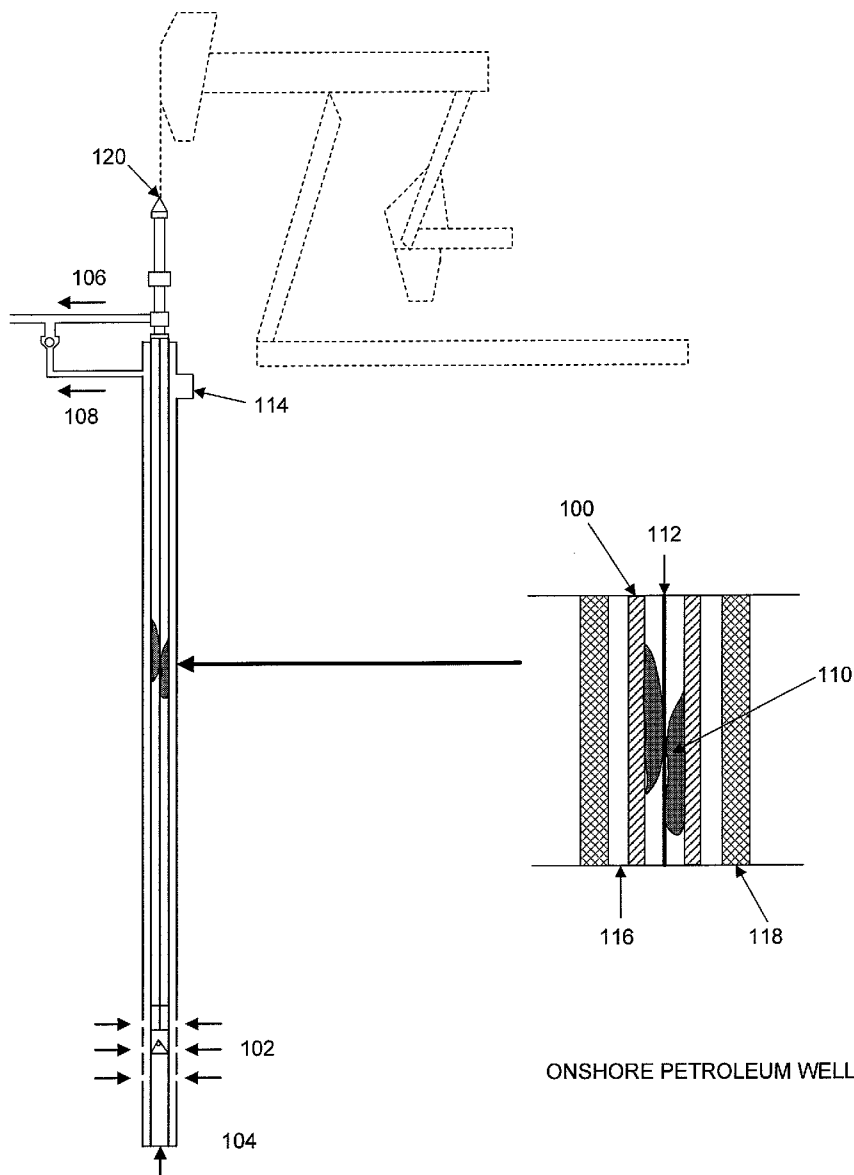




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(19) **United States**(12) **Patent Application Publication**
Sears et al.(10) **Pub. No.: US 2011/0056694 A1**(43) **Pub. Date: Mar. 10, 2011**(54) **METHODS FOR REMOVING PARAFFINIC
HYDROCARBON OR BITUMEN IN OIL
PRODUCING OR DISPOSAL WELLS**(52) **U.S. Cl. 166/312**(75) **Inventors:** **Sean E. Sears**, The Woodlands, TX
(US); **Kevin L. Roberts**, Spring,
TX (US)(73) **Assignee:** **Refined Technologies, Inc.**(21) **Appl. No.:** **12/557,168**(22) **Filed:** **Sep. 10, 2009****Publication Classification**(51) **Int. Cl.**
E21B 37/00 (2006.01)(57) **ABSTRACT**

Disclosed is an improved process for removing heavy oil, bitumen and/or paraffinic materials in oil production or storage wells including onshore and offshore petroleum wells, petroleum residual disposal wells and Steam Assisted Gravity Drainage (SAGD) or Cyclic Steam Stimulation (CSS) producing wells used in the oil sands industry. This process helps restore the operating efficiency of organically contaminated hydrocarbon producing wells in a safe, fast and effective manner without the need to insert any equipment to mechanically remove organic contaminants. Used is a heated terpene-based chemical injected with or without steam following a hot water or steam pre-heat to create a very effective cleaning process.



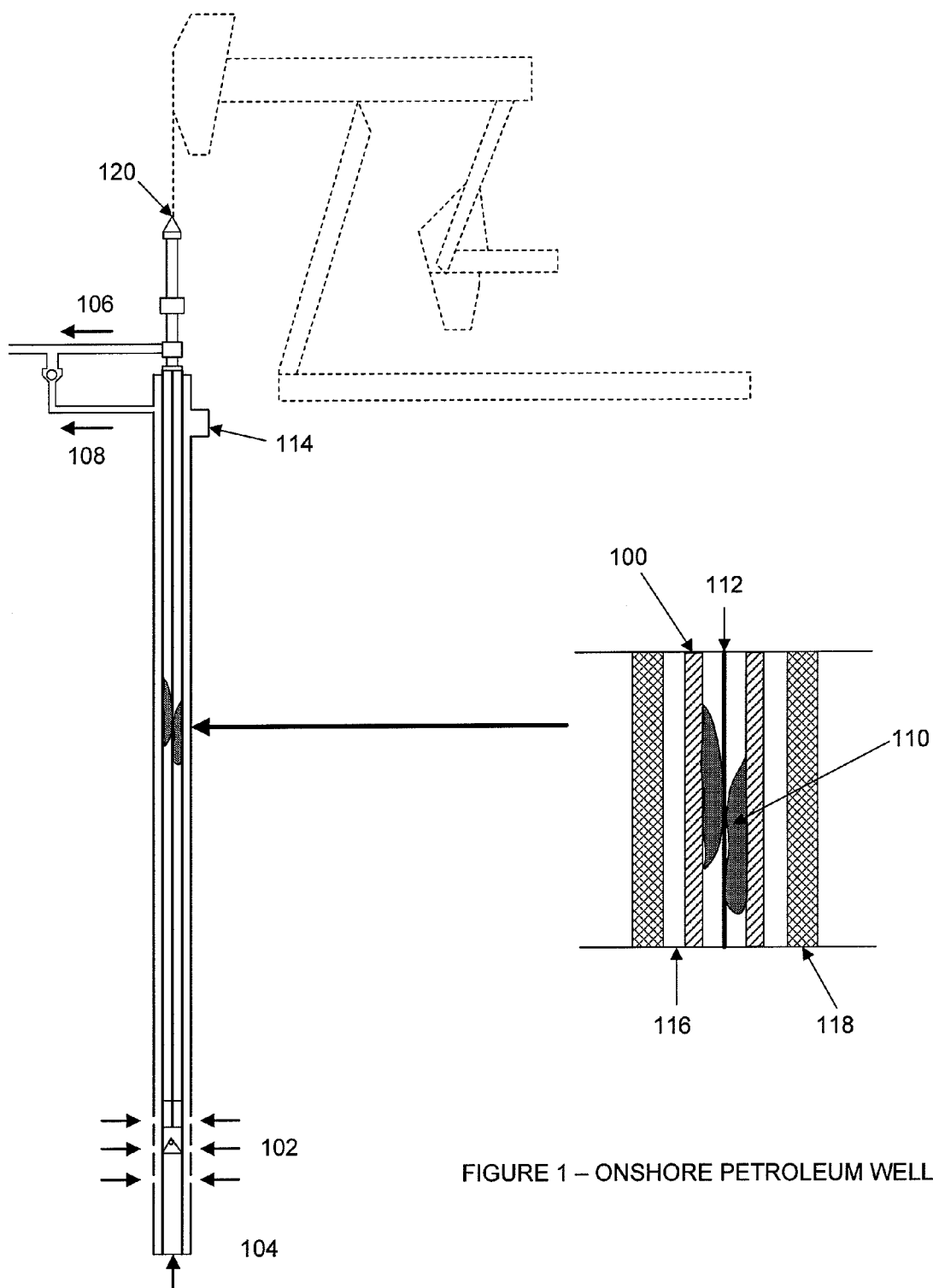


FIGURE 1 – ONSHORE PETROLEUM WELL

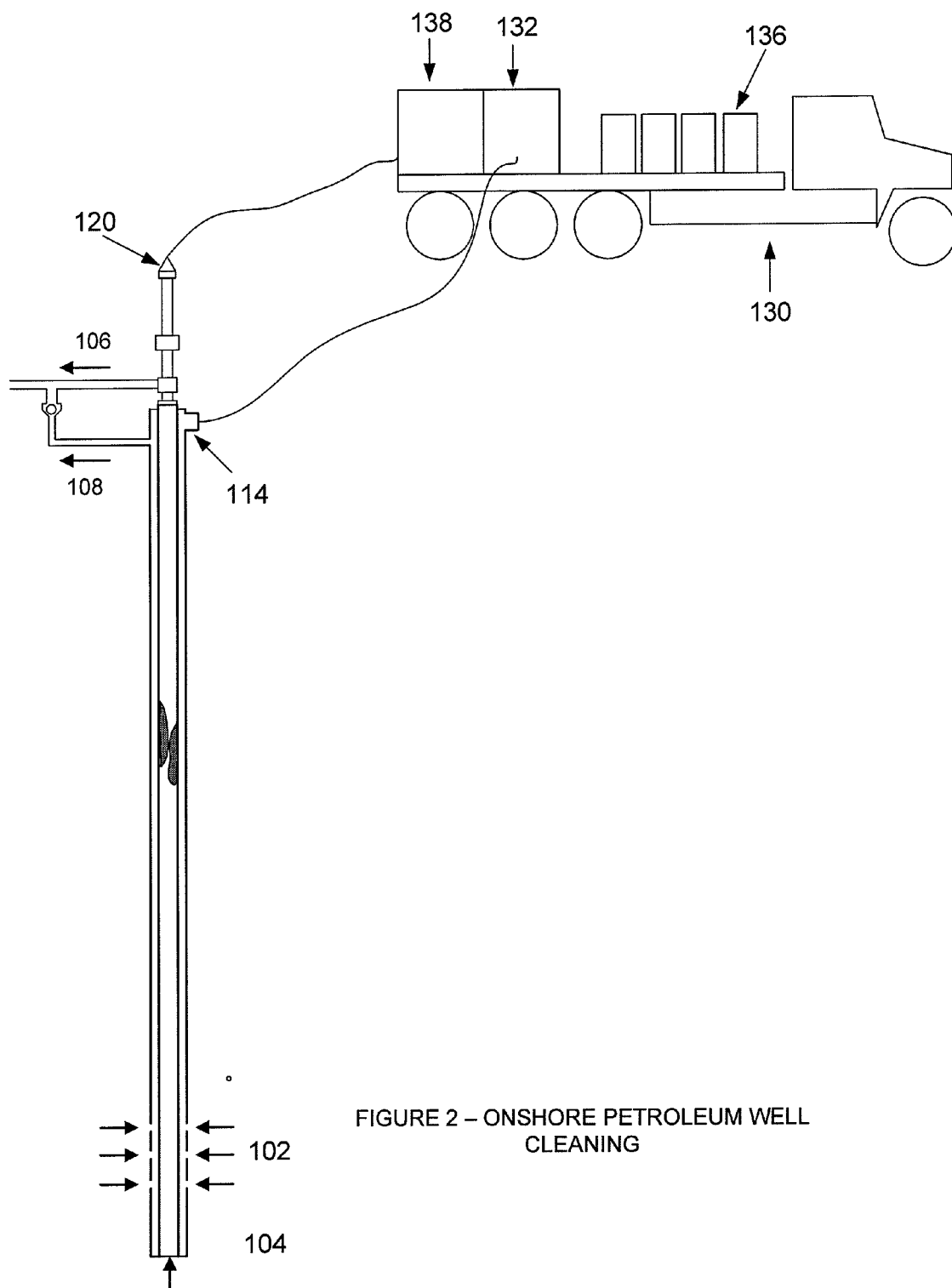


FIGURE 2 – ONSHORE PETROLEUM WELL
CLEANING

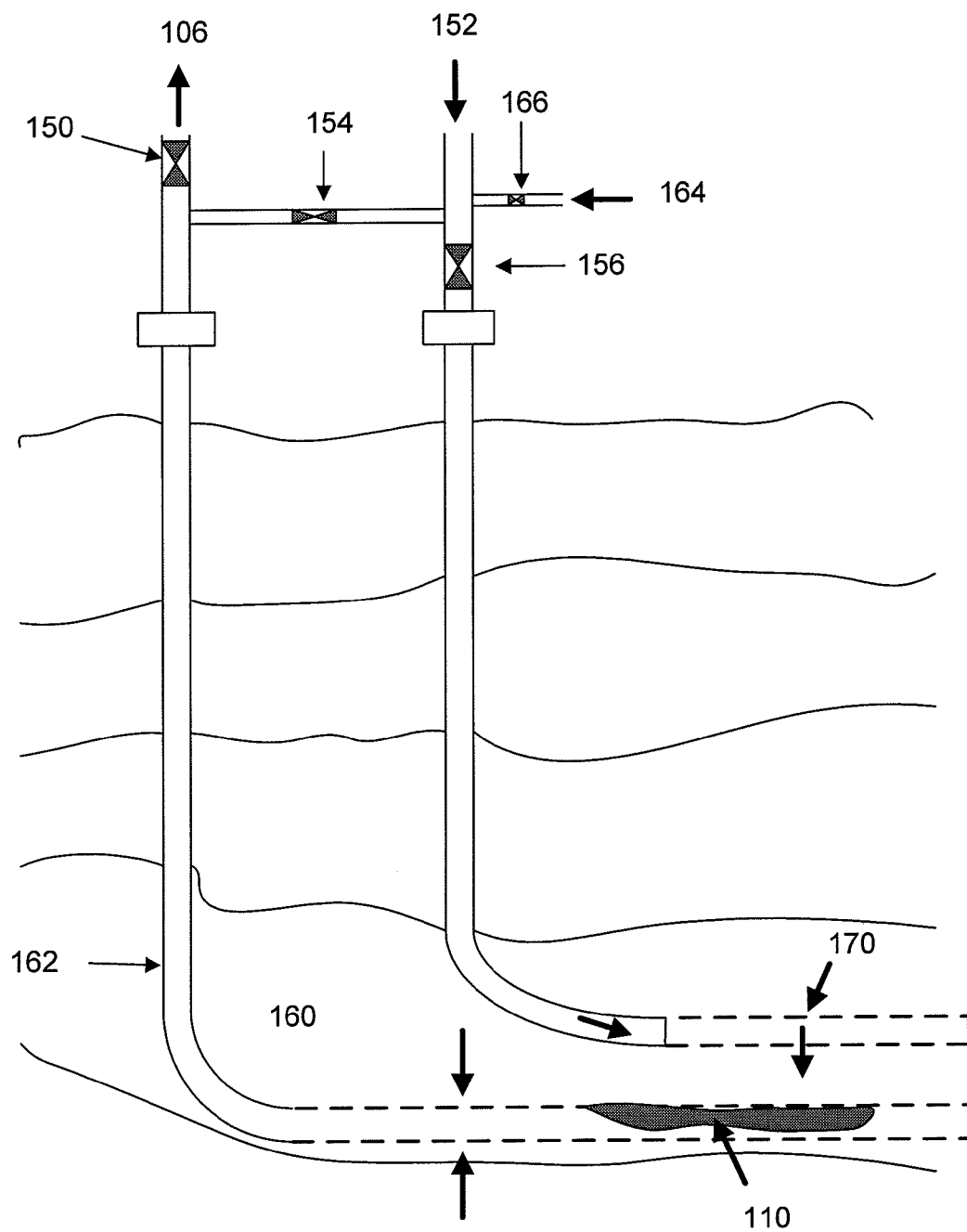


FIGURE 3 – SAGD

METHODS FOR REMOVING PARAFFINIC HYDROCARBON OR BITUMEN IN OIL PRODUCING OR DISPOSAL WELLS

BACKGROUND

[0001] This disclosure relates to a process for enhancing oil production in traditional onshore and offshore oil wells (upstream), and a process for restoring storage capacity in onshore disposal wells that handle the waste generated during oil production. More specifically, the disclosed methods help enhance the production of the wells and the capacity of the storage wells by (a) removing bitumen or heavy paraffinic hydrocarbon that tend to deposit on the inner wall and wall perforations of the piping and (b) acting as a steam-assisted solvent to dissolve oil, and to reduce the viscosity of the oil thus making the oil flow more freely from the well(s).

[0002] In the petroleum industry, the term "upstream" typically refers to the various systems and methods for producing oil onshore or offshore, while the term "downstream" typically refers to the refining process for producing petroleum. If the oil production takes place in an oil sands reservoir, the oil is typically mined mechanically or produced through injection of steam to heat the oil in order to lower its viscosity. In order to maintain efficient oil flow, maintenance programs need to be performed in the upstream industry to maintain the efficiency of oil production. To date, most primary treatments, such as hot oil flushes and acidizing, are only marginally effective.

[0003] In many oil-drilling sites, build-up of contaminants in oil wells and inside the piping presents an enormous maintenance challenge to the crew. These contaminants may include, for example, drilling residues, bitumen, sludge, muds, paraffin, asphaltene, mud solids, biological or synthetic solids and the like. More particularly, paraffin or asphaltene materials may adhere to the inside of the piping and restrict the flow of oil from the reservoir. The deposits inside the production piping typically occur in the first 30% of the well's piping when measured from well head.

[0004] The contaminant problem is most prominent on the well sucker rods. Sometimes, the contaminants are so heavy that they completely block all flow from the well. In addition to the blockage problem, large amounts of paraffinic fouling may also increase the friction on the sucker rod which, in turn, causes more energy consumption by the pump to maintain the same pumping rate. This build-up is particularly troublesome with offshore wells as it restricts subsea flow lines, manifolds and creates a maintenance challenge that can adversely affect production volume and downtime.

[0005] The build-up materials are usually composed of solids such as clay, paraffin, crude oil, sand, and bitumen. The term "bitumen" refers to a mixture of organic liquids that are highly viscous, black, sticky, entirely soluble in carbon disulfide, and composed primarily of highly condensed polycyclic aromatic hydrocarbons. Naturally occurring or crude bitumen is a sticky, tar-like tacky organic form of petroleum which is typically very viscous. It is commonly known as tar or pitch. The high viscosity of the build-up makes these materials extremely difficult to remove from the piping. According to the SAGD (steam assisted gravity drainage) and CSS (cyclic steam stimulation) methods, significant volumes of steam are injected into the piping to lower the viscosity of the material. SAGD allows for the material to be produced in the lower horizontal piping of the well system, while CSS injects and produces bitumen material through a common

vertical well. However, significant challenges remain for both the SAGD and CSS methods due to the high viscosity of the build-up materials combined with solids that are naturally occurring in the formation.

[0006] Several methods have been attempted to alleviate this problem in offshore and onshore oil production. Some methods, such as acid washing, are corrosive and hazardous. Some other methods use surfactants and inhibitors with low or no KB (kauri butanol) value. A KB value is used to measure the solvency strength of an organic solvent. The KB value of a solvent may be measured in an ASTM lab test. Yet some other methods include hydrocarbon solvents that are not readily biodegradable and also contain hazardous aromatic compounds like xylene.

[0007] U.S. Pat. No. 4,609,041 issued to Magda and U.S. Pat. No. 3,574,319 issued to Tenneco disclose "diesel" or "hot oil" flushes or circulations to clean the pipeline build-ups. These methods are only marginally effective due to the low KB value of the solvent. Diesel is commonly used because it is relatively inexpensive and available. However, diesel is a poor solvent, rating only at 30-33 on the KB scale.

[0008] U.S. Pat. No. 7,198,103 issued to Campbell discloses addition of one or more stimulants to a petroleum well in order to enhance the production of the well. According to the '103 patent, if the well is suffering from asphaltene or paraffin build up, the well may be heated either chemically or with steam prior to introduction of the stimulant. Additionally, a solvent may be added to dissolve the asphaltenes and paraffins. The stimulants may be allowed to soak into the formation before the well is returned to production. The stimulants increase the ability of oil to flow through the formation and decrease the ability of water to flow through the formation by coating the water wet portions of the formation with oil soluble chemicals. The stimulants also decrease the viscosity of the oil in formation.

[0009] U.S. Pat. No. 5,104,556 issued to Al-Yazdi discloses the use of kerosene, alkyl phenols or cresylic acid as solvent compositions for dissolution of both asphaltene and paraffin petroleum based deposits. U.S. Pat. No. 4,049,057 issued to Hewes discloses the use of an eduction tube to remove paraffin by mechanical force. However, the use of mechanical mechanism for cleanup is limited because it is expensive and complicated to set up. U.S. Pat. No. 4,933,089 issued to Newton teaches a process for preventing the accumulation of paraffin deposits by using a metal tube having an inner surface and an outer surface comprising at least seventy-five percent nickel. The use of special metal in the '089 patent may limit its application in large scale cleaning operation.

[0010] U.S. Pat. No. 6,972,274 discloses a method to improve the permeability of the formation by treating the formation with a composition comprising at least one non-ionic compound, such as an alkoxylated alcohol, and at least one cationic compound. U.S. Pat. No. 6,534,449 issued to Gilmour et al., discloses a wellbore fluid composition to reduce oil-containing residue and water wet wellbore surfaces.

[0011] U.S. Pat. No. 5,678,631 issued to Salisbury et al. discloses a process for cleaning a well system and equipment using a chemical additive that includes an alkene alcohol, and either an ether amine or base fluid or combination of the two. The process includes circulating the chemical additive in the well system with spacer fluids, where the additive is used in an aqueous or a salt solution.

[0012] The method disclosed in U.S. Pat. No. 5,670,460 to enhance hydrocarbon production from wells entails injection into a well a five-part concentrate containing xylene, an aliphatic hydrocarbon solvent such as kerosene, a non-ionic emulsifier, a non-ionic surfactant and an amphoteric detergent. U.S. Pat. No. 5,183,581 issued to Khalil et al. uses heat generation and nitrogen reaction system to remove wax from the well system. U.S. Pat. No. 4,975,208 teaches use of a steam system having a vapor phase and a liquid phase and a fluorocarbon surfactant to enhance oil recovery.

[0013] Many of these previously disclosed methods have drawbacks that make them less attractive as a method of choice for cleaning oil production system. Some methods are too time consuming, some do not remove the contaminants effectively, still other methods use chemicals that are themselves "contaminants" and need to be removed from the system.

SUMMARY

[0014] The present disclosure provides an improved method for enhancing oil flow and production by injecting a composition comprising a readily biodegradable, fully organic terpene-based solvent with a very high KB value. A method to inject the composition and a preheating method to prepare the piping before the chemical injection are also disclosed. U.S. Pat. No. 6,893,509 ('509 patent) issued to Sears and Roberts teaches a novel process for interior cleaning and removal of noxious gas from refinery using monocyclic saturated terpene mixed with a non-ionic surfactant. The '509 patent is hereby incorporated by reference into this disclosure.

[0015] The present disclosure overcomes some of the unsolved problems in the field by introducing a cleaning agent (also referred to as "the chemical composition," "the composition," or "the chemical" in this disclosure) in small quantities (e.g. about 55-220 gallons) into the oil production system by the use of heated water, steam, nitrogen or a preheat system to heat the cleaning agent. The heated water, hot steam, or heated nitrogen may volatilize the cleaning agent which, in turn, quickly dissolves the organic contaminants from the piping. Pre-heating the cleaning agent with a circulating boiler is also effective if steam is not available at the job site, for example, at an offshore drilling site.

[0016] The method of the present disclosure may include, among others, the following steps:

[0017] (a) providing a water source;

[0018] (b) providing a chemical source capable of providing a chemical;

[0019] (c) delivering water from said water source to said oil production system, wherein said water is in the form of heated water or steam when delivered to said oil production system;

[0020] (d) introducing said chemical from said chemical source into said system, said chemical comprising terpene;

[0021] (e) removing contaminants from said oil production system while said contaminants are in a heated or vaporized form.

[0022] Water may be used as both a carrier and a heat conductor. On the one hand, water may help carrying the cleaning agent through the entire system; On the other hand, the heated water or steam helps raise the temperature of the contaminants, the well, the piping, the tubing and their respective surrounding area. Higher temperature, in turn,

helps lower the viscosity of the contaminants to be removed. It is to be recognized that media other than water may also be suitable as a carrier and a heat conductor and may be used in place of water.

[0023] In another aspect, the water source may be able to provide heated water or steam. For example, the water source can be a water truck with a heater that can bring the temperature of the water up to boiling temperature. Typically, the heated water to be delivered into the system has a temperature ranging from about 75 C to the boiling temperature of water under the atmospheric pressure at the site of intended use, preferably in the range of about 90 C to the boiling temperature of water. Most preferably, the water source in step (a) above is a steam source, and the water in step (c) is in the form of water steam (also referred to as "steam" in this disclosure). Under normal pressure at sea level, the boiling temperature of water is 100 C. If other media are used, the boiling temperature of the medium is used instead of the boiling temperature of water.

[0024] In another aspect, the piping and tubing from which the contaminant is to be removed may be preheated to about 70-80 C before the cleaning agent is delivered into the system. In one preferred embodiment of this disclosure, this preheating step is accomplished by delivering steam into the system prior to the delivery of the chemical into the system. After the preheating step, the chemical (or cleaning agent) may then be delivered into the steam already present in the system. In one aspect, the chemical cleaning agent may be fully vaporized when it gets in contact with the steam. Subsequent to the delivery of the chemical, steam may be continuously pumped into the system for a period from 1 minute to several hours, or until the desired cleaning effect has been achieved. Hot flush water may then be introduced into the system to further remove any residual contaminants and/or chemical cleaning agent. After the flushing step is complete and flush water is removed, the system may be connected back on line for operation.

[0025] In another aspect, heated chemical may be pumped into the process tube while heated water is continuously pumped into the annulus. The amount of chemical to be delivered into the system depends on the amount of contaminant present in the system. Typically, the amount of chemical to be used ranges between 0.1-10 gal per ft³ of enclosed well tubing, or more preferably, between 1 and 2 gal per ft³ of enclosed well tubing.

[0026] In another aspect, the chemical and the steam or heated water may be mixed together before each component enters the oil production system. Under this method, the chemical is heated and/or vaporized by the steam or heated water. The mixture containing the chemical and the steam or heated water then enters the system together. Alternatively, the chemical may be preheated by a different means such as by a heating element other than the heated water or steam. The preheated chemical may then enter the system separately or together with the heated water or steam to clean the contaminants. Examples of such a heating element include but are not limited to a circular boiler.

[0027] In another aspect, the presently disclosed cleaning process may also increase the effectiveness of other techniques that have been used to enhance well production. For example, the well stimulation method also known as "acidizing" involves the injection of hydrochloric acid or other acids (most notably acetic and formic) into acid-soluble carbonate zones of the formation surrounding the well bore. There, the

carbonate-dissolving properties of the acid help enlarge existing voids which in turn results in increased formation permeability and consequently higher production rates. By applying the techniques of this disclosure, paraffinic and other organic contaminants may be first removed from the carbonate zones surrounding the well bore. By first removing the contaminants, the acid treatment becomes more effective because the acid will not be consumed by its reaction with the contaminant.

[0028] In one preferred embodiment, the cleaning agent may be a chemical composition containing terpene. More preferably, the cleaning agent used is comprised of a naturally occurring organic terpene. In a preferred embodiment, the cleaning agent is a chemical composition that is readily biodegradable. Preferably, the terpene is at least one member selected from the group consisting of monocyclic saturated terpene, monocyclic unsaturated isoprenoid, and bicyclic pine terpene. More preferably, the terpene is para-menthane.

[0029] In one embodiment, the cleaning agent contains 100% terpene with no other additives. Accordingly, the cleaning agent does not contain any surfactant, isopropyl benzene, demulsifiers, naphtha, xylene, mineral oil, dodecylbenzylsulfonic acid (DDBSA) or vinyl acetate, but only contains terpene as an solvent for removing the contaminants. When no surfactant is present in the cleaning agent, the paraffinic material is typically converted to a material with water-like viscosity, which remains separate from the water phase because of the absence of surfactants.

[0030] In another aspect, a second ingredient may be added to the chemical composition to provide additional detergency, wetting or rinsing. The additive may be a nonionic surfactant package which enhances detergency, wetting, and rinsing. The first major constituent of the surfactant package may include a linear alcohol ethoxylate (C_{12} - C_{15}) with an ethoxylated propoxylated end cap. This linear alcohol ethoxylate helps enhance the detergency and/or cleaning power of the chemical composition to a great extent. Linear alcohol ethoxylates are also more environmentally friendly than more traditional surfactants. They exhibit good biodegradation and aquatic toxicity properties. Another major constituent of the surfactant package that may be added to the chemical composition is a fatty alkanolamide primarily consisting of amides and tall oil fatty N,N-bis(hydroxyethyl) This fatty alkanolamide primarily aids in rinsing, oil solubility, and wetting. The combination of these two classes of surfactants in a proper ratio significantly enhances the cleaning results of the chemical composition. The following nonionic surfactants with an HLB range of 6.0-10.5 are also acceptable as an additive package which may include but are not limited to (i) nonylphenol polyethoxylates, (ii) straight chain linear alcohol ethoxylates, (iii) linear alcohol ethoxylates with block copolymers of ethylene and propylene oxide, (iv) oleamide DEA, or (v) diethanolamine. One skilled in the art will recognize whether an additive is appropriate for a particular application as well as other additives that could be used which would still fall within the scope of this invention.

[0031] Because of the relatively high KB Value of the cleaning agent used and the pre-heating of the annulus void using a solution such as KCl water, the presently disclosed method makes cleaning of production piping much easier as compared to prior art methods. Because the cleaning of the equipment takes less time, the driller may be able to boost efficiency by minimizing downtime while removing "solids" that are previously bound by bitumen or paraffin matrixes. In

one aspect, the cleaning agent is an organic solvent that have a KB value ranging from 105-135 on the scale.

[0032] In addition to improving the overall efficiency of an oil production system by removing contaminants such as paraffinic and asphaltene materials, the instant disclosure also provides a methodology addressing two other post-cleaning issues. The first issue involves the acidization of limestone and other subterranean carbonate formations exposed after the chemical treatment. The second issue involves the effective removal of iron sulfides from disposal wells, using an acid treatment, following the chemical treatment. The methods disclosed herein help resolve both issues because the chemical terpene treatment may effectively remove nearly all hydrocarbon barriers from the system, rendering the system more susceptible and responsive to acid treatments.

[0033] Yet another advantage of the presently disclosed methods is that the injection under the present methods does not normally require elaborate use of new equipment, tools, or valves. Moreover, existing hot oil trucks may be used to heat the water and the terpene to allow for a fast and easy injection into the well.

[0034] In one preferred embodiment, formulation of the cleaning agent of the present disclosure is more effective when it is in a natural, fully organic phase containing at least 90% (w/w) terpene. More preferably, the cleaning agent comprises at least 95% (w/w) terpene. Most preferably, the cleaning agent comprises nearly or at 100% (w/w) terpene so that the KB value will not be diminished due to dilution when the cleaning agent gets in contact with any source of water in the well.

[0035] One advantage of the instantly disclosed method is that the cleaning process may be completed in a matter of a few hours, for example, 4-6 hours. The use of heat in the present method may not only advance the cleaning timeframe, but also allow for a more efficient injection of less chemical than what would typically be needed for extracting bitumen or heavy paraffin fouling from the same site.

[0036] In another aspect, the oil production or storage system of the present disclosure may include one or more oil reservoir. The oil production or storage system may also include piping and/or tubing leading into and out of the one or more oil reservoir. The disclosed method may further include a step of determining whether the piping are partially or totally blocked and a step of determining the property of the material that causes the blockage.

BRIEF DESCRIPTION OF THE DRAWINGS

[0037] FIG. 1 is a schematic diagram showing an embodiment in which the cleaning processes are administered to an onshore petroleum well.

[0038] FIG. 2 is a schematic diagram showing an embodiment in which the cleaning processes are administered to an onshore petroleum well using a hot oil truck.

[0039] FIG. 3 is a schematic diagram showing an embodiment wherein the cleaning processes are used in cleaning the piping associated with SAGD or CSS production wells.

DETAILED DESCRIPTION OF THE INVENTION

[0040] The disclosed embodiments provide methods for enhancing the production of traditional onshore and offshore petroleum wells (upstream), including SAGD and CSS production methods that produce heavy bitumen material, as well as onshore disposal wells needed to handle waste. Spe-

cifically, through the fast, effective removal of bitumen or heavy paraffinic fouling, the disclosed methods may help enhance the production of the wells by increasing the diameter of the opening inside the pipe (upstream), clearing heavy oil and paraffinic clogging from petroleum disposal wells, clearing bitumen related solids/obstructions from the slots or slits in the lower horizontal piping (producing side) of SAGD wells or the injection side of CSS wells.

[0041] More specifically, a method of cleaning piping and associated apparatus in an oil production or storage system is provided. The oil production or storage system may include upstream petroleum production wells such as onshore and offshore wells, oil sands production systems known as SAGD or CSS, and oil production disposal wells that are partially or fully plugged (abandoned). In one embodiment when an organic solvent is used as the cleaning agent, this method may contain the steps of (i) providing a steam source or a method for heating the piping and solvent; (ii) providing a water source; (iii) providing an organic solvent source; (iv) delivering steam from said steam source to said piping; (v) introducing the heated organic solvent from the organic solvent source into the steam or piping.

[0042] One group of common contaminant that may adversely affect the efficiency and/or yield in oil production is hydrocarbons with the formula C_nH_{2n+2} , wherein n is an integer equal to or greater than 1. For example, Methane (CH_4) is the simplest member of this group. In one aspect, the contaminant is hydrocarbons with the formula C_nH_{2n+2} , wherein n is equal to or greater than 10, more preferably, is equal to or greater than 18. Higher members, such as those with n equal to or greater than 18, are usually wax-like and are called paraffin in the field. Excessive amounts of paraffinic hydrocarbons in an oil mud may adversely affect mud and oil flow, especially at low temperature.

[0043] Other contaminants that are not specifically named in this disclosure may accumulate inside an oil production system including wells and their vicinity. It is to be recognized that the presently disclosed methods may be applicable to these contaminants provided they are at least partially soluble in the cleaning agent disclosed herein.

[0044] As used herein, an oil production and storage system comprises at least one oil reservoir and the piping, tubing and apparatus suitable for obtaining oil from said oil reservoir. The piping includes, but are not limited to piping leading into and out of the oil reservoir.

[0045] Annulus refers to the void between a pipe string and a surrounding pipe string or formation, see FIG. 1. In a preferred embodiment, the annulus of the oil production system are heated with hot water or steam prior to the introduction of the chemical into the system. In another aspect, the annulus of the oil production system may remained heated after the chemical has been injected into the system to help maintain the temperature of the cleaning chemical.

[0046] The term "terpenes" or "terpene" is traditionally applied to cyclic hydrocarbons having structures with empirical formula $(C_5H_8)_n$, where n is the number of linked isoprene (C_5H_8) units. Many terpenes have as their carbon skeletons multiples of the isoprene nucleus, C_5H_8 or multiples of $C_{10}H_{16}$. Terpene may be found in the essential oils of certain plants. Knowledge of the chemistry of the terpene field has developed and compounds related both chemically and biogenetically to terpene have been identified or developed.

[0047] Some natural products have been successfully synthesized in the lab. Synthetic compounds resembling known

terpene structures have also been made in the lab. Consequently, the term "terpenes" may now be understood to include not only the numerous C_5H_8 or $C_{10}H_{16}$ hydrocarbons but also their hydrogenated derivatives and other hydrocarbons possessing similar fundamental chemical structures. These hydrocarbons may be acyclic or cyclic, simple or complex, and of natural or synthetic origin. The cyclic terpene hydrocarbons may be classified as monocyclic, bicyclic, or tricyclic.

[0048] For purpose of this disclosure, the terpene to be used may be acyclic, bicyclic, or tricyclic. Examples of acyclic terpenes that may be used are geraniolene, myrcene, dihydromyrcene, ocimene, and allo-ocimene. Examples of monocyclic terpenes that might be used are ρ -menthane; carvomenthene, methene, dihydroterpinolene; dihydrodipentene; α -terpinene; γ -terpinene; α -phellandrene; pseudolimonene; limonene; d-limonene; l-limonene; d,l-limonene; isolimonene; terpinolene; isoterpinolene; β -phellandrene; β -terpinene; cyclogeraniolane; pyronane; α -cyclogeraniolene; β -cyclogeraniolene; γ -cyclogeraniolene; methyl- γ -pyronene; 1-ethyl-5,5-dimethyl-1,3-cyclohexadiene; 2-ethyl-6,6-dimethyl-1,3-cyclohexadiene; 2- ρ -menthene 1(7)- ρ -methadiene; 3,8- ρ -menthene; 2,4- ρ -menthadiene; 1(7),4(8)- ρ -methadiene; 3,8- ρ -menthadiene; 1,2,3,5-tetramethyl-1,3-cyclohexadiene; 1,2,4,6-tetramethyl-1,3-cyclohexadiene; 1,6,6-trimethylcyclohexene and 1,1-dimethylcyclohexane. Examples of bicyclic terpenes that might be used are norsabinane; northujene; 5-isopropylbicyclohex-2-ene; thujane; β -thujene; α -thujene; sabinene; 3,7-thujadiene; norcarane; 2-norcarane; 3-norcarane; 2,4-norcaradiene; carane; 2-carene; 3-carene; β -carene; nonpinane; 2-norpinene; apopinane; apopinene; orthodene; norpadiene; homopinene; pinane; 2-pinene; 3-pinene; β -pinene; verbenene; homoverbanene; 4-methylene-2-pinene; norcamphane; apocamphane; campane; α -fenchane; α -fenchene; sartenane; santane; norcamphene; camphenilene; fenchane; isocamphane; β -fenchane; camphene; β -fenchane; 2-norbornene; apobornylene; bornylene; 2,7,7-trimethyl-2-norbornene; santene; 1,2,3-trimethyl-2-norbornene; isocamphodiene; camphenilene; isofenchene and 2,5-trimethyl-2-norbornene.

[0049] The most preferred terpene is a monocyclic saturated terpene that is rich in para-menthane ($C_{10}H_{20}$). Para-menthane has a molecular weight of 140.268. This active ingredient may include both the cis- and trans-isomers. Common and approved synonyms for para-menthane include: 1-methyl-4-(1-methylethyl)-cyclohexane and 1-isopropyl-4-methylcyclohexane. Para-menthane is all natural, readily biodegradable by EPA methods, and nontoxic by OSHA standards. Monocyclic saturated terpenes, however, are not the only compounds that may be used as the active ingredient of the cleaning agent. Other naturally occurring or synthetic terpenes may also be used, which may include, by way of example, (i) monocyclic unsaturated isoprenoids such as d-limonene ($C_{10}H_{16}$), (ii) bicyclic pine terpenes such as -pinene & -pinene, or (iii) any combination of monocyclic and bicyclic terpenes.

[0050] It is not uncommon that equipment may become fouled with organic contamination to the point where operating rates must be reduced to prevent catastrophic failure or a shutdown of the entire unit. One skilled in the art will be able to determine when to shut down the operation so that cleaning may be conducted.

Examples

[0051] The following examples are provided to illustrate the present disclosure but not to limit the scope of the disclo-

sure. Other applications of the disclosed process with or without modification will be apparent to one skilled in the art.

Example 1

Administration of the Cleaning Process to an Onshore Petroleum Well

[0052] A typical cleaning process for an onshore petroleum well is illustrated in FIG. 1. The process tubing (or process tube) 100 delivers oil 102 from the well (or reservoir) 104 to the surface for further processing. The oil typically exists in one of two phases when it reaches the surface, liquid oil phase 106 and gas phase 108. In this case, the process tubing 100 is restricted by a contaminant or contaminants 110. The contaminant(s) is restricting flow through the process tube 100 and restricting free movement of the sucker rod 112. The process involves taking the well out of service by removing the sucker rod 112. A source of hot water (such as from a barrel truck or hot oil truck) is connected to a tee 114 that provides an opening to the annulus 116 between the process tube 100 and the well casing 118. Hot water at a temperature of approximately 200° F. (i.e., about 93° C.) is pumped into tee 114 and an upper opening 120 of the process tube 100, sufficient for heating the process tubing 100 to approximately 170° F. (i.e., about 77° C.). FIG. 2 shows a hot oil truck 130 carrying water 132 and cleaning agent (chemicals) 136. The truck 130 also carries a boiler 138 for heating the cleaning agent 136 and/or the water 132. The water source 132 and the boiler 138 may be connected to the tee 114 and the processing tube opening 120 as needed.

[0053] After preheating the processing tubing 100, a source of hot chemical is then attached to the top of the process tubing at opening 120. Hot water is again pumped into the annulus 116 while hot chemical is pumped into the process tube 100. The amount of chemical to be used ranges between 1 and 2 gal/ft³ of enclosed well tubing. Following addition of the cleaning chemical, additional hot water is pumped into the process tube 100 to clear the residual chemicals.

[0054] In a similar way, the cleaning process may be applied to partially or fully plugged disposal wells. Offshore wells that utilize gas lift techniques may also be cleaned using similar methods.

Example 2

Administration of the Cleaning Process to an SAGD Well

[0055] A second embodiment of the invention is illustrated by FIG. 2. In this case, the contaminant 110 is to be removed from the producing side of an SAGD well. The well is first shut off by closing valve 150. Steam 152 is first applied to the producing side of the well by opening valve 154 and closing valve 156. The steam 152 is allowed to flow into the well 160 as necessary to heat the well pipe 162 to a temperature of about 200 F, this heating step usually lasts approximately 30 minutes.

[0056] After preheating the well and piping in this manner, cleaning chemical 164 is added to the steam by opening valve 166. The amount of chemical 164 depends on the nature and the amount of the contaminant 110 but typically ranges between 1 and 2 gal/ft³ of enclosed well tubing. After the chemical 164 is injected, more steam 152 is allowed to flow into the system for an additional 30 minutes.

[0057] In a similar fashion, production in the well is enhanced by injecting the cleaning chemical into valve 166 while valve 154 remains shut and valve 156 remains open. Injecting into the steam assisting well 170 in this manner opens up the formation between the steam assisting well (170) and the producing well 162. This procedure also allows the chemical to be applied to the opposite side, namely, the well bore side of the contaminant 110, thus removing layers of the contaminant not reached by the original injection. In addition, injecting the high KB terpene into the steam assisting well dissolves significant bitumen and is a preferred and more powerful alternative as compared to previously known methods wherein propane or other light ends materials are used. The terpene may act as a primary diluent and it usually remains in the product without separation until the product reaches the refinery (endpoint). When used as described herein, the terpene may dissolve as much as 2.5 times its own weight of asphaltene material (heavy oil).

[0058] CSS wells may be cleaned using a similar technique.

[0059] Thus, there have been shown and described methods for cleaning an oil production or storage system, which fulfills all of the object and advantages sought therefore. Many changes, modifications, variations, and other uses and applications of the subject invention will, however, become apparent to those skilled in the art after considering this specification together with the accompanying figures and claims. All such changes, modifications, variations and other uses and applications which do not depart from the spirit and scope of the invention are deemed to be covered by the invention which is limited only by the claims which follow.

What is claimed is:

1. A method for cleaning an oil production or storage system, comprising the steps of:

- (a) providing a water source;
- (b) providing a chemical source capable of providing a chemical;
- (c) delivering water from said water source to said system, wherein said water is in the form of heated water or steam when delivered to said system;
- (d) introducing said chemical from said chemical source into said system, said chemical comprising a terpene;
- (e) removing a contaminant from said system while said contaminant is in a heated or vaporized form.

2. The method of claim 1, wherein the water source is capable of providing heated water.

3. The method of claim 1, wherein the water source in step (a) is a steam source, and the water in step (c) is steam.

4. The method of claim 1, wherein said chemical is delivered into said heated water or steam, said heated water or steam having been delivered into the system prior to the delivery of the chemical into the system.

5. The method of claim 1, wherein said water is in the form of a steam, and said chemical is delivered into said steam, said steam having been delivered into the system prior to the delivery of the chemical into the system.

6. The method of claim 1, wherein the chemical and the steam are mixed before said chemical and said steam are delivered into said system.

7. The method of claim 1, wherein said chemical is preheated prior to its delivery into the system.

8. The method of claim 7, wherein the chemical is preheated by a circulating boiler.

9. The method of claim 1, wherein said contaminant has a formula of C₂H_{2n+2}, wherein n is an integer greater than 10.

10. The method of claim 9, wherein n is greater than 18.

11. The method of claim 1 further comprising a step of injecting an acid to permeate the limestone in the vicinity of the system, said limestone having been exposed to the chemical after the introduction of said chemical into said system.

12. The method of claim 1 further comprising a step of preheating the annulus of said system with said hot water or steam prior to the introduction of said chemical into said system.

13. The method of claim 1 wherein said chemical comprises at least 90% (w/w) terpene.

14. The method of claim 1 wherein said chemical comprises at least 95% (w/w) terpene.

15. The method of claim 1 wherein said chemical comprises about 100% (w/w) terpene.

16. The method of claim 1 wherein said terpene is at least one member selected from the group consisting of monocyclic saturated terpene, monocyclic unsaturated isoprenoid, and bicyclic pine terpene.

17. The method of claim 16 wherein said terpene is a monocyclic saturated terpene.

18. The method of claim 16 wherein said terpene is parmenthane.

19. The method of claim 1 wherein said chemical further comprises a surfactant additive.

20. The method of claim 1 wherein the oil production or storage system comprises one or more oil reservoir.

21. The method of claim 20, wherein the oil production or storage system comprises piping leading into and out of said one or more oil reservoir.

22. The method of claim 21, further comprising a step of determining whether the piping are partially or totally blocked and a step of determining the property of the material that causes the blockage.

23. The method of claim 1, wherein said oil production or storage system is part of or is connected with an oil production operation selected from the group consisting of an on-shore or off-shore oil production well, an oil production related onshore disposal well, an oil sands SAGD (steam assisted gravity drainage) and a CSS (cyclic steam stimulation) well.

24. The method of claim 1, further comprising the steps of introducing a hot water flush into the system and removing the hot water flush from said system.

25. A method for cleaning an oil production or storage system, comprising the steps of:

- (a) providing a water source;
- (b) providing a chemical source capable of providing a chemical;
- (c) delivering water from said water source to said system, wherein said water is in the form of heated water or steam when delivered to said system;
- (d) introducing said chemical from said chemical source into said system, said chemical comprising terpene;
- (e) removing a contaminant from said system while said contaminant is in a heated or vaporized form, wherein no surfactant is used to clean said system.

26. The method of claim 25, wherein said chemical comprises about 100% (w/w) terpene.

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