13.67	1.3		
		700 nm	14.85	18.09	45.02	22.04	0.8		
Gravimetric Asphaltenes Analysis							Area Percent	Wt. %	Total
Material/	Wt. %	Asphaltene Determinator Area Percent					Toluene +	Toluene +	Wt. %
Amt. Inj.	Whole Oil	Detector	Heptane	CyC ₆	Toluene	CH ₂ Cl ₂ :MeOH	CH ₂ Cl ₂ :MeOH	CH ₂ Cl ₂ :MeOH	Asphaltenes
C7 Asphaltenes 10 μ 0.4075 mg	1.62	ELSD	13.04	18.00	58.62	10.34	68.96	1.12	1.76
		500 nm	7.09	18.90	62.39	11.62	74.01		
		700 nm	3.90	17.92	63.30	14.88	78.18		
C7 Asphaltenes 0.45 μ 0.3900 mg	0.14	ELSD	30.96	23.48	39.62	5.93	45.55	0.06	
		500 nm	14.89	26.44	44.84	13.83	58.67		
		700 nm	7.93	24.62	42.63	24.82	67.45		

Sample:		WRI 1338-94-26							
		Medium Crude Emulsion Shaken (Contains 80 vol. % Oil) Set 2						AD Asphalt	
Material/ Amt. Inj.	Wt. % ELSD	Asphaltene Determinator Area Percent					Coke Index	Aging Index	Percent
	Volatiles	Detector	Heptane	CyC ₆	Toluene	CH ₂ Cl ₂ :MeOH	Ratio Cy/CCl	Ratio T/H	TPA
Whole Oil 2.0002 mg	89.76	ELSD	94.06	1.57	3.02	1.35	1.2	1.32	8.5
		500 nm	29.99	17.49	39.48	13.04	1.3		
		700 nm	19.13	19.43	41.43	20.00	1.0		
		Whole Oil ELSD Area:		598385	QC ELSD Area:		5843181		
Corrected for		ELSD	99.39	0.16	0.31	0.14	1.2	1.32	0.9
Volatiles Loss		500 nm	29.99	17.49	39.48	13.04	1.3		
		700 nm	19.13	19.43	41.43	20.00	1.0		
Gravimetric Asphaltenes Analysis							Area Percent	Wt. %	Total
Material/ Amt. Inj.	Wt. %	Asphaltene Determinator Area Percent					Toluene +	Toluene +	Wt. %
	Whole Oil	Detector	Heptane	CyC ₆	Toluene	CH ₂ Cl ₂ :MeOH	CH ₂ Cl ₂ :MeOH	CH ₂ Cl ₂ :MeOH	Asphaltenes
C7 Asphaltenes 10 μ 0.4004 mg	2.16	ELSD	10.81	15.05	48.61	25.54	74.15	1.60	2.47
		500 nm	5.66	12.59	44.56	37.19	81.75		
		700 nm	2.69	9.01	34.39	53.91	88.30		
C7 Asphaltenes 0.45 μ 0.4160 mg	0.31	ELSD	14.73	20.01	47.44	17.81	65.25	0.20	
		500 nm	7.70	16.93	41.97	33.40	75.37		
		700 nm	3.50	12.89	32.36	51.25	83.61		

Table 9. Asphaltene Determinator Characterization of Medium Desalter Centrifuged Oils from Emulsions from Sets 1 and 2.

Sample:		WRI 1338-94-25							
		Medium Crude Emulsion Oil Separated by Centrifugation Set 1					AD Asphalt		
Material/	Wt. % ELSD	Asphaltene Determinator Area Percent					Coke Index	Aging Index	Percent
Amt. Inj.	Volatiles	Detector	Heptane	CyC ₆	Toluene	CH ₂ Cl ₂ :MeOH	Ratio Cy/CCI	Ratio T/H	TPA
Whole Oil 2.0005 mg	56.51	ELSD	94.70	1.89	2.93	0.48	3.9	0.99	8.2
		500 nm	35.22	20.13	35.04	9.61	2.1		
		700 nm	22.71	23.39	39.16	14.74	1.6		
		Whole Oil ELSD Area: 2979118			QC ELSD Area:		6849664		
Corrected for Volatiles Loss		ELSD	97.70	0.82	1.27	0.21	3.9	0.99	3.6
		500 nm	35.22	20.13	35.04	9.61	2.1		
		700 nm	22.71	23.39	39.16	14.74	1.6		
Gravimetric Asphaltenes Analysis							Area Percent	Wt. %	Total
Material/	Wt.% of	Asphaltene Determinator Area Percent					Toluene +	Toluene +	Wt. %
Amt. Inj.	Whole Oil	Detector	Heptane	CyC ₆	Toluene	CH ₂ Cl ₂ :MeOH	CH ₂ Cl ₂ :MeOH	CH ₂ Cl ₂ :MeOH	Asphaltenes
C7 Asphaltenes 10 μ 0.3981 mg	1.84	ELSD	14.87	30.22	51.76	3.15	54.91	1.01	2.69
		500 nm	10.67	31.85	52.36	5.12	57.48		
		700 nm	6.37	32.94	54.26	6.43	60.69		
C7 Asphaltenes 0.45 μ 0.4240 mg	0.85	ELSD	27.25	26.10	43.67	2.98	46.65	0.40	
		500 nm	12.35	31.39	51.06	5.20	56.26		
		700 nm	7.41	32.65	53.25	6.69	59.94		

Sample:		WRI 1338-94-26							
		Medium Crude Emulsion Oil Separated by Centrifugation Set 2					AD Asphalt		
Material/ Amt. Inj.	Wt. % ELSD	Asphaltene Determinator Area Percent					Coke Index	Aging Index	Percent
	Volatiles	Detector	Heptane	CyC ₆	Toluene	CH ₂ Cl ₂ :MeOH	Ratio Cy/CCI	Ratio T/H	TPA
Whole Oil 2.0006 mg	56.52	ELSD	94.92	1.88	2.78	0.42	4.5	0.97	7.9
		500 nm	35.92	20.14	35.01	8.93	2.3		
		700 nm	22.77	23.54	39.58	14.11	1.7		
		Whole Oil ELSD Area: 2978183			QC ELSD Area: 6849664				
Corrected for Volatiles Loss		ELSD	97.79	0.82	1.21	0.18	4.5	0.97	3.4
		500 nm	35.92	20.14	35.01	8.93	2.3		
		700 nm	22.77	23.54	39.58	14.11	1.7		
Gravimetric Asphaltenes Analysis							Area Percent	Wt. %	Total
Material/ Amt. Inj.	Wt. %	Asphaltene Determinator Area Percent					Toluene +	Toluene +	Wt. %
	Whole Oil	Detector	Heptane	CyC ₆	Toluene	CH ₂ Cl ₂ :MeOH	CH ₂ Cl ₂ :MeOH	CH ₂ Cl ₂ :MeOH	Asphaltenes
C7 Asphaltenes 10 μ 0.4008 mg	1.96	ELSD	15.30	29.18	50.56	4.96	55.52	1.09	2.81
		500 nm	11.29	30.98	51.69	6.04	57.73		
		700 nm	6.80	31.86	53.39	7.94	61.33		
C7 Asphaltenes 0.45 μ 0.4012 mg	0.85	ELSD	21.55	28.34	46.90	3.21	50.11	0.43	
		500 nm	12.45	31.34	50.92	5.30	56.22		
		700 nm	7.27	32.67	53.43	6.63	60.06		

Table 10. Summary of Results for the 500 nm Methylene Chloride:methanol Peak Areas for the Medium Oil Sets 1 and 2.

Asphaltene Determinator CH₂Cl₂:MeOH (98:2 v:v) Area Percent		
Medium Crude 1 API ~25	500 nm Relative Area Percent	
<u>Material</u>	<u>Whole Oil</u>	<u>10 Micron Asphaltenes</u>
Inlet Crude	9.02	6.21
Rag layer Emulsion	13.67	11.62
Centrifuged Rag Layer Oil	9.61	5.12
Desalted Outlet Crude	8.67	6.01

5

Asphaltene Determinator CH₂Cl₂:MeOH (98:2 v:v) Area Percent		
Medium Crude 2 API ~25	500 nm Relative Area Percent	
<u>Material</u>	<u>Whole Oil</u>	<u>10 Micron Asphaltenes</u>
Inlet Crude	9.01	6.12
Rag layer Emulsion	13.04	37.19
Centrifuged Rag Layer Oil	8.93	6.04
Desalted Outlet Crude	7.42	5.03

Table 11. Amount of Oil, Water, and Sediment following Centrifugation of Emulsions.

Emulsions from Heavy Crude Set (API ~20)			
<u>Try Layer</u>	Centrifuged Volume Percent		
	<u>Oil</u>	<u>Water</u>	<u>Sediment</u>
T-1	50	34	16
T-2	40	49	11
T-3	56	30	14
T-4	56	35	9

Table 12. Relative 500 nm Absorbance Detector Peak Area Percents for the Most Pericondensed Material in the Heavy Oil Desalter Sample Set.

Asphaltene Determinator 500 nm CH₂Cl₂:MeOH (98:2 v:v) Peaks		
Heavy Crude API~20	500 nm Relative Area Percent	
<u>Sample</u>	<u>Whole Material</u>	<u>10 μ Asphaltenes</u>
Inlet Crude	4.31	3.03
Desalted Outlet Crude	4.12	2.86
<u>Try Layer 1</u>		
Whole Sample Shaken	5.74	11.23
Whole Emulsion	5.84	10.58
Emulsion Centrifuged Oil	3.73	3.91
Emulsion Centrifuged Water, Evaporated	7.71	na
<u>Try Layer 2</u>		
Whole Sample Shaken	5.37	13.71
Whole Emulsion	5.77	10.99
Emulsion Centrifuged Oil	3.95	3.94
Emulsion Centrifuged Water, Evaporated	6.82	na
Bottle 2 Centrifuged Emulsion Water, Evaporated	18.79	na
<u>Try Layer 3</u>		
Whole Sample Shaken	5.69	13.99
Top Layer Oil Only	4.69	3.70
Whole Emulsion	5.74	13.08
Emulsion Centrifuged Oil	5.79	4.13
Emulsion Centrifuged Water, Evaporated	4.48	na
Middle Bottle 2 Whole Emulsion	29.03	4.65
Middle Bottle 2 Water, Evaporated	8.16	na
<u>Try Layer 4</u>		
Whole Sample Shaken	5.45	8.74
Whole Emulsion	5.29	3.75
Emulsion Centrifuged Oil	4.00	3.75
Emulsion Centrifuged Water, Evaporated	3.39	na
<u>Try Layer 5</u>		
Whole Oil	4.13	4.14
<u>Try Layer 7</u>		
Whole Oil	3.93	4.14

Table 13. Relative Volatiles Corrected ELSD Peak Area Percents for the Most Pericondensed Material in the Heavy Oil Desalter Sample Set.

Asphaltene Determinator Volatiles Corrected ELSD Peaks		CH₂Cl₂:MeOH (98:2 v:v) Peak	
Heavy Crude API~20		ELSD Relative Area Percent	
Sample	Volatiles Corrected Area % C7 Insolubles	Whole Material	10 μ Asphaltenes
Inlet Crude	3.67	0.09	0.90
Desalted Outlet Crude	3.84	0.09	0.84
Try Layer 1			
Whole Sample Shaken	1.91	0.08	5.79
Whole Emulsion	2.06	0.11	6.40
Emulsion Centrifuged Oil	3.58	0.13	2.52
Emulsion Centrifuged Water, Evaporated	7.76	0.45	na
Try Layer 2			
Whole Sample Shaken	2.16	0.09	6.87
Whole Emulsion	2.19	0.10	5.90
Emulsion Centrifuged Oil	3.60	0.14	2.27
Emulsion Centrifuged Water, Evaporated	7.18	0.57	na
Bottle 2 Centrifuged Emulsion Water, Evaporated	31.99	2.20	na
Try Layer 3			
Whole Sample Shaken	2.30	0.10	6.89
Top Layer Oil Only	1.96	0.20	2.14
Whole Emulsion	2.15	0.34	7.29
Emulsion Centrifuged Oil	2.55	0.15	2.46
Emulsion Centrifuged Water, Evaporated	6.27	0.77	na
Middle Bottle 2 Whole Emulsion	0.31	0.17	2.20
Middle Bottle 2 Water, Evaporated	22.67	1.87	na
Try Layer 4			
Whole Sample Shaken	2.11	0.09	4.74
Whole Emulsion	2.60	0.10	1.82
Emulsion Centrifuged Oil	5.29	0.17	1.68
Emulsion Centrifuged Water, Evaporated	8.94	0.79	na
Try Layer 5			
Whole Oil	3.97	0.11	1.11
Try Layer 7			
Whole Oil	4.19	0.10	0.92

Table 14. Relative ELSD Non-Volatile Component ELSD Peak Area Percents for the Most Polar and Pericondensed Material in the Heavy Oil Desalter Sample Set.

Asphaltene Determinator ELSD Peaks for ELSD non-Volatile Components				<u>CH₂Cl₂:MeOH (98:2 v:v) Peak</u>	
<u>Heavy Crude API~20</u>	<u>Area Percent</u>	<u>ELSD Non-Volatile</u>		<u>ELSD Relative Area Percent</u>	
<u>Sample</u>	<u>ELSD Volatiles</u>	<u>Area % C7 Insolubles</u>	<u>Percent TPA</u>	<u>Whole Material</u>	<u>10 μ Asphaltenes</u>
Inlet Crude	41.02	6.22	9.8	0.16	0.90
Desalted Outlet Crude	40.85	6.49	10.2	0.16	0.84
<u>Try Layer 1</u>					
Whole Sample Shaken	74.29	7.43	11.5	0.31	5.79
Whole Emulsion	68.58	7.19	11.6	0.35	6.40
Emulsion Centrifuged Oil	50.91	7.29	11.4	0.27	2.52
Emulsion Centrifuged Water, Evaporated	70.88	26.64	37.1	10.41	na
<u>Try Layer 2</u>					
Whole Sample Shaken	69.82	7.17	11.1	0.29	6.87
Whole Emulsion	70.26	7.35	11.9	0.33	5.90
Emulsion Centrifuged Oil	51.69	7.45	11.6	0.28	2.27
Emulsion Centrifuged Water, Evaporated	79.21	34.53	51.3	11.84	na
Bottle 2 Centrifuged Emulsion Water, Evaporated	60.35	80.68	103.6	5.55	na
<u>Try Layer 3</u>					
Whole Sample Shaken	69.39	7.52	11.7	0.34	6.89
Top Layer Oil Only	79.99	9.80	14.3	1.01	2.14
Whole Emulsion	69.47	7.05	11.5	0.90	7.29
Emulsion Centrifuged Oil	69.11	8.25	12.6	0.47	2.46
Emulsion Centrifuged Water, Evaporated	56.33	14.35	22.9	0.77	na
Middle Bottle 2 Whole Emulsion	99.48	60.51	74.6	33.42	2.20
Middle Bottle 2 Water, Evaporated	58.54	54.68	84.4	1.87	na
<u>Try Layer 4</u>					
Whole Sample Shaken	73.87	8.06	12.1	0.36	4.74
Whole Emulsion	62.98	7.03	11.3	0.27	1.82
Emulsion Centrifuged Oil	33.04	7.90	12.4	0.25	1.68
Emulsion Centrifuged Water, Evaporated	48.87	17.48	29.0	3.38	na
<u>Try Layer 5</u>					
Whole Oil	40.24	6.65	10.5	0.18	1.11
<u>Try Layer 7</u>					
Whole Oil	37.91	6.75	10.5	0.16	0.92

Table 15. Relative 500 nm Absorbance Detector Peak Area Percents for the Gravimetric Asphaltenes from the Heavy Oil Desalter Sample Set.

Asphaltene Determinator 500 nm Peaks from 10 μ Gravimetric Asphaltenes			
<u>Asphaltenes from Heavy Crude API~20</u>		<u>500 nm Relative Area Percent</u>	
<u>Sample</u>	<u>wt.%</u>	<u>Toluene</u>	<u>CH₂Cl₂:MeOH</u>
Inlet Crude	7.51	54.14	3.03
Desalted Outlet Crude	8.21	52.35	2.86
<u>Try Layer 1</u>			
Whole Oil	2.86	51.94	11.23
Whole Emulsion	2.39	53.44	10.58
Emulsoin Centrifuged Oil	3.54	53.20	3.91
<u>Try Layer 2</u>			
Whole Oil	1.79	53.13	13.71
Whole Emulsion	1.72	54.05	10.99
Emulsoin Centrifuged Oil	6.92	52.08	3.94
<u>Try Layer 3</u>			
Whole Oil	2.95	52.78	13.99
Top 1.5 Inch Oil	0.78	57.17	3.70
Whole Emulsion	2.00	49.85	13.08
Emulsoin Centrifuged Oil	5.95	51.39	4.13
<u>Try Layer 4</u>			
Whole Oil	3.29	55.37	8.74
Whole Emulsion	4.88	57.21	3.75
Emulsoin Centrifuged Oil	9.06	51.55	3.75
<u>Try Layer 5</u>			
Whole Oil	8.97	52.63	4.14
<u>Try Layer 7</u>			
Whole Oil	8.98	50.33	3.82

Appendix A

Asphaltene Determinator Data for Heavy Oil Desalter Emulsion Samples

Sample:	WRI 1338-131-9 (#4 Raw)				Heavy Oil Set 3				
	Desalter Inlet Oil						AD Asphalt		
Material/ Amt. Inj.	Wt. % ELSD	Asphaltene Determinator Area Percent				Coke Index	Aging Index	Percent	
	Volatiles	Detector	Heptane	CyC ₆	Toluene	CH ₂ Cl ₂ :MeOH	Ratio Cy/CCl	Ratio T/H	TPA
Whole Oil	41.02	ELSD	93.78	2.17	3.89	0.16	13.6		9.8
2.0000 mg		500 nm	36.39	23.64	35.66	4.31	5.5	0.98	
		700 nm	24.58	26.67	42.17	6.58	4.1		
		Whole Oil ELSD Area:			4478821	QC ELSD Area:		7594086	
Corrected for		ELSD	96.33	1.28	2.29	0.09	13.6		5.8
Volatiles Loss		500 nm	36.39	23.64	35.66	4.31	5.5	0.98	
		700 nm	24.58	26.67	42.17	6.58	4.1		
Gravimetric Asphaltenes Analysis							Area Percent	Wt. %	Total
Material/ Amt. Inj.	Wt. %	Asphaltene Determinator Area Percent				Toluene +	Toluene +	Wt. %	Wt. %
	Whole Oil	Detector	Heptane	CyC ₆	Toluene	CH ₂ Cl ₂ :MeOH	CH ₂ Cl ₂ :MeOH	CH ₂ Cl ₂ :MeOH	Asphaltenes
									7.54
C7 Asphaltenes	7.51	ELSD	13.34	25.76	60.00	0.90	60.90	4.57	
10 μ		500 nm	13.87	28.96	54.14	3.03	57.17		
.4012 mg		700 nm	9.16	30.22	56.90	3.72	60.62		
C7 Asphaltenes	0.03	ELSD	Insufficient Material						
0.45 μ		500 nm	Insufficient Material						
		700 nm	Insufficient Material						

Sample:	WRI 1338-131-27A (2nd Desalted)				Heavy Oil Set 3				
	Desalted Outlet Oil								
Material/ Amt. Inj.	Wt. % ELSD Volatiles	Asphaltene Determinator Detector	Area Percent Heptane	Area Percent CyC ₆	Coke Index Toluene	AD Asphalt Aging Index CH ₂ Cl ₂ :MeOH	Percent Ratio Cy/CCl	Percent Ratio T/H	Percent TPA
Whole Oil 2.0000 mg	40.85	ELSD	93.51	2.31	4.01	0.16	14.4	0.99	10.2
		500 nm	36.31	23.72	35.85	4.12	5.8		
		700 nm	24.61	26.80	42.47	6.12	4.4		
		Whole Oil ELSD Area:		4492090	QC ELSD Area:		7594086		
Corrected for		ELSD	96.16	1.37	2.37	0.09	14.4		6.0
Volatiles Loss		500 nm	36.31	23.72	35.85	4.12	5.8	0.99	
		700 nm	24.61	26.80	42.47	6.12	4.4		
Gravimetric Asphaltenes Analysis							Area Percent	Wt. %	Total
Material/ Amt. Inj.	Wt. % Whole Oil	Asphaltene Determinator Detector	Area Percent Heptane	Area Percent CyC ₆	Area Percent Toluene	Area Percent CH ₂ Cl ₂ :MeOH	Toluene + CH ₂ Cl ₂ :MeOH	Toluene + CH ₂ Cl ₂ :MeOH	Wt. % Asphaltenes
C7 Asphaltenes 10 μ .4002 mg	8.21	ELSD	16.64	25.67	56.85	0.84	57.69	4.74	8.27
		500 nm	15.12	29.68	52.35	2.86	55.21		
		700 nm	10.31	31.03	55.03	3.63	58.66		
C7 Asphaltenes 0.45 μ .2340 mg	0.06	ELSD	49.07	15.79	34.34	0.79	35.13	0.02	
		500 nm	23.04	26.17	46.33	4.46	50.79		
		700 nm	17.97	26.95	48.97	6.11	55.08		

Sample:	WRI 1338-131-10 (#1st Try Layer-1)				Heavy Oil Set 3				
	Whole Sample Shaken								AD Asphalt
Material/ Amt. Inj.	Wt. % ELSD	Asphaltene Determinator Area Percent					Coke Index	Aging Index	Percent
	Volatiles	Detector	Heptane	CyC ₆	Toluene	CH ₂ Cl ₂ :MeOH	Ratio Cy/CCl	Ratio T/H	TPA
Whole Oil 2.0008 mg	74.29	ELSD	92.57	2.80	4.32	0.31	9.0	1.01	11.5
		500 nm	35.42	23.19	35.65	5.74	4.0		
		700 nm	24.37	26.23	41.09	8.32	3.2		
Whole Oil ELSD Area:		1952211		QC ELSD Area:		7594086			
Corrected for Volatiles Loss		ELSD	98.09	0.72	1.11	0.08	9.0	1.01	3.0
		500 nm	35.42	23.19	35.65	5.74	4.0		
		700 nm	24.37	26.23	41.09	8.32	3.2		
Gravimetric Asphaltenes Analysis							Area Percent	Wt. %	Total
Material/ Amt. Inj.	Wt. %	Asphaltene Determinator Area Percent					Toluene +	Toluene +	Wt. %
	Whole Oil	Detector	Heptane	CyC ₆	Toluene	CH ₂ Cl ₂ :MeOH	CH ₂ Cl ₂ :MeOH	CH ₂ Cl ₂ :MeOH	Asphaltenes
C7 Asphaltenes 10 μ 0.4014 mg	2.86	ELSD	7.26	25.01	61.94	5.79	67.73	1.94	2.88
		500 nm	11.73	25.10	51.94	11.23	63.17		
		700 nm	6.76	22.99	49.93	20.31	70.24		
C7 Asphaltenes 0.45 μ	0.02	ELSD	Insufficient Material						
		500 nm	Insufficient Material						
		700 nm	Insufficient Material						

Sample:	WRI 1338-131-10 (#1st Try Layer-1)				Heavy Oil Set 3				
	Whole Emulsion Layer Shaken						AD Asphalt		
Material/ Amt. Inj.	Wt. % ELSD	Asphaltene Determinator Area Percent					Coke Index	Aging Index	Percent
	Volatiles	Detector	Heptane	CyC ₆	Toluene	CH ₂ Cl ₂ :MeOH	Ratio Cy/CCl	Ratio T/H	TPA
Whole Oil 2.0016 mg	68.58	ELSD	92.81	2.34	4.49	0.35	6.7	0.94	11.6
		500 nm	37.95	20.49	35.71	5.84	3.5		
		700 nm	26.36	22.72	41.86	9.06	2.5		
		Whole Oil ELSD Area:		2532470	QC ELSD Area:		8060927		
Corrected for Volatiles Loss		ELSD	97.74	0.74	1.41	0.11	6.7	0.94	3.6
		500 nm	37.95	20.49	35.71	5.84	3.5		
		700 nm	26.36	22.72	41.86	9.06	2.5		
Gravimetric Asphaltenes Analysis							Area Percent	Wt. %	Total
Material/ Amt. Inj.	Wt. %	Asphaltene Determinator Area Percent					Toluene +	Toluene +	Wt. %
	Whole Oil	Detector	Heptane	CyC ₆	Toluene	CH ₂ Cl ₂ :MeOH	CH ₂ Cl ₂ :MeOH	CH ₂ Cl ₂ :MeOH	Asphaltenes
C7 Asphaltenes 10 μ 0.4004 mg	2.39	ELSD	8.50	22.37	62.73	6.40	69.13	1.35	2.40
		500 nm	12.07	23.90	53.44	10.58	64.02		
		700 nm	8.23	24.04	55.08	12.64	67.72		
C7 Asphaltenes 0.45 μ	0.01	ELSD	Insufficient Material						
		500 nm	Insufficient Material						
		700 nm	Insufficient Material						

Sample:	WRI 1338-131-10 (#1st T-1)		Heavy Oil Set 3						
	Centrifuged Oil from Emulsion Layer							AD Asphalt	
Material/ Amt. Inj.	Wt. % ELSD Volatiles	Detector	Asphaltene Determinator Heptane	Area Percent CyC ₆	Toluene	CH ₂ Cl ₂ :MeOH	Coke Index Ratio Cy/CCI	Aging Index Ratio T/H	Percent TPA
Whole Oil	50.91	ELSD	92.71	1.93	5.08	0.27	7.1		11.4
2.0016 mg		500 nm	36.02	23.02	37.23	3.73	6.2	1.03	
		700 nm	25.44	25.91	42.97	5.68	4.6		
		Whole Oil ELSD Area:		3850429	QC ELSD Area:		7842919		
Corrected for		ELSD	96.42	0.95	2.49	0.13	7.1		5.6
Volatiles Loss		500 nm	36.02	23.02	37.23	3.73	6.2	1.03	
		700 nm	25.44	25.91	42.97	5.68	4.6		
Gravimetric Asphaltenes Analysis									
Material/ Amt. Inj.	Wt. % Whole Oil	Detector	Asphaltene Determinator Heptane	Area Percent CyC ₆	Toluene	CH ₂ Cl ₂ :MeOH	Area Percent Toluene + CH ₂ Cl ₂ :MeOH	Wt. % Toluene + CH ₂ Cl ₂ :MeOH	Total Wt. % Asphaltenes
C7 Asphaltenes	3.54	ELSD	11.12	22.17	64.19	2.52	66.71	2.37	3.55
10 μ		500 nm	14.51	28.38	53.20	3.91	57.11		
0.4020 mg		700 nm	9.68	28.94	56.19	5.18	61.37		
C7 Asphaltenes	0.01	ELSD	Insufficient Material						
0.45 μ		500 nm	Insufficient Material						
		700 nm	Insufficient Material						

Sample:	WRI 1338-131-10 (#1st Try Layer-1)		Heavy Oil Set 3						
	Oil Residue from Evaporated Centrifuged Water Fraction from Emulsion Layer							AD Asphalt	
Material/ Amt. Inj.	Wt. % ELSD Volatiles	Detector	Asphaltene Determinator Heptane	Area Percent CyC ₆	Toluene	CH ₂ Cl ₂ :MeOH	Coke Index Ratio Cy/CCI	Aging Index Ratio T/H	Percent TPA
Whole Oil	70.88	ELSD	73.36	3.02	13.20	10.41	0.3		37.1
0.2947 mg		500 nm	28.26	24.03	40.01	7.71	3.1	1.42	
		700 nm	23.00	25.75	40.50	10.76	2.4		
		Whole Oil 2mg ELSD Area:		2283936	QC ELSD Area:		7842919		
Corrected for		ELSD	92.24	0.88	3.84	3.03	0.3		
Volatiles Loss		500 nm	28.26	24.03	40.01	7.71	3.1		
		700 nm	23.00	25.75	40.50	10.76	2.4		
Gravimetric Asphaltenes Analysis									
Material/ Amt. Inj.	Wt. % Whole Oil	Detector	Asphaltene Determinator Heptane	Area Percent CyC ₆	Toluene	CH ₂ Cl ₂ :MeOH	Area Percent Toluene + CH ₂ Cl ₂ :MeOH	Wt. % Toluene + CH ₂ Cl ₂ :MeOH	Total Wt. % Asphaltenes
C7 Asphaltenes		ELSD	Insufficient Material						
10 μ		500 nm	Insufficient Material						
		700 nm	Insufficient Material						
C7 Asphaltenes		ELSD	Insufficient Material						
0.45 μ		500 nm	Insufficient Material						
		700 nm	Insufficient Material						

Sample:	WRI 1338-131-11 (#1st Try Layer-2)				Heavy Oil Set 3				
	Whole Sample Shaken								AD Asphalt
Material/	Wt. % ELSD	Asphaltene Determinator Area Percent				Coke Index	Aging Index	Percent	
Amt. Inj.	Volatiles	Detector	Heptane	CyC ₆	Toluene	CH ₂ Cl ₂ :MeOH	Ratio Cy/CCl	Ratio T/H	TPA
Whole Oil 2.0004 mg	69.82	ELSD	92.83	2.50	4.38	0.29	8.6	1.01	11.1
		500 nm	35.49	23.13	36.01	5.37	4.3		
		700 nm	24.04	26.30	42.04	7.62	3.5		
		Whole Oil ELSD Area:			2291864	QC ELSD Area:		7594086	
Corrected for Volatiles Loss		ELSD	97.84	0.75	1.32	0.09	8.6	1.01	3.4
		500 nm	35.49	23.13	36.01	5.37	4.3		
		700 nm	24.04	26.30	42.04	7.62	3.5		
Gravimetric Asphaltenes Analysis							Area Percent	Wt. %	Total
Material/	Wt. %	Asphaltene Determinator Area Percent				Toluene +	Toluene +		
Amt. Inj.	Whole Oil	Detector	Heptane	CyC ₆	Toluene	CH ₂ Cl ₂ :MeOH	CH ₂ Cl ₂ :MeOH	CH ₂ Cl ₂ :MeOH	Asphaltenes
C7 Asphaltenes 10 μ 0.4028 mg	1.79	ELSD	4.48	23.95	64.70	6.87	71.57	1.28	1.80
		500 nm	9.62	23.54	53.13	13.71	66.84		
		700 nm	5.60	21.34	49.71	23.34	73.05		
C7 Asphaltenes 0.45 μ	0.01	ELSD	Insufficient Material						
		500 nm	Insufficient Material						
		700 nm	Insufficient Material						

Sample:	WRI 1338-131-11 (#1st Try Layer-2)				Heavy Oil Set 3				
	Whole Emulsion Layer Shaken						AD Asphalt		
Material/ Amt. Inj.	Wt. % ELSD	Asphaltene Determinator Area Percent				Coke Index	Aging Index	Percent	
	Volatiles	Detector	Heptane	CyC ₆	Toluene	CH ₂ Cl ₂ :MeOH	Ratio Cy/CCl	Ratio T/H	TPA
Whole Oil 2.0000 mg	70.26	ELSD	92.65	2.42	4.59	0.33	7.3	0.93	11.9
		500 nm	38.03	20.73	35.48	5.77	3.6		
		700 nm	26.80	22.67	40.73	9.80	2.3		
		Whole Oil ELSD Area:		2397115	QC ELSD Area:		8060927		
Corrected for Volatiles Loss		ELSD	97.81	0.72	1.37	0.10	7.3	0.93	3.5
		500 nm	38.03	20.73	35.48	5.77	3.6		
		700 nm	26.80	22.67	40.73	9.80	2.3		
Gravimetric Asphaltenes Analysis							Area Percent	Wt. %	Total
Material/ Amt. Inj.	Wt. %	Asphaltene Determinator Area Percent				Toluene +	Toluene +	Wt. %	
	Whole Oil	Detector	Heptane	CyC ₆	Toluene	CH ₂ Cl ₂ :MeOH	CH ₂ Cl ₂ :MeOH	CH ₂ Cl ₂ :MeOH	Asphaltenes
C7 Asphaltenes 10 μ 0.4020 mg	1.72	ELSD	8.66	21.26	64.17	5.90	70.07	1.37	1.73
		500 nm	11.93	23.02	54.05	10.99	65.04		
		700 nm	8.43	23.05	55.24	13.28	68.52		
C7 Asphaltenes 0.45 μ	0.01	ELSD	Insufficient Material						
		500 nm	Insufficient Material						
		700 nm	Insufficient Material						

Sample:	WRI 1338-131-11 (#1st Try Layer-2)				Heavy Oil Set 3				
	Centrifuged Oil from Emulsion Layer							AD Asphalt	
Material/ Amt. Inj.	Wt. % ELSD Volatiles	Detector	Asphaltene Determinator Heptane	Area Percent CyC ₆	Toluene	CH ₂ Cl ₂ :MeOH	Coke Index Ratio Cy/CCI	Aging Index Ratio T/H	Percent TPA
Whole Oil	51.69	ELSD	92.55	1.94	5.23	0.28	6.9		11.6
2.0008 mg		500 nm	35.54	22.93	37.58	3.95	5.8	1.06	
		700 nm	25.40	25.71	42.94	5.95	4.3		
Whole Oil ELSD Area:			3789074		QC ELSD Area:		7842919		
Corrected for		ELSD	96.40	0.94	2.53	0.14	6.9		5.6
Volatiles Loss		500 nm	35.54	22.93	37.58	3.95	5.8	1.06	
		700 nm	25.40	25.71	42.94	5.95	4.3		
Gravimetric Asphaltenes Analysis							Area Percent	Wt. %	Total
Material/ Amt. Inj.	Wt. % Whole Oil	Detector	Asphaltene Determinator Heptane	Area Percent CyC ₆	Toluene	CH ₂ Cl ₂ :MeOH	Toluene + CH ₂ Cl ₂ :MeOH	Toluene + CH ₂ Cl ₂ :MeOH	Wt. % Asphaltenes
C7 Asphaltenes	6.92	ELSD	15.61	21.42	60.71	2.27	62.98	4.42	7.02
10 μ		500 nm	15.73	28.25	52.08	3.94	56.02		
0.4024 mg		700 nm	10.84	28.98	55.15	5.03	60.18		
C7 Asphaltenes	0.10	ELSD	Insufficient Material						
0.45 μ		500 nm	Insufficient Material						
		700 nm	Insufficient Material						

Sample:	WRI 1338-131-11 (#1st Try Layer-2)				Heavy Oil Set 3				
	Oil Residue from Evaporated Centrifuged Water Fraction from Emulsion Layer							AD Asphalt	
Material/ Amt. Inj.	Wt. % ELSD Volatiles	Detector	Asphaltene Determinator Heptane	Area Percent CyC ₆	Toluene	CH ₂ Cl ₂ :MeOH	Coke Index Ratio Cy/CCI	Aging Index Ratio T/H	Percent TPA
Whole Oil	79.21	ELSD	65.47	5.77	16.92	11.84	0.5		51.3
0.4633 mg		500 nm	32.71	25.12	35.35	6.82	3.7	1.08	
		700 nm	27.26	27.02	35.92	9.81	2.8		
Whole Oil 2mg ELSD Area:				1630870	QC ELSD Area:		7842919		
Corrected for		ELSD	92.82	1.20	3.52	2.46	0.5		
Volatiles Loss		500 nm	32.71	25.12	35.35	6.82	3.7		
		700 nm	27.26	27.02	35.92	9.81	2.8		
Gravimetric Asphaltenes Analysis							Area Percent	Wt. %	Total
Material/ Amt. Inj.	Wt. % Whole Oil	Detector	Asphaltene Determinator Heptane	Area Percent CyC ₆	Toluene	CH ₂ Cl ₂ :MeOH	Toluene + CH ₂ Cl ₂ :MeOH	Toluene + CH ₂ Cl ₂ :MeOH	Wt. % Asphaltenes
C7 Asphaltenes		ELSD	Insufficient Material						
10 μ		500 nm	Insufficient Material						
		700 nm	Insufficient Material						
C7 Asphaltenes		ELSD	Insufficient Material						
0.45 μ		500 nm	Insufficient Material						
		700 nm	Insufficient Material						

Sample:	WRI 1338-131-12 (#1st Try Layer-3)				Heavy Oil Set 3				
	Whole Sample Shaken							AD Asphalt	
Material/ Amt. Inj.	Wt. % ELSD	Asphaltene Determinator Area Percent				Coke Index	Aging Index	Percent	
	<u>Volatiles</u>	<u>Detector</u>	<u>Heptane</u>	<u>CyC₆</u>	<u>Toluene</u>	<u>CH₂Cl₂:MeOH</u>	<u>Ratio Cy/CCI</u>	<u>Ratio T/H</u>	
								<u>TPA</u>	
Whole Oil	69.39	ELSD	92.48	2.47	4.70	0.34	7.3	11.7	
2.0006 mg		500 nm	35.89	21.60	36.82	5.69	3.8	1.03	
		700 nm	23.98	24.29	43.47	8.26	2.9		
		Whole Oil ELSD Area:		2310376	QC ELSD Area:		7547625		
Corrected for		ELSD	97.70	0.76	1.44	0.10	7.3	3.6	
Volatiles Loss		500 nm	35.89	21.60	36.82	5.69	3.8	1.03	
		700 nm	23.98	24.29	43.47	8.26	2.9		
Gravimetric Asphaltenes Analysis							Area Percent	Wt. %	Total
Material/ Amt. Inj.	Wt. %	Asphaltene Determinator Area Percent				Toluene +	Toluene +	Wt. %	
	<u>Whole Oil</u>	<u>Detector</u>	<u>Heptane</u>	<u>CyC₆</u>	<u>Toluene</u>	<u>CH₂Cl₂:MeOH</u>	<u>CH₂Cl₂:MeOH</u>	<u>Asphaltenes</u>	
								2.98	
C7 Asphaltenes	2.95	ELSD	7.64	22.72	62.75	6.89	69.64	2.05	
10 μ		500 nm	11.24	22.00	52.78	13.99	66.77		
0.4006 mg		700 nm	6.12	19.94	50.67	23.27	73.94		
C7 Asphaltenes	0.03	ELSD	Insufficient Material						
0.45 μ		500 nm	Insufficient Material						
		700 nm	Insufficient Material						

Sample:	WRI 1338-131-12 (#1st Try Layer-3)				Heavy Oil Set 3				
	Whole Emulsion Layer Shaken							AD Asphalt	
Material/ Amt. Inj.	Wt. % ELSD	Asphaltene Determinator Area Percent				Coke Index	Aging Index	Percent	
	<u>Volatiles</u>	<u>Detector</u>	<u>Heptane</u>	<u>CyC₆</u>	<u>Toluene</u>	<u>CH₂Cl₂:MeOH</u>	<u>Ratio Cy/CCI</u>	<u>Ratio T/H</u>	<u>TPA</u>
Whole Oil 2.0000 mg	69.47	ELSD	92.95	2.33	4.38	0.34	6.9		11.5
		500 nm	38.49	20.98	34.78	5.74	3.7	0.90	
		700 nm	26.92	23.44	40.18	9.46	2.5		
		Whole Oil ELSD Area:			2461011	QC ELSD Area:		8060927	
Corrected for Volatiles Loss		ELSD	97.85	0.71	1.34	0.10	6.9		3.5
		500 nm	38.49	20.98	34.78	5.74	3.7	0.90	
		700 nm	26.92	23.44	40.18	9.46	2.5		
Gravimetric Asphaltenes Analysis							Area Percent	Wt. %	Total
Material/ Amt. Inj.	Wt. %	Asphaltene Determinator Area Percent				Toluene +	Toluene +	Wt. %	
	<u>Whole Oil</u>	<u>Detector</u>	<u>Heptane</u>	<u>CyC₆</u>	<u>Toluene</u>	<u>CH₂Cl₂:MeOH</u>	<u>CH₂Cl₂:MeOH</u>	<u>CH₂Cl₂:MeOH</u>	<u>Asphaltenes</u>
C7 Asphaltenes 10 μ .4020 mg	2.00	ELSD	12.05	21.97	58.69	7.29	65.98	1.29	2.02
		500 nm	13.42	23.64	49.85	13.08	62.93		
		700 nm	9.28	23.68	50.75	16.28	67.03		
C7 Asphaltenes 0.45 μ	0.02	ELSD	Insufficient Material						
		500 nm	Insufficient Material						
		700 nm	Insufficient Material						

Sample:	WRI 1338-131-12 (#1st Try Layer-3)						Heavy Oil Set 3		
	Emulsoin Centrifuged Oil Fraction							AD Asphalt	
Material/ Amt. Inj.	Wt. % ELSD Volatiles	Detector	Asphaltene Determinator Heptane	Area Percent CyC ₆	Toluene	CH ₂ Cl ₂ :MeOH	Coke Index Ratio Cy/CCI	Aging Index Ratio T/H	Percent TPA
Whole Oil	69.11	ELSD	91.75	2.34	5.44	0.47	5.0		12.6
2.0012 mg		500 nm	34.64	21.79	37.78	5.79	3.8	1.09	
		700 nm	24.22	24.30	43.18	8.29	2.9		
Whole Oil ELSD Area:			2602764		QC ELSD Area:		8427234		
Corrected for		ELSD	97.45	0.72	1.68	0.15	5.0		
Volatiles Loss		500 nm	34.64	21.79	37.78	5.79	3.8		
		700 nm	24.22	24.30	43.18	8.29	2.9		
Gravimetric Asphaltenes Analysis							Area Percent	Wt. %	Total
Material/ Amt. Inj.	Wt. % Whole Oil	Detector	Asphaltene Determinator Heptane	Area Percent CyC ₆	Toluene	CH ₂ Cl ₂ :MeOH	Toluene + CH ₂ Cl ₂ :MeOH	Toluene + CH ₂ Cl ₂ :MeOH	Wt. % Asphaltenes
C7 Asphaltenes	5.95	ELSD	12.95	27.08	57.51	2.46	59.97	3.57	5.97
10 μ		500 nm	13.74	30.73	51.39	4.13	55.52		
2.0036 mg		700 nm	8.86	31.43	54.44	5.27	59.71		
C7 Asphaltenes	0.024	ELSD	Insufficient Material						
0.45 μ		500 nm	Insufficient Material						
		700 nm	Insufficient Material						

Sample:	WRI 1338-131-12 (#1st Try Layer-3)						Heavy Oil Set 3		
	Oil Residue from Evaporated Centrifuged Water Fraction from Emulsion Layer							AD Asphalt	
Material/ Amt. Inj.	Wt. % ELSD Volatiles	Detector	Asphaltene Determinator Heptane	Area Percent CyC ₆	Toluene	CH ₂ Cl ₂ :MeOH	Coke Index Ratio Cy/CCI	Aging Index Ratio T/H	Percent TPA
Whole Oil	56.33	ELSD	85.65	3.77	7.40	3.18	1.2		22.9
1.1087 mg		500 nm	37.36	25.86	32.31	4.48	5.8	0.86	
		700 nm	27.04	28.81	37.41	6.74	4.3		
Whole Oil 2mg ELSD Area:			3680435		QC ELSD Area:		8427234		
Corrected for		ELSD	93.73	1.65	3.23	1.39	1.2		10.0
Volatiles Loss		500 nm	37.36	25.86	32.31	4.48	5.8	0.86	
		700 nm	27.04	28.81	37.41	6.74	4.3		
Gravimetric Asphaltenes Analysis							Area Percent	Wt. %	Total
Material/ Amt. Inj.	Wt. % Whole Oil	Detector	Asphaltene Determinator Heptane	Area Percent CyC ₆	Toluene	CH ₂ Cl ₂ :MeOH	Toluene + CH ₂ Cl ₂ :MeOH	Toluene + CH ₂ Cl ₂ :MeOH	Wt. % Asphaltenes
C7 Asphaltenes		ELSD	Insufficient Material						
10 μ		500 nm	Insufficient Material						
		700 nm	Insufficient Material						
C7 Asphaltenes		ELSD	Insufficient Material						
0.45 μ		500 nm	Insufficient Material						
		700 nm	Insufficient Material						

Sample:	WRI 1338-131-13 (#1st Try layer-4)				Heavy Oil Set 3				
	Whole Sample Shaken								
Material/ Amt. Inj.	Wt. % ELSD	Asphaltene Determinator Area Percent				Coke Index	AD Asphalt Aging Index	Percent	
	Volatiles	Detector	Heptane	CyC ₆	Toluene	CH ₂ Cl ₂ :MeOH	Ratio Cy/CCl	Ratio T/H	TPA
Whole Oil 2.0000 mg	73.87	ELSD	91.94	2.73	4.96	0.36	7.6	1.14	12.1
		500 nm	33.44	22.99	38.13	5.45	4.2		
		700 nm	21.55	25.27	44.67	8.51	3.0		
		Whole Oil ELSD Area:		1972189	QC ELSD Area:		7547625		
Corrected for Volatiles Loss		ELSD	97.89	0.71	1.30	0.09	7.6	1.14	3.2
		500 nm	33.44	22.99	38.13	5.45	4.2		
		700 nm	21.55	25.27	44.67	8.51	3.0		
Gravimetric Asphaltenes Analysis							Area Percent	Wt. %	Total
Material/ Amt. Inj.	Wt. %	Asphaltene Determinator Area Percent				Toluene +	Toluene +	Total	
	Whole Oil	Detector	Heptane	CyC ₆	Toluene	CH ₂ Cl ₂ :MeOH	CH ₂ Cl ₂ :MeOH	CH ₂ Cl ₂ :MeOH	Wt. % Asphaltenes
C7 Asphaltenes 10 μ 0.4028 mg	3.29	ELSD	6.60	18.02	70.64	4.74	75.38	2.48	3.31
		500 nm	11.83	24.06	55.37	8.74	64.11		
		700 nm	8.01	23.83	56.69	11.47	68.16		
C7 Asphaltenes 0.45 μ	0.02	ELSD	Insufficient Material						
		500 nm	Insufficient Material						
		700 nm	Insufficient Material						

Sample:	WRI 1338-131-13 (#1st Try Layer-4)				Heavy Oil Set 3				
	Whole Emulsion Layer Shaken							AD Asphalt	
Material/ Amt. Inj.	Wt. % ELSD	Asphaltene Determinator			Area Percent		Coke Index	Aging Index	Percent
	Volatiles	Detector	Heptane	CyC ₆	Toluene	CH ₂ Cl ₂ :MeOH	Ratio Cy/CCl	Ratio T/H	TPA
Whole Oil 2.0000 mg	62.98	ELSD	92.97	2.26	4.50	0.27	8.4	0.95	11.3
		500 nm	37.73	21.06	35.91	5.29	4.0		
		700 nm	26.28	23.63	42.09	8.00	3.0		
		Whole Oil ELSD Area:			2983869	QC ELSD Area:		8060927	
Corrected for Volatiles Loss		ELSD	97.40	0.84	1.67	0.10	8.4	0.95	4.2
		500 nm	37.73	21.06	35.91	5.29	4.0		
		700 nm	26.28	23.63	42.09	8.00	3.0		
Gravimetric Asphaltenes Analysis							Area Percent	Wt. %	Total
Material/ Amt. Inj.	Wt. %	Asphaltene Determinator			Area Percent		Toluene +	Toluene +	Wt. %
	Whole Oil	Detector	Heptane	CyC ₆	Toluene	CH ₂ Cl ₂ :MeOH	CH ₂ Cl ₂ :MeOH	CH ₂ Cl ₂ :MeOH	Asphaltenes
C7 Asphaltenes 10 μ .4004 mg	4.88	ELSD	12.38	20.80	65.00	1.82	66.82	1.31	4.89
		500 nm	12.36	26.67	57.21	3.75	60.96		
		700 nm	8.10	27.25	60.02	4.63	64.65		
C7 Asphaltenes 0.45 μ	0.01	ELSD	Insufficient Material						
		500 nm	Insufficient Material						
		700 nm	Insufficient Material						

Sample:	WRI 1338-131-13 (#1st Try Layer-4)						Heavy Oil Set 3		
	Emulsion Centrifuged Oil Fraction							AD Asphalt	
Material/ Amt. Inj.	Wt. % ELSD Volatiles	Detector	Asphaltene Determinator Area Percent				Coke Index Ratio Cy/CCI	Aging Index Ratio T/H	Percent TPA
			Heptane	CyC ₆	Toluene	CH ₂ Cl ₂ :MeOH			
Whole Oil	33.04	ELSD	92.10	2.50	5.16	0.25	10.0		12.4
2.0010 mg		500 nm	36.15	22.64	37.21	4.00	5.7	1.03	
		700 nm	25.31	25.62	43.29	5.78	4.4		
Whole Oil ELSD Area:			5642749		QC ELSD Area:		8427234		
Corrected for		ELSD	94.71	1.67	3.46	0.17	10.0		
Volatiles Loss		500 nm	36.15	22.64	37.21	4.00	5.7		
		700 nm	25.31	25.62	43.29	5.78	4.4		
Gravimetric Asphaltenes Analysis							Area Percent	Wt. %	Total
Material/ Amt. Inj.	Wt. % Whole Oil	Detector	Heptane	CyC ₆	Toluene	CH ₂ Cl ₂ :MeOH	Toluene + CH ₂ Cl ₂ :MeOH	Toluene + CH ₂ Cl ₂ :MeOH	Wt. % Asphaltenes
									9.09
C7 Asphaltenes	9.0585	ELSD	20.48	23.96	53.87	1.68	55.55	5.03	
10 μ		500 nm	15.18	29.52	51.55	3.75	55.30		
2.0004 mg		700 nm	10.61	30.45	54.21	4.72	58.93		
C7 Asphaltenes	0.0316	ELSD	Insufficient Material						
0.45 μ		500 nm	Insufficient Material						
		700 nm	Insufficient Material						

Sample:	WRI 1338-131-13 (#1st Try Layer-4)						Heavy Oil Set 3		
	Oil Residue from Evaporated Centrifuged Water Fraction from Emulsion Layer							AD Asphalt	
Material/ Amt. Inj.	Wt. % ELSD Volatiles	Detector	Asphaltene Determinator Area Percent				Coke Index Ratio Cy/CCI	Aging Index Ratio T/H	Percent TPA
			Heptane	CyC ₆	Toluene	CH ₂ Cl ₂ :MeOH			
Whole Oil	48.87	ELSD	82.52	5.71	8.40	3.38	1.7		29.0
0.9160 mg		500 nm	39.75	24.80	32.07	3.39	7.3	0.81	
		700 nm	30.48	27.85	36.46	5.20	5.4		
Whole Oil 2mg ELSD Area:			4308742		QC ELSD Area:		8427234		
Corrected for		ELSD	91.06	2.92	4.29	1.73	1.7		14.8
Volatiles Loss		500 nm	39.75	24.80	32.07	3.39	7.3	0.81	
		700 nm	30.48	27.85	36.46	5.20	5.4		
Gravimetric Asphaltenes Analysis							Area Percent	Wt. %	Total
Material/ Amt. Inj.	Wt. % Whole Oil	Detector	Heptane	CyC ₆	Toluene	CH ₂ Cl ₂ :MeOH	Toluene + CH ₂ Cl ₂ :MeOH	Toluene + CH ₂ Cl ₂ :MeOH	Wt. % Asphaltenes
C7 Asphaltenes		ELSD	Insufficient Material						
10 μ		500 nm	Insufficient Material						
		700 nm	Insufficient Material						
C7 Asphaltenes		ELSD	Insufficient Material						
0.45 μ		500 nm	Insufficient Material						
		700 nm	Insufficient Material						

Sample:	WRI 1338-131-14 (#1st Try Layer-5)				Heavy Oil Set 3				
	Whole Sample Shaken (all oil)								
Material/ Amt. Inj.	Wt. % ELSD	Asphaltene Determinator Area Percent					Coke Index	AD Asphalt Aging Index	Percent
	Volatiles	Detector	Heptane	CyC ₆	Toluene	CH ₂ Cl ₂ :MeOH	Ratio Cy/CCl	Ratio T/H	TPA
Whole Oil 2.0000 mg	40.24	ELSD	93.35	2.42	4.05	0.18	13.4		10.5
		500 nm	36.43	23.71	35.73	4.13	5.7	0.98	
		700 nm	25.02	26.84	41.94	6.20	4.3		
		Whole Oil ELSD Area:			4510300	QC ELSD Area:		7547625	
Corrected for Volatiles Loss		ELSD	96.03	1.45	2.42	0.11	13.4		6.3
		500 nm	36.43	23.71	35.73	4.13	5.7	0.98	
		700 nm	25.02	26.84	41.94	6.20	4.3		
Gravimetric Asphaltenes Analysis							Area Percent	Wt. %	Total
Material/ Amt. Inj.	Wt. %	Asphaltene Determinator Area Percent					Toluene +	Toluene +	Wt. %
	Whole Oil	Detector	Heptane	CyC ₆	Toluene	CH ₂ Cl ₂ :MeOH	CH ₂ Cl ₂ :MeOH	CH ₂ Cl ₂ :MeOH	Asphaltenes
C7 Asphaltenes 10 μ 0.4036 mg	8.97	ELSD	12.00	22.50	64.38	1.11	65.49	58.70	9.40
		500 nm	13.93	29.30	52.63	4.14	56.77		
		700 nm	9.34	31.25	54.34	5.07	59.41		
C7 Asphaltenes 0.45 μ 0.4290 mg	0.43	ELSD	8.45	12.95	76.79	1.81	78.60		
		500 nm	9.10	20.14	66.11	4.65	70.76		
		700 nm	5.77	21.03	68.06	5.14	73.20		

Sample:	WRI 1338-131-16 (#1st Try Layer-7)				Heavy Oil Set 3				
	Whole Sample Shaken (all oil)								
Material/ Amt. Inj.	Wt. % ELSD	Asphaltene Determinator Area Percent					Coke Index	AD Asphalt Aging Index	Percent
	Volatiles	Detector	Heptane	CyC ₆	Toluene	CH ₂ Cl ₂ :MeOH	Ratio Cy/CCl	Ratio T/H	TPA
Whole Oil 2.0016 mg	37.91	ELSD	93.25	2.39	4.19	0.16	14.9		10.5
		500 nm	35.85	23.66	36.55	3.93	6.0	1.02	
		700 nm	23.79	27.08	43.39	5.74	4.7		
		Whole Oil ELSD Area:			4686428	QC ELSD Area:		7547625	
Corrected for Volatiles Loss		ELSD	95.81	1.48	2.60	0.10	14.9		6.5
		500 nm	35.85	23.66	36.55	3.93	6.0	1.02	
		700 nm	23.79	27.08	43.39	5.74	4.7		
Gravimetric Asphaltenes Analysis							Area Percent	Wt. %	Total
Material/ Amt. Inj.	Wt. %	Asphaltene Determinator Area Percent					Toluene +	Toluene +	Wt. %
	Whole Oil	Detector	Heptane	CyC ₆	Toluene	CH ₂ Cl ₂ :MeOH	CH ₂ Cl ₂ :MeOH	CH ₂ Cl ₂ :MeOH	Asphaltenes
C7 Asphaltenes 10 μ 0.4032 mg	8.98	ELSD	13.78	24.99	60.32	0.92	61.24	55.00	9.21
		500 nm	14.51	31.34	50.33	3.82	54.15		
		700 nm	9.97	33.51	51.95	4.57	56.52		
C7 Asphaltenes 0.45 μ 0.4550 mg	0.23	ELSD	5.58	11.53	80.73	2.17	82.90		
		500 nm	8.12	18.20	68.11	5.58	73.69		
		700 nm	4.86	19.25	69.82	6.06	75.88		

It is of further note that an oil and water emulsion is typically formed or made by vigorous agitation such as shaking, ultrasonic vibration, nozzle flow mixing, or high shear mixing of oil and water, for example. The emulsion itself typically appears as a single phase. Depending on the relative densities of the oil and water, if the emulsion is not complete, there can be oil and water also present, on top or below the emulsion phase. In certain cases, the oil is an oil that contains very condensed aromatic molecules. A solid material called asphaltene can be precipitated from the oil using an excess of aliphatic hydrocarbon solvent, for example (or, as but one additional example, an alkane mobile phase). This solubility class of associated species consists of various chemical types, including the most aromatic and polar components of the oil. It is these most aromatic components that are believed to be the “core” or nucleating agents for attraction for other “peptizing” molecules in the oil in order to render the whole mixture stable (lowest free energy possible by most favorable arrangement of molecules). These solid asphaltene contain an asphaltene subfraction that comprises the most aromatic molecules in the original oil. It also contains a large amount of less aromatic species that are associated with the most aromatic material. The most aromatic material is what may be referred to as the “peak 4” material (because in a successive dissolution protocol involving three dissolving solvents, where (a first solvent is initially used before dissolution to precipitate asphaltene, the most aromatic material may (in certain embodiments) precipitate with the third dissolving (or the fourth total) solvent).

At least one embodiment of the inventive technology may be described as a method for changing the stability of an emulsion that comprises an emulsion hydrocarbon, from a first stability to a second, more desired stability, the method comprising the steps of precipitating at least a first asphaltene subfraction of a hydrocarbon and a second asphaltene subfraction of the hydrocarbon within a substantially inert stationary phase to generate precipitated asphaltene, wherein the second asphaltene subfraction is more aromatic than the first asphaltene subfraction; dissolving at least a portion of at least the first asphaltene subfraction from the precipitated asphaltene to generate at least one dissolved asphaltene subfraction; adding at least some of one of the at least one dissolved asphaltene subfraction to the emulsion hydrocarbon (whether it be some of the first or some of the second asphaltene subfraction); and changing the stability of the emulsion comprising the emulsion hydrocarbon from the first stability to the second, more desired stability.

In this and other aspects of the inventive technology, the emulsion hydrocarbon may comprise a hydrocarbon selected from the group consisting of: crude oils, asphalts, distillation residua, processed oils, oils processed via catalytic hydrotreating, oils processed via pyrolysis, tar sands oils, shale oils, coal oils, synthetic oils, biologically derived oils, asphaltenes, modified and unmodified asphalt binders and formulations, emulsions containing oils, bitumen, atmospheric bitumen, vacuum bitumen, coal tar, heavy oil or residuum, as but a few of many possible examples. Of course, solutions of such substances comprise such substances. It is of note that certain embodiments of the inventive technology may also have the effect of reducing fouling, or extending catalyst life (where a reduction in asphaltene content or a particular subfraction such as the 2nd subfraction is achieved). Both effects may be found in applications involving oil and water emulsions, but not necessarily. Also, ranking or valuing hydrocarbons such as oils relative to their ability to create emulsions of a certain stability, or achieve desired changes in stability, are also considered an aspect of the inventive technology. Further, even where an entire asphaltene is added to an emulsion hydrocarbon to effect a stability change (typically this would effect a stability increase), one or more subfraction of such asphaltenes is considered as being added to the emulsion hydrocarbon. It is of note that industrial scale, and much smaller, even laboratory scale, applications of the inventive technology, are considered within its ambit. Determination of solubility profiles as an ancillary aspect of the core inventive technology, in addition to determination of solubility parameters as may assist in, e.g., predicting emulsion stability and/or ranking oils relative to formation thereof, may also form part of the inventive technology.

Note that in this and other aspects of the inventive technology, the emulsion may be a water and oil emulsion (e.g., a water in oil emulsion, an oil in water emulsion, a mixed emulsion, or a foam (such as an asphalt foam, which is considered a type of emulsion in this disclosure)).

Further note that the step of precipitating at least a first asphaltene subfraction of a hydrocarbon and a second asphaltene subfraction of the hydrocarbon within a substantially inert stationary phase may comprise the step of precipitating at least a first asphaltene subfraction of a hydrocarbon and a second asphaltene subfraction of the hydrocarbon within a substantially inert stationary phase that is selected from the group consisting of: oligomers or polymers of polytetrafluorethylene, PTFE, polyphenylene sulfide, silicon polymer, fluorinated polymers or

elastomers, and PEEK stationary phase, as but a few examples of substantially inert stationary phases. Within a stationary phase includes but is not limited to on precipitation and/or accumulation of precipitated materials in the direct vicinity of the stationary phase, on a surface(s) of the stationary phase, and between discretized portions of a total stationary phase amount (e.g., a stationary phase bed or packing material, perhaps as established in a column).

Note that the first and second asphaltene subfractions (whether precipitated, absorbed, dissolved, or isolated) need not total the total asphaltenes; indeed, they may together amount to less than the total amount of asphaltenes (even significantly less than the total amount of asphaltenes). Not all precipitated or adsorbed subfraction amounts may be dissolved. Typically, such subfractions do not overlap. In certain embodiments, one asphaltene subfraction may be defined as those asphaltenes that have a parameter value that is above (or below and including) a certain value, while the other asphaltene subfraction may (but not of necessity) have a value (of that same parameter) that is below and including (or above) such certain value. For example, the second asphaltene subfraction may be a subfraction having a H/C ratio of less than or equal to 1.3. Other ways of describing such subfractions include: the second asphaltene subfraction may be a pre-coke asphaltene subfraction; the first asphaltene subfraction may be more resinous than the second asphaltene subfraction; the second asphaltene subfraction may be more polar than the first asphaltene subfraction; the second asphaltene subfraction may be more pericondensed than the first asphaltene subfraction; the second asphaltene subfraction may be a subfraction that is poorly soluble in a solvent (including, not dissolving at all or only in de minimus amounts) having a solubility parameter that is less than ($<$) $17 \text{ MPa}^{1/2}$ (or even $16 \text{ MPa}^{1/2}$); the second asphaltene subfraction may be a subfraction that is poorly soluble in at least one aliphatic solvent (e.g., heptane and cyclohexane); the second asphaltene subfraction may be a subfraction that is soluble only in a solvent having a solubility parameter that is $>16 \text{ MPa}^{1/2}$. Note also that certain subfractions are defined herein in terms of what is precipitated or adsorbed (so all asphaltenes having a H/C ratio of less than or equal to 1.3 in an original oil may be greater in amount than the second subfraction, which is all of that original oil's precipitated (or adsorbed) asphaltenes having a H/C ratio of less than or equal to 1.3). Indeed, while values of a parameter (e.g., H/C ratio) may be helpful in characterizing a subfraction, parameter measurements (e.g., of a H/C ratio) are not a required step in any embodiments (although they certainly may be made if desired). Note that the inventive technology is extremely flexible. For example, a second

subfraction may be the top 22% - 16% most aromatic of the precipitated or absorbed asphaltenes, while the 1st subfraction may be the 10% - 15% lowest aromaticity subfraction.

At times, the goal of certain aspects of the inventive technology may be to change the stability (as desired) of an existing emulsion (as opposed to using a subfraction as an ingredient
5 during emulsion generation to generate emulsion on with the desired, second stability). As such, the step of adding at least some of one of the at least one dissolved asphaltene subfraction to an emulsion hydrocarbon may comprise the step of adding at least some of one of the at least one dissolved asphaltene subfraction to the emulsion comprising the emulsion hydrocarbon, while the emulsion hydrocarbon is part of the emulsion. In such embodiments, the emulsion may have
10 the first stability before the step of adding at least some of one of the at least one dissolved asphaltene subfraction is performed.

In certain embodiments of the inventive technology, the second, more desired stability may be of a different emulsion type (e.g., where one desires to change an emulsion from oil in water to water in oil, that is considered a change in stability). Similarly, where one desires to
15 generate an emulsion of a certain type (e.g., oil in water), where that type would be different (e.g., water in oil) without addition of some or all of a certain subfraction, then that also is considered changing of stability.

In those embodiments involving precipitation, and where the second, more desired stability is greater than the first stability, the step of dissolving may further comprise the step of
20 dissolving at least a portion the second asphaltene subfraction to generate a dissolved second asphaltene subfraction. Such step itself may be performed after the first asphaltene subfraction is dissolved. As explained, particularly when the goal is to change the stability (as desired) of an existing emulsion, the step of adding at least some of one of the at least one dissolved asphaltene subfraction to the emulsion may comprise the step of adding at least some of the dissolved
25 second asphaltene subfraction to the emulsion. As should be understood, the second asphaltene subfraction has the effect of stabilizing emulsions, or causing the emulsion to shift from a first type to a second type, or perhaps even causing the emulsion to form where it would not otherwise.

In those embodiments involving precipitation, and where the second, more desired stability is less than the first stability, the step of dissolving may comprise dissolving at least a portion of the first asphaltene subfraction from the precipitated asphaltenes to generate a dissolved first asphaltene subfraction. To achieve the change in destabilization of the emulsion as desired (whether that be destabilizing the emulsion (which includes breaking the emulsion), and particularly where the goal is to change the stability of an existing (already generated) emulsion), the step of adding at least some of one of the at least one dissolved asphaltene subfraction to the emulsion may comprise the step of adding at least some of the dissolved first asphaltene subfraction to the emulsion. Note that even where the goal is to destabilize an emulsion, the method may further comprise the step of dissolving at least a portion of the second asphaltene subfraction to generate a dissolved second asphaltene subfraction; such second subfraction may be used in other applications to achieve, e.g., a stabilization of an emulsion.

As mentioned, the method may be a method for generating the emulsion to have the desired, second stability instead of the first stability (even if such first stability is a “destability”, meaning absence of emulsion formulation). One way of describing certain embodiments may be adding a subfraction amount to an emulsion hydrocarbon (any hydrocarbon that will, that may (e.g., without addition of an appropriate subfraction), or that does form part of a hydrocarbon emulsion) during or before emulsion formation (emulsion generation) so that the stability of the generated emulsion will be different from what the stability would have been without such subfraction addition. Again, note that a non-emulsion is considered a destabilized emulsion; as such, certain embodiments of the inventive technology may involve adding a first subfraction to an emulsion oil to prevent such emulsion oil from becoming part of an emulsion during, e.g., agitation with water. Often, however, a second subfraction may be added as part of the emulsion recipe’s ingredients in proper amount to render an emulsion (where it otherwise would not occur), or to render an emulsion with a greater stability than it would otherwise have. As such, the emulsion hydrocarbon may be generally defined as the hydrocarbon that is part of an emulsion that exists, or is to be part of an emulsion that will exist, or is to be part of an emulsion that will exist if steps are not taken to destabilize it. Other applications include rendering an emulsion to be of a certain type (e.g., water in oil), which is considered a stability, than it would otherwise have.

In certain methods involving precipitation that are for generating the emulsion to have the desired, second stability instead of the first stability, where the second stability is less than the first stability, the step of dissolving may comprise the step of dissolving to generate a dissolved first asphaltene subfraction and the step of adding at least some of one of the at least one dissolved asphaltene subfraction to an emulsion hydrocarbon may comprise the step of adding at least some of one of the dissolved first asphaltene subfraction to an emulsion hydrocarbon before the emulsion hydrocarbon is part of the emulsion and before the emulsion is formed. After such addition, the method may further comprise the step of agitating the emulsion hydrocarbon with water to generate the emulsion. Adding at least some of this first subfraction to an emulsion hydrocarbon may lower the stability of the generated emulsion as compared to what it would be without performance of the steps of adding (and changing). Particularly in those embodiments involving precipitation and re-dissolution techniques, the step of dissolving may further comprise the step of dissolving at least a portion of the second asphaltene subfraction to generate a dissolved second asphaltene subfraction. As mentioned and as is discussed elsewhere, at least some of the dissolved second asphaltene subfraction may be added to the emulsion hydrocarbon to increase the stability of the generated emulsion above what it would be without performance of the steps of adding and changing (this includes rendering an emulsion that otherwise would not be generated). As mentioned, adding at least a portion of the dissolved first asphaltene subfraction could have the effect of making the emulsion less stable as compared to what it would otherwise be (or could have the effect of the emulsion not even forming in the first place).

In certain embodiments (particularly those involving precipitation of asphaltenes), the step of dissolving may involve the step of dissolving at least a portion of the second asphaltene subfraction to generate a dissolved second asphaltene subfraction. This step may be performed after the at least a portion of the first asphaltene subfraction is dissolved (particularly in redissolution embodiments, or embodiments involving a successive dissolution protocol). As mentioned, adding at least a portion of such dissolved second asphaltene subfraction to the emulsion hydrocarbon (whether when that hydrocarbon is part of an emulsion or before it's part of an emulsion), may have the effect of increasing emulsion stability. A few examples of possible amounts to add may be as indicated in the figures or tables supplied herewith. In redissolution protocols, the step of dissolving at least a portion of at least the first asphaltene subfraction from the precipitated asphaltenes to generate at least one dissolved asphaltene

subfraction may comprise the step of dissolving with solvents of increasing strength (e.g., with solvents (perhaps mobile phase) that increase in strength via step change, or more gradually, perhaps during continuous solvent flow (although this is not necessarily required). The increasing strength may be associated with increasing polarity; one example may be dissolving
5 in three different stages to produce three discrete asphaltene subfractions (each associated with a peak). Such dissolution protocol may be as described in US Pat. No. 7,875,464, which is incorporated herein in its entirety. Such subfractions may be of increasing aromaticity.

It is of note that certain embodiments may further comprise the step of treating (e.g., via heating) the hydrocarbon before performing the step of precipitating. This, in certain
10 embodiments, may have the effect of improving results (perhaps resulting in sharper peaks, or more Peak 4 materials (which may be eluted with the strongest, or third solvent). As discussed in US Pat. No. 7,875,464, while chromatographic equipment may be used in the precipitation and redissolution type embodiments, the method is typically not chromatographic.

15 It is note also that the stock of the hydrocarbon from which the asphaltenes are precipitated or adsorbed (in sorbent based technologies discussed below) may be different from, or the same as, a stock of the emulsion hydrocarbon. Regardless, certain aspects of the inventive technology, particularly those involving adding a dissolved subfraction to change the stability of an emulsion yet to be formed, may involve the step of designing the oil emulsion to have the
20 second, more desired stability (perhaps by consulting known data relative to how much of a certain dissolved asphaltene subfraction, perhaps of a particular oil stock, effects stability, and to what degree).

As with other aspects of the inventive technology, the precipitation redissolution technique may include as part of the inventive technology the refinery or apparatus in which at
25 least part of the method is performed; in those embodiments where emulsions are part of the hydrocarbon extraction process, the inventive technology may include a refinery that processes hydrocarbons extracted, at least in part, through use of the method. Further, the inventive technology may include the dissolved asphaltene subfraction, and the substance emulsion or non-emulsion having a lowered stability) having the second, more desired stability, in addition to the
30 including the emulsion itself.

It is of note that emulsion stability can be measured in any manner of known ways, such as length of time for the emulsion to collapse or fall; measurements of water in an emulsion may provide information as to emulsion stability or related qualities, in certain instances.

It is of further note that the subfraction used to change the stability, whether in a precipitation and dissolution protocol, or an adsorbance protocol, need not be the most or least aromatic or most or least polar subfraction (e.g., if one wants to make a stable emulsion but wants asphaltenes that are soluble in toluene, you can use the toluene-soluble asphaltenes); sometimes the most polar and most aromatic subfraction (e.g., the Peak 4 materials (that are dissolved by the third solvent in certain embodiments, such as CH_2Cl_2) might impede emulsion formation for a particular source of oil (because sometimes in order to use this Peak 4 material, one may need to add resins to the asphaltenes to make the emulsion). Relatedly, one can eliminate the most aggregated least soluble CH_2Cl_2 -soluble fraction if it hinders emulsion stability. Note that other examples of the strongest solvent used in the successive dissolution protocol may include alkane solvent, a cycloalkane solvent, a chlorinated hydrocarbon solvent, an ether solvent, an aromatic hydrocarbon solvent, a blend of a solvent with alcohol, a blend of chlorinated hydrocarbon solvent and a C_1 to C_6 alcohol, a ketone solvent, and mixtures thereof, as just a few examples.

Particular embodiments of sorbent-based inventive technologies may be described as a method for changing the stability of an emulsion that comprises an emulsion hydrocarbon, from a first stability to a second, more desired stability, the method comprising the steps of: contacting a hydrocarbon with a sorbent (or perhaps even achieving adsorption without such contact), wherein the hydrocarbon has a first asphaltene subfraction and a second asphaltene subfraction, the second asphaltene subfraction being more aromatic than the first asphaltene subfraction; adsorbing at least one of the asphaltene subfractions onto the sorbent to generate adsorbed asphaltenes; desorbing (e.g., by dissolving) at least a portion of the adsorbed asphaltenes from the sorbent to generate an isolated asphaltene subfraction; adding the isolated asphaltene subfraction to the emulsion hydrocarbon; and changing the stability of the emulsion comprising the emulsion hydrocarbon from the first stability to the second, more desired stability (e.g., predictably, as based on data, and/or controllably, perhaps in carefully measured fashion).

The emulsion hydrocarbon, the emulsion, and the first and second asphaltene subfractions may be as described elsewhere in this disclosure. One particular aspect of the sorbent-based technology that may not be found in strict precipitation and redissolution approaches may involve selective adsorption, such as use of sorbents known to adsorb a particular subfraction (e.g., reverse phase sorbents for adsorbing a first asphaltene subfraction, and sorbents such as glass (see below for other examples) for adsorbing a second asphaltene subfraction).

As with precipitation and redissolution embodiments, one may desire to change the stability of an emulsion that is yet to be formed such that it has a stability that is different than it would be without addition of at least a portion of the isolated subfraction, or one may wish to change the stability of an existing emulsion. Regardless, the addition of at least a portion of an isolated subfraction may have effects on stability as indicated above relative to the dissolved first and second subfractions. Note that generally, the sorbent (perhaps upon consideration of what effect on stability is desired) may include a stationary phase sorbent, a solid sorbent, a fixed bed, a fluidized bed, surfaced sorbent, porous membrane sorbent, high surface energy sorbent, aromatic sorbent, highly aromatic sorbent, and sorbent that is selective to adsorption of one of the asphaltene subfractions. Sorbents that may be particularly selective to the second asphaltene subfraction include metals, steel, steel wire, steel wire coils, metal wire, metal wire coils, ceramics, zeolites, clays, silica, silica gel, limestone, glass, mesh glass, glass beads, mesh glass beads, quartz, sand, alumina, and high surface energy carbonaceous materials, as but a few examples. Generally, it may be an acid or a base (although it certainly need not be).

Note that certain sorbent-based technologies may involve the step of treating a hydrocarbon having asphaltenes therein to generate a treated hydrocarbon. Such treatment, whether involving heating and/or addition of solvent or chemical additive, may help to effect selective adsorption, or compromise selective adsorption that otherwise might occur, in known manner. For example, adding cyclohexane to oil to create a solution will render a silica sorbent less selective to the most aromatic subfraction. Solvents used to contact sorbents (thereby rinse asphaltenes of fractions thereof) (regardless of whether the sorbent is small particulate, larger particulate, bulk, gel, or has any other form) may, in particular embodiments, be as described relative to the precipitation and redissolution technologies indicated elsewhere herein. Where

selective adsorption is used to adsorb only the second subfraction (or portion thereof), then a strong solvent may desorb only such subfraction; where selective adsorption is used to adsorb only the first subfraction (or portion thereof), a weaker solvent may be all that is needed to desorb the desired subfraction; where no selective adsorption is used (i.e., all or some of the entire aromaticity spectrum of the asphaltenes are adsorbed), a weaker solvent may desorb only the first subfraction (or portion thereof), while in order to isolate the second subfraction, solvents of increasing strength (e.g., polarity), perhaps in a sequential desorption or dissolution protocol, may be necessary (perhaps only one additional stronger solvent is necessary). WO2012121804, which is incorporated herein in its entirety, may present desorption methods that may be implemented in certain aspects of the inventive technology.

Note that “Schabron, J.F., A.T. Pauli, and J.F. Rovani, Jr., 2001, Molecular Weight Polarity Map for Residua Pyrolysis, Fuel, 80 (4), 529-537, incorporated herein, which relates to selective solubility of asphaltenes using different solvent, may also provide examples of certain solvents that may be used in either the precipitation-based embodiments, or the adsorption-based embodiments. Further, as mentioned elsewhere herein, selectivity can be adjusted using known techniques that involve the addition of solvents to the oil (including solution thereof) that is to be contacted with the sorbent.

Note that applications of the inventive technologies disclosed herein include but are not limited to: rag layer; emulsions formed from tar sands froth extractions; warm mix asphalt preparation, cold mix asphalt preparation, modification of asphalt viscosity properties, creating desired emulsions in enhanced oil recovery, creating water and oil emulsions for pipeline shipment, modifications of emulsion stability, emulsion-based fuel formulations; making water and oil emulsions using the second subfraction (e.g., more or very polar and pericondensed materials and/or more aromatic materials) as a emulsifying agent or co-agent; oil production, desalinization, oil refining, oil processing, asphalt emulsion formulation, enhanced oil recovery, bitumen recovery, and all applications indicated in patent application US2011/0253598 (hereby incorporated herein), as but a few examples.

Note that, relative to sorbent-based inventive technology, with certain sorbents, both the less polar and the more or most polar materials (and/or the less aromatic and the more or most aromatic materials) will adsorb, while the relatively non-polar components will either not be adsorbed, or they will be adsorbed and can be washed off/desorbed with a relatively low polarity

solvent (or solvent with a low chromatographic sorbent strength). The less aromatic (and/or less polar and less pericondensed) material would be adsorbed along with the most aromatic (and/or most polar and pericondensed) materials. Then, one could desorb the less polar and pericondensed material with a solvent of less/intermediate polarity, chromatographic strength or with different chemical features than is required to desorb the most polar material. Further, it is of note that where asphaltenes (or subfraction thereof) stick to a sorbent (e.g., clay fines), then silica gel may be used to separate such asphaltenes from the clay.

Particular embodiments of an additional independent aspect of the inventive technology may be described as a method for decreasing the stability of an oil emulsion, wherein oil in the oil emulsion comprises a first asphaltene subfraction and a second asphaltene subfraction, the second asphaltene subfraction being more aromatic than the first asphaltene subfraction, the method comprising the steps of: contacting the oil emulsion with a sorbent (which may, but need not at times, be selective to adsorption of the second subfraction); adsorbing the second subfraction onto the sorbent; and decreasing the stability of the oil emulsion. The sorbent selective to adsorption of the second subfraction may comprise metals, steel, steel wire, steel wire coils, metal wire, metal wire coils, ceramics, zeolites, clays, silica, silica gel, limestone, glass, mesh glass, glass beads, mesh glass beads, quartz, sand, alumina, and high surface energy carbonaceous materials, as but a few examples. It may be high surface energy, and/or high charge. The method may further comprise the step of removing the sorbent and the second asphaltene subfraction adsorbed thereon from the oil emulsion, perhaps in order that the second subfraction be useful in an application to enhance stability of an emulsion. This step may be achieved via settling, floatation or filtration as but a few examples. In order to isolate the adsorbed second subfraction, it may be desorbed therefrom (e.g., via contact, such as by rinsing, with a solvent strong enough to desorb it).

Note that Snyder, L.R., 1968, "Principles of Adsorption Chromatography" Marcel Dekker, Inc., New York, pp. 125-131 & 155-181; and Barton, A.F., 1974, "Solubility Parameters," Chemical Reviews, 75 (6), 731-753, each of which is hereby incorporated herein, may disclose sorbents and related data useful in sorbent selection in application of certain aspects of the inventive sorbent-based technology.

It is of note that that solubility parameters of solvents are generally additive when mixed, but when two or more solvents of different chromatographic strength are mixed, the stronger solvent has much larger effect than simply additive. Considerations when selecting solvents for solubility separations are different than selecting solvents for chromatographic separations (i.e.,
5 desorption from sorbents). So polarity might, at times, not be the only parameter which governs solvent selection.

Additionally, conventional partial precipitation-based approaches, which often simply use solvent mixtures, may provide precipitates of asphaltenes that are associated peptized complexes, whereas the inventive precipitation process may, in certain embodiments, isolate the most
10 aromatic and/or polar and most pericondensed asphaltene subfraction species (which appear to have less associated peptized complexes and are more pure than partial precipitation materials).

The initial oil used to make the emulsion contains a certain percentage of asphaltenes as usually isolated by precipitation in a hydrocarbon solvent. In the emulsion, in certain embodiments, the most aromatic portion (peak 4) of what we call asphaltenes is enriched at the
15 water and oil interface, and this helps stabilize the emulsion. Therefore, since these molecules are at the interface, they are no longer present in the original oil (but still may be considered a part of the emulsion or a part of the oil in the emulsion, the emulsion hydrocarbon). Other molecules that are less aromatic subfraction components of asphaltenes (if they were to be precipitated with a hydrocarbon solvent), could therefore be soluble in the oil in the emulsion
20 and therefore would not participate in asphaltene precipitation from the emulsion oil, and this the asphaltene content of the emulsion oil will apparently decrease in greater proportion than water dilution, even when the emulsion water content is accounted for. Alternatively, one may also observe apparent increases in asphaltene content in some oils centrifuged from emulsions relative to the original oil. Indeed, the phenomenon is quite complex.

What has been observed, is that for gravimetric asphaltenes precipitated with heptane from the whole sample of oil, water, and emulsion shaken for emulsion-containing Try Layers 1,2,3, and 4 is that the peak 4 material in the gravimetric asphaltenes is significantly enriched relative to the material in the asphaltenes from the original or desalted oil. This is also true but to a lesser extent for the gravimetric asphaltenes from the centrifuged oils (most water removed)
30 from the emulsions for these try layers. The presence of water seems to drive this effect. An

interesting observation is that the content of the most aromatic peak 4 material in the whole emulsion oils does not seem to change significantly relative to the original oil.

Embodiments of an additional aspect of the inventive technology may be described as a method for isolating a higher aromaticity asphaltene subfraction and may comprise the steps of:

5 forming an oil emulsion from an oil and water, the oil having a pre-emulsification concentration of the higher aromaticity asphaltene subfraction; increasing the pre-emulsification concentration to a post-emulsification concentration upon performance of the step of forming the oil emulsion, wherein the post-emulsification concentration is greater than the pre-emulsification concentration; and removing the higher aromaticity asphaltene subfraction from the emulsified

10 oil. The step of removing may be accomplished via precipitation of asphaltenes and dissolution of at least the higher aromaticity subfraction, or via adsorption of at least the higher aromaticity subfraction and desorption of the higher aromaticity subfraction (both according to methods disclosed elsewhere in this specification as applied to the emulsion). Note that concentrations are concentrations relative to a total asphaltene content of the respective pre-emulsified or post-

15 emulsified oil. In adsorption based sub-embodiments, the step of removing may comprise the step of contacting the oil emulsion with a sorbent onto which the higher aromaticity asphaltene subfraction adsorbs (whether selectively or not). Note that treating the emulsion to adjust selectivity (increase or reduce it) may be achieved as mentioned elsewhere in this disclosure, and according to known methods. Where adsorption selective to the higher aromaticity subfraction is

20 desired, the sorbent may be, e.g., metals, steel, steel wire, steel wire coils, metal wire, metal wire coils, ceramics, zeolites, clays, silica, silica gel, limestone, glass, mesh glass, glass beads, mesh glass beads, quartz, sand, alumina, and high surface energy carbonaceous materials. Instead of using sorbent based technology to achieve the intended subfraction removal, one may remove via precipitating asphaltenes within a substantially inert stationary phase and removing the

25 higher aromaticity subfraction via dissolution.

As can be easily understood from the foregoing, the basic concepts of the present invention may be embodied in a variety of ways. It involves both subfraction isolation and emulsion stability changing techniques as well as devices to accomplish these functions. In this application, the monitoring techniques are disclosed as part of the results shown to be achieved

30 by the various devices described and as steps which are inherent to utilization. They are simply

the natural result of utilizing the devices as intended and described. In addition, while some devices are disclosed, it should be understood that these not only accomplish certain methods but also can be varied in a number of ways. Importantly, as to all of the foregoing, all of these facets should be understood to be encompassed by this disclosure.

5 The discussion included in this application is intended to serve as a basic description. The reader should be aware that the specific discussion may not explicitly describe all embodiments possible; many alternatives are implicit. It also may not fully explain the generic nature of the invention and may not explicitly show how each feature or element can actually be representative of a broader function or of a great variety of alternative or equivalent elements.
10 Again, these are implicitly included in this disclosure. Where the invention is described in device-oriented terminology, each element of the device implicitly performs a function. Apparatus claims may not only be included for the device described, but also method or process claims may be included to address the functions the invention and each element performs. Neither the description nor the terminology is intended to limit the scope of the claims that will
15 be included in any subsequent patent application.

 It should also be understood that a variety of changes may be made without departing from the essence of the invention. Such changes are also implicitly included in the description. They still fall within the scope of this invention. A broad disclosure encompassing both the explicit embodiment(s) shown, the great variety of implicit alternative embodiments, and the
20 broad methods or processes and the like are encompassed by this disclosure and may be relied upon when drafting the claims for any subsequent patent application. It should be understood that such language changes and broader or more detailed claiming may be accomplished at a later date (such as by any required deadline) or in the event the applicant subsequently seeks a patent filing based on this filing. With this understanding, the reader should be aware that this
25 disclosure is to be understood to support any subsequently filed patent application that may seek examination of as broad a base of claims as deemed within the applicant's right and may be designed to yield a patent covering numerous aspects of the invention both independently and as an overall system.

 Further, each of the various elements of the invention and claims may also be achieved in
30 a variety of manners. Additionally, when used or implied, an element is to be understood as

encompassing individual as well as plural structures that may or may not be physically connected. This disclosure should be understood to encompass each such variation, be it a variation of an embodiment of any apparatus embodiment, a method or process embodiment, or even merely a variation of any element of these. Particularly, it should be understood that as the
5 disclosure relates to elements of the invention, the words for each element may be expressed by equivalent apparatus terms or method terms -- even if only the function or result is the same. Such equivalent, broader, or even more generic terms should be considered to be encompassed in the description of each element or action. Such terms can be substituted where desired to make explicit the implicitly broad coverage to which this invention is entitled. As but one example, it
10 should be understood that all actions may be expressed as a means for taking that action or as an element which causes that action. Similarly, each physical element disclosed should be understood to encompass a disclosure of the action which that physical element facilitates. Regarding this last aspect, as but one example, the disclosure of a "controller" should be understood to encompass disclosure of the act of "controlling" -- whether explicitly discussed or
15 not -- and, conversely, were there effectively disclosure of the act of "controlling", such a disclosure should be understood to encompass disclosure of a "controller" and even a "means for controlling". Such changes and alternative terms are to be understood to be explicitly included in the description. Further, each such means (whether explicitly so described or not) should be understood as encompassing all elements that can perform the given function, and all
20 descriptions of elements that perform a described function should be understood as a non-limiting example of means for performing that function.

Any patents, publications, or other references mentioned in this application for patent are hereby incorporated by reference in their entirety. Any priority case(s) claimed by this application is hereby appended and hereby incorporated by reference. In addition, as to each
25 term used it should be understood that unless its utilization in this application is inconsistent with a broadly supporting interpretation, common dictionary definitions should be understood as incorporated for each term and all definitions, alternative terms, and synonyms such as contained in the Random House Webster's Unabridged Dictionary, second edition are hereby incorporated by reference. Finally, all references listed in the list of References To Be Incorporated By
30 Reference In Accordance With The Patent Application or other information statement filed with the application are hereby appended and hereby incorporated by reference, however, as to each

of the above, to the extent that such information or statements incorporated by reference might be considered inconsistent with the patenting of this/these invention(s) such statements are expressly not to be considered as made by the applicant(s).

U.S.PATENTS

Patent Number	Kind Code	Pub/Issue Date	Inventor/Applicant
6773921		8/10/2004	Schabron et al.
462804		12/9/1986	Maes
4493765		1/15/1985	Long, et al.
5092983		3/3/1992	Eppig, et al.
5574215		11/12/1996	Bunger, et al.
5861228		1/19/1999	Descalles, et al.
4990773		2/5/1991	Supernaw et al.
5969237		10/19/1999	Jones et al.
4865741		9/12/1989	Nolte et al.
4988446		1/29/1991	Haberman et al.
7875464	B2	1/25/2011	Schabron et al.
4634680		1/6/1987	Kingsley
8241920	B2	8/14/2012	Schabron et al.
8273581	B2	9/25/2012	Schabron et al.
7875464	B2	2011-01-25	Schabron et al.
4006077		1977/02/01	Wegner et al.
4036732		1997-07-19	Iranietal.
4088540		1978-05-09	Bunas
4101415		1978-07-18	Crowley
4125459		1978-11-14	Garwin
4395330		1983-07-26	Aubior et al.
4403765		1983-09-13	Billion et al.
4419219		1983-12-06	Long et al.

4422926		1983-12-27	Gould et al.
4424114		1984-01-03	Murrell et al.
4498971		1985-02-12	Angelov et al.
4502944		1985-03-05	Nelson
4502950		1985-03-05	Ikematsu et al.
4514287		1985-04-30	Ikematsu et al.
4514787		1985-04-30	Kaneko et al.
4525269		1985-06-25	Ikematsu et al.
4572781		1986-02-25	Krasuk et al.
4765885		1988-08-23	Sadeghi et al.
4810367		1989-03-07	Chombart et al.
4816140		1989-03-28	Trambouze et al.
4888108		1989-12-19	Farnand
5124025		1992-06-23	Kolstad et al.
5124026		1992-06-23	Taylor, et al.
5152886		1992-10-06	Paris-Marcano
5258117		1993-11-02	Kolstad et al.
5326456		1994-07-05	Brons et al.
5893302		1999-04-13	Strom
5944010		1999-08-31	Hoffschmidt et al.
5944984		1999-08-31	Benguigui et al.
7223603	B2	2007-05-29	Rovani,Jr. et al.
7718049	B2	2007-05-18	Strack et al.
7736900	B2	2010-06-15	Pauli, et al.
7981277	B2	2011-07-19	Subramaniau et al.

U.S.PATENT APPLICATION PUBLICATIONS

Publication Number	Kind Code	Pub/Issue Date	Inventor
20030211621	A1	11/13/2003	Rovani et al.

20110066441	A1	3/17/2011	Ovalles et al.
20110062058	A1	3/17/2011	Rogel et al.
20110120950	A1	5/26/2011	Schabron et al.
20120160015	A1	6/28/2012	Ovalles et al.
20120016168	A1	1/19/2012	Schabron et al.
20030221992	A1	12/04/2003	Gorbaty et al.
20060113218	A1	06-01-2006	Hart et al.
20080230442	A1	09-25-2008	Iqbal et al.
20110215030	A1	09-08-2011	Corscadden
20110266198	A1	11-03-2011	Hassan et al.

FOREIGN PATENT DOCUMENTS

Patent No.	Kind Code	Country	Pub/Issue Date
2011113017A2	A2	WO	9/15/2011
0077120A2	A2	WO	12/21/2000
0077120A3	A3	WO	12/21/2000
02063292A1	A1	WO	8/15/2002
03096011A1	A1	WO	11/20/2003
400989A	A	EP	5/12/1990
2011032123A2	A2	WO	3/17/2011
2011032125A2	A2	WO	3/17/2011

NON-PATENT LITERATURE DOCUMENTS

Nonpatent Literature Reference Document

"Energy and Environmental Profile of the US Petroleum Refining Industry," 1988, Prepared by Energetics Inc. for U.S. Department of Energy Office of Industrial Technologies, pp 4-5, 27, 33,

49 and 62-63.
"Standard Test Method for Molecular Weight (Relative Molecular Mass) of Hydrocarbons by Thermoelectric Measurement of Vapor Pressure," ASTM Designation: D 2503-82 (Reapproved 1997), 871-873.
Andersen, S.I. et al., 1991, "Aggregation of Asphaltenes as Determined by Calorimetry," Journal of Colloid and Interface Science, 142, 497-502, 1991.
Barton, A.F., 1974, "Solubility Parameters," Chemical Reviews, 75 (6), 731-753.
Bodusynski, M.M. et al., 1982, Separation of Solvent-Refined Coal into Solvent-Derived Fractions, Analytical Chemistry, 54, 372-375.
Burrell, H., 1955, "Solubility Parameters" Interchemical Review, 3-16
Carrier, H. et al; "Acoustic method for measuring asphaltene flocculation in crude oil", Journal of Petroleum Science and Engineering, pp 111-117
Cartz, L., ch. 3, Ultrasonic Testin, Nondestructive Testing, 1995, pp. 81-98.
Del Bianco, A. et al., 1993, Thermal Cracking of Petroleum Residues 1. Kinetic Analysis of the Reaction. Fuel, 72 (1), 7-80.
Heithaus, J.J., 1962, "Measurement and Significance of Asphaltene Peptization," Journal of the Institute of Petroleum 48 (458), 45-53
Hildebrand, J.H. et al., 1970, "Regular and Related Solutions" Van Nostrand Reinhold, NY, pp 24-27, pp 152-153, pp 212-215
Jones et al. "Development of an ultrasonic oil stability monitor for the assessment of asphaltene aggregation in hydrocarbon stream", Proceed. Intern. Conf. Mitigat. Heat Exch. Foul. Econ. Envir. Implic. Banff, AB, Canada, July, 1999, 84-94
Long, R.B. et al., 1989, "Studies in Petroleum Composition" Revue de Institute Francais du Petrole, abstract
Long, R.B., 1979, "The Concept of Asphaltenes" Preprints, Div. Petroleum Chemistry, American Chemical Society, 24, 891-901
Magaril, R.Z. et al., 1968, Study of the Mechanism of Coke Formation in the Cracking of Petroleum Resins, International Chemical Engineering 8 (4), 727.
McClements, D.J., "Ultrasonic Measurements in Particle Size Analysis", University of Massachusetts, Amherst, USA, Encyclopedia of Analytical Chemistry (Applications, Theory and

Instrumentation) pp 5581-5587
Pal R. et al., 1989, Viscosity/Concentration Relationships for Emulsions. Journal of Rheology, 33 (7), 1021-1045.
Pauli, A.T. 1996, "Asphalt Compatibility Testing Using the Automated Heithaus Titration Test" Preprints, Division of Fuel Chemistry, American Chemical Society, 41 (4), 1276 - 1281.
Pauli, A.T. et al., 1998, Relationships Between Asphaltenes, Heithaus Compatibility Parameters, and Asphalt Viscosity. Petrol. Science and Technology, 16 (9&10), 1125-1147.
Scatchard, G. 1931, "Equilibria in Non-Electrolyte Solutions in Relation to the Vapor Pressure and Densities of the Components" Chemical Reviews, 321-333
Pauli, A.T. et al., "Stability and Compatibility Testing of Petroleum and Asphalt" American Laboratory, September 2003, 2 pages
Phillips, C.R. et al. 1985, Kinetic Models for the Thermal Cracking of Athabaska Bitumen, Fuel 64(5), 678-691
Schabron, J.F. et al. "Coking indexes using the Heithaus titration and asphaltene solubility," Preprints – American Chemical Society, Division of Petroleum Chemistry (1999), 44(2), 187-189
Schabron, J.F. et al., 1998, "The Solubility and Three-Dimensional Structure of Asphaltenes" Petroleum Science and Technology, 16 (3-4), 361-376
Schabron, J.F. et al., 1999 "Petroleum Residua Solubility Parameter/Polarity Map: Stability Studies of Residua Pyrolysis" Department of Energy Report under contract # DE-FC26-98FT40322 Task, 1.2, 24 pages.
Schabron, J.F. et al., 2000 "Deposition from Heavy Oils" Department of Energy Report under contract # DEFC26-98FT40322, 35 pages
Schabron, J.F. et al., 2001b, Molecular Weight / Polarity Map for Residua Pyrolysis, Fuel, 80 (4), 529-537.
Schabron, J.F. et al., 2001c, Non-Pyrolytic Heat Induced Deposition from Heavy Oils, Fuel, 80 (7) 919-928.
Schabron, J.F., et al., 2002b, Residua Coke Formation Predictability Maps, Fuel, 81 (17) 2227-2240.

Schabron, J.F. et al., 2001a, Predicting Coke Formation Tendencies, Fuel, 80 (10) 1435-1446.
Schabron, J.F. et al., 2002a, Characterization of Residua During Pyrolysis, Preprints, Div. of Petroleum Chemistry, American Chemical Society, 47 (1), 17-21.
Schabron, J.F. et al., 1993,"The Characterization of Petroleum Residua" U.S. Dept of Energy Report under contract # DE-FC21-86MC110761, 68 pages.
Schabron, J.F. et al., 2002, "Coke Formation Process Model for Petroleum Refining Efficiency Improvement", US Department of Energy Report DE/FG36/01G011018, 18 pages
Schabron, J.F. et al , 2002,"Coke Formation Process Model For Petroleum Refining Efficiency Improvement", US Department of Energy Report under contract # DE/FG36/01G011018, 40 pages
Schabron, J.F. et al., 2004, Refinery Efficiency Improvement Ultrasonic Spectroscopy and WRI Coking Indexes, WRI Report 04-R009 to DOE under Cooperative Agreement DE-FC26-98FT40322
Singh, I.D., V. Kothiyal, V. Ramaswamy, and R. Krishna, 1990, Characteristic Changes of Asphaltenes During Visbreaking of North Gujarat Short Residue. Fuel, 69 (3), 28-292.
Small, P.A., 1953,"Some Factors Affecting the Solubility of Polymers" Journal of Applied Chemistry, 71-80
Snyder, L.R., 1968, "Principles of Adsorption Chromatography" Marcel Dekker, Inc., New York, pp. 125-131 and 155-181
Snyder, L.R., 1968, "Principles of Adsorption Chromatography" Marcel Dekker, Inc., New York, pp. 155-199
Snyder, L.R., 1968, "Principles of Adsorption Chromatography" Marcel Dekker, Inc., New York, 206 – 210
Wiehe, I.A., 1993, A Phase-Separation Kinetic Model for Coke Formation, Ind. Eng. Chem. Res., 32 (11), 244-2454.
Wiehe, I.A., 1996, "Two-Dimensional Solubility Parameter Mapping of Heavy Oils" Fuel Science and Technology International, 14 (1&2), 289-312
Bodusynski, M.S. et al., 1987, "Composition of heavy petroleums: 1. molecular weight, hydrogen deficiency, and heteroatom concentration as a function of atmospheric equivalent boiling point up to 1400 degrees F" Energy & Fuels, 1, 2-11.

Schabron, J.F., et al., 2006, "Initial studies using ultrasonic spectroscopy for monitoring changes in residua with pyrolysis," Fuel 85, 2093-2105.
Chiantore, Oscar and Simonelli, Alessandra, "Precipitation-redissolution Liquid Chromatography of Styrene-ethyl Acrylate Copolymers," Polymer Engineering and Science, August 1999, Vol. 39 No. 8, p. 1383-1388.
Cortell, Jessica M. et al., "Influence of Vine Vigor on Grape (Vitis vinifera L. Cv. Pino Noir) Anthocyanins. 2. Anthocyanins and Pigmented Polymers in Wine," J. Agric. Food Chem. 2007, 55, p. 6585-6595.
Aske, Narve et al.; "Determination of Saturate, Aromatic, Resin, and Asphaltenic (SARA) Components in Crude Oils by Means of Infrared and Near-Infrared Spectroscopy," Energy & Fuels, 2001, 15, 1304-1312.
Corbett, L.W., "Composition of Asphalt Based on Generic Fractionation, Using Solvent Deasphalting, Elution-Adsorption Chromatography, and Densimetric Characterization," Analytical Chemistry, p. 576
McCarthy, James E. et al.; "EPA's Regulation of Coal-Fired Power: Is a "Train Wreck" Coming?", Congressional Research Service, CRS Report for Congress, August 8, 2011, 7-5700, R41914.
"Standard Test Method for n-Heptane Insolubles ¹ ", Designation: D 3279-97 (Reapproved 2001)
"Standard Test Method for Separation of Asphalt into Four Fractions ¹ ," ASTM International, Designation D4124-09.
Schabron, J.F., et al., "Asphaltene Determinator Method for Automated On-Column Precipitation and Redissolution of Pericondensed Aromatic Asphaltene Components," Energy Fuels 2010, 24, 5984-5996, DOI: 10.102/ef100822f.
Fan, T. et al., "Rapid and Accurate SARA Analysis of Medium Gravity Crude Oils," Energy & Fuels 2002, 16, 1571-1575.
Schabron, J.F., et al., "On-column precipitation and re-dissolution of asphaltenes in petroleum residua," Fuel 87 (2008) 165-176.
Grizzle, Patrick L, et al., "Automated Liquid Chromatographic Compound Class Group-Type Separation of Crude Oils and Bitumens Using Chemically Bonded Aminosilane," Anal. Chem. 1986, 58, 2389-2396.

Jewell, D.M. et al., "Ion-Exchange, Coordination, and Adsorption Chromatographic Separation of Heavy-End Petroleum Distillates," Laramie Energy Research Center, Analytical Chemistry, vol. 44, No. 8, July 1972, p 1391.
Jiang, C et al., "TLC-FID (Iatroscan) analysis of heavy oil and tar sand samples," Organic Geochemistry 39 (2008) 1210-1214.
Karlsen, D.A. et al., "Analysis of petroleum fractions by TLC-FID: applications to petroleum reservoir description," Org. Geochem. Vol. 17, No. 5, pp. 603-617, 1991.
Kharrat, A. et al., "Issues with Comparing SARA Methodologies," Energy & Fuels 2007, 21, 3618-3621.
Masson, J-F et al., "Dynamics of Bitumen Fractions by Thin-Layer Chromatography/Flame Ionization Detection," Energy & Fuels 2001, 15, 955-960.
Radke, M et al., "Preparative Hydrocarbon Group Type Determination by Automated Medium Pressure Liquid Chromatography," Anal. Chem. 1980, 52, 406-411.
Schabron, J.F. et al.; "Petroleum Processing Efficiency Improvement," Topical Report, May 2011
Wiehe, Irwin A. et al.; "The Oil Compatibility Model and Crude Oil Incompatibility," Energy & Fuels 2000, 14, 56-59.
Fan, Z et al.; "Challenges in Processing Bitumens and Heavy Oils," Prepr. Pap.-Am. Chem. Soc., Div. Petr. Chem. 2009, 54 (1), 4.
"Canada regulator approves Enbridge diluent Line," Reuters, Business & Financial News, February 19, 2008, Calgary, Alberta.
"Opportunity Crudes Report II: Technologies and Strategies for Meeting Evolving Market and Environmental Challenges," Hydrocarbon Publishing Company, an updated and expanded study of the 2006 report titled "Opportunity Crudes: Technical Challenges and Economic Benefits."
U.S. Provisional Application Number 60/711,599, filed August 25, 2005, entitled Rapid Determination of Asphaltenes and the Cyclohexane Soluble Portion of Asphaltenes by Automated On-Column Precipitation and Re-Dissolution; Specification 24 pages, Drawings 8 pages
USPTO Office Action for Patent Application No. 11/510,491 dated July 13, 2009.
USPTO Office Action for Patent Application No. 11/510,491 dated September 3, 2010.

USPTO Office Action for Patent Application No. 11/510,491 dated March 30, 2011.
USPTO Notice of Allowance for Patent Application No. 11/510,491 dated November 17, 2010
USPTO Supplemental Notice of Allowance for Patent Application No. 11/510,491 dated December 9, 2010.
http://www.specialchem4adhesives.com/resources , Determining Critical Surface Tension of Solid Substrates, printed 9/13/2011, 3 pages
Energy Information Administration/Capacity Report 2001
Robinson, P. R., Petroleum Processing Overview, Practical Advances in Petroleum Processing 2006:1-78
Rogel, E. et al. Asphaltene Stability in Processed Samples using Solubility Profile Analysis, Prepr. Pap.-Am. Chem. Soc. Div. Pet. Chem. 2011, 56(1), 3
Ovalles, C. et al. Characterization and Preparative Separation of Heavy Crude Oils, their fractions and thermally Cracked Products by the Asphaltene solubility Fractions Method, Prepr. Pap.-Am. Chem. Soc. Div. Pet. Chem. 2011, 56(1), 8
Schabron J. F. et al., Total Pericondensed Aromatic (TPA) Determination as an Alternative to Gravimetric Asphaltenes, Prepr. Pap.-Am. Chem. Soc. Div. Pet. Chem. 20011, 56(1), 38
Rogel, E. et al. Determination of Asphaltenes in Crude Oil and Petroleum Products by the on Column Precipitation Method, Energy Fuels 2009, 23, 4515–4521
Ovalles, C. et al. Characterization of Heavy Crude Oils, Their Fractions, and Hydrovisbroken Products by the Asphaltene Solubility Fraction Method, dx.doi.org/10.1021/ef201499f Energy Fuels 2012, 26, 549–556, Published: December 7, 2011
Lopez-Linares, F. et al. Adsorption of Athabasca Vacuum Residues and Their Visbroken Products over Macroporous Solids: Influence of Their Molecular Characteristics, dx.doi.org/10.1021/ef201047z Energy Fuels 2011, 25, 4049–4054, Published August 17, 2011
Rogel, E., Asphaltene Chemical Characterization as a Function of Solubility: Effects on Stability and Aggregation, dx. doi.org/10.1021/ef2013979 Energy Fuels, Published November 7, 2011
Schabron, J. F. et al. The Waxphaltene Determinator Method for Automated Precipitation and Re-Dissolution of Wax and Asphaltene Components, Energy Fuels, Article ASAP, DOI: 10.1021/ef300184s, February 27, 2012
Parallel application number 12/970,535, Office action dated 03/02/2011

Parallel application number 12/970,535, Office action dated 10/07/2011
Parallel application number 12/970,535, Office action dated 01/12/2012
Parallel application number 12/970,535, Notice of Allowance dated 06/08/2012
Parallel application number 13/243,782, Office action dated 03/23/2012
Parallel application number 13/243,782, Office action dated 06/27/2012
Parallel application number 13/243,782, Notice of Allowance dated 08/03/2012
Ovalles, C. et al. Predicting Reactivity of Feedstocks to Hydroprocessing by Using Asphaltene Characterization Techniques. Prepr. Pap.-Am. Chem. Soc., Div. Energy Fuels Chem. 2012, 57(2), 763
Rogel, E. et al. Sediment Formation in Residue Hydroconversion Processes and Its Correlation to Asphaltene Behavior. Prepr. Pap.-Am. Chem. Soc., Div. Energy Fuels Chem. 2012, 57(2), 745
Parallel application number 13/490,316; Office action dated 08/03/2012
Schabron, J.F. Use of the Asphaltene Determinator™ Method to Monitor Vacuum Residue Stability to Improve Refinery Distillation Efficiency, 2011
Parallel application number 13/490,307; Office action dated 10/04/2012
McLean J. B. et al. Reactivity Screening of Feedstocks for Catalytic Coal/Oil Co-Processing, September 1986, http://web.anl.gov/PCS/acsfuel/preprint%20archive/Files/31_4_ANAHEIM_09-86_0169.pdf
Mariaca-DomAnguez et al. "Reactivity of Fluid Catalytic Cracking Feedstocks as a Function of Reactive Hydrogen Content", Petroleum Science and Technology, 2004, Vol. 22, Issue 1-2, pp. 13-29
Johnson and Moyse, "Pretreatment of resid FCC feedstocks", July 2004, http://www.digitalrefining.com/article/1000161
Baker, C. A. et al. A new chromatographic procedure and its application to high polymers, J. Chem. Soc., 1956, 2352-2362
Parallel application number 13/600,039; Office action dated 11/19/2012
Parallel application number 13/490,316; Notice of Allowance dated 12/10/2012
Alvarez, G., et al., Heavy Oil-Water Interfacial Properties and Emulsion Stability: Influence of Dilution. Energy and Fuels, 23, 294-299, 2009
Collins, S. H., et al., Adsorption of Asphaltenes and Water on Reservoir Rock Minerals, Society

of Petroleum Engineers, SPE 11800, 1983
Czarnecki, J., et al., On the Stabilization Mechanism of Water-in-Oil Emulsions in Petroleum Systems. Energy and Fuels, 19, 2074-2079, 2005
Czarnecki, J., Stabilization of Water in Crude Oil Emulsions. Part 2, 2009, Energy and Fuels, 23, 1253
Czarnecki, J., et al., Possible Role of Asphaltenes in the Stabilization of Water-in-Crude Oil Emulsions, Energy and Fuels, 26, ASAP article August 13, 2012
Goual, L., et al., On-column Separation of Wax and Asphaltenes in Petroleum Fluids, Energy and Fuels, 22, 4019-4028, 2008
Hannisdal, A., et al., Particle-Stabilized Emulsions: Effect of Heavy Crude Oil Components Pre-Adsorbed onto Stabilizing Solids. Colloids and Surfaces A: Physicochem. Eng. Aspects, 276, 45-58, 2006
Hemmingsen, P. V., et al., Emulsions of Heavy Crude Oils. I: Influence of Viscosity, Temperature, and Dilution. J. of Dispersion Sci. Tech., 26, 615
Jestin, J., et al., A Small Angle neutron Scattering Study of the Adsorbed Asphaltene layer in Water-in-Hydrocarbon Emulsions: Structural Description Related to Stability Langmuir, 23, 10471-10478, 2007
Menon, V.B., et al., A Review of the Factors Affecting the Stability of Solids-Stabilized Emulsions, Separation Science and Technology, 12-13, 2131-2142, 1988
Ortiz, D.P., et al., Effect of Surfactants on Interfacial Films and Stability of Water-in-Oil Emulsions Stabilized by Asphaltenes, J. Colloidal and Interface Science, 351 (2), 542-555, 2010
Pauli, A.T., et al., Assessment of Physical Property Prediction Based on Asphalt Average Molecular Structures, Prepr. Pap.-Am. Chem. Soc. Div. Pet. Chem., 255-259, 2005
Peng, J., et al., Novel Magnetic Demulsifier for Water Removal from Diluted Bitumen Emulsion, Energy and Fuels, 26, 2705 - 2710, 2012
Rovani, J.F., et al., Enhanced Oil Recovery: Investigation of Oil, Water, and Emulsion Chemistry, Western Research Institute Final Report WRI-09-027, Task 73 to the U.S. Department of Energy under Cooperative Agreement DEFC26- 98FT40323 and to the University of Wyoming Enhanced Oil Recovery Institute, 2009
Spiecker, P.M., et al., Interfacial Rheology of Petroleum Asphaltenes at the Oil-Water Interface,

Langmuir, 20,4022-4032, 2010, 2004
Stanford, L.A., et al., Compositional Characterization of Bitumen/Water Emulsion Films by Negative- and Positive-Ion Electrospray Ionization and Field Desorption/Ionization Fourier Transform Ion Cyclotron Resonance Mass Spectrometry, Energy and Fuels, 21, 963-972, 2007
Sztukowski, D. M.; et al., Asphaltene Self-Association and Water-in-Hydrocarbon Emulsions. J. of Colloid and Interface Sci., 265, 179-186, 2003
Sztukowski, D.M., et al., Oilfield Solids and Water-in Oil Emulsion Stability, J. Colloidal and Interface Science, 285 (2), 821-833, 2005
Transportation Research Board, Asphalt Emulsion Technology, Circular E-C102, assembled by Delmar R. Salomon, Transportation Research Board of the National Academies, Washington, D.C., 2006
Wu, X., Investigating the Stability Mechanism of Water-in-Diluted Bitumen Emulsions through Isolation and Characterization of the Stabilizing Materials at the Interface. Energy and Fuels, 17, 179-190, 2003
Wikipedia, 2012, Pickering Emulsions, http://en.wikipedia.org/wiki/Pickering_emulsion
Gu, G., et al. Influence of water-soluble and water-insoluble natural surface active components on the stability of water-in-toluene-diluted bitumen emulsion, Fuel 81 (2002) 1859–1869
Honse, S. O., et al. Separation and Characterization of Asphaltenic Subfractions, Quim. Nova, Vol. 35, No. 10, 1991-1994, 2012
Mullins, O.C. et al. Advances in Asphaltene Science and the Yen–Mullins Model, dx.doi.org/10.1021/ef300185p Energy Fuels 2012, 26, 3986–4003
Nordgard, E. L, et al., Behavior of Asphaltene Model Compounds at W/O Interfaces, Langmuir 2010, 26(4), 2352– 2360, Published on Web 10/23/2009
Spiecker, P. M., et al. Aggregation and solubility behavior of asphaltenes and their subfractions, Journal of Colloid and Interface Science 267 (2003) 178–193
Spiecker, P. M., et al. Effects of petroleum resins on asphaltene aggregation and water-in-oil emulsion formation, Colloids and Surfaces A: Physicochem. Eng. Aspects 220 (2003) 9-27
Wang, S. Understanding Stability of Water-in-Dilutes Bitumen Emulsions by Colloidal Force Measurements, Thesis, Department of Chemical and Materials Engineering, Edmonton, Alberta,

CA
Zhang, L. Y. et al. Asphaltene Monolayers at a Toluene/Water Interface, Energy & Fuels 2005, 19, 1330-1336
Yang, X., et al. Investigation of Subfractions of Athabasca Asphaltenes and their role in Emulsion Stability, Energy & Fuels 2004, 18, 770-777
Hawkins, D.J., et al., Diluent availability will constrain Canada's heavy oil, bitumen development, Oil & Gas Journal, October 29, 2002, Vol. 100, Issue 44, Pg. 64
Kharrat, A.M., Characterization of Canadian heavy oils using sequential extraction approach, Energy & Fuels 2009, 23, 828-834
Maqbool, T., P. Srikiratiwong, and H.S. Fogler, 2011, Effect of Temperature on the Precipitation Kinetics of Asphaltenes, Energy & Fuels, 25, 694-700.
Pauli, A.T. et al., Assessment of physical property prediction based on asphalt average molecular structures, Prepr. Pap.-Am. Chem. Soc., Div. Pet. Chem. 2005, 50(2), 255-259
Perry, G.F., 2002, Diluent Availability will Constrain Canada's Heavy Oil, Bitumen Development, Oil and Gas Journal, 100, 44, October 28, 2002.
Pratt, S., NAFTA bumps into Alberta's upgrader plans; Trade deal would prohibit the province from reducing the flow of bitumen to the United States once it starts, Edmonton Journal, 06/07/2008, Page A19
Storm, D.A., et al., Development of solid properties and thermochemistry of asphalt binders in the 25-65 degreeC temperature range, Energy & Fuels, 1996, 10, 855-864.
Storm, D.A. et al., Rheological study of Ratawi vacuum residue in the 298-673 K temperature range, Energy & Fuels, 1995, 9, 168-176.
US Provisional Application No. 61/450,515 filed 08 March 2011 entitled Reduction of Heavy Oil Viscosity Using Solid Sorbents.

Thus, the applicant(s) should be understood to have support to claim and make a statement of invention to at least: i) each of the subfraction isolation devices as herein disclosed and described, ii) the related methods disclosed and described, iii) similar, equivalent, and even implicit variations of each of these devices and methods, iv) those alternative designs which

accomplish each of the functions shown as are disclosed and described, v) those alternative designs and methods which accomplish each of the functions shown as are implicit to accomplish that which is disclosed and described, vi) each feature, component, and step shown as separate and independent inventions, vii) the applications enhanced by the various systems or components disclosed, viii) the resulting products produced by such systems or components, ix) each system, method, and element shown or described as now applied to any specific field or devices mentioned, x) methods and apparatuses substantially as described hereinbefore and with reference to any of the accompanying examples, xi) an apparatus for performing the methods described herein comprising means for performing the steps, xii) the various combinations and permutations of each of the elements disclosed, xiii) each potentially dependent claim or concept as a dependency on each and every one of the independent claims or concepts presented, and xiv) all inventions described herein.

In addition and as to computer aspects and each aspect amenable to programming or other electronic automation, the applicant(s) should be understood to have support to claim and make a statement of invention to at least: xv) processes performed with the aid of or on a computer, machine, or computing machine as described throughout the above discussion, xvi) a programmable apparatus as described throughout the above discussion, xvii) a computer readable memory encoded with data to direct a computer comprising means or elements which function as described throughout the above discussion, xviii) a computer, machine, or computing machine configured as herein disclosed and described, xix) individual or combined subroutines and programs as herein disclosed and described, xx) a carrier medium carrying computer readable code for control of a computer to carry out separately each and every individual and combined method described herein or in any claim, xxi) a computer program to perform separately each and every individual and combined method disclosed, xxii) a computer program containing all and each combination of means for performing each and every individual and combined step disclosed, xxiii) a storage medium storing each computer program disclosed, xxiv) a signal carrying a computer program disclosed, xxv) the related methods disclosed and described, xxvi) similar, equivalent, and even implicit variations of each of these systems and methods, xxvii) those alternative designs which accomplish each of the functions shown as are disclosed and described, xxviii) those alternative designs and methods which accomplish each of the functions shown as are implicit to accomplish that which is disclosed and described, xxix) each feature,

component, and step shown as separate and independent inventions, and xxx) the various combinations and permutations of each of the above.

With regard to claims whether now or later presented for examination, it should be understood that for practical reasons and so as to avoid great expansion of the examination
5 burden, the applicant may at any time present only initial claims or perhaps only initial claims with only initial dependencies. The office and any third persons interested in potential scope of this or subsequent applications should understand that broader claims may be presented at a later date in this case, in a case claiming the benefit of this case, or in any continuation in spite of any preliminary amendments, other amendments, claim language, or arguments presented, thus
10 throughout the pendency of any case there is no intention to disclaim or surrender any potential subject matter. It should be understood that if or when broader claims are presented, such may require that any relevant prior art that may have been considered at any prior time may need to be re-visited since it is possible that to the extent any amendments, claim language, or arguments presented in this or any subsequent application are considered as made to avoid such prior art,
15 such reasons may be eliminated by later presented claims or the like. Both the examiner and any person otherwise interested in existing or later potential coverage, or considering if there has at any time been any possibility of an indication of disclaimer or surrender of potential coverage, should be aware that no such surrender or disclaimer is ever intended or ever exists in this or any subsequent application. Limitations such as arose in *Hakim v. Cannon Avent Group, PLC*, 479
20 F.3d 1313 (Fed. Cir 2007), or the like are expressly not intended in this or any subsequent related matter. In addition, support should be understood to exist to the degree required under new matter laws -- including but not limited to European Patent Convention Article 123(2) and United States Patent Law 35 USC 132 or other such laws-- to permit the addition of any of the various dependencies or other elements presented under one independent claim or concept as
25 dependencies or elements under any other independent claim or concept. In drafting any claims at any time whether in this application or in any subsequent application, it should also be understood that the applicant has intended to capture as full and broad a scope of coverage as legally available. To the extent that insubstantial substitutes are made, to the extent that the applicant did not in fact draft any claim so as to literally encompass any particular embodiment,
30 and to the extent otherwise applicable, the applicant should not be understood to have in any way intended to or actually relinquished such coverage as the applicant simply may not have been

able to anticipate all eventualities; one skilled in the art, should not be reasonably expected to have drafted a claim that would have literally encompassed such alternative embodiments.

Further, if or when used, the use of the transitional phrase “comprising” is used to maintain the “open-end” claims herein, according to traditional claim interpretation. Thus, unless the context requires otherwise, it should be understood that the term “comprise” or variations such as “comprises” or “comprising”, are intended to imply the inclusion of a stated element or step or group of elements or steps but not the exclusion of any other element or step or group of elements or steps. Such terms should be interpreted in their most expansive form so as to afford the applicant the broadest coverage legally permissible. The use of the phrase, “or any other claim” is used to provide support for any claim to be dependent on any other claim, such as another dependent claim, another independent claim, a previously listed claim, a subsequently listed claim, and the like. As one clarifying example, if a claim were dependent “on claim 20 or any other claim” or the like, it could be re-drafted as dependent on claim 1, claim 15, or even claim 25 (if such were to exist) if desired and still fall with the disclosure. It should be understood that this phrase also provides support for any combination of elements in the claims and even incorporates any desired proper antecedent basis for certain claim combinations such as with combinations of method, apparatus, process, and the like claims.

Finally, any claims set forth at any time are hereby incorporated by reference as part of this description of the invention, and the applicant expressly reserves the right to use all of or a portion of such incorporated content of such claims as additional description to support any of or all of the claims or any element or component thereof, and the applicant further expressly reserves the right to move any portion of or all of the incorporated content of such claims or any element or component thereof from the description into the claims or vice-versa as necessary to define the matter for which protection is sought by this application or by any subsequent continuation, division, or continuation-in-part application thereof, or to obtain any benefit of, reduction in fees pursuant to, or to comply with the patent laws, rules, or regulations of any country or treaty, and such content incorporated by reference shall survive during the entire pendency of this application including any subsequent continuation, division, or continuation-in-part application thereof or any reissue or extension thereon.

CLAIMS:

What is claimed is:

- I. A method for changing the stability of an emulsion that comprises an emulsion hydrocarbon, from a first stability to a second, more desired stability, said method comprising the steps of:
 - precipitating at least a first asphaltene subfraction of a hydrocarbon and a second asphaltene subfraction of said hydrocarbon within a substantially inert stationary phase to generate precipitated asphaltenes, wherein said second asphaltene subfraction is more aromatic than said first asphaltene subfraction;
 - dissolving at least a portion of at least said first asphaltene subfraction from said precipitated asphaltenes to generate at least one dissolved asphaltene subfraction;
 - adding at least some of one of said at least one dissolved asphaltene subfraction to said emulsion hydrocarbon; and
 - changing the stability of said emulsion comprising said emulsion hydrocarbon from said first stability to said second, more desired stability.
2. The method as described in claim 1 wherein said hydrocarbon comprises a hydrocarbon selected from the group consisting of: crude oils, asphalts, distillation residua, processed oils, oils processed via catalytic hydrotreating, oils processed via pyrolysis, tar sands oils, shale oils, coal oils, synthetic oils, biologically derived oils, modified and unmodified asphalt binders and formulations, emulsions containing oils.
3. The method as described in claim 1 wherein said emulsion is a water and oil emulsion.
4. The method as described in claim 3 wherein said emulsion is a water in oil emulsion.
5. The method as described in claim 3 wherein said emulsion is an oil in water emulsion.
6. The method as described in claim 3 wherein said emulsion is a mixed emulsion.
7. The method as described in claim 3 wherein said emulsion is a foam.
8. The method as described in claim 1 wherein said step of precipitating at least a first asphaltene subfraction of a hydrocarbon and a second asphaltene subfraction of said hydrocarbon within a substantially inert stationary phase comprises the step of precipitating at least a first asphaltene subfraction of a hydrocarbon and a second asphaltene subfraction of said hydrocarbon within a substantially inert stationary phase

that is selected from the group consisting of: oligomers or polymers of polytetrafluorethylene, PTFE, polyphenylene sulfide, silicon polymer, fluorinated polymers or elastomers, and PEEK stationary phase.

9. The method as described in claim 1 wherein said substantially inert stationary phase
5 comprises a stationary phase bed.

10. The method as described in claim 1 wherein said substantially inert stationary phase comprises a stationary phase established in a column.

11. The method as described in claim 1 wherein said second asphaltene subfraction is a subfraction having a H/C ratio of less than or equal to 1.3.

10 12. The method as described in claim 1 wherein said second asphaltene subfraction is a pre-coke asphaltene subfraction.

13. The method as described in claim 1 wherein said first asphaltene subfraction is more resinous than said second asphaltene subfraction.

14. The method as described in claim 1 wherein said second asphaltene subfraction is more
15 polar than said first asphaltene subfraction.

15. The method as described in claim 1 wherein said second asphaltene subfraction is more pericondensed than said first asphaltene subfraction.

16. The method as described in claim 1 wherein said second asphaltene subfraction is a subfraction that is poorly soluble in a solvent having a solubility parameter that is <17
20 $\text{MPa}^{1/2}$.

17. The method as described in claim 16 wherein said second asphaltene subfraction is a subfraction that is poorly soluble in a solvent having a solubility parameter that is <16
 $\text{MPa}^{1/2}$.

18. The method as described in claim 16 wherein said second asphaltene subfraction is a
25 subfraction that is poorly soluble in at least one aliphatic solvent.

19. The method as described in claim 18 wherein said at least one aliphatic solvent is a solvent selected from the group consisting of: heptane and cyclohexane.

20. The method as described in claim 16 wherein said second asphaltene subfraction is a subfraction that is soluble only in a solvent having a solubility parameter that is
30 $>16\text{MPa}^{1/2}$.

21. The method as described in claim 1 wherein said step of adding at least some of one of said at least one dissolved asphaltene subfraction to an emulsion hydrocarbon comprises the step of adding at least some of one of said at least one dissolved asphaltene subfraction to said emulsion comprising said emulsion hydrocarbon, while said emulsion hydrocarbon is part of said emulsion.
22. The method as described in claim 21 wherein said emulsion has said first stability before said step of adding at least some of one of said at least one dissolved asphaltene subfraction is performed.
23. The method as described in claim 22 wherein said second, more desired stability is of a different emulsion type.
24. The method as described in claim 22 wherein said second, more desired stability is greater than said first stability.
25. The method as described in claim 24 wherein said step of dissolving further comprising the step of dissolving at least a portion said second asphaltene subfraction to generate a dissolved second asphaltene subfraction.
26. The method as described in claim 25 wherein said step of dissolving at least a portion of said second asphaltene subfraction is performed after dissolving at least said first asphaltene subfraction.
27. The method as described in claim 26 wherein said step of adding at least some of one of said at least one dissolved asphaltene subfraction to said emulsion comprises the step of adding at least some of said dissolved second asphaltene subfraction to said emulsion.
28. The method as described in claim 22 wherein said second, more desired stability, is less than said first stability.
29. The method as described in claim 28 wherein said step of dissolving at least a portion of at least said first asphaltene subfraction from said precipitated asphaltenes to generate at least one dissolved asphaltene subfraction comprises the step of dissolving at least a portion of said first asphaltene subfraction from said precipitated asphaltenes to generate a dissolved first asphaltene subfraction.
30. The method as described in claim 29 wherein said step of adding at least some of one of said at least one dissolved asphaltene subfraction to said emulsion comprises the step of adding at least some of said dissolved first asphaltene subfraction to said emulsion.

31. The method as described in claim 29 wherein said second stability is of a broken, destabilized emulsion.
32. The method as described in claim 31 wherein said method is a method of preventing emulsion formation.
- 5 33. The method as described in claim 29 wherein said step of dissolving further comprising the step of dissolving at least a portion of said second asphaltene subfraction to generate a dissolved second asphaltene subfraction.
34. The method as described in claim 1 wherein said method is a method for generating said emulsion to have said desired, second stability instead of said first stability.
- 10 35. The method as described in claim 34 wherein said desired stability is emulsion type.
36. The method as described in claim 34 wherein said step of adding at least some of one of said at least one dissolved asphaltene subfraction to an emulsion hydrocarbon comprises the step of adding at least some of one of said at least one dissolved asphaltene subfraction to an emulsion hydrocarbon before said emulsion hydrocarbon is part of said emulsion and before said emulsion is formed.
- 15 37. The method as described in claim 36 further comprises the step of agitating said emulsion hydrocarbon with water to generate said emulsion after performing said step of adding.
38. The method as described in claim 36 wherein said step of dissolving comprises the step of dissolving to generate a dissolved first asphaltene subfraction.
- 20 39. The method as described in claim 38 wherein said step of adding at least some of one of said at least one dissolved asphaltene subfraction to an emulsion hydrocarbon comprises the step of adding at least some of said dissolved first asphaltene subfraction so as to lower the stability of said generated emulsion as compared to what it would be without performance of said steps of adding and changing.
- 25 40. The method as described in claim 36 wherein said step of dissolving further comprising the step of dissolving at least a portion of said second asphaltene subfraction to generate a dissolved second asphaltene subfraction.
41. The method as described in claim 40 wherein said step of adding at least some of one of said at least one dissolved asphaltene subfraction to an emulsion hydrocarbon comprises the step of adding at least some of said dissolved second asphaltene subfraction so as to
- 30

increase the stability of said generated emulsion over than what it would be without performance of said steps of adding and changing.

42. The method as described in claim 1 wherein said step of adding at least some of one of said at least one dissolved asphaltene subfraction to said emulsion hydrocarbon comprises the step of adding at least some of a dissolved first asphaltene subfraction to said emulsion hydrocarbon.

43. The method as described in claim 1 wherein said step of dissolving further comprising the step of dissolving at least a portion of said second asphaltene subfraction to generate a dissolved second asphaltene subfraction.

44. The method as described in claim 43 wherein said step of dissolving at least a portion said second asphaltene subfraction is performed after said at least a portion of said first asphaltene subfraction is dissolved.

45. The method as described in claim 44 wherein said step of adding at least some of one of said at least one dissolved asphaltene subfraction to said emulsion hydrocarbon comprises the step of adding at least some of said dissolved second asphaltene subfraction to said emulsion hydrocarbon.

46. The method as described in claim 44 wherein said step of dissolving at least a portion of at least said first asphaltene subfraction from said precipitated asphaltenes to generate at least one dissolved asphaltene subfraction comprises the step of dissolving with solvents of increasing strength.

47. The method as described in claim 46 wherein said step of dissolving with solvents of increasing strength comprises the step of dissolving with solvents that increase in strength via step change.

48. The method as described in claim 46 wherein said step of dissolving with solvents of increasing strength comprises the step of dissolving with solvents that increase in strength via continuous, non-step change.

49. The method as described in claim 46 wherein said solvents of increasing strength are solvents of increasing polarity.

50. The method as described in claim 46 wherein said step of dissolving comprises the step of dissolving first with a solvent comprising cyclohexane, then with a solvent comprising toluene, then with a solvent comprising methylene chloride.

51. The method as described in claim 46 wherein said step of dissolving with solvents of increasing strength comprises the step of dissolving in stages with three different solvents to produce three discrete dissolved asphaltene subfractions.
52. The method as described in claim 51 wherein said three discrete asphaltene subfractions are of increasing aromaticity.
53. The method as described in claim 1 further comprising the step of heating said hydrocarbon before performing said step of precipitating.
54. The method as described in claim 1 wherein said method for changing the stability of an emulsion is a method for changing the stability of a foam.
55. The method as described in claim 54 wherein said foam is an asphalt foam.
56. The method as described in claim 1 wherein said step of dissolving is part of a redissolution protocol.
57. The method as described in claim 1 wherein said method is non-chromatographic.
58. The method as described in claim 1 wherein stock of said hydrocarbon from which said asphaltenes are precipitated is different from a stock of said emulsion hydrocarbon.
59. The method as described in claim 1 wherein said hydrocarbon from which said asphaltenes are precipitated is of the same stock as said emulsion hydrocarbon.
60. The method as described in claim 1 further comprising the step of designing said oil emulsion to have said second, more desired stability.
61. A refinery or apparatus in which at least part of the method of claim 1 is performed..
62. A refinery that processes hydrocarbons extracted, at least in part, through use of the method of claim 1..
63. The substance of claim 1 having said second, more desired stability.
64. The emulsion of claim 1.
65. The at least one dissolved asphaltene subfraction of claim 1.
66. A method for changing the stability of an emulsion that comprises an emulsion hydrocarbon, from a first stability to a second, more desired stability, said method comprising the steps of:
- contacting a hydrocarbon with a sorbent, wherein said hydrocarbon has a first asphaltene subfraction and a second asphaltene subfraction, said second asphaltene subfraction being more aromatic than said first asphaltene subfraction;

- adsorbing at least one of said asphaltene subfractions onto said sorbent to generate adsorbed asphaltenes;
 - desorbing at least a portion of said adsorbed asphaltenes from said sorbent to generate an isolated asphaltene subfraction;
 - 5 - adding said isolated asphaltene subfraction to said emulsion hydrocarbon; and
 - changing the stability of said emulsion comprising said emulsion hydrocarbon from said first stability to said second, more desired stability.
67. The method as described in claim 66 said hydrocarbon comprises a hydrocarbon selected from the group consisting of: crude oils, asphalts, distillation residua, processed oils, oils
10 processed via catalytic hydrotreating, oils processed via pyrolysis, tar sands oils, shale oils, coal oils, synthetic oils, biologically derived oils, modified and unmodified asphalt binders and formulations, emulsions containing oils.
68. The method as described in claim 66 wherein said emulsion is a water and oil emulsion.
69. The method as described in claim 68 wherein said emulsion is a water in oil emulsion.
- 15 70. The method as described in claim 68 wherein said emulsion is an oil in water emulsion.
71. The method as described in claim 68 wherein said emulsion is a mixed emulsion.
72. The method as described in claim 68 wherein said emulsion is a foam.
73. The method as described in claim 66 wherein said step of changing the stability of said emulsion comprises the step of predictably changing.
- 20 74. The method as described in claim 66 wherein said step of changing the stability of said emulsion comprises the step of controllably changing.
75. The method as described in claim 66 wherein said second asphaltene subfraction is a subfraction having a H/C ratio of less than or equal to 1.3.
76. The method as described in claim 66 wherein said second asphaltene subfraction is a pre-
25 coke asphaltene subfraction.
77. The method as described in claim 66 wherein said first asphaltene subfraction is more resinous than said second asphaltene subfraction.
78. The method as described in claim 66 wherein said second asphaltene subfraction is more polar than said first asphaltene subfraction.
- 30 79. The method as described in claim 66 wherein said second asphaltene subfraction is more pericondensed than said first asphaltene subfraction.

80. The method as described in claim 66 wherein said second asphaltene subfraction is a subfraction that is poorly soluble in a solvent having a solubility parameter that is $<17 \text{ MPa}^{1/2}$.
81. The method as described in claim 80 wherein said second asphaltene subfraction is a subfraction that is poorly soluble in a solvent having a solubility parameter that is $<16 \text{ MPa}^{1/2}$.
82. The method as described in claim 80 wherein said second asphaltene subfraction is a subfraction that is poorly soluble in at least one aliphatic solvent.
83. The method as described in claim 82 wherein said at least one aliphatic solvent is a solvent selected from the group consisting of: heptane and cyclohexane.
84. The method as described in claim 66 wherein said second asphaltene subfraction is a subfraction that is soluble only in a solvent having a solubility parameter that is $>16 \text{ MPa}^{1/2}$.
85. The method as described in claim 66 wherein said second asphaltene subfraction comprises the most pericondensed, aromatic and refractory structures of said hydrocarbon.
86. The method as described in claim 66 wherein said second asphaltene subfraction comprises the most pericondensed and highest surface energy pre-coke asphaltene materials of said hydrocarbon.
87. The method as described in claim 66 wherein said isolated asphaltene subfraction is less in amount than said adsorbed asphaltenes.
88. The method as described in claim 66 wherein said isolated asphaltene subfraction is substantially equal in amount to an adsorbed respective subfraction.
89. The method as described in claim 66 wherein said step of adsorbing at least one of said asphaltene subfractions onto a sorbent to generate adsorbed asphaltenes comprises the step of selectively adsorbing.
90. The method as described in claim 66 wherein said step of adding said isolated asphaltene subfraction to said emulsion hydrocarbon comprises the step of adding said isolated asphaltene subfraction to said emulsion comprising said emulsion hydrocarbon, while said emulsion hydrocarbon is a part of said emulsion.

91. The method as described in claim 90 wherein said step of adsorbing comprises the step of adsorbing at least said first asphaltene subfraction.
92. The method as described in claim 91 wherein said step of desorbing comprises the step of desorbing to generate an isolated first asphaltene subfraction.
- 5 93. The method as described in claim 92 wherein said step of adding said isolated asphaltene subfraction to said emulsion comprises the step of adding said isolated first asphaltene subfraction to said emulsion.
94. The method as described in claim 93 wherein said step of changing the stability of said emulsion comprises the step of decreasing the stability of said emulsion.
- 10 95. The method as described in claim 94 wherein said step of decreasing the stability of said emulsion comprises the step of breaking said emulsion.
96. The method as described in claim 90 wherein said step of adsorbing comprises the step of adsorbing at least said second asphaltene subfraction.
97. The method as described in claim 96 wherein said step of desorbing comprises the step of
15 desorbing to generate an isolated second asphaltene subfraction.
98. The method as described in claim 97 wherein said step of adding said isolated asphaltene subfraction to said emulsion comprises the step of adding said isolated second asphaltene subfraction to said emulsion.
99. The method as described in claim 98 wherein said step of changing the stability of said
20 emulsion comprises the step of increasing the stability of said emulsion.
100. The method as described in claim 96 wherein said step of adding said isolated asphaltene subfraction to said emulsion hydrocarbon comprises the step of adding to said emulsion hydrocarbon before said emulsion has been generated.
101. The method as described in claim 90 wherein said first stability is a stability of said
25 emulsion that would be observed if said step of adding were not performed and said stability were not changed.
102. The method as described in claim 90 wherein said step of adding said isolated asphaltene subfraction to said emulsion hydrocarbon effects a change in an emulsion recipe.
103. The method as described in claim 90 wherein said step of changing the stability effects a
30 change in emulsion type from what it would be without performance of said step of adding.

104. The method as described in claim 90 wherein said step of adsorbing comprises the step of adsorbing at least said first asphaltene subfraction.
105. The method as described in claim 104 wherein said step of desorbing comprises the step of desorbing to generate an isolated first asphaltene subfraction.
- 5 106. The method as described in claim 104 wherein said step of adding said isolated asphaltene subfraction to said emulsion hydrocarbon comprises the step of adding said isolated first asphaltene subfraction to said emulsion hydrocarbon.
107. The method as described in claim 106 wherein said step of changing the stability of said emulsion comprises the step of decreasing the stability of said emulsion below what it
10 would be without performance of said step of adding and said step of changing.
108. The method as described in claim 107 wherein said step of changing the stability of said emulsion comprises the step of preventing the formation of said emulsion.
109. The method as described in claim 90 wherein said step of adsorbing comprises the step of adsorbing at least said second asphaltene subfraction.
- 15 110. The method as described in claim 109 wherein said step of desorbing comprises the step of desorbing to generate an isolated second asphaltene subfraction.
111. The method as described in claim 110 wherein said step of adding said isolated asphaltene subfraction to said emulsion hydrocarbon comprises the step of adding said isolated second asphaltene subfraction to said emulsion hydrocarbon.
- 20 112. The method as described in claim 111 wherein said step of changing the stability of said emulsion comprises the step of increasing the stability of said emulsion above what it would be without performance of said step of adding and said step of changing.
113. The method as described in claim 112 wherein said step of changing the stability of said emulsion comprises the step of causing or assuring the formation of said emulsion.
- 25 114. The method as described in claim 66 wherein stock of said hydrocarbon whose asphaltenes are adsorbed is different from a stock of said emulsion hydrocarbon.
115. The method as described in claim 66 wherein said hydrocarbon whose asphaltenes are adsorbed is of the same stock as said emulsion hydrocarbon.
- 30 116. The method as described in claim 66 wherein said sorbent is selected from the group consisting of: a stationary phase sorbent, a solid sorbent, a fixed bed, a fluidized bed, surfaced sorbent, porous membrane sorbent, high surface energy sorbent, aromatic

sorbent, highly aromatic sorbent, sorbent that is selective to adsorption of one of said asphaltene subfractions.

117. The method as described in claim 66 wherein said sorbent is a reverse-phase sorben.

118. The method as described in claim 66 wherein said sorbent is a sorbent selected from the group consisting of: metals, steel, steel wire, steel wire coils, metal wire, metal wire coils, ceramics, zeolites, clays, silica, silica gel, limestone, glass, mesh glass, glass beads, mesh glass beads, quartz, sand, alumina, and high surface energy carbonaceous materials.

119. The method as described in claim 66 wherein said sorbent is a salt, acid or base.

120. The method as described in claim 66 wherein said sorbent comprises a carbon based sorbent.

121. The method as described in claim 66 wherein said hydrocarbon comprises a hydrocarbon selected from the group consisting of bitumen, shale oil, coal oil, coal tar, biological oil, heavy oil or residuum.

122. The method as described in claim 66 wherein said hydrocarbon comprises an atmospheric bitumen.

123. The method as described in claim 66 wherein said hydrocarbon comprises a vacuum bitumen.

124. The method as described in claim 66 further comprising the step of treating a hydrocarbon having asphaltenes therein to generate a treated hydrocarbon.

125. The method as described in claim 124 wherein said step of treating a hydrocarbon comprises the step of heating said hydrocarbon.

126. The method as described in claim 125 wherein said step of heating said hydrocarbon comprises the step of heating said hydrocarbon to a cracking temperature.

127. The method as described in claim 125 wherein said step of heating said hydrocarbon comprises the step of heating said hydrocarbon to a temperature that is below a cracking temperature.

128. The method as described in claim 125 wherein said step of heating said hydrocarbon comprises the step of heating said hydrocarbon from a heat source that is upstream of said sorbent.

129. The method as described in claim 125 further comprising the step of heating said sorbent to generate a heated sorbent.

130. The method as described in claim 125 wherein said step of heating said hydrocarbon comprises the step of heating said hydrocarbon to below 340C.
131. The method as described in claim 66 w said step of desorbing said at least a portion of said adsorbed asphaltenes from said sorbent comprises the step of rising said sorbent with a solvent having a solubility parameter that is less than 16 MPa^{1/2}.
132. The method as described in claim 131 wherein said step of desorbing comprises the step of desorbing at least a portion of said first asphaltene subfraction to generate an isolated first asphaltene subfraction.
133. The method as described in claim 66 wherein said step of desorbing said at least a portion of said adsorbed asphaltenes from said sorbent comprises the step of rising said sorbent with a solvent having a solubility parameter that is greater than 16 MPa^{1/2}.
134. The method as described in claim 133 wherein said step of desorbing comprises the step of desorbing as part of a sequential solvent dissolution protocol, wherein said solvents of said sequential solvent dissolution protocol increase in strength.
135. The method as described in claim 134 wherein said step of desorbing comprises the step of desorbing at least a portion of said second asphaltene subfraction to generate an isolated second asphaltene subfraction.
136. The method as described in claim 133 wherein said solvent having a solubility parameter that is greater than 16 MPa^{1/2} comprises methylene chloride.
137. The method as described in claim 133 wherein said solvent having a solubility parameter that is greater than 16 MPa^{1/2} further comprises methanol.
138. The method as described in claim 133 wherein said solvent having a solubility parameter that is greater than 16 MPa^{1/2} comprises toluene.
139. The method as described in claim 133 wherein said step of desorbing said at least a portion of said adsorbed asphaltenes from said sorbent comprises the step of contacting said sorbent with a solvent selected from the group consisting of: aromatic solvent, strong chromatographic extraction solvent, alcohol, or a mixture of any of the preceding solvents.
140. The method as described in claim 124 wherein said step of treating said hydrocarbon is solventless.

141. The method as described in claim 124 wherein said step of treating said hydrocarbon comprises the step of adding a substance to said hydrocarbon, wherein said substance is selected from the group consisting of solvent and chemical additive.
142. The method as described in claim 124 wherein said step of treating said hydrocarbon comprises the step of contacting said hydrocarbon with a heated sorbent.
143. The method as described in claim 66 further comprising the step of contacting a material with a sorbent by pouring said material over said sorbent, wherein said material comprises a material selected from the group consisting of said treated hydrocarbon and said hydrocarbon.
144. The method as described in claim 66 further comprising the step of contacting a material with a sorbent by mixing said material with said sorbent, wherein said material comprises a material selected from the group consisting of said treated hydrocarbon and said hydrocarbon.
145. The method as described in claim 66 further comprising the step of designing said oil emulsion to have said second, more desired stability.
146. A refinery or apparatus in which the method of claim 66 is performed.
147. A refinery that processes hydrocarbons extracted, at least in part, through use of the method of claim 66.
148. The substance of claim 66 having said second, more desired stability
149. The isolated asphaltene subfraction of claim 66.
150. The method for decreasing the stability of an oil emulsion, wherein oil in said oil emulsion comprises a first asphaltene subfraction and a second asphaltene subfraction, said second asphaltene subfraction being more aromatic than said first asphaltene subfraction, said method comprising the steps of:
- contacting said oil emulsion with a sorbent;
 - adsorbing said second subfraction onto said sorbent; and
 - decreasing the stability of said oil emulsion.
151. The method as described in claim 150 wherein said oil emulsion is a water and oil emulsion.
152. The method as described in claim 151 wherein said oil emulsion is a water in oil emulsion.

153. The method as described in claim 151 wherein said oil emulsion is an oil in water emulsion.
154. The method as described in claim 151 wherein said oil emulsion is a mixed emulsion.
155. The method as described in claim 151 wherein said oil emulsion is a foam.
- 5 156. The method as described in claim 150 wherein said second asphaltene subfraction is a subfraction having a H/C ratio of less than or equal to 1.3.
157. The method as described in claim 150 wherein said second asphaltene subfraction is a pre-coke asphaltene subfraction.
158. The method as described in claim 150 wherein said first asphaltene subfraction is more
10 resinous than said second asphaltene subfraction.
159. The method as described in claim 150 wherein said second asphaltene subfraction is more polar than said first asphaltene subfraction.
160. The method as described in claim 150 wherein said second asphaltene subfraction is more pericondensed than said first asphaltene subfraction.
- 15 161. The method as described in claim 150 wherein said second asphaltene subfraction is a subfraction that is poorly soluble in a solvent having a solubility parameter that is $<17 \text{ MPa}^{1/2}$.
162. The method as described in claim 161 wherein said second asphaltene subfraction is a subfraction that is poorly soluble in a solvent having a solubility parameter that is <16
20 $\text{MPa}^{1/2}$.
163. The method as described in claim 161 wherein said second asphaltene subfraction is a subfraction that is poorly soluble in at least one aliphatic solvent.
164. The method as described in claim 163 wherein said at least one aliphatic solvent is a solvent selected from the group consisting of: heptane and cyclohexane.
- 25 165. The method as described in claim 150 wherein said second asphaltene subfraction is a subfraction that is soluble only in a solvent having a solubility parameter that is $>16 \text{ MPa}^{1/2}$.
166. The method as described in claim 150 wherein said step of contacting said oil emulsion with a sorbent comprises the step of adding particulate sorbent to said oil emulsion.
- 30 167. The method as described in claim 166 wherein said step of adding sorbent comprises the step of adding particulate sorbent to said oil emulsion.

168. The method as described in claim 167 wherein said step of adding particulate sorbent to said oil emulsion comprises the step of adding granulated sorbent to said oil emulsion.
169. The method as described in claim 150 wherein said sorbent comprises a high surface energy sorbent.
- 5 170. The method as described in claim 150 wherein said sorbent comprises a high charge sorbent.
171. The method as described in claim 150 wherein said sorbent is a sorbent selected from the group consisting of: metals, steel, steel wire, steel wire coils, metal wire, metal wire coils, ceramics, zeolites, clays, silica, silica gel, limestone, glass, mesh glass, glass beads, mesh
10 glass beads, quartz, sand, alumina, and high surface energy carbonaceous materials.
172. The method as described in claim 150 further comprising the step of removing said sorbent and said second asphaltene subfraction adsorbed thereon from said oil emulsion.
173. The method as described in claim 172 wherein said step of removing said sorbent and said second asphaltene subfraction adsorbed thereon from said oil emulsion comprises
15 the step of removing via a removal technique selected from the group consisting of: settling, floatation and filtration.
174. The method as described in claim 172 further comprising the step of desorbing said second asphaltene subfraction adsorbed thereon from said sorbent.
175. The method as described in claim 174 wherein said step of desorbing said second
20 asphaltene subfraction comprises the step of contacting said sorbent with a solvent.
176. The method as described in claim 175 wherein said step of contacting said sorbent with a solvent comprises the step of contacting said sorbent with a solvent having a solubility parameter greater than $16 \text{ MPa}^{1/2}$.
177. The method as described in claim 175 wherein said step of contacting said sorbent with a
25 solvent having a solubility parameter greater than $16 \text{ MPa}^{1/2}$ comprises the step of contacting said sorbent with a solvent that comprises a substance selected from the group consisting of: aromatic solvent, strong chromatographic extraction solvent, strong chromatographic solvent, alcohol, or a mixture of any of the preceding solvents.
178. The method as described in claim 150 wherein said step of decreasing the stability of said
30 oil emulsion comprises the step of breaking said oil emulsion.

179. The method as described in claim 150 further comprising the step of treating said oil emulsion.
180. The method as described in claim 179 wherein said step of treating said oil emulsion comprises the step of heating said oil emulsion.
- 5 181. The method as described in claim 180 wherein said step of heating said oil emulsion comprises the step of heating said oil emulsion before performing said step of contacting said oil emulsion with said sorbent.
182. The method as described in claim 180 wherein said step of heating said oil emulsion comprises the step of heating said oil emulsion while performing said step of contacting
10 said oil emulsion with said sorbent.
183. The method as described in claim 179 wherein said step of treating said oil emulsion is performed before said step of contacting said oil emulsion with said sorbent.
184. The method as described in claim 179 wherein said step of treating comprises the step of adding a solvent or a chemical additive to said oil emulsion.
- 15 185. The oil emulsion having the decreased stability, of claim 150.
186. The second subfraction of claim 150.
187. A method for isolating a higher aromaticity asphaltene subfraction, said method comprising the steps of:
- forming an oil emulsion from an oil and water, said oil having a pre-emulsification
20 concentration of said higher aromaticity asphaltene subfraction;
 - increasing said pre-emulsification concentration to a post-emulsification concentration upon performance of said step of forming said oil emulsion, wherein said post-emulsification concentration is greater than said pre-emulsification concentration; and
 - removing said higher aromaticity asphaltene subfraction from said emulsified oil.
- 25 188. The method as described in claim 187 wherein said step of removing comprises the step of removing via precipitation of asphaltenes and dissolution of at least said higher aromaticity subfraction.
189. The method as described in claim 187 wherein said step of removing comprises the step of removing via adsorption of at least said higher aromaticity subfraction and desorption
30 of said higher aromaticity subfraction.

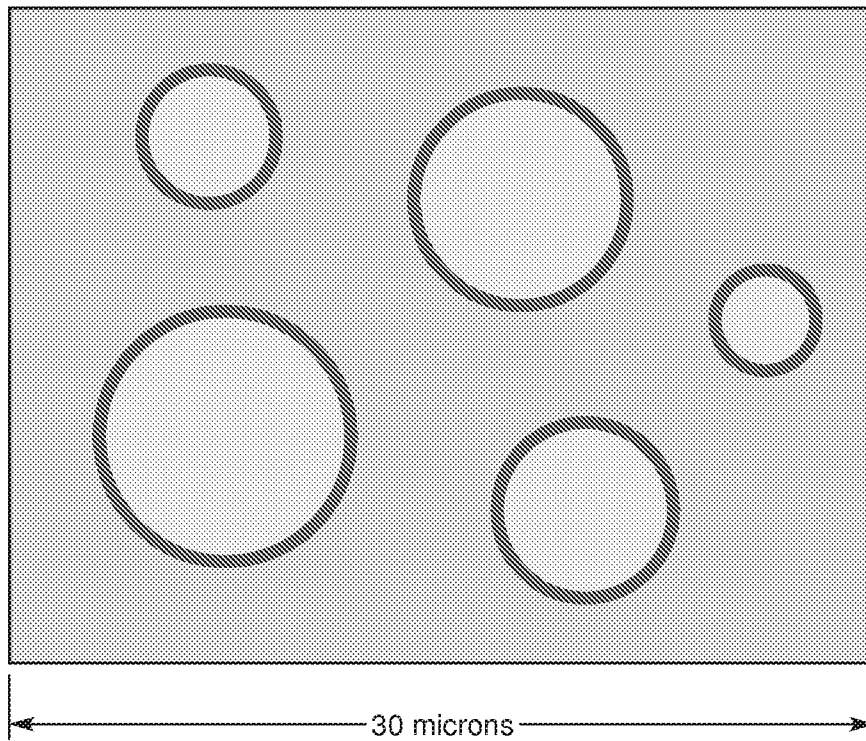
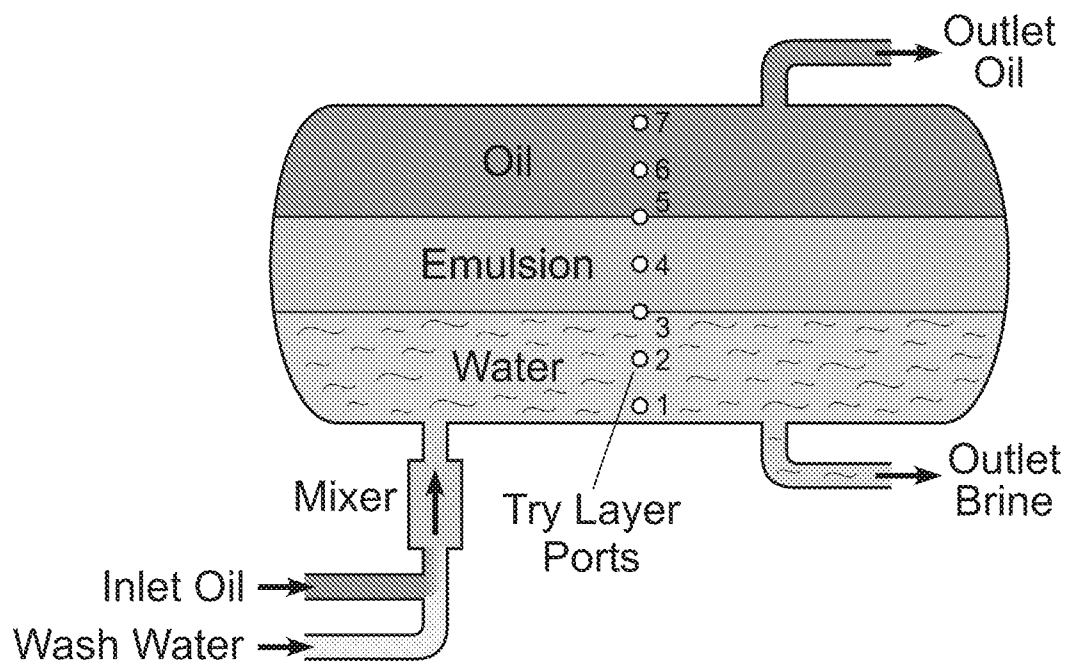
190. The method as described in claim 187 wherein said concentrations are concentrations relative to a total asphaltene content of the respective pre-emulsified or post-emulsified oil.
191. The method as described in claim 187 wherein said oil emulsion is a water and oil emulsion.
192. The method as described in claim 191 wherein said oil emulsion is a water in oil emulsion.
193. The method as described in claim 191 wherein said oil emulsion is an oil in water emulsion.
194. The method as described in claim 191 wherein said oil emulsion is a mixed emulsion.
195. The method as described in claim 191 wherein said oil emulsion is a foam.
196. The method as described in claim 187 wherein said higher aromaticity asphaltene subfraction is a subfraction having a H/C ratio of less than or equal to 1.3.
197. The method as described in claim 187 wherein said higher aromaticity asphaltene subfraction is a pre-coke asphaltene subfraction.
198. The method as described in claim 187 wherein said higher aromaticity asphaltene subfraction is a higher polarity asphaltene subfraction.
199. The method as described in claim 187 wherein said higher aromaticity asphaltene subfraction is a more pericondensed asphaltene subfraction.
200. The method as described in claim 187 wherein said higher aromaticity asphaltene subfraction is a subfraction that is poorly soluble in a solvent having a solubility parameter that is $<17 \text{ MPa}^{1/2}$.
201. The method as described in claim 200 wherein said higher aromaticity asphaltene subfraction is a subfraction that is poorly soluble in a solvent having a solubility parameter that is $<16 \text{ MPa}^{1/2}$.
202. The method as described in claim 200 wherein said higher aromaticity asphaltene subfraction is a subfraction that is poorly soluble in at least one aliphatic solvent.
203. The method as described in claim 202 wherein said at least one aliphatic solvent is a solvent selected from the group consisting of: heptane and cyclohexane.

204. The method as described in claim 187 wherein said higher aromaticity asphaltene subfraction is a subfraction that is soluble only in a solvent having a solubility parameter that is $>16\text{MPa}^{1/2}$.
205. The method as described in claim 187 wherein said step of removing comprises the step of contacting said oil emulsion with a sorbent onto which said higher aromaticity asphaltene subfraction adsorbs.
206. The method as described in claim 205 wherein said sorbent is selective to said higher aromaticity asphaltene subfraction.
207. The method as described in claim further comprising the step of adding a solvent to said oil emulsion.
208. The method as described in claim 205 wherein said sorbent comprises a high surface energy sorbent.
209. The method as described in claim 205 wherein said sorbent comprises a high charge sorbent.
210. The method as described in claim 205 wherein said sorbent is a sorbent selected from the group consisting of: metals, steel, steel wire, steel wire coils, metal wire, metal wire coils, ceramics, zeolites, clays, silica, silica gel, limestone, glass, mesh glass, glass beads, mesh glass beads, quartz, sand, alumina, and high surface energy carbonaceous materials.
211. The method as described in claim 205 further comprising the step of desorbing said higher aromaticity asphaltene subfraction adsorbed thereon from said sorbent.
212. The method as described in claim 211 wherein said step of desorbing said higher aromaticity asphaltene subfraction comprises the step of contacting said sorbent with a solvent.
213. The method as described in claim 212 wherein said step of contacting said sorbent with a solvent comprises the step of contacting said sorbent with a solvent having a solubility parameter greater than $16\text{MPa}^{1/2}$.
214. The method as described in claim 212 wherein said step of contacting said sorbent with a solvent having a solubility parameter greater than $16\text{MPa}^{1/2}$ comprises the step of contacting said sorbent with a solvent that comprises a substance selected from the group consisting of: substance selected from the group consisting of: aromatic solvent, strong

chromatographic extraction solvent, strong chromatographic solvent, alcohol, or a mixture of any of the preceding solvents.

215. The method as described in claim 187 wherein said step of removing comprises the step of precipitating asphaltenes within a substantially inert stationary phase and removing
5 said higher aromaticity subfraction via dissolution.
216. The method as described in claim 215 wherein said dissolution is part of a dissolution protocol using solvents of increasing strength.
217. The method as described in claim 187 further comprising the step of treating said oil emulsion.
- 10 218. The method as described in claim 217 wherein said step of treating said oil emulsion comprises the step of heating said oil emulsion.
219. The method as described in claim 217 wherein said step of treating comprises the step of adding a solvent or a chemical additive to said oil emulsion.
220. The oil emulsion of claim 187.
- 15 221. The second asphlatene subfraction of claim 187.

1/6

**Fig. 1****Fig. 2**

2/6

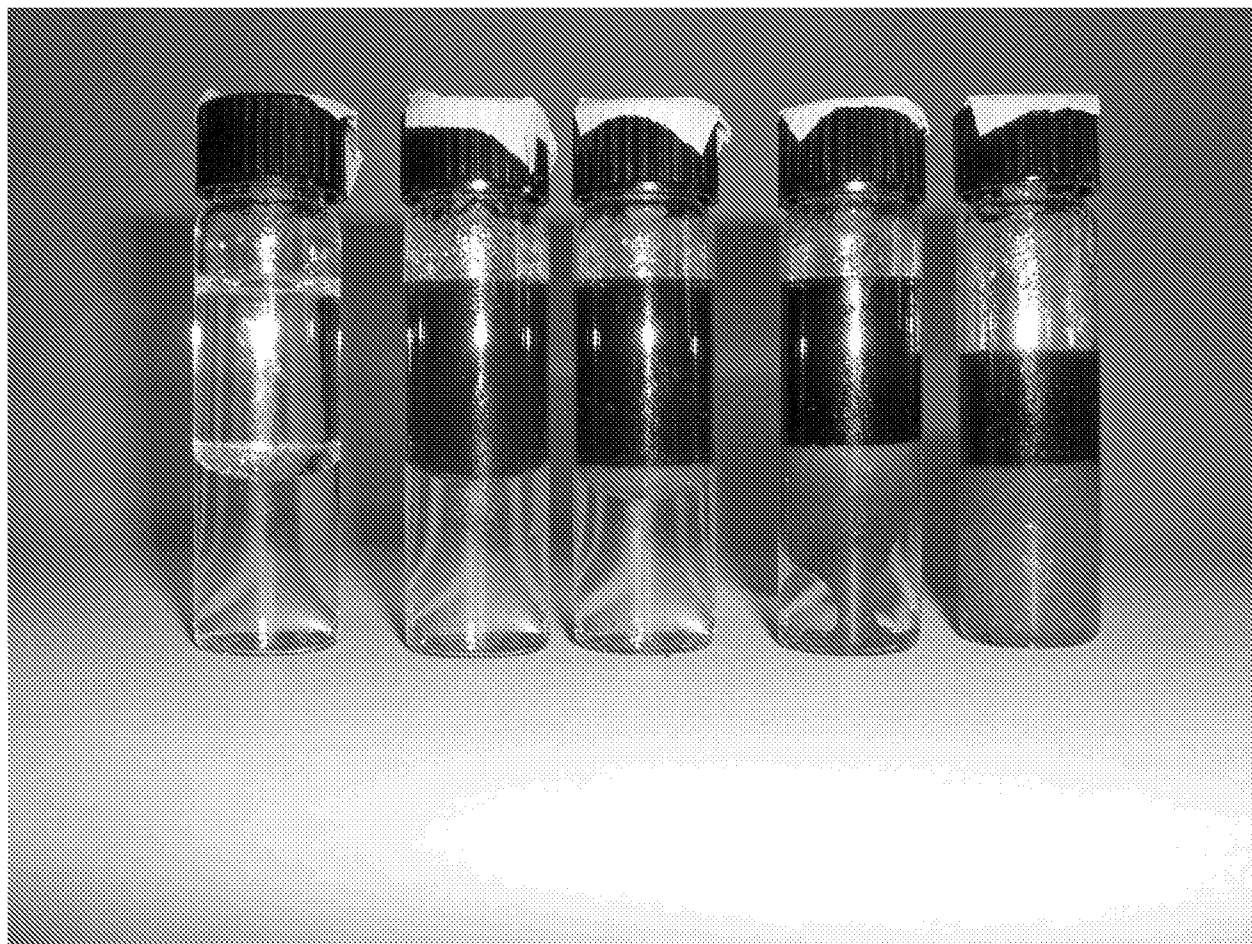


Fig. 3

3/6



Fig. 4

4/6

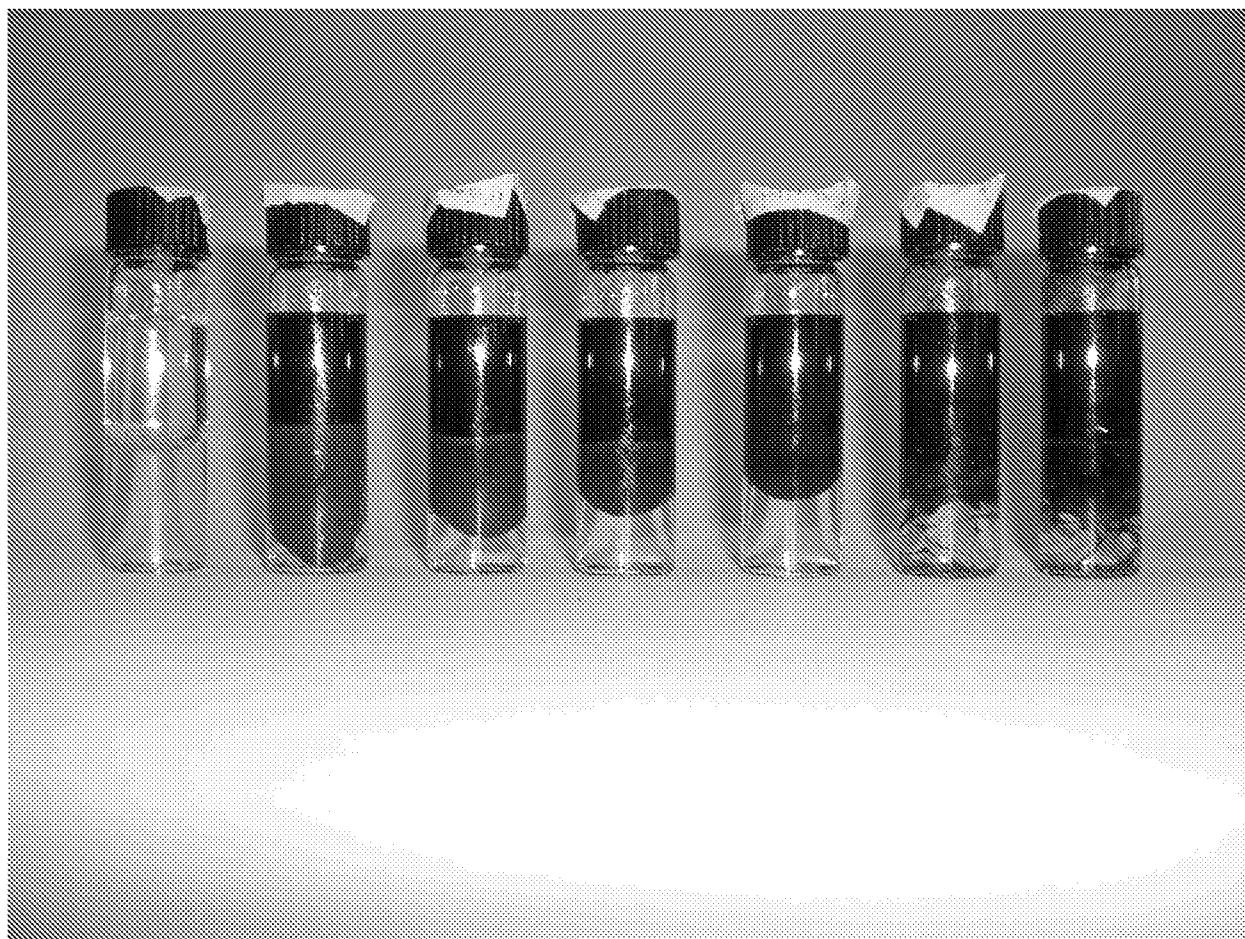


Fig. 5

5/6



Fig. 6

6/6

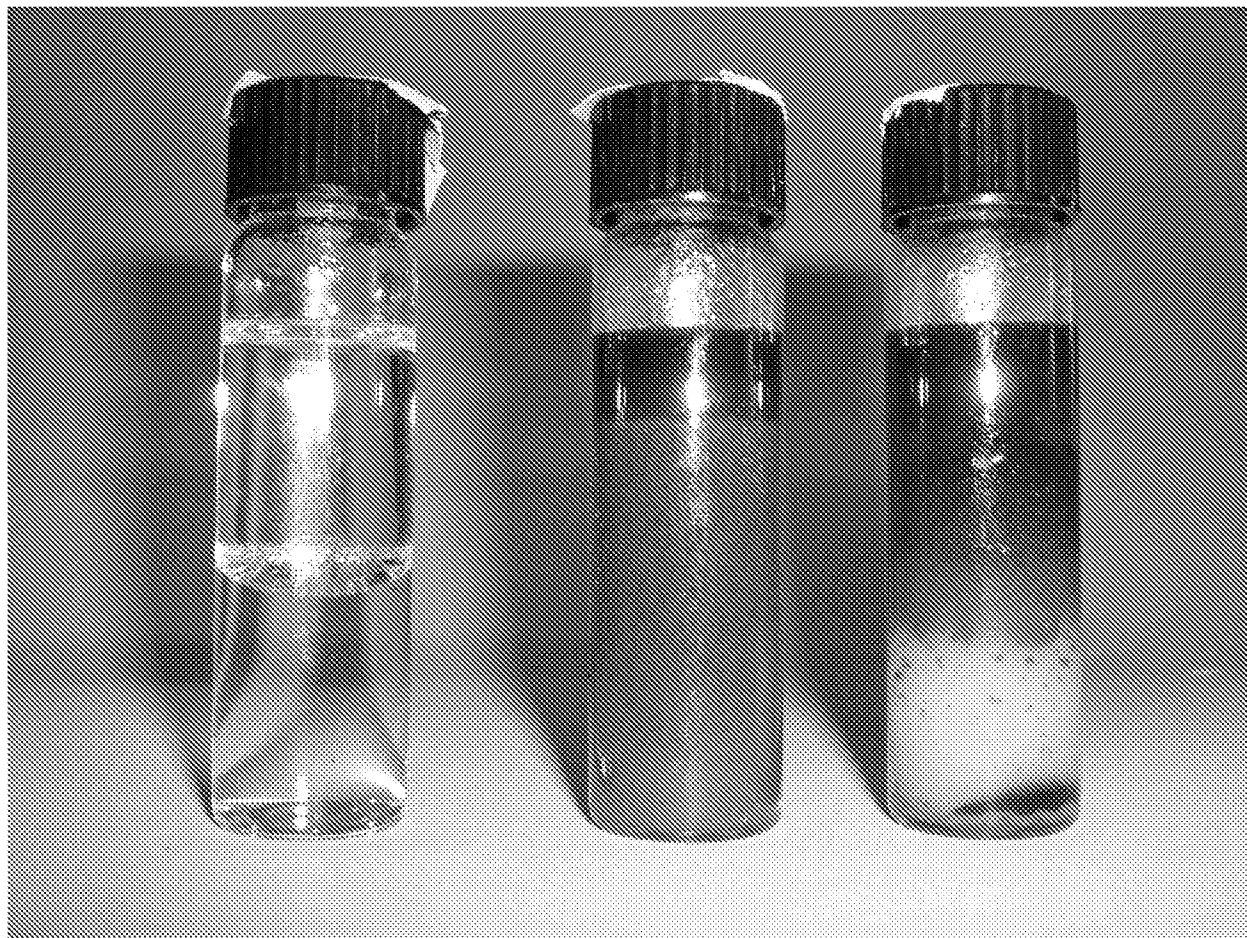


Fig. 7

INTERNATIONAL SEARCH REPORT

International application No.

PCT/US 12/71087

A. CLASSIFICATION OF SUBJECT MATTER

IPC(8) - C10C 3/00 (2013.01)

USPC - 208/22

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC(8) -- C10C 3/00 (2013.01)

USPC -- 208/22

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

IPC(8) -- C10C 3/00; C10C; C10G (2013.01)

USPC -- 208/22, \$

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

PubWest (PGPB,USPT,USOC,EPAB,JPAB); Patbase; USPTO; Espacenet; Google Scholar -- ACID ADSOR\$ ASPHALTEN\$ BREAK\$ CARBON DESOR\$ DESTABIL\$ EMULSION OIL PERICONDENS\$ POLAR\$ PRECIPITAT\$ REVERSE-PHASE SALT SOLVENT SORB\$ STABIL\$ WATER ZEOLITES

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	US 2003/0188995 A1 (Varadaraj) 09 October 2003 (09.10.2003); para [0002] - [0008]; [0016]; [0017]; [0029] - [0039];	1-221
Y	US 2007/0048874 A1 (Schabron et al.) 01 March 2007 (01.03.2007); Table 4; para [0006]; [0008]; [0035]; [0036]; [0046]; [0047]; [0048]; [0057]; [0058]; [0063]; [0067]; [0072]; [0078];	1-221
Y	US 2009/0211758 A1 (Bragg et al.) 27 August 2009 (27.08.2009); para [0009]; [0013]; [0017]; [0021]	5-7,54,55,70-72, 153-155,193-195
Y	US 2010/0176032 A1 (Droughton) 15 July 2010 (15.07.2010); Fig 1; para [0047]; [0053]; [0054]; [0059]; [0060]; [0062]; [0063]; [0066]; [0068]; [0079]; [0080]; [0084]	66-186,189,205-214, 217-219
Y	US 2008/0164137 A1 (Messer et al.) 10 July 2008 (10.07.2008); para [0030]; [0031]	117
Y	US 4,419,219 A (Long et al.) 06 December 1983 (06.12.1983); col 2, ln 10-25	119
Y	WO 2010/147583 A1 (Janssen et al.) 23 December 2010 (23.12.2010); para [0028]	120

☒ Further documents are listed in the continuation of Box C.



* Special categories of cited documents:

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier application or patent but published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art

"&" document member of the same patent family

Date of the actual completion of the international search

16 February 2013 (16.02.2013)

Date of mailing of the international search report

12 MAR 2013

Name and mailing address of the ISA/US

Mail Stop PCT, Attn: ISA/US, Commissioner for Patents
P.O. Box 1450, Alexandria, Virginia 22313-1450

Facsimile No. 571-273-3201

Authorized officer:

Lee W. Young

PCT Helpdesk: 571-272-4300

PCT OSP: 571-272-7774

INTERNATIONAL SEARCH REPORT

International application No.

PCT/US 12/71087

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	US 2012/0016168 A1 (Schabron et al.) 19 January 2012 (19.01.2012); Table 4; para [0037]; [0104]; [0147]; [0148];	1-221
A	US 2010/0096297 A1 (Stevens et al.) 22 April 2010 (22.04.2010); para [0002]; [0037]; [0057]	1-221
A	US 2009/0301931 A1 (Koseoglu et al.) 10 December 2009 (10.12.2009); para [0017]; [0037]; [0040]; [0056];	1-221
A	US 2010/0116716 A1 (Yeung) 13 May 2010 (13.05.2010); para [0007]; [0013]; [0014]; [0019]; [0034];	1-221
A	US 2011/0127196 A1 (Henaut et al.) 02 June 2011 (02.06.2011); para [0007]; [0009]; [0023]; [0027]; [0034]	1-221
A	US 4,515,685 A (Yeh) 07 May 1985 (07.05.1985); Fig 1; col 4, ln 54-65; col 6, ln 62 to col 7, ln 3; col 9, ln 34-41	1-221
A	'Investigation of Subfractions of Athabasca Asphaltenes and Their Role in Emulsion Stability,' Yang et al.; Energy Fuels, 2004, 18 (3), pp 770-777; April 15, 2004	1-221