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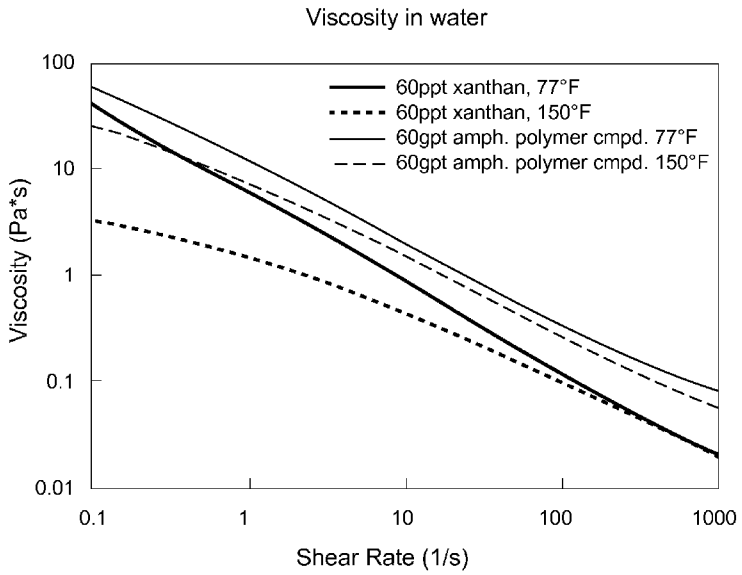


Fig. 4

(57) Abstract: Various embodiments disclosed relate to a composition including a crosslinkable ampholyte polymer or a crosslinked product of the same, methods of making and using the composition, and systems including the composition. In various embodiments, the present invention provides a method of treating a subterranean formation. The method can include obtaining or providing a composition including a crosslinkable ampholyte polymer. The composition can also include at least one crosslinker. The method can include placing the composition in a subterranean formation.

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AMPHOLYTE POLYMERS AND METHODS OF TREATING SUBTERRANEAN FORMATIONS WITH THE SAME

CROSS-REFERENCE TO RELATED APPLICATIONS

[0001] This application claims the benefit of priority to U.S. Patent Application Serial No. 14/204,506, filed on 11 March 2014, the disclosure of which is incorporated herein in its entirety by reference.

BACKGROUND OF THE INVENTION

[0002] During the drilling, stimulation, completion, and production phases of wells for petroleum or water extraction, the use of compositions having high viscosities in subterranean formations is important for a wide variety of purposes. Higher viscosity fluids can more effectively carry materials to a desired location in a subterranean formation, such as proppants. The use of higher viscosity fluids during hydraulic fracturing generally results in larger more dominant fractures. Higher viscosity drilling fluids can more effectively carry materials away from a drilling location downhole.

[0003] One common way to attain high viscosities in drilling fluids is to use a mixture of water and a viscosifier, such as guar gum. However, typically viscosifiers must be added in high concentrations to provide viscosities sufficient to suspend a desired proppant or to suspend drill cuttings, which can result in high transportation costs and low efficiency preparation of viscous materials. However, pumping high viscosity materials into a subterranean formation can require a large amount of energy. Also, the higher temperatures experienced in a subterranean formation can limit, reduce, or degrade the effectiveness of certain viscosifiers, resulting in the use of larger amounts of viscosifiers to compensate for the high temperatures, or the use of expensive temperature-resistant viscosifiers. In addition, the presence of certain ions in water can limit, reduce, or degrade the effectiveness of certain viscosifiers. This limits the use of certain ion-containing water, such as sea water, or water recovered from or naturally produced by some subterranean formations. As a result, the oil and gas industry spends substantial amounts of money and energy to use large amounts of viscosifiers to compensate for salt sensitivity, obtain expensive salt-resistant viscosifiers, obtain fresh water used for drilling fluid or fracturing fluid

applications, or to avoid formations having substantial concentrations of particular ions.

BRIEF DESCRIPTION OF THE FIGURES

[0004] The drawings illustrate generally, by way of example, but not by way of limitation, various embodiments discussed in the present document.

[0005] FIG. 1 illustrates a drilling assembly, in accordance with various embodiments.

[0006] FIG. 2 illustrates a system or apparatus for delivering a composition in a subterranean formation, in accordance with various embodiments.

[0007] FIG. 3 provides a graph of the viscosity of an ampholyte polymeric compound at various concentrations over time at an elevated temperature, in accordance with various embodiments.

[0008] FIG. 4 provides a graph comparing the viscosity of an ampholyte polymeric compound and a traditional viscosifier in water, in accordance with various embodiments.

[0009] FIG. 5 provides a graph comparing the viscosity of an ampholyte polymeric compound and a traditional viscosifier in a high TDS water, in accordance with various embodiments.

[0010] FIG. 6 provides a graph of percent friction reduction at various salinities for three friction reducing additives including one ampholyte polymeric compound, in accordance with various embodiments.

[0011] FIG. 7 provides a graph of viscosity measurements over time at various temperatures for a fluid including an ampholyte polymeric compound, in accordance with various embodiments.

[0012] FIG. 8 provides a graph comparing the intrinsic viscosity over time for a fluid including an ampholyte polymeric compound and a fluid including a traditional friction reducing agent, in accordance with various embodiments.

[0013] FIG. 9 provides a graph of viscosity measurements over time at various TDS concentrations for fluids including an ampholyte polymeric compound, in accordance with various embodiments.

[0014] FIG. 10 illustrates a photograph of a crosslinked ampholyte polymer, in accordance with various embodiments.

[0015] FIG. 11 illustrates viscosity versus shear rate for a crosslinked ampholyte terpolymer, in accordance with various embodiments.

[0016] FIG 12 illustrates frequency sweep data for various crosslinked polymers at 77 °F, in accordance with various embodiments.

[0017] FIG. 13 illustrates frequency sweep data for various crosslinked polymers at 150 °F, in accordance with various embodiments.

[0018] FIG. 14 illustrates a permeability profile for a crosslinked polyacrylamide, in accordance with various embodiments.

[0019] FIG. 15 illustrates a permeability profile for a crosslinked ampholyte terpolymer, in accordance with various embodiments.

DETAILED DESCRIPTION OF THE INVENTION

[0020] Reference will now be made in detail to certain embodiments of the disclosed subject matter, examples of which are illustrated in part in the accompanying drawings. While the disclosed subject matter will be described in conjunction with the enumerated claims, it will be understood that the exemplified subject matter is not intended to limit the claims to the disclosed subject matter.

[0021] Values expressed in a range format should be interpreted in a flexible manner to include not only the numerical values explicitly recited as the limits of the range, but also to include all the individual numerical values or sub-ranges encompassed within that range as if each numerical value and sub-range is explicitly recited. For example, a range of "about 0.1% to about 5%" or "about 0.1% to 5%" should be interpreted to include not just about 0.1% to about 5%, but also the individual values (e.g., 1%, 2%, 3%, and 4%) and the sub-ranges (e.g., 0.1% to 0.5%, 1.1% to 2.2%, 3.3% to 4.4%) within the indicated range. The statement "about X to Y" has the same meaning as "about X to about Y," unless indicated otherwise. Likewise, the statement "about X, Y, or about Z" has the same meaning as "about X, about Y, or about Z," unless indicated otherwise.

[0022] In this document, the terms "a," "an," or "the" are used to include one or more than one unless the context clearly dictates otherwise. The term

"or" is used to refer to a nonexclusive "or" unless otherwise indicated. The statement "at least one of A and B" has the same meaning as "A, B, or A and B." In addition, it is to be understood that the phraseology or terminology employed herein, and not otherwise defined, is for the purpose of description only and not of limitation. Any use of section headings is intended to aid reading of the document and is not to be interpreted as limiting; information that is relevant to a section heading may occur within or outside of that particular section. Furthermore, all publications, patents, and patent documents referred to in this document are incorporated by reference herein in their entirety, as though individually incorporated by reference. In the event of inconsistent usages between this document and those documents so incorporated by reference, the usage in the incorporated reference should be considered supplementary to that of this document; for irreconcilable inconsistencies, the usage in this document controls.

[0023] In the methods of manufacturing described herein, the steps can be carried out in any order without departing from the principles of the invention, except when a temporal or operational sequence is explicitly recited. Furthermore, specified steps can be carried out concurrently unless explicit claim language recites that they be carried out separately. For example, a claimed step of doing X and a claimed step of doing Y can be conducted simultaneously within a single operation, and the resulting process will fall within the literal scope of the claimed process.

[0024] Selected substituents within the compounds described herein are present to a recursive degree. In this context, "recursive substituent" means that a substituent may recite another instance of itself or of another substituent that itself recites the first substituent. Recursive substituents are an intended aspect of the disclosed subject matter. Because of the recursive nature of such substituents, theoretically, a large number may be present in any given claim. One of ordinary skill in the art of organic chemistry understands that the total number of such substituents is reasonably limited by the desired properties of the compound intended. Such properties include, by way of example and not limitation, physical properties such as molecular weight, solubility, and practical properties such as ease of synthesis. Recursive substituents can call back on themselves any suitable number of times, such as about 1 time, about 2 times, 3,

4, 5, 6, 7, 8, 9, 10, 15, 20, 30, 50, 100, 200, 300, 400, 500, 750, 1000, 1500, 2000, 3000, 4000, 5000, 10,000, 15,000, 20,000, 30,000, 50,000, 100,000, 200,000, 500,000, 750,000, or about 1,000,000 times or more.

[0025] The term "about" as used herein can allow for a degree of variability in a value or range, for example, within 10%, within 5%, or within 1% of a stated value or of a stated limit of a range.

[0026] The term "substantially" as used herein refers to a majority of, or mostly, as in at least about 50%, 60%, 70%, 80%, 90%, 95%, 96%, 97%, 98%, 99%, 99.5%, 99.9%, 99.99%, or at least about 99.999% or more.

[0027] The term "organic group" as used herein refers to but is not limited to any carbon-containing functional group. For example, an oxygen-containing group such as an alkoxy group, aryloxy group, aralkyloxy group, oxo(carbonyl) group, a carboxyl group including a carboxylic acid, carboxylate, and a carboxylate ester; a sulfur-containing group such as an alkyl and aryl sulfide group; and other heteroatom-containing groups. Non-limiting examples of organic groups include OR, OOR, $OC(O)N(R)_2$, CN, CF_3, OCF_3, R, C(O), methylenedioxy, ethylenedioxy, $N(R)_2$, SR, SOR, SO_2R, $SO_2N(R)_2$, SO_3R, C(O)R, C(O)C(O)R, $C(O)CH_2C(O)R$, C(S)R, C(O)OR, OC(O)R, $C(O)N(R)_2$, $OC(O)N(R)_2$, $C(S)N(R)_2$, $(CH_2)_{0-2}N(R)C(O)R$, $(CH_2)_{0-2}N(R)N(R)_2$, N(R)N(R)C(O)R, N(R)N(R)C(O)OR, $N(R)N(R)CON(R)_2$, $N(R)SO_2R$, $N(R)SO_2N(R)_2$, N(R)C(O)OR, N(R)C(O)R, N(R)C(S)R, $N(R)C(O)N(R)_2$, $N(R)C(S)N(R)_2$, N(COR)COR, N(OR)R, $C(=NH)N(R)_2$, C(O)N(OR)R, or C(=NOR)R, wherein R can be hydrogen (in examples that include other carbon atoms) or a carbon-based moiety, and wherein the carbon-based moiety can itself be further substituted.

[0028] The term "substituted" as used herein refers to an organic group as defined herein or molecule in which one or more hydrogen atoms contained therein are replaced by one or more non-hydrogen atoms. The term "functional group" or "substituent" as used herein refers to a group that can be or is substituted onto a molecule or onto an organic group. Examples of substituents or functional groups include, but are not limited to, a halogen (e.g., F, Cl, Br, and I); an oxygen atom in groups such as hydroxyl groups, alkoxy groups, aryloxy groups, aralkyloxy groups, oxo(carbonyl) groups, carboxyl groups including carboxylic acids, carboxylates, and carboxylate esters; a sulfur atom in

groups such as thiol groups, alkyl and aryl sulfide groups, sulfoxide groups, sulfone groups, sulfonyl groups, and sulfonamide groups; a nitrogen atom in groups such as amines, hydroxylamines, nitriles, nitro groups, N-oxides, hydrazides, azides, and enamines; and other heteroatoms in various other groups. Non-limiting examples of substituents J that can be bonded to a substituted carbon (or other) atom include F, Cl, Br, I, OR, $OC(O)N(R')_2$, CN, NO, NO_2, ONO_2, azido, CF_3, OCF_3, R, O (oxo), S (thiono), C(O), S(O), methylenedioxy, ethylenedioxy, $N(R)_2$, SR, SOR, SO_2R, $SO_2N(R)_2$, SO_3R, C(O)R, C(O)C(O)R, $C(O)CH_2C(O)R$, C(S)R, C(O)OR, OC(O)R, $C(O)N(R)_2$, $OC(O)N(R)_2$, $C(S)N(R)_2$, $(CH_2)_{0-2}N(R)C(O)R$, $(CH_2)_{0-2}N(R)N(R)_2$, N(R)N(R)C(O)R, N(R)N(R)C(O)OR, $N(R)N(R)CON(R)_2$, $N(R)SO_2R$, $N(R)SO_2N(R)_2$, N(R)C(O)OR, N(R)C(O)R, N(R)C(S)R, $N(R)C(O)N(R)_2$, $N(R)C(S)N(R)_2$, N(COR)COR, N(OR)R, $C(=NH)N(R)_2$, C(O)N(OR)R, or C(=NOR)R, wherein R can be hydrogen or a carbon-based moiety, and wherein the carbon-based moiety can itself be further substituted; for example, wherein R can be hydrogen, alkyl, acyl, cycloalkyl, aryl, aralkyl, heterocyclyl, heteroaryl, or heteroarylalkyl, wherein any alkyl, acyl, cycloalkyl, aryl, aralkyl, heterocyclyl, heteroaryl, or heteroarylalkyl or R can be independently mono- or multi-substituted with J; or wherein two R groups bonded to a nitrogen atom or to adjacent nitrogen atoms can together with the nitrogen atom or atoms form a heterocyclyl, which can be mono- or independently multi-substituted with J.

[0029] The term “alkyl” as used herein refers to straight chain and branched alkyl groups and cycloalkyl groups having from 1 to 40 carbon atoms, 1 to about 20 carbon atoms, 1 to 12 carbons or, in some embodiments, from 1 to 8 carbon atoms. Examples of straight chain alkyl groups include those with from 1 to 8 carbon atoms such as methyl, ethyl, n-propyl, n-butyl, n-pentyl, n-hexyl, n-heptyl, and n-octyl groups. Examples of branched alkyl groups include, but are not limited to, isopropyl, iso-butyl, sec-butyl, t-butyl, neopentyl, isopentyl, and 2,2-dimethylpropyl groups. As used herein, the term “alkyl” encompasses n-alkyl, isoalkyl, and anteisoalkyl groups as well as other branched chain forms of alkyl. Representative substituted alkyl groups can be substituted one or more times with any of the groups listed herein, for example, amino, hydroxy, cyano, carboxy, nitro, thio, alkoxy, and halogen groups.

[0030] The term "alkenyl" as used herein refers to straight and branched chain and cyclic alkyl groups as defined herein, except that at least one double bond exists between two carbon atoms. Thus, alkenyl groups have from 2 to 40 carbon atoms, or 2 to about 20 carbon atoms, or 2 to 12 carbons or, in some embodiments, from 2 to 8 carbon atoms. Examples include, but are not limited to vinyl, -CH=CH(CH_3), -CH=C(CH_3)$_2$, -C(CH_3)=CH_2, -C(CH_3)=CH(CH_3), -C(CH_2CH_3)=CH_2, cyclohexenyl, cyclopentenyl, cyclohexadienyl, butadienyl, pentadienyl, and hexadienyl among others.

[0031] The term "alkynyl" as used herein refers to straight and branched chain alkyl groups, except that at least one triple bond exists between two carbon atoms. Thus, alkynyl groups have from 2 to 40 carbon atoms, 2 to about 20 carbon atoms, or from 2 to 12 carbons or, in some embodiments, from 2 to 8 carbon atoms. Examples include, but are not limited to –C≡CH, -C≡C(CH_3), -C≡C(CH_2CH_3), -CH_2C≡CH, -CH_2C≡C(CH_3), and -CH_2C≡C(CH_2CH_3) among others.

[0032] The term "acyl" as used herein refers to a group containing a carbonyl moiety wherein the group is bonded via the carbonyl carbon atom. The carbonyl carbon atom is also bonded to another carbon atom, which can be part of an alkyl, aryl, aralkyl cycloalkyl, cycloalkylalkyl, heterocyclyl, heterocyclylalkyl, heteroaryl, heteroarylalkyl group or the like. In the special case wherein the carbonyl carbon atom is bonded to a hydrogen, the group is a "formyl" group, an acyl group as the term is defined herein. An acyl group can include 0 to about 12-20 or 12-40 additional carbon atoms bonded to the carbonyl group. An acyl group can include double or triple bonds within the meaning herein. An acryloyl group is an example of an acyl group. An acyl group can also include heteroatoms within the meaning here. A nicotinoyl group (pyridyl-3-carbonyl) is an example of an acyl group within the meaning herein. Other examples include acetyl, benzoyl, phenylacetyl, pyridylacetyl, cinnamoyl, and acryloyl groups and the like. When the group containing the carbon atom that is bonded to the carbonyl carbon atom contains a halogen, the group is termed a "haloacyl" group. An example is a trifluoroacetyl group.

[0033] The term "aryl" as used herein refers to cyclic aromatic hydrocarbons that do not contain heteroatoms in the ring. Thus aryl groups include, but are not limited to, phenyl, azulenyl, heptalenyl, biphenyl, indacenyl,

fluorenyl, phenanthrenyl, triphenylenyl, pyrenyl, naphthacenyl, chrysenyl, biphenylenyl, anthracenyl, and naphthyl groups. In some embodiments, aryl groups contain about 6 to about 14 carbons in the ring portions of the groups. Aryl groups can be unsubstituted or substituted, as defined herein. Representative substituted aryl groups can be mono-substituted or substituted more than once, such as, but not limited to, 2-, 3-, 4-, 5-, or 6-substituted phenyl or 2-8 substituted naphthyl groups, which can be substituted with carbon or non-carbon groups such as those listed herein.

[0034] The term "heterocyclyl" as used herein refers to aromatic and non-aromatic ring compounds containing 3 or more ring members, of which one or more is a heteroatom such as, but not limited to, N, O, and S. Thus, a heterocyclyl can be a cycloheteroalkyl, or a heteroaryl, or if polycyclic, any combination thereof. In some embodiments, heterocyclyl groups include 3 to about 20 ring members, whereas other such groups have 3 to about 15 ring members. A heterocyclyl group designated as a C_2-heterocyclyl can be a 5-ring with two carbon atoms and three heteroatoms, a 6-ring with two carbon atoms and four heteroatoms and so forth. Likewise a C_4-heterocyclyl can be a 5-ring with one heteroatom, a 6-ring with two heteroatoms, and so forth. The number of carbon atoms plus the number of heteroatoms equals the total number of ring atoms. A heterocyclyl ring can also include one or more double bonds. A heteroaryl ring is an embodiment of a heterocyclyl group. The phrase "heterocyclyl group" includes fused ring species including those that include fused aromatic and non-aromatic groups.

[0035] The term "alkoxy" as used herein refers to an oxygen atom connected to an alkyl group, including a cycloalkyl group, as are defined herein. Examples of linear alkoxy groups include but are not limited to methoxy, ethoxy, propoxy, butoxy, pentyloxy, hexyloxy, and the like. Examples of branched alkoxy include but are not limited to isopropoxy, sec-butoxy, tert-butoxy, isopentyloxy, isohexyloxy, and the like. Examples of cyclic alkoxy include but are not limited to cyclopropyloxy, cyclobutyloxy, cyclopentyloxy, cyclohexyloxy, and the like. An alkoxy group can include one to about 12-20 or about 12-40 carbon atoms bonded to the oxygen atom, and can further include double or triple bonds, and can also include heteroatoms. For example, an allyloxy group is an alkoxy group within the meaning herein. A methoxyethoxy

group is also an alkoxy group within the meaning herein, as is a methylenedioxy group in a context where two adjacent atoms of a structure are substituted therewith.

[0036] The term "amine" as used herein refers to primary, secondary, and tertiary amines having, e.g., the formula $N(group)_3$ wherein each group can independently be H or non-H, such as alkyl, aryl, and the like. Amines include but are not limited to $R\text{-}NH_2$, for example, alkylamines, arylamines, alkylarylamines; R_2NH wherein each R is independently selected, such as dialkylamines, diarylamines, aralkylamines, heterocyclylamines and the like; and R_3N wherein each R is independently selected, such as trialkylamines, dialkylarylamines, alkyldiarylamines, triarylamines, and the like. The term "amine" also includes ammonium ions as used herein.

[0037] The term "amino group" as used herein refers to a substituent of the form $-NH_2$, -NHR, $-NR_2$, $-NR_3^+$, wherein each R is independently selected, and protonated forms of each, except for $-NR_3^+$, which cannot be protonated. Accordingly, any compound substituted with an amino group can be viewed as an amine. An "amino group" within the meaning herein can be a primary, secondary, tertiary, or quaternary amino group. An "alkylamino" group includes a monoalkylamino, dialkylamino, and trialkylamino group.

[0038] The terms "halo," "halogen," or "halide" group, as used herein, by themselves or as part of another substituent, mean, unless otherwise stated, a fluorine, chlorine, bromine, or iodine atom.

[0039] The term "haloalkyl" group, as used herein, includes mono-halo alkyl groups, poly-halo alkyl groups wherein all halo atoms can be the same or different, and per-halo alkyl groups, wherein all hydrogen atoms are replaced by halogen atoms, such as fluoro. Examples of haloalkyl include trifluoromethyl, 1,1-dichloroethyl, 1,2-dichloroethyl, 1,3-dibromo-3,3-difluoropropyl, perfluorobutyl, and the like.

[0040] The term "hydrocarbon" as used herein refers to a functional group or molecule that includes carbon and hydrogen atoms. The term can also refer to a functional group or molecule that normally includes both carbon and hydrogen atoms but wherein all the hydrogen atoms are substituted with other functional groups.

[0041] As used herein, the term "hydrocarbyl" refers to a functional group derived from a straight chain, branched, or cyclic hydrocarbon, and can be alkyl, alkenyl, alkynyl, aryl, cycloalkyl, acyl, or any combination thereof.

[0042] The term "solvent" as used herein refers to a liquid that can dissolve a solid, liquid, or gas. Nonlimiting examples of solvents are silicones, organic compounds, water, alcohols, ionic liquids, and supercritical fluids.

[0043] The term "number-average molecular weight" as used herein refers to the ordinary arithmetic mean of the molecular weight of individual molecules in a sample. It is defined as the total weight of all molecules in a sample divided by the total number of molecules in the sample. Experimentally, the number-average molecular weight (M_n) is determined by analyzing a sample divided into molecular weight fractions of species i having n_i molecules of molecular weight M_i through the formula $M_n = \Sigma M_i n_i / \Sigma n_i$. The number-average molecular weight can be measured by a variety of well-known methods including gel permeation chromatography, spectroscopic end group analysis, and osmometry. If unspecified, molecular weights of polymers given herein are number-average molecular weights.

[0044] The term "weight-average molecular weight" as used herein refers to M_w, which is equal to $\Sigma M_i^2 n_i / \Sigma M_i n_i$, where n_i is the number of molecules of molecular weight M_i. In various examples, the weight-average molecular weight can be determined using light scattering, small angle neutron scattering, X-ray scattering, and sedimentation velocity.

[0045] The term "room temperature" as used herein refers to a temperature of about 15 °C to 28 °C.

[0046] The term "standard temperature and pressure" as used herein refers to 20 °C and 101 kPa.

[0047] As used herein, "degree of polymerization" is the number of repeating units in a polymer.

[0048] As used herein, the term "polymer" refers to a molecule having at least one repeating unit and can include copolymers.

[0049] The term "copolymer" as used herein refers to a polymer that includes at least two different monomers. A copolymer can include any suitable number of monomers.

[0050] The term "downhole" as used herein refers to under the surface of the earth, such as a location within or fluidly connected to a wellbore.

[0051] As used herein, the term "drilling fluid" refers to fluids, slurries, or muds used in drilling operations downhole, such as during the formation of the wellbore.

[0052] As used herein, the term "stimulation fluid" refers to fluids or slurries used downhole during stimulation activities of the well that can increase the production of a well, including perforation activities. In some examples, a stimulation fluid can include a fracturing fluid or an acidizing fluid.

[0053] As used herein, the term "clean-up fluid" refers to fluids or slurries used downhole during clean-up activities of the well, such as any treatment to remove material obstructing the flow of desired material from the subterranean formation. In one example, a clean-up fluid can be an acidification treatment to remove material formed by one or more perforation treatments. In another example, a clean-up fluid can be used to remove a filter cake.

[0054] As used herein, the term "fracturing fluid" refers to fluids or slurries used downhole during fracturing operations.

[0055] As used herein, the term "spotting fluid" refers to fluids or slurries used downhole during spotting operations, and can be any fluid designed for localized treatment of a downhole region. In one example, a spotting fluid can include a lost circulation material for treatment of a specific section of the wellbore, such as to seal off fractures in the wellbore and prevent sag. In another example, a spotting fluid can include a water control material. In some examples, a spotting fluid can be designed to free a stuck piece of drilling or extraction equipment, can reduce torque and drag with drilling lubricants, prevent differential sticking, promote wellbore stability, and can help to control mud weight.

[0056] As used herein, the term "completion fluid" refers to fluids or slurries used downhole during the completion phase of a well, including cementing compositions.

[0057] As used herein, the term "remedial treatment fluid" refers to fluids or slurries used downhole for remedial treatment of a well. Remedial treatments can include treatments designed to increase or maintain the production rate of a well, such as stimulation or clean-up treatments.

[0058] As used herein, the term "abandonment fluid" refers to fluids or slurries used downhole during or preceding the abandonment phase of a well.

[0059] As used herein, the term "acidizing fluid" refers to fluids or slurries used downhole during acidizing treatments. In one example, an acidizing fluid is used in a clean-up operation to remove material obstructing the flow of desired material, such as material formed during a perforation operation. In some examples, an acidizing fluid can be used for damage removal.

[0060] As used herein, the term "cementing fluid" refers to fluids or slurries used during cementing operations of a well. For example, a cementing fluid can include an aqueous mixture including at least one of cement and cement kiln dust. In another example, a cementing fluid can include a curable resinous material such as a polymer that is in an at least partially uncured state.

[0061] As used herein, the term "water control material" refers to a solid or liquid material that interacts with aqueous material downhole, such that hydrophobic material can more easily travel to the surface and such that hydrophilic material (including water) can less easily travel to the surface. A water control material can be used to treat a well to cause the proportion of water produced to decrease and to cause the proportion of hydrocarbons produced to increase, such as by selectively binding together material between water-producing subterranean formations and the wellbore while still allowing hydrocarbon-producing formations to maintain output.

[0062] As used herein, the term "packing fluid" refers to fluids or slurries that can be placed in the annular region of a well between tubing and outer casing above a packer. In various examples, the packing fluid can provide hydrostatic pressure in order to lower differential pressure across the sealing element, lower differential pressure on the wellbore and casing to prevent collapse, and protect metals and elastomers from corrosion.

[0063] As used herein, the term "fluid" refers to liquids and gels, unless otherwise indicated.

[0064] As used herein, the term "subterranean material" or "subterranean formation" refers to any material under the surface of the earth, including under the surface of the bottom of the ocean. For example, a subterranean formation or material can be any section of a wellbore and any section of a subterranean petroleum- or water-producing formation or region in fluid contact with the

wellbore. Placing a material in a subterranean formation can include contacting the material with any section of a wellbore or with any subterranean region in fluid contact therewith. Subterranean materials can include any materials placed into the wellbore such as cement, drill shafts, liners, tubing, or screens; placing a material in a subterranean formation can include contacting with such subterranean materials. In some examples, a subterranean formation or material can be any below-ground region that can produce liquid or gaseous petroleum materials, water, or any section below-ground in fluid contact therewith. For example, a subterranean formation or material can be at least one of an area desired to be fractured, a fracture or an area surrounding a fracture, and a flow pathway or an area surrounding a flow pathway, wherein a fracture or a flow pathway can be optionally fluidly connected to a subterranean petroleum- or water-producing region, directly or through one or more fractures or flow pathways.

[0065] As used herein, "treatment of a subterranean formation" can include any activity directed to extraction of water or petroleum materials from a subterranean petroleum- or water-producing formation or region, for example, including drilling, stimulation, hydraulic fracturing, clean-up, acidizing, completion, cementing, remedial treatment, abandonment, and the like.

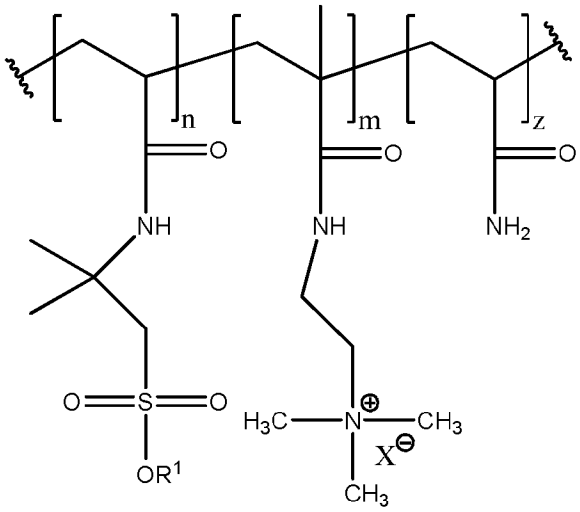
[0066] As used herein, a "flow pathway" downhole can include any suitable subterranean flow pathway through which two subterranean locations are in fluid connection. The flow pathway can be sufficient for petroleum or water to flow from one subterranean location to the wellbore, or vice-versa. A flow pathway can include at least one of a hydraulic fracture, a fluid connection across a screen, across gravel pack, across proppant, including across resin-bonded proppant or proppant deposited in a fracture, and across sand. A flow pathway can include a natural subterranean passageway through which fluids can flow. In some embodiments, a flow pathway can be a water source and can include water. In some embodiments, a flow pathway can be a petroleum source and can include petroleum. In some embodiments, a flow pathway can be sufficient to divert from a wellbore, fracture, or flow pathway connected thereto at least one of water, a downhole fluid, or a produced hydrocarbon.

[0067] As used herein "gpt" refers to gallons per thousand gallons.

[0068] In various embodiments, the present invention provides a method of treating a subterranean formation. The method includes obtaining or providing a composition including a crosslinkable ampholyte polymer. The crosslinkable ampholyte polymer includes an ethylene repeating unit including a $-C(O)NH_2$ group, an ethylene repeating unit including an $-S(O)_2OR^1$ group, and an ethylene repeating unit including an $-N^+R^2{}_3X^-$ group. At each occurrence, R^1 is independently selected from the group consisting of -H and a counterion. At each occurrence, R^2 is independently substituted or unsubstituted (C_1-C_{20})hydrocarbyl. At each occurrence, X^- is independently a counterion. The composition includes at least one crosslinker. The method includes placing the composition in a subterranean formation.

[0069] In various embodiments, the present invention provides a method of treating a subterranean formation. The method includes obtaining or providing a composition. The composition includes a reaction product of a mixture. The mixture includes a crosslinkable ampholyte polymer including an ethylene repeating unit including a $-C(O)NH_2$ group, an ethylene repeating unit including an $-S(O)_2OR^1$ group, and an ethylene repeating unit including an $-N^+R^2{}_3X^-$ group. At each occurrence, R^1 is independently selected from the group consisting of -H and a counterion. At each occurrence, R^2 is independently substituted or unsubstituted (C_1-C_{20})hydrocarbyl. At each occurrence, X^- is independently a counterion. The mixture also includes at least one crosslinker. The method also includes placing the composition in a subterranean formation.

[0070] In various embodiments, the present invention provides a method of treating a subterranean formation. The method includes obtaining or providing a composition including a crosslinkable ampholyte polymer. The crosslinkable ampholyte polymer includes repeating units having the structure:



At each occurrence, R^1 is independently selected from the group consisting of -H and a counterion. The repeating units are in a block, alternate, or random configuration, and each repeating unit is independently in the orientation shown or in the opposite orientation. The crosslinkable ampholyte polymer has a molecular weight of about 100,000 g/mol to about 20,000,000 g/mol. The crosslinkable ampholyte polymer has about 30 wt% to about 50 wt% of the ethylene repeating unit including the $-C(O)NH_2$ group, about 5 wt% to about 15 wt% of the ethylene repeating unit including the $-S(O)_2OR^1$ group, and about 40 wt% to about 60 wt% of the ethylene repeating unit including the $-N^+R^2{}_3X^-$ group. The composition also includes a crosslinker including polyethyleneimine. The composition also includes a downhole fluid including at least one of a drilling fluid, a fracturing fluid, a diverting fluid, and a lost circulation treatment fluid. The method also includes placing the composition in a subterranean formation. About 0.001 wt% to about 30 v/v% of the composition is the crosslinkable ampholyte polymer and the crosslinker.

[0071] In various embodiments, the present invention provides a system. The system includes a composition including a crosslinkable ampholyte polymer. The crosslinkable ampholyte polymer has about Z^{wt} wt% of an ethylene repeating unit including the $-C(O)NH_2$ group, about N^{wt} wt% of an ethylene repeating unit including a $-S(O)_2OR^1$ group, and about M^{wt} wt% of an ethylene repeating unit including an $-N^+R^2{}_3X^-$ group. At each occurrence R^1 is independently selected from the group consisting of -H and a counterion. At each occurrence, R^2 is independently substituted or unsubstituted (C_1-

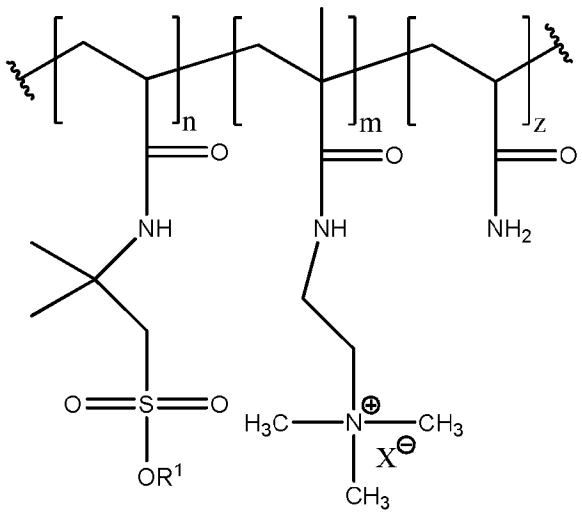
C_{20})hydrocarbyl. At each occurrence, X^- is independently a counterion. The repeating units are in block, alternate, or random configuration. The variable Z^{wt} is about 10% to about 70%, N^{wt} is about 1% to about 40%, and M^{wt} is about 20% to about 80%. The crosslinkable ampholyte polymer has a molecular weight of about 100,000 g/mol to about 20,000,000 g/mol. The composition also includes at least one crosslinker. The system also includes a subterranean formation including the composition therein.

[0072] In various embodiments, the present invention provides a composition for treatment of a subterranean formation. The composition includes a crosslinkable ampholyte polymer having about Z^{wt} wt% of an ethylene repeating unit including the $-C(O)NH_2$ group, about N^{wt} wt% of an ethylene repeating unit including a $-S(O)_2OR^1$ group, and about M^{wt} wt% of an ethylene repeating unit including an $-N^+R^2{}_3X^-$ group. At each occurrence R^1 is independently selected from the group consisting of -H and a counterion. At each occurrence, R^2 is independently substituted or unsubstituted (C_1-C_{20})hydrocarbyl. At each occurrence, X^- is independently a counterion. The repeating units are in block, alternate, or random configuration. The variable Z^{wt} is about 10% to about 70%, N^{wt} is about 1% to about 40%, and M^{wt} is about 20% to about 80%. The crosslinkable ampholyte polymer has a molecular weight of about 100,000 g/mol to about 20,000,000 g/mol. The composition includes at least one crosslinker. The composition also includes a downhole fluid.

[0073] In various embodiments, the present invention provides a composition for treatment of a subterranean formation. The composition includes a reaction product of a mixture. The mixture includes a crosslinkable ampholyte polymer having about Z^{wt} wt% of an ethylene repeating unit including the $-C(O)NH_2$ group, about N^{wt} wt% of an ethylene repeating unit including a $-S(O)_2OR^1$ group, and about M^{wt} wt% of an ethylene repeating unit including an $-N^+R^2{}_3X^-$ group. At each occurrence R^1 is independently selected from the group consisting of -H and a counterion. At each occurrence, R^2 is independently substituted or unsubstituted (C_1-C_{20})hydrocarbyl. At each occurrence, X^- is independently a counterion. The repeating units are in block, alternate, or random configuration. The variable Z^{wt} is about 10% to about 70%, N^{wt} is about 1% to about 40%, and M^{wt} is about 20% to about 80%. The crosslinkable ampholyte polymer has a molecular weight of about 100,000 g/mol

to about 20,000,000 g/mol. The mixture also includes at least one crosslinker. The composition also includes a downhole fluid.

[0074] In various embodiments, the present invention provides a composition for treatment of a subterranean formation. The composition includes a crosslinkable ampholyte polymer including repeating units having the structure:



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At each occurrence R^1 is independently selected from the group consisting of -H and a counterion. The repeating units are in a block, alternate, or random configuration, and each repeating unit is independently in the orientation shown or in the opposite orientation. The crosslinkable ampholyte polymer has a molecular weight of about 100,000 g/mol to about 20,000,000 g/mol. The crosslinkable ampholyte polymer has about 30 wt% to about 50 wt% of the ethylene repeating unit including the $-C(O)NH_2$ group, about 5 wt% to about 15 wt% of the ethylene repeating unit including the $-S(O)_2OR^1$ group, and about 40 wt% to about 60 wt% of the ethylene repeating unit including the $-N^+R^2{}_3X^-$ group. The composition includes a crosslinker including polyethyleneimine. The composition also includes a downhole fluid including at least one of a drilling fluid, a fracturing fluid, a diverting fluid, and a lost circulation treatment fluid. About 0.001 wt% to about 30 v/v% of the composition is the crosslinkable ampholyte polymer and the crosslinker.

[0075] In various embodiments, the present invention provides a method of preparing a composition for treatment of a subterranean formation. The method includes forming a composition including a crosslinkable ampholyte

polymer including an ethylene repeating unit including a $-C(O)NH_2$ group, an ethylene repeating unit including an $-S(O)_2OR^1$ group, and an ethylene repeating unit including an $-N^+R^2{}_3X^-$ group. At each occurrence, R^1 is independently selected from the group consisting of -H and a counterion. At each occurrence, R^2 is independently substituted or unsubstituted (C_1-C_{20})hydrocarbyl. At each occurrence, X^- is independently a counterion. The composition also includes at least one crosslinker.

[0076] Various embodiments of the present invention provide certain advantages over other compositions including viscosifiers and methods of using the same, at least some of which are unexpected. For example, in some embodiments, the uncrosslinked crosslinkable ampholyte polymer can act as a friction reducer before crosslinking (e.g., for slickwater fracturing or other uses), and can act as a viscosifier after crosslinking. In some embodiments, the uncrosslinked crosslinkable ampholyte polymer can act as a viscosifier before crosslinking, and can provide an even greater viscosity increase or even a solidification after crosslinking. In some embodiments, the ability of the crosslinkable ampholyte polymer to provide multiple uses in addition to viscosification or gelation in a subterranean formation, such as friction reduction and viscosification, can at least one of: simplify a subterranean operation, reduce transportation costs, reduce the costs of storing and blending multiple materials at a worksite, reduce the amount of equipment needed at a worksite (e.g., reduce footprint), and reduce the equipment cost overall.

[0077] In some embodiments, the crosslinkable ampholyte polymer can provide a greater increase in viscosity of a downhole fluid per mass (e.g., via at least partially crosslinking the crosslinkable ampholyte polymer) than other viscosifiers. Compared to the viscosity of a downhole fluid having a given concentration of a viscosifier (or, e.g., a downhole fluid formed by at least partially crosslinking a given concentration of a viscosifier), a corresponding downhole fluid having the same or lower concentration of various embodiments of the crosslinkable ampholyte polymer (or, e.g., formed by at least partially crosslinking the crosslinkable ampholyte polymer) can have a higher viscosity. In some embodiments, by enabling a higher viscosity with the use of less viscosifier, the crosslinkable ampholyte polymer can provide lower

transportation costs and shorter preparation time, making operations more efficient overall.

[0078] In various embodiments, the crosslinkable ampholyte polymer can be less expensive per unit mass as compared to conventional viscosifiers. In various embodiments, the crosslinkable ampholyte polymer can provide a greater viscosity increase or a higher gel strength per unit cost as compared to other viscosifiers. In various embodiments, the crosslinkable ampholyte polymer can provide a greater viscosity increase or a higher gel strength per unit cost in the presence of various salts or under high temperature conditions, as compared to other viscosifiers.

[0079] Conventional viscosifiers provide viscosification of a composition before and during transport to a desired location in a subterranean formation, requiring the energy-intensive pumping of a high viscosity composition through tubular conduits to reach the desired location in the subterranean formation. In various embodiments, the crosslinkable ampholyte polymer partially or fully avoids providing a viscosity increase until the composition reaches or becomes near a desired subterranean location, and in some embodiments provides a reduction in friction en route to the desired location. In various embodiments, the viscosity increase provided by the crosslinkable ampholyte polymer can be triggered by heat, such as the higher temperature of the desired location in a subterranean formation. In various embodiments, by delaying the viscosity increase, the crosslinkable ampholyte polymer can provide a more efficient method of providing high viscosity compositions to a desired location in a subterranean formation. In some embodiments, the crosslinkable ampholyte polymer can be optimized for use at a particular temperature by varying the structure or concentration of at least one of the viscosifier and the crosslinker to provide a desired viscosity in a desired location.

[0080] Many conventional viscosifiers suffer a decrease in the viscosity or gel strength provided when used under high temperature conditions such as the conditions found in many subterranean formations. In some embodiments, under high temperature conditions, the crosslinkable ampholyte polymer can provide a higher viscosity or higher gel strength, or can provide less or no decrease in viscosity or gel strength, as compared to the viscosity provided by

other conventional viscosifiers under corresponding conditions. In various embodiments, the higher temperature stability of the crosslinkable ampholyte polymer can allow a desired level of viscosification or gelation with the use of less viscosifier, or can allow a higher viscosity or gel strength to be achieved in a subterranean formation, as compared to other conventional viscosifiers, thereby providing a more versatile, more cost effective, or more efficient viscosification or gelation in the subterranean formation than other methods and compositions.

[0081] Many conventional viscosifiers suffer a decrease in the viscosity or gel strength provided when used with liquids such as water having certain ions present at particular concentrations. For example, many viscosifiers suffer a decrease in the viscosity or gel strength provided when used with liquids having certain amounts of salts dissolved therein such as sodium chloride or potassium chloride. In some embodiments, the crosslinkable ampholyte polymer can be used with liquids having ions dissolved therein and can suffer less or no negative effects from the ions, as compared to conventional methods and compositions for use in subterranean formations, such as less or no decrease in the viscosity provided. By being able to retain the viscosity or gel strength provided or suffer less reduction in viscosity or gel strength in the presence of various ions or in the presence of larger amounts of particular ions than other methods and compositions, various embodiments can avoid the need for ion-free or ion-depleted water, or can avoid a need to add greater amounts of viscosifier to achieve a desired effect in a subterranean formation, and can thereby be more versatile, more cost effective, or more efficient than other methods and compositions for subterranean use.

[0082] In various embodiments, by providing a higher viscosity or higher gel strength under high temperature conditions or high salinity conditions, the crosslinkable ampholyte polymer can provide a more effective subterranean or downhole fluid, such as a more effective drilling fluid that has greater cutting carrying capacity, sag resistance, or equivalent circulating density, a more effective hydraulic fracturing fluid that can more effectively carry proppant or form more dominant fractures, or a more effective diverter or lost circulation material that more effectively seals off flow pathways or controls permeability. In various embodiments, by providing a higher viscosity or gel strength under high temperature conditions or high salinity conditions, the crosslinkable

ampholyte polymer can provide a more effective sweeping agent (e.g., for removing cuttings from the wellbore), improved equivalent circulating density management, and improved fluid loss control (e.g., the higher viscosity can reduce fluid flow in pore spaces).

Method of treating a subterranean formation.

[0083] In various embodiments, the present invention provides a method of treating a subterranean formation. In some embodiments, the method includes obtaining or providing a composition including a crosslinker and a crosslinkable ampholyte polymer including an ethylene repeating unit including a $-C(O)NH_2$ group, an ethylene repeating unit including an $-S(O)_2OR^1$ group, and an ethylene repeating unit including an $-N^+R^2{}_3X^-$ group. At each occurrence, R^1 can be independently selected from the group consisting of -H and a counterion. At each occurrence, R^2 can be independently substituted or unsubstituted $(C_1\text{-}C_{20})$hydrocarbyl, and at each occurrence, X^- can be independently a counterion. In some embodiments, the method includes obtaining or providing a composition including a reaction product of a crosslinker and the crosslinkable ampholyte polymer (e.g., a product of a crosslinking reaction between the crosslinker and the crosslinkable ampholyte polymer). The obtaining or providing of the composition can occur at any suitable time and at any suitable location. The obtaining or providing of the composition can occur above the surface. The obtaining or providing of the composition can occur in the subterranean formation (e.g., downhole). The method also includes placing the composition in a subterranean formation. The placing of the composition in the subterranean formation can include contacting the composition and any suitable part of the subterranean formation, or contacting the composition and a subterranean material, such as any suitable subterranean material. The subterranean formation can be any suitable subterranean formation. In some embodiments, the method is a method of drilling the subterranean formation. In some embodiments, the method is a method of fracturing the subterranean formation. For example, the composition can be used as or with a drilling fluid, a hydraulic fracturing fluid, a diverting fluid, and a lost circulation treatment fluid.

[0084] In some examples, the placing of the composition in the subterranean formation (e.g., downhole) includes contacting the composition with or placing the composition in at least one of a fracture, at least a part of an area surrounding a fracture, a flow pathway, an area surrounding a flow pathway, and an area desired to be fractured. The placing of the composition in the subterranean formation can be any suitable placing and can include any suitable contacting between the subterranean formation and the composition. The placing of the composition in the subterranean formation can include at least partially depositing the composition in a fracture, flow pathway, or area surrounding the same.

[0085] The method can include hydraulic fracturing, such as a method of hydraulic fracturing to generate a fracture or flow pathway. The placing of the composition in the subterranean formation or the contacting of the subterranean formation and the hydraulic fracturing can occur at any time with respect to one another; for example, the hydraulic fracturing can occur at least one of before, during, and after the contacting or placing. In some embodiments, the contacting or placing occurs during the hydraulic fracturing, such as during any suitable stage of the hydraulic fracturing, such as during at least one of a pre-pad stage (e.g., during injection of water with no proppant, and additionally optionally mid- to low-strength acid), a pad stage (e.g., during injection of fluid only with no proppant, with some viscosifier, such as to begin to break into an area and initiate fractures to produce sufficient penetration and width to allow proppant-laden later stages to enter), or a slurry stage of the fracturing (e.g., viscous fluid with proppant). The method can include performing a stimulation treatment at least one of before, during, and after placing the composition in the subterranean formation in the fracture, flow pathway, or area surrounding the same. The stimulation treatment can be, for example, at least one of perforating, acidizing, injecting of cleaning fluids, propellant stimulation, and hydraulic fracturing. In some embodiments, the stimulation treatment at least partially generates a fracture or flow pathway where the composition is placed or contacted, or the composition is placed or contacted to an area surrounding the generated fracture or flow pathway.

[0086] The method can include diverting or fluid loss control. The composition can be delivered to the subterranean formation to a flowpath

causing fluid loss or undesired introduction of water. The composition can be crosslinked, such that the flowpath is at least partially sealed by the reaction product of the ampholyte polymer and the crosslinker, at least partially stopping fluid loss or preventing water from entering the wellbore and contaminating fluids such as production fluids.

[0087] In some embodiments, in addition to the crosslinkable ampholyte polymer and the crosslinker, or a reaction product thereof, the composition can include an aqueous liquid. The method can further include mixing the aqueous liquid with the polymer viscosifier. The mixing can occur at any suitable time and at any suitable location, such as above surface or in the subterranean formation. The aqueous liquid can be any suitable aqueous liquid, such as at least one of water, brine, produced water, flowback water, brackish water, and sea water. In some embodiments, the aqueous liquid can include at least one of an aqueous drilling fluid, aqueous fracturing fluid, aqueous diverting fluid, and an aqueous fluid loss control fluid. In some embodiments, the aqueous liquid can be the aqueous phase of an emulsion (e.g., the composition can include an emulsion having as the aqueous phase the aqueous liquid).

[0088] The composition can include any suitable proportion of the aqueous liquid, such that the composition can be used as described herein. For example, about 0.000,1 wt% to 99.999,9 wt% of the composition can be the aqueous liquid, or about 0.01 wt% to about 99.99 wt%, about 0.1 wt% to about 99.9 wt%, or about 20 wt% to about 90 wt%, or about 0.000,1 wt% or less, or about 0.000,001 wt%, 0.000,1, 0.001, 0.01, 0.1, 1, 2, 3, 4, 5, 10, 15, 20, 30, 40, 50, 60, 70, 80, 85, 90, 91, 92, 93, 94, 95, 96, 97, 98, 99, 99.9, 99.99, 99.999 wt%, or about 99.999,9 wt% or more of the composition can be the aqueous liquid.

[0089] The aqueous liquid be a salt water. The salt can be any suitable salt, such as at least one of NaBr, $CaCl_2$, $CaBr_2$, $ZnBr_2$, KCl, NaCl, a magnesium salt, a bromide salt, a formate salt, an acetate salt, and a nitrate salt. The crosslinkable ampholyte polymer and crosslinker can effectively provide increased viscosity in aqueous solutions having various total dissolved solids levels, or having various ppm salt concentrations. The crosslinkable ampholyte polymer and crosslinker can provide effective increased viscosity of a salt water having any suitable total dissolved solids level (e.g., wherein the dissolved solids

correspond to dissolved salts), such as about 1,000 mg/L to about 250,000 mg/L, or about 1,000 mg/L or less, or about 5,000 mg/L, 10,000, 15,000, 20,000, 25,000, 30,000, 40,000, 50,000, 75,000, 100,000, 125,000, 150,000, 175,000, 200,000, 225,000, or about 250,000 mg/L or more. The crosslinkable ampholyte polymer and crosslinker can provide effective increased viscosity of a salt water having any suitable salt concentration, such as about 1,000 ppm to about 300,000 ppm, or about 1,000 ppm to about 150,000 ppm, or about 1,000 ppm or less, or about 5,000 ppm, 10,000, 15,000, 20,000, 25,000, 30,000, 40,000, 50,000, 75,000, 100,000, 125,000, 150,000, 175,000, 200,000, 225,000, 250,000, 275,000, or about 300,000 ppm or more. In some examples, the aqueous liquid can have a concentration of at least one of NaBr, $CaCl_2$, $CaBr_2$, $ZnBr_2$, KCl, and NaCl of about 0.1% w/v to about 20% w/v, or about 0.1% w/v or less, or about 0.5% w/v, 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21, 22, 23, 24, 25, 26, 27, 28, 29, or about 30% w/v or more.

[0090] The crosslinkable ampholyte polymer and crosslinker, or a reaction product thereof, can be sufficient to provide effective increased viscosity to an aqueous liquid at various high temperatures. For example, the crosslinkable ampholyte polymer and crosslinker, or a reaction product thereof, can provide effective increased viscosity at up to about 500 °F, or up to about 490 °F, 480, 470, 460, 450, 440, 430, 420, 410, 400, 390, 380, 370, 360, 350, 340, 330, 320, 310, 300, 290, 280, 270, 260, 250, 240, 230, 220, 210, 200, 190, 180, 170, 160, 150 , 140, 130, 120, 110, or up to about 100 °F.

[0091] The method can include at least partially crosslinking the crosslinkable ampholyte polymer to provide a crosslinked ampholyte polymer. The crosslinking can include at least partially reacting the crosslinkable ampholyte polymer with at least the crosslinker to provide an at least partially crosslinked ampholyte polymer. The crosslinking can occur in any suitable location and at any suitable time. For example, the crosslinking can occur above-surface, in the subterranean formation, or a combination thereof. In some embodiments, the crosslinking can be triggered by a suitable event, for example, chemical triggering (e.g., contacting with one or more chemicals that initiate or catalyze the crosslinking reaction), temperature triggering (e.g., raising the temperature of the composition such that the crosslinking reaction occurs), or a combination thereof.

[0092] Temperature triggering can include exposing the composition to suitably high temperature in the subterranean formation wherein a higher viscosity is desired. Temperature-triggered crosslinking can include exposing the composition to a temperature of about 100 °F to about 500 °F, 125 °F to about 350 °F, 125 °F to about 250 °F, 175 °F to about 250 °F, or about 450 °F or more, or about 440 °F, 430, 420, 410, 400, 390, 380, 370, 360, 350, 340, 330, 320, 310, 300, 290, 280, 270, 260, 250, 240, 230, 220, 210, 200, 190, 180, 170, 160, 150 , 140, 130, 120, 110, or about 100 °F or less.

[0093] The composition can have any suitable viscosity above surface and in the subterranean formation, such that the composition can be used as described herein. The viscosity can be affected by any suitable component, such as one or more crosslinkable ampholyte polymers, one or more crosslinkers, one or more crosslinked products of the crosslinkable ampholyte polymer and the crosslinker, one or more secondary viscosifiers, one or more secondary crosslinkers, one or more crosslinked products of a secondary viscosifier and a secondary crosslinker, or any combination thereof. In some embodiments, the viscosity is affected by one or more crosslinked products of the crosslinkable ampholyte polymer. In some embodiments, the viscosity of the composition, at standard temperature and pressure and at a shear rate of about 50 s^{-1} to about 500 s^{-1}, or about 50 s^{-1} or less to about 1000 s^{-1} or more, is about 0.01 cP to about 10,000,000 cP, or about 0.01 cP or less, or about 0.1 cP, 1, 2, 3, 4, 5, 10, 15, 20, 25, 50, 75, 100, 150, 200, 250, 500, 750, 1,000, 1,250, 1,500, 2,000, 2,500, 5,000, 10,000, 15,000, 20,000, 25,000, 50,000, 75,000, 100,000, 125,000, 150,000, 175,000, 200,000, 225,000, 250,000, 500,000, 1,000,000, 1,250,000, 1,500,000, 2,000,000, 2,500,000, 5,000,000, 7,500,000, or about 10,000,000 cP or more. In some embodiments, the viscosity of the composition, at standard temperature and pressure and at a shear rate of about 0 s^{-1} to about 1 s^{-1}, or about 0.1 s^{-1} or less to about 1 s^{-1} or more, is about 0.01 cP to about 1,000,000 cP, or about 0.01 cP or less, or about 0.1 cP, 1, 2, 3, 4, 5, 10, 15, 20, 25, 50, 75, 100, 150, 200, 250, 500, 750, 1,000, 1,250, 1,500, 2,000, 2,500, 5,000, 10,000, 15,000, 20,000, 25,000, 50,000, 75,000, 100,000, 125,000, 150,000, 175,000, 200,000, 225,000, 250,000, 500,000, 1,000,000, 1,250,000, 1,500,000, 2,000,000, 2,500,000, 5,000,000, 7,500,000, or about 10,000,000 cP or more.

[0094] Prior to the at least partial crosslinking of the composition, the composition can have any suitable viscosity. In some embodiments, the viscosity of the composition, at standard temperature and pressure and at a shear rate of about 50 s^{-1} to about 500 s^{-1}, or about 50 s^{-1} or less to about 1000 s^{-1} or more, is about 0.01 cP to about 1,000,000 cP, about 0.01 cP to about 10,000 cP, or about 0.01 cP or less, or about 0.1 cP, 1, 2, 3, 4, 5, 10, 15, 20, 25, 50, 75, 100, 150, 200, 250, 500, 750, 1,000, 1,250, 1,500, 2,000, 2,500, 5,000, 10,000, 15,000, 20,000, 25,000, 50,000, 75,000, 100,000, 125,000, 150,000, 175,000, 200,000, 225,000, 250,000, 500,000, or about 1,000,000 cP or more.

[0095] After the at least partial crosslinking of the composition, the composition can have any suitable viscosity. In some embodiments, after the crosslinking, the viscosity of the composition, at standard temperature and pressure and at a shear rate of about 50 s^{-1} to about 500 s^{-1}, or about 50 s^{-1} or less to about 1000 s^{-1} or more, can be about 10 cP to about 10,000,000 cP (e.g., the composition can be a gel with essentially infinite viscosity), about 1,000 cP to about 500,000 cP, or about 10 cP or less, or about 15 cP, 20, 25, 50, 75, 100, 150, 200, 250, 500, 750, 1,000, 1,250, 1,500, 2,000, 2,500, 5,000, 10,000, 15,000, 20,000, 25,000, 50,000, 75,000, 100,000, 125,000, 150,000, 175,000, 200,000, 225,000, 250,000, 500,000, 1,000,000, 1,250,000, 1,500,000, 2,000,000, 2,500,000, 5,000,000, 7,500,000, or about 10,000,000 cP or more. In some embodiments, after the crosslinking, the viscosity of the composition, at standard temperature and pressure and at a shear rate of about 0 s^{-1} to about 1 s^{-1}, or about 0.1 s^{-1} or less to about 1 s^{-1} or more, can be about 10 cP to about 1,000,000 cP, about 1,000 cP to about 500,000 cP, or about 10 cP or less, or about 15 cP, 20, 25, 50, 75, 100, 150, 200, 250, 500, 750, 1,000, 1,250, 1,500, 2,000, 2,500, 5,000, 10,000, 15,000, 20,000, 25,000, 50,000, 75,000, 100,000, 125,000, 150,000, 175,000, 200,000, 225,000, 250,000, 500,000, 1,000,000, 1,250,000, 1,500,000, 2,000,000, 2,500,000, 5,000,000, 7,500,000, or about 10,000,000 cP or more.

[0096] After the at least partial crosslinking of the composition, the composition can have any suitable shear stress (e.g., the composition can be a gel with essentially infinite viscosity). In some embodiments, after the crosslinking, the shear stress of the composition can be about 0.1 Pa to about 500,000 Pa, about 1 Pa to about 1,000 Pa, about 1 Pa to about 500 Pa, about 0.1

Pa or less, about 0.5 Pa, 1, 2, 3, 4, 5, 10, 15, 20, 25, 50, 75, 100, 150, 200, 250, 500, 750, 1,000, 1,250, 1,500, 1,750, 2,000, 2,500, 5,000, 10,000, 20,000, 25,000, 50,000, 75,000, 100,000, 250,000, 500,000, 750,000, or about 1,000,000 Pa or more.

[0097] In some embodiments, the crosslinkable ampholyte polymer is sufficient such that, when crosslinked in an aqueous solution at a concentration of about 40 gpt with a polyethyleneimine crosslinker at a concentration of about 10 ppt to form a crosslinked ampholyte polymer, at 77 °F and standard pressure, with a strain of about 10%, at a frequency of about 0.1 rad/s to about 100 rad/s, or about 0.1 rad/s or less to about 1000 rad/s or more, the aqueous solution comprising the crosslinked ampholyte polymer has a loss modulus G'' of about 0.1 Pa to about 1000 Pa, about 0.1 Pa to about 100 Pa, about 0.1 Pa to about 10 Pa, or about 0.1 Pa or less, or about 0.5 Pa, 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 15, 20, 30, 40, 50, 60, 70, 80, 90, 100, 150, 200, 250, 300, 350, 400, 450, 500, 550, 600, 700, 800, 900, or about 1,000 Pa or more. In some embodiments, the crosslinkable ampholyte polymer is sufficient such that, when crosslinked in an aqueous solution at a concentration of about 40 gpt with a polyethyleneimine crosslinker at a concentration of about 10 ppt to form a crosslinked ampholyte polymer, at 150 °F and standard pressure, with a strain of about 10%, at a frequency of about 0.1 rad/s to about 100 rad/s, or about 0.1 rad/s or less to about 1000 rad/s or more, the aqueous solution comprising the crosslinked polymer has a storage modulus G' of about 10 Pa to about 1000 Pa, or about 10 Pa to about 100 Pa, or about 10 Pa or less, or about 20 Pa, 30, 40, 50, 60, 70, 80, 90, 100, 150, 200, 250, 300, 350, 400, 450, 500, 550, 600, 700, 800, 900, or about 1,000 Pa or more. In some embodiments, the crosslinkable ampholyte polymer is sufficient such that, when crosslinked in an aqueous solution at a concentration of about 40 gpt with a polyethyleneimine crosslinker at a concentration of about 10 ppt to form a crosslinked ampholyte polymer, at 150 °F and standard pressure, with a strain of about 10%, at a frequency of about 0.1 rad/s to about 100 rad/s, or about 0.1 rad/s or less to about 1000 rad/s or more, the aqueous solution comprising the crosslinked polymer has a loss modulus G'' of about 0.5 Pa to about 10 Pa, or about 0.5 to about 5 Pa, or about 0.5 Pa or less, or about 1 Pa, 2, 3, 4, 5, 6, 7, 8, 9, or about 10 Pa or more.

Crosslinkable ampholyte polymer.

[0098] The composition includes at least one crosslinkable ampholyte polymer, or a crosslinked reaction product thereof (e.g., a reaction product of a crosslinking reaction between the crosslinkable ampholyte polymer and a crosslinker). The crosslinkable ampholyte polymer can include an ethylene repeating unit including a $-C(O)NH_2$ group, an ethylene repeating unit including an $-S(O)_2OR^1$ group, and an ethylene repeating unit including an $-N^+R^2{}_3X^-$ group. At each occurrence, R^1 can be independently selected from the group consisting of -H and a counterion. At each occurrence, R^2 can be independently substituted or unsubstituted (C_1-C_{20})hydrocarbyl, and at each occurrence, X^- can be independently a counterion.

[0099] Any suitable concentration of the crosslinkable ampholyte polymer can be present in the composition, such that the composition can be used as described herein. In some embodiments, about 0.001 wt% to about 95 wt% of the composition is the one or more crosslinkable ampholyte polymers, or about 30 wt% to about 95 wt%, or about 70 wt% to about 90 wt%, or about 0.001 wt% or less, or about 0.01 wt%, 0.1, 1, 2, 3, 4, 5, 10, 15, 20, 25, 30, 35, 40, 45, 50, 55, 60, 65, 70, 75, 80, 85, 86, 87, 88, 89, 90, 91, 92, 93, 94, 95, 96, 97, 98, 99, 99.9, 99.99, or about 99.999 wt% or more of the composition is the one or more crosslinkable ampholyte polymers. In some examples, for a composition including the crosslinkable ampholyte polymer and an aqueous component, about 0.001 wt% to about 50 wt% of the composition is the one or more crosslinkable ampholyte polymers, or about 0.01 wt% to about 10 wt% of the composition, about 0.01 wt% to about 30 wt%, or about 0.001 wt% or less, or about 0.01 wt%, 0.1, 1, 2, 3, 4, 5, 10, 15, 20, 25, 30, 35, 40, 45, or about 50 wt% or more of the composition is the one or more crosslinkable ampholyte polymers. In some examples, for a composition including the crosslinkable ampholyte polymer or a reaction product thereof and an aqueous component, about 0.001 vol% to about 30 vol% of the composition is the one or more crosslinkable ampholyte polymers or a reaction product thereof, or is the combined volume of the crosslinkable ampholyte polymers and the crosslinker, or about 0.001 vol% or less, or about 0.01 vol%, 0.1, 1, 2, 3, 4, 5, 6, 8, 10, 12, 14, 16, 18, 20, 22, 24, 26, 28, or about 30 vol% or more.

[00100] The crosslinkable ampholyte polymer can have about Z^{wt} wt% of the ethylene repeating unit including the -C(O)NH_2 group, wherein Z^{wt} is any suitable wt%, such as about 10% to about 70%, about 30% to about 50%, or about 10% or less, or about 15%, 20, 25, 30, 31, 32, 33, 34, 35, 36, 37, 38, 39, 40, 41, 42, 43, 44, 45, 46, 47, 48, 49, 50, 55, 60, 65%, or about 70% or more. The crosslinkable ampholyte polymer can have about Z^{mol} mol% of the ethylene repeating unit including the -C(O)NH_2 group, wherein Z^{mol} is any suitable mol%, such as about 5% to about 50%, about 10% to about 25%, or about 5% or less, or about 10%, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21, 22, 23, 24, 25, 30, 35, 40, 45, or about 50% or more.

[00101] The crosslinkable ampholyte polymer can have about N^{wt} wt% of the ethylene repeating unit including the -$S(O)_2OR^1$ group, wherein N^{wt} wt% is any suitable wt%, such as about 1% to about 40%, 5% to about 15%, or about 1% or less, or about 5%, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 20, 25, 30, 35, or about 40% or more. The crosslinkable ampholyte polymer can have about N^{mol} mol% of the ethylene repeating unit including the -$S(O)_2OR^1$ group, wherein N^{mol} mol% is any suitable mol%, such as about 1% to about 40%, 5% to about 20%, or about 1% or less, 5%, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 25, 30, 35, or about 40% or more.

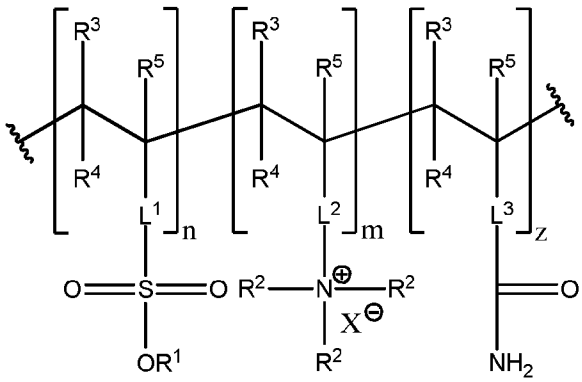
[00102] The crosslinkable ampholyte polymer can have about M^{wt} wt% of the ethylene repeating unit including the -$N^+R^2{}_3X^-$ group, wherein M^{wt} wt% is any suitable wt%, such as about 20% to about 80%, 40% to about 60%, or about 20% or less, 25%, 30, 35, 40, 41, 42, 43, 44, 45, 46, 47, 48, 49, 50, 51, 52, 53, 54, 55, 56, 57, 58, 59, 60, 65, 70, 75, or about 80% or more. The crosslinkable ampholyte polymer can have about M^{mol} mol% of the ethylene repeating unit including the -$N^+R^2{}_3X^-$ group, wherein M^{mol} mol% is any suitable mol%, such as about 40% to about 90%, 55% to about 70%, or about 40% or less, 45, 50, 55, 56, 57, 58, 59, 60, 61, 62, 63, 64, 65, 66, 67, 68, 69, 70, 75, 80, 85, or about 90% or more.

[00103] In various embodiments, the crosslinkable ampholyte polymer is a terpolymer, e.g., $Z^{wt} + N^{wt} + M^{wt}$ is about 100%, and $Z^{mol} + N^{mol} + M^{mol}$ is about 100%.

[00104] The crosslinkable ampholyte polymer can have any suitable molecular weight, such as about 100,000 g/mol to about 20,000,000 g/mol,

2,000,000 g/mol to about 20,000,000 g/mol, about 5,000,000 g/mol to about 15,000,000 g/mol, or about 100,000 g/mol or less, or about 200,000 g/mol, 300,000, 400,000, 500,000, 750,000, 1,000,000, 2,000,000, 3,000,000, 4,000,000, 6,000,000, 8,000,000, 10,000,000, 12,000,000, 14,000,000, 16,000,000, 18,000,000, or about 20,000,000 g/mol or more.

[00105] In various embodiments, the crosslinkable ampholyte polymer includes repeating units having the structure:



The repeating units are in a block, alternate, or random configuration, and each repeating unit is independently in the orientation shown or in the opposite orientation.

[00106] At each occurrence, R^1 can be independently selected from the group consisting of -H and a counterion. At each occurrence R^1 can be independently selected from the group consisting of -H, Na^+, K^+, Li^+, NH_4^+, Zn^+, Ca^{2+}, Zn^{2+}, Al^{3+}, and Mg^{2+}. At each occurrence, R^1 can be -H.

[00107] At each occurrence, R^2 can be independently substituted or unsubstituted (C_1-C_{20})hydrocarbyl. At each occurrence R^2 can be independently (C_1-C_{20})alkyl. At each occurrence R^2 can be independently (C_1-C_{10})alkyl. At each occurrence R^2 can be independently selected from the group consisting of methyl, ethyl, propyl, butyl, and pentyl. At each occurrence, R^2 can be methyl.

[00108] At each occurrence, X^- can independently be a counterion. For example, the counterion can be a halide, such as fluoro, chloro, iodo, or bromo. In other examples, the counterion can be nitrate, hydrogen sulfate, dihydrogen phosphate, bicarbonate, nitrite, perchlorate, iodate, chlorate, bromate, chlorite, hypochlorite, hypobromite, cyanide, amide, cyanate, hydroxide, permanganate. The counterion can be a conjugate base of any carboxylic acid, such as acetate or formate. In some embodiments, a counterion can have a negative charge greater

than -1, which can in some embodiments complex to multiple ionized groups, such as oxide, sulfide, nitride, arsenate, phosphate, arsenite, hydrogen phosphate, sulfate, thiosulfate, sulfite, carbonate, chromate, dichromate, peroxide, or oxalate. At each occurrence, X^- can be Cl^-.

[00109] At each occurrence R^3, R^4, and R^5 can each independently be selected from the group consisting of -H and a substituted or unsubstituted C_1-C_5 hydrocarbyl. At each occurrence R^3, R^4, and R^5 can be independently selected from the group consisting of -H and a C_1-C_5 alkyl. At each occurrence R^3, R^4, and R^5 can be independently selected from the group consisting of -H and a C_1-C_3 alkyl (e.g., methyl, ethyl, or propyl). At each occurrence R^3, R^4, and R^5 can be each -H.

[00110] At each occurrence L^1, L^2, and L^3 can be each independently selected from the group consisting of a bond and a substituted or unsubstituted C_1-C_{20} hydrocarbyl interrupted or terminated with 0, 1, 2, or 3 of at least one of -NR^3-, -S-, and -O-.

[00111] At each occurrence L^1 can be independently selected from the group consisting of a bond and -(substituted or unsubstituted C_1-C_{20} hydrocarbyl)-NR^3-(substituted or unsubstituted C_1-C_{20} hydrocarbyl)-. At each occurrence L^1 can be independently -C(O)-NH-(substituted or unsubstituted C_1-C_{19} hydrocarbyl)-. At each occurrence L^1 can be independently -C(O)-NH-(C_1-C_5 hydrocarbyl)-. The variable L^1 can be -C(O)-NH-CH$(CH_3)_2$-CH_2-.

[00112] At each occurrence, L^2 can be independently selected from the group consisting of -O-(C_1-C_{20})hydrocarbyl- and -NR^3-(C_1-C_{20})hydrocarbyl-. At each occurrence, L^2 can be independently selected from -O-(C_1-C_{10})alkyl- and -NH-(C_1-C_{10})alkyl-. At each occurrence, L^2 can be independently selected from -O-CH_2-CH_2- and -NH-CH_2-CH_2.

[00113] At each occurrence L^3 can be independently selected from the group consisting of a bond and C_1-C_{20} hydrocarbyl. At each occurrence L^3 can be independently selected from the group consisting of a bond and C_1-C_5 alkyl. At each occurrence L^3 can be a bond.

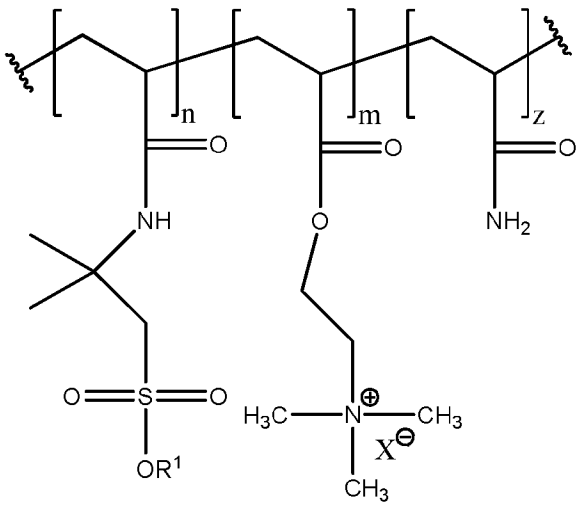
[00114] The variable n can be about 4 to about 40,000, about 90 to about 40,000, about 450 to about 14,500, or about 4 or less, or about 5, 6, 7, 8, 9, 10, 15, 20, 25, 30, 40, 50, 60, 70, 80, 90, 100, 200, 250, 500, 750, 1,000, 1,250, 1,500, 1,750, 2,000, 2,250, 2,500, 3,000, 3,500, 4,000, 4,500, 5,000, 6,000,

7,000, 8,000, 9,000, 10,000, 11,000, 12,000, 13,000, 14,000, 15,000, 20,000, 25,000, 30,000, 35,000, or about 40,000 or more.

[00115] The variable m can be about 100 to about 83,000, about 2,000 to about 83,000, about 4,000 to about 62,000, or about 100 or less, or about 200, 300, 400, 500, 750, 1,000, 1,500, 2,000, 3,000, 4,000, 7,500, 10,000, 15,000, 20,000, 25,000, 30,000, 35,000, 40,000, 45,000, 50,000, 55,000, 60,000, 65,000, 70,000, 75,000, 80,000, or about 85,000 or more.

[00116] The variable z can be about 125 to about 200,000, about 2,500 to about 200,000, about 8,500 to about 140,000, or about 125 or less, 150, 175, 200, 250, 300, 400, 500, 750, 1,000, 1,500, 2,000, 2,500, 3,000, 4,000, 5,000, 10,000, 15,000, 20,000, 25,000, 30,000, 40,000, 50,000, 60,000, 70,000, 80,000, 90,000, 100,000, 110,000, 120,000, 130,000, 140,000, 150,000, 160,000, 170,000, 180,000, 190,000, or about 200,000 or more.

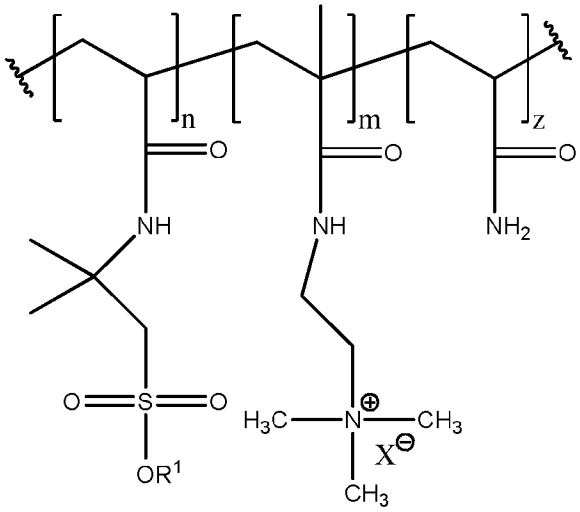
[00117] In some embodiments, the crosslinkable ampholyte polymer can be derived from acrylamide, acryloyloxyethyl trimethylammonium chloride, and 2-acrylamido-2-methylpropane sulfonic acid (AMPS) or a salt thereof, and includes repeating units having the structure:



The repeating units are in a block, alternate, or random configuration, and each repeating unit is independently in the orientation shown or in the opposite orientation.

[00118] In some embodiments, the crosslinkable ampholyte polymer can be derived from acrylamide, methacrylamidopropyl trimethylammonium

chloride, and 2-acrylamido-2-methylpropane sulfonic acid (AMPS) or a salt thereof, and includes repeating units having the structure:



The repeating units are in a block, alternate, or random configuration, and each repeating unit is independently in the orientation shown or in the opposite orientation.

Crosslinker.

[00119] The composition including the crosslinkable ampholyte polymer can include one or more crosslinkers. The crosslinker can be any suitable crosslinker, such that the composition can be used as described herein.

[00120] In some embodiments, the crosslinker can be at least one of a poly(amino(C_2-C_{10})hydrocarbylene) crosslinker and a (C_6-C_{20})aryl alcohol-(C_1-C_{20})aldehyde crosslinker. In some examples, the crosslinker can be at least one of polyethyleneimine, phenol-formaldehyde, and glyoxal. In some embodiments, the crosslinker is polyethyleneimine.

[00121] In some embodiments, the crosslinker can be a molecule including at least one of chromium, aluminum, antimony, zirconium, titanium, calcium, boron, iron, silicon, copper, zinc, magnesium, and an ion thereof. The crosslinker can be at least one of boric acid, borax, a borate, a (C_1-C_{30})hydrocarbylboronic acid, a (C_1-C_{30})hydrocarbyl ester of a (C_1-C_{30})hydrocarbylboronic acid, a (C_1-C_{30})hydrocarbylboronic acid-modified polyacrylamide, ferric chloride, disodium octaborate tetrahydrate, sodium metaborate, sodium diborate, sodium tetraborate, disodium tetraborate, a

pentaborate, ulexite, colemanite, magnesium oxide, zirconium lactate, zirconium triethanol amine, zirconium lactate triethanolamine, zirconium carbonate, zirconium acetylacetonate, zirconium malate, zirconium citrate, zirconium diisopropylamine lactate, zirconium glycolate, zirconium triethanol amine glycolate, zirconium lactate glycolate, titanium lactate, titanium malate, titanium citrate, titanium ammonium lactate, titanium triethanolamine, titanium acetylacetonate, aluminum lactate, and aluminum citrate.

[00122] In some embodiments, the crosslinker includes zirconium or a zirconium derivative. The crosslinker can include at least one of zirconium lactate, zirconium triethanol amine, zirconium lactate triethanolamine, zirconium carbonate, zirconium acetylacetonate, zirconium malate, zirconium citrate, zirconium diisopropylamine lactate, zirconium glycolate, zirconium triethanol amine glycolate, and zirconium lactate glycolate.

[00123] The composition can include any suitable concentration of the one or more crosslinkers. For example, 0.000,1 wt% to about 80 wt% of the composition can be the one or more crosslinkers, or about 0.001 wt% to about 80 wt%, 10 wt% to about 30 wt%, or about 0.000,1 wt% or less, or about 0.001 wt%, 0.01, 0.1, 1, 2, 3, 4, 5, 10, 15, 20, 25, 30, 35, 40, 45, 50, 55, 60, 65, 70, 75, or about 80 wt% or more of the composition can be the one or more crosslinkers. In some examples, in embodiments of the composition including an aqueous composition, about 0.000,1 wt% to about 50 wt% of the composition is the crosslinker, or about 0.001 wt% to about 1 wt%, or about 0.000,1 wt% or less, or about 0.001 wt%, 0.01, 0.1, 1, 2, 3, 4, 5, 10, 15, 20, 25, 30, 35, 40, 45, or about 50 wt% or more of the composition.

Other components.

[00124] In various embodiments, the composition including the crosslinkable ampholyte polymer and the crosslinker can further include one or more suitable additional components. The additional components can be any suitable additional components, such that the composition can be used as described herein.

[00125] The composition can further include one or more fluids. The composition can include a fluid including at least one of water, an organic solvent, and an oil. The composition can include a fluid including at least one of

dipropylene glycol methyl ether, dipropylene glycol dimethyl ether, dimethyl formamide, diethylene glycol methyl ether, ethylene glycol butyl ether, diethylene glycol butyl ether, propylene carbonate, D-limonene, a C_2-C_{40} fatty acid C_1-C_{10} alkyl ester, 2-butoxy ethanol, butyl acetate, furfuryl acetate, dimethyl sulfoxide, dimethyl formamide, diesel, kerosene, mineral oil, a hydrocarbon including an internal olefin, a hydrocarbon including an alpha olefin, xylenes, an ionic liquid, methyl ethyl ketone, and cyclohexanone. The composition can further include at least one of water, brine, produced water, flowback water, brackish water, and sea water. The composition can include any suitable proportion of the one or more fluids, such as about 0.001 wt% to 99.999 wt%, about 0.01 wt% to about 99.99 wt%, about 0.1 wt% to about 99.9 wt%, or about 20 wt% to about 90 wt%, or about 0.001 wt% or less, or about 0.01 wt%, 0.1, 1, 2, 3, 4, 5, 10, 15, 20, 30, 40, 50, 60, 70, 80, 85, 90, 91, 92, 93, 94, 95, 96, 97, 98, 99, 99.9, 99.99, or about 99.999 wt% or more of the composition.

[00126] The composition can further include a secondary viscosifier, in addition to the crosslinkable ampholyte polymer. The secondary viscosifier can be present in any suitable concentration, such as more, less, or an equal concentration as compared to the concentration of the crosslinkable ampholyte polymer. The secondary viscosifier can include at least one of a substituted or unsubstituted polysaccharide, and a substituted or unsubstituted polyalkenylene, wherein the polysaccharide or polyalkenylene is crosslinked or uncrosslinked. The secondary viscosifier can include a polymer including at least one monomer selected from the group consisting of ethylene glycol, acrylamide, vinyl acetate, 2-acrylamidomethylpropane sulfonic acid or its salts, trimethylammoniumethyl acrylate halide, and trimethylammoniumethyl methacrylate halide. The secondary viscosifier can include a crosslinked gel or a crosslinkable gel.

[00127] The secondary viscosifier can affect the viscosity of the composition at any suitable time and location. In some embodiments, the secondary viscosifier provides an increased viscosity at least one of before placement in the subterranean formation, at the time of placement into the subterranean formation, during travel in the subterranean formation, once the composition reaches a particular location in the subterranean formation, or some period of time after the composition reaches a particular location in the

subterranean formation. In some embodiments, the secondary viscosifier can provide some or no increased viscosity until the secondary viscosifier reaches a desired location, at which point the secondary viscosifier can provide a small or large increase in viscosity.

[00128] In some embodiments, the secondary viscosifier includes at least one of a linear polysaccharide, and poly((C_2-C_{10})alkenylene), wherein at each occurrence, the (C_2-C_{10})alkenylene is independently substituted or unsubstituted. In some embodiments, the secondary viscosifier can include at least one of poly(acrylic acid) or (C_1-C_5)alkyl esters thereof, poly(methacrylic acid) or (C_1-C_5)alkyl esters thereof, poly(vinyl acetate), poly(vinyl alcohol), poly(ethylene glycol), poly(vinyl pyrrolidone), polyacrylamide, poly (hydroxyethyl methacrylate), alginate, chitosan, curdlan, dextran, emulsan, gellan, glucuronan, N-acetyl-glucosamine, N-acetyl-heparosan, hyaluronic acid, kefiran, lentinan, levan, mauran, pullulan, scleroglucan, schizophyllan, stewartan, succinoglycan, xanthan, welan, derivatized starch, tamarind, tragacanth, guar gum, derivatized guar (e.g., hydroxypropyl guar, carboxy methyl guar, or carboxymethyl hydroxylpropyl guar), gum ghatti, gum arabic, locust bean gum, and derivatized cellulose (e.g., carboxymethyl cellulose, hydroxyethyl cellulose, carboxymethyl hydroxyethyl cellulose, hydroxypropyl cellulose, or methyl hydroxyl ethyl cellulose).

[00129] In some embodiments, the secondary viscosifier can include a poly(vinyl alcohol) homopolymer, poly(vinyl alcohol) copolymer, a crosslinked poly(vinyl alcohol) homopolymer, and a crosslinked poly(vinyl alcohol) copolymer. The secondary viscosifier can include a poly(vinyl alcohol) copolymer or a crosslinked poly(vinyl alcohol) copolymer including at least one of a graft, linear, branched, block, and random copolymer of vinyl alcohol and at least one of a substituted or unsubstitued (C_2-C_{50})hydrocarbyl having at least one aliphatic unsaturated C-C bond therein, and a substituted or unsubstituted (C_2-C_{50})alkene. The secondary viscosifier can include a poly(vinyl alcohol) copolymer or a crosslinked poly(vinyl alcohol) copolymer including at least one of a graft, linear, branched, block, and random copolymer of vinyl alcohol and at least one of vinyl phosphonic acid, vinylidene diphosphonic acid, substituted or unsubstituted 2-acrylamido-2-methylpropanesulfonic acid, a substituted or unsubstituted (C_1-C_{20})alkenoic acid, propenoic acid, butenoic acid, pentenoic

acid, hexenoic acid, octenoic acid, nonenoic acid, decenoic acid, acrylic acid, methacrylic acid, hydroxypropyl acrylic acid, acrylamide, fumaric acid, methacrylic acid, hydroxypropyl acrylic acid, vinyl phosphonic acid, vinylidene diphosphonic acid, itaconic acid, crotonic acid, mesoconic acid, citraconic acid, styrene sulfonic acid, allyl sulfonic acid, methallyl sulfonic acid, vinyl sulfonic acid, and a substituted or unsubstituted (C_1-C_{20})alkyl ester thereof. The secondary viscosifier can include a poly(vinyl alcohol) copolymer or a crosslinked poly(vinyl alcohol) copolymer including at least one of a graft, linear, branched, block, and random copolymer of vinyl alcohol and at least one of vinyl acetate, vinyl propanoate, vinyl butanoate, vinyl pentanoate, vinyl hexanoate, vinyl 2-methyl butanoate, vinyl 3-ethylpentanoate, and vinyl 3-ethylhexanoate, maleic anhydride, a substituted or unsubstituted (C_1-C_{20})alkenoic substituted or unsubstituted (C_1-C_{20})alkanoic anhydride, a substituted or unsubstituted (C_1-C_{20})alkenoic substituted or unsubstituted (C_1-C_{20})alkenoic anhydride, propenoic acid anhydride, butenoic acid anhydride, pentenoic acid anhydride, hexenoic acid anhydride, octenoic acid anhydride, nonenoic acid anhydride, decenoic acid anhydride, acrylic acid anhydride, fumaric acid anhydride, methacrylic acid anhydride, hydroxypropyl acrylic acid anhydride, vinyl phosphonic acid anhydride, vinylidene diphosphonic acid anhydride, itaconic acid anhydride, crotonic acid anhydride, mesoconic acid anhydride, citraconic acid anhydride, styrene sulfonic acid anhydride, allyl sulfonic acid anhydride, methallyl sulfonic acid anhydride, vinyl sulfonic acid anhydride, and an N-(C_1-C_{10})alkenyl nitrogen containing substituted or unsubstituted (C_1-C_{10})heterocycle. The secondary viscosifier can include a poly(vinyl alcohol) copolymer or a crosslinked poly(vinyl alcohol) copolymer including at least one of a graft, linear, branched, block, and random copolymer that includes a poly(vinylalcohol)-poly(acrylamide) copolymer, a poly(vinylalcohol)-poly(2-acrylamido-2-methylpropanesulfonic acid) copolymer, or a poly(vinylalcohol)-poly(N-vinylpyrrolidone) copolymer. The secondary viscosifier can include a crosslinked poly(vinyl alcohol) homopolymer or copolymer including a crosslinker including at least one of chromium, aluminum, antimony, zirconium, titanium, calcium, boron, iron, silicon, copper, zinc, magnesium, and an ion thereof. The secondary viscosifier can include a crosslinked poly(vinyl alcohol) homopolymer or copolymer

including a crosslinker including at least one of an aldehyde, an aldehyde-forming compound, a carboxylic acid or an ester thereof, a sulfonic acid or an ester thereof, a phosphonic acid or an ester thereof, an acid anhydride, and an epihalohydrin.

[00130] In some embodiments, the secondary viscosifier can be a polymer including at least one of, or the ampholyte polymer can include a monomer derived from at least one of, 2,2′-azobis(2,4-dimethyl valeronitrile), 2,2′-azobis(2,4-dimethyl-4-methoxy valeronitrile), acrylamide ethyltrimethyl ammonium chloride, acrylamide, acrylamido- and methacrylamido-alkyl trialkyl ammonium salts, acrylamidomethylpropane sulfonic acid, acrylamidopropyl trimethyl ammonium chloride, acrylic acid, dimethylaminoethyl methacrylamide, dimethylaminoethyl methacrylate, dimethylaminopropyl methacrylamide, dimethylaminopropylmethacrylamide, dimethyldiallylammonium chloride, dimethylethyl acrylate, fumaramide, methacrylamide, methacrylamidopropyl trimethyl ammonium chloride, methacrylamidopropyldimethyl-n-dodecylammonium chloride, methacrylamidopropyldimethyl-n-octylammonium chloride, methacrylamidopropyltrimethylammonium chloride, methacryloylalkyl trialkyl ammonium salts, methacryloylethyl trimethyl ammonium chloride, methacrylylamidopropyldimethylcetylammonium chloride, N-(3-sulfopropyl)-N-methacrylamidopropyl-N,N-dimethyl ammonium betaine, N,N-dimethylacrylamide, N-methylacrylamide, nonylphenoxypoly(ethyleneoxy)ethylmethacrylate, partially hydrolyzed polyacrylamide, poly 2-amino-2-methyl propane sulfonic acid, polyvinyl alcohol, sodium 2-acrylamido-2-methylpropane sulfonate, quaternized dimethylaminoethylacrylate, quaternized dimethylaminoethylmethacrylate, 2-(methacryloyloxy)ethyltrimethylammonium methyl sulfate or sulfonic acid or a salt thereof, 2-(methacryloyloxy)ethyltrimethylammonium chloride copolymer, or any combination thereof. In certain embodiments, the secondary viscosifier may include a derivatized cellulose that includes cellulose grafted with an allyl or a vinyl monomer, such as those disclosed in U.S. Pat. Nos. 4,982,793, 5,067,565, and 5,122,549, the entire disclosures of which are incorporated herein by reference.

[00131] The composition can include any suitable proportion of the secondary viscosifier, such as about 0.001 wt% to 99.999 wt%, about 0.01wt% to about 99.99 wt%, about 0.1 wt% to about 50 wt%, or about 0.1 wt% to about 20 wt%, or about 0.001 wt% or less, or about 0.01 wt%, 0.1, 1, 2, 3, 4, 5, 10, 15, 20, 30, 40, 50, 60, 70, 80, 85, 90, 91, 92, 93, 94, 95, 96, 97, 98, 99, 99.9, 99.99, or about 99.999 wt% or more of the composition.

[00132] The composition can further include a secondary crosslinker. The crosslinker can be any suitable crosslinker. The secondary crosslinker can be present in any suitable concentration, such as more, less, or an equal concentration as compared to the concentration of the crosslinker. In various embodiments, the secondary crosslinker can include at least one of chromium, aluminum, antimony, zirconium, titanium, calcium, boron, iron, silicon, copper, zinc, magnesium, and an ion thereof. The secondary crosslinker can include at least one of boric acid, borax, a borate, a (C_1-C_{30})hydrocarbylboronic acid, a (C_1-C_{30})hydrocarbyl ester of a (C_1-C_{30})hydrocarbylboronic acid, a (C_1-C_{30})hydrocarbylboronic acid-modified polyacrylamide, ferric chloride, disodium octaborate tetrahydrate, sodium metaborate, sodium diborate, sodium tetraborate, disodium tetraborate, a pentaborate, ulexite, colemanite, magnesium oxide, zirconium lactate, zirconium triethanol amine, zirconium lactate triethanolamine, zirconium carbonate, zirconium acetylacetonate, zirconium malate, zirconium citrate, zirconium diisopropylamine lactate, zirconium glycolate, zirconium triethanol amine glycolate, zirconium lactate glycolate, titanium lactate, titanium malate, titanium citrate, titanium ammonium lactate, titanium triethanolamine, titanium acetylacetonate, aluminum lactate, and aluminum citrate. The composition can include any suitable proportion of the secondary crosslinker, such as about 0.000,1 wt% to 99.999,9 wt%, about 0.01 wt% to about 99.99 wt%, about 0.1 wt% to about 50 wt%, or about 0.1 wt% to about 20 wt%, or about 0.000,1 wt% or less, or about 0.001 wt%, 0.01, 0.1, 1, 2, 3, 4, 5, 10, 15, 20, 30, 40, 50, 60, 70, 80, 85, 90, 91, 92, 93, 94, 95, 96, 97, 98, 99, 99.9, 99.99, 99.999, or about 99.999,9 wt% or more of the composition.

[00133] Some embodiments of the method can include breaking the composition including the crosslinkable ampholyte polymers, especially non-crosslinked ampholyte polymer, but in some embodiments crosslinked ampholyte polymer can be broken. In some instances, breaking can be achieved

by partially hydrolyzing the ampholyte polymers. Partial hydrolysis (or breaking) can be achieved by increasing the temperature, increasing the pH, or both.

[00134] In some instances, breaking can be achieved by exposure to the elevated temperatures in the wellbore and/or subterranean formation. For example, the bottom hole circulating temperature can be about 100°F or greater (e.g., about 100°F to about 200°F, about 120°F to about 200°F, or about 150°F to about 200°F). The rate of breaking (or partial hydrolysis and contraction of the ampholyte polymer) can depend on the composition of the ampholyte polymer, the relative ratios of the monomers of the ampholyte polymer, the TDS of the composition, and the like. Therefore, in some instances, the method can include breaking the composition including the ampholyte polymer with minimal to no chemical breaker (e.g., less than about 1% of a chemical breaker).

[00135] In some instances, breaking can involve increasing the pH of the composition including the ampholyte polymeric compounds. Increasing the pH can be achieved by introducing a suitable breaking fluid or including a suitable breaker in the composition (e.g., sodium perborate).

[00136] The composition described herein can, in some instances, be foamed. As used herein the term "foam" refers to a two-phase composition having a continuous liquid phase and a discontinuous gas phase. In some embodiments, the composition described herein can include a base fluid, a gas, a foaming agent, and an ampholyte polymeric compound.

[00137] Suitable gases can include, but are not limited to, nitrogen, carbon dioxide, air, methane, helium, argon, and any combination thereof. One skilled in the art, with the benefit of this disclosure, should understand the benefit of each gas. By way of nonlimiting example, carbon dioxide foams can have deeper well capability than nitrogen foams because carbon dioxide emulsions have greater density than nitrogen gas foams so that the surface pumping pressure required to reach a corresponding depth is lower with carbon dioxide than with nitrogen. Moreover, the higher density can impart greater proppant transport capability, up to about 12 lb of proppant per gal of composition.

[00138] In some embodiments, the quality of a foamed composition can range from a lower limit of about 5%, 10%, 25%, 40%, 50%, 60%, or 70% gas volume to an upper limit of about 95%, 90%, 80%, 75%, 60%, or 50% gas

volume, and wherein the quality of the foamed composition can range from any lower limit to any upper limit and encompasses any subset therebetween. The foamed composition can have a foam quality from about 85% to about 95%, or about 90% to about 95%.

[00139] Suitable foaming agents can include, but are not limited to, cationic foaming agents, anionic foaming agents, amphoteric foaming agents, nonionic foaming agents, or any combination thereof. Nonlimiting examples of suitable foaming agents can include, but are not limited to, surfactants like betaines, sulfated or sulfonated alkoxylates, alkyl quarternary amines, alkoxylated linear alcohols, alkyl sulfonates, alkyl aryl sulfonates, C_{10}-C_{20} alkyldiphenyl ether sulfonates, polyethylene glycols, ethers of alkylated phenol, sodium dodecylsulfate, alpha olefin sulfonates such as sodium dodecane sulfonate, trimethyl hexadecyl ammonium bromide, and the like, any derivative thereof, or any combination thereof. Foaming agents can be included in compositions at concentrations ranging typically from about 0.05% to about 2% of the liquid component by weight (*e.g.*, from about 0.5 to about 20 gallons per 1000 gallons of liquid).

[00140] The composition including the crosslinkable ampholyte polymer and the crosslinker, or a crosslinked reaction product thereof, can be combined with any suitable downhole fluid before, during, or after the placement of the composition in the subterranean formation or the contacting of the composition and the subterranean material. In some examples, the composition including the crosslinkable ampholyte polymer and the crosslinker, or a crosslinked reaction product thereof, is combined with a downhole fluid above the surface, and then the combined composition is placed in a subterranean formation or contacted with a subterranean material. In another example, the composition including the crosslinkable ampholyte polymer and the crosslinker, or a crosslinked reaction product thereof, is injected into a subterranean formation to combine with a downhole fluid, and the combined composition is contacted with a subterranean material or is considered to be placed in the subterranean formation. In various examples, at least one of prior to, during, and after the placement of the composition in the subterranean formation or contacting of the subterranean material and the composition, the composition is used in the subterranean formation, at least one of alone and in combination with other materials, as a

drilling fluid, stimulation fluid, fracturing fluid, spotting fluid, clean-up fluid, completion fluid, remedial treatment fluid, abandonment fluid, pill, acidizing fluid, cementing fluid, packer fluid, or a combination thereof.

[00141] In various embodiments, the method includes combining the composition including the crosslinkable ampholyte polymer and the crosslinker, or a crosslinked reaction product thereof, with any suitable downhole fluid, such as an aqueous or oil-based fluid including a drilling fluid, stimulation fluid, fracturing fluid, spotting fluid, clean-up fluid, completion fluid, remedial treatment fluid, abandonment fluid, pill, acidizing fluid, cementing fluid, packer fluid, or a combination thereof, to form a mixture. The placement of the composition in the subterranean formation can include contacting the subterranean material and the mixture. The contacting of the subterranean material and the composition can include contacting the subterranean material and the mixture. Any suitable weight percent of a mixture that is placed in the subterranean formation or contacted with the subterranean material can be the composition including the crosslinkable ampholyte polymer and the crosslinker, or a crosslinked reaction product thereof, such as about 0.001 wt% to 99.999 wt%, about 0.01 wt% to about 99.99 wt%, about 0.1 wt% to about 99.9 wt%, or about 20 wt% to about 90 wt%, or about 0.001 wt% or less, or about 0.01 wt%, 0.1, 1, 2, 3, 4, 5, 10, 15, 20, 30, 40, 50, 60, 70, 80, 85, 90, 91, 92, 93, 94, 95, 96, 97, 98, 99, 99.9, 99.99 wt%, or about 99.999 wt% or more of the mixture or composition.

[00142] In some embodiments, the composition can include any suitable amount of any suitable material used in a downhole fluid. For example, the composition can include water, saline, aqueous base, acid, oil, organic solvent, synthetic fluid oil phase, aqueous solution, alcohol or polyol, cellulose, starch, alkalinity control agents, acidity control agents, density control agents, density modifiers, emulsifiers, dispersants, polymeric stabilizers, crosslinking agents, polyacrylamide, a polymer or combination of polymers, antioxidants, heat stabilizers, foam control agents, foaming agents, solvents, diluents, plasticizer, filler or inorganic particle, pigment, dye, precipitating agent, rheology modifier, oil-wetting agents, set retarding additives, surfactants, gases, weight reducing additives, heavy-weight additives, lost circulation materials, filtration control additives, salts, fibers, thixotropic additives, breakers, crosslinkers, rheology

modifiers, curing accelerators, curing retarders, pH modifiers, chelating agents, scale inhibitors, enzymes, resins, water control materials, oxidizers, markers, Portland cement, pozzolana cement, gypsum cement, high alumina content cement, slag cement, silica cement, fly ash, metakaolin, shale, zeolite, a crystalline silica compound, amorphous silica, hydratable clays, microspheres, pozzolan lime, or a combination thereof. In various embodiments, the composition can include one or more additive components such as: thinner additives such as COLDTROL®, ATC®, OMC 2™, and OMC 42™; RHEMOD™, a viscosifier and suspension agent including a modified fatty acid; additives for providing temporary increased viscosity, such as for shipping (e.g., transport to the well site) and for use in sweeps (for example, additives having the trade name TEMPERUS™ (a modified fatty acid) and VIS-PLUS®, a thixotropic viscosifying polymer blend); TAU-MOD™, a viscosifying/suspension agent including an amorphous/fibrous material; additives for filtration control, for example, ADAPTA®, a HTHP filtration control agent including a crosslinked copolymer; DURATONE® HT, a filtration control agent that includes an organophilic lignite, more particularly organophilic leonardite; THERMO TONE™, a high temperature high pressure (HTHP) filtration control agent including a synthetic polymer; BDF™-366, a HTHP filtration control agent; BDF™-454, a HTHP filtration control agent; LIQUITONE™, a polymeric filtration agent and viscosifier; additives for HTHP emulsion stability, for example, FACTANT™, which includes highly concentrated tall oil derivative; emulsifiers such as LE SUPERMUL™ and EZ MUL® NT, polyaminated fatty acid emulsifiers, and FORTI-MUL®; DRIL TREAT®, an oil wetting agent for heavy fluids; BARACARB®, a sized ground marble bridging agent; BAROID®, a ground barium sulfate weighting agent; BAROLIFT®, a hole sweeping agent; SWEEP-WATE®, a sweep weighting agent; BDF-508, a diamine dimer rheology modifier; GELTONE® II organophilic clay; BAROFIBRE™ O for lost circulation management and seepage loss prevention, including a natural cellulose fiber; STEELSEAL®, a resilient graphitic carbon lost circulation material; HYDRO-PLUG®, a hydratable swelling lost circulation material; lime, which can provide alkalinity and can activate certain emulsifiers; and calcium chloride, which can provide salinity. Any suitable proportion of the composition can include any optional

component listed in this paragraph, such as about 0.000,1 wt% to 99.999,9 wt%, about 0.01wt% to about 99.99 wt%, about 0.1 wt% to about 99.9 wt%, or about 20 wt% to about 90 wt%, or about 0.000,1 wt% or less, or about 0.001 wt%, 0.01, 0.1, 1, 2, 3, 4, 5, 10, 15, 20, 30, 40, 50, 60, 70, 80, 85, 90, 91, 92, 93, 94, 95, 96, 97, 98, 99, 99.9, 99.99, 99.999 wt%, or 99.999,9 wt% or more of the composition.

[00143] A drilling fluid, also known as a drilling mud or simply "mud," is a specially designed fluid that is circulated through a wellbore as the wellbore is being drilled to facilitate the drilling operation. The drilling fluid can be water-based or oil-based. The drilling fluid can carry cuttings up from beneath and around the bit, transport them up the annulus, and allow their separation. Also, a drilling fluid can cool and lubricate the drill head as well as reduce friction between the drill string and the sides of the hole. The drilling fluid aids in support of the drill pipe and drill head, and provides a hydrostatic head to maintain the integrity of the wellbore walls and prevent well blowouts. Specific drilling fluid systems can be selected to optimize a drilling operation in accordance with the characteristics of a particular geological formation. The drilling fluid can be formulated to prevent unwanted influxes of formation fluids from permeable rocks and also to form a thin, low permeability filter cake that temporarily seals pores, other openings, and formations penetrated by the bit. In water-based drilling fluids, solid particles are suspended in a water or brine solution containing other components. Oils or other non-aqueous liquids can be emulsified in the water or brine or at least partially solubilized (for less hydrophobic non-aqueous liquids), but water is the continuous phase. A drilling fluid can be present in the mixture with the composition including the crosslinkable ampholyte polymer and the crosslinker, or a crosslinked reaction product thereof, in any suitable amount, such as about 1 wt% or less, about 2 wt%, 3, 4, 5, 10, 15, 20, 30, 40, 50, 60, 70, 80, 85, 90, 95, 96, 97, 98, 99, 99.9, 99.99, 99.999, or about 99.999,9 wt% or more of the mixture.

[00144] A water-based drilling fluid in embodiments of the present invention can be any suitable water-based drilling fluid. In various embodiments, the drilling fluid can include at least one of water (fresh or brine), a salt (e.g., calcium chloride, sodium chloride, potassium chloride, magnesium chloride, calcium bromide, sodium bromide, potassium bromide, calcium nitrate,

sodium formate, potassium formate, cesium formate), aqueous base (e.g., sodium hydroxide or potassium hydroxide), alcohol or polyol, cellulose, starches, alkalinity control agents, density control agents such as a density modifier (e.g., barium sulfate), surfactants (e.g., betaines, alkali metal alkylene acetates, sultaines, ether carboxylates), emulsifiers, dispersants, polymeric stabilizers, crosslinking agents, polyacrylamides, polymers or combinations of polymers, antioxidants, heat stabilizers, foam control agents, foaming agents, solvents, diluents, plasticizers, filler or inorganic particles (e.g., silica), pigments, dyes, precipitating agents (e.g., silicates or aluminum complexes), and rheology modifiers such as thickeners or viscosifiers (e.g., xanthan gum). Any ingredient listed in this paragraph can be either present or not present in the mixture.

[00145] An oil-based drilling fluid or mud in embodiments of the present invention can be any suitable oil-based drilling fluid. In various embodiments the drilling fluid can include at least one of an oil-based fluid (or synthetic fluid), saline, aqueous solution, emulsifiers, other agents of additives for suspension control, weight or density control, oil-wetting agents, fluid loss or filtration control agents, and rheology control agents. For example, see H. C. H. Darley and George R. Gray, Composition and Properties of Drilling and Completion Fluids 66-67, 561-562 (5^{th} ed. 1988). An oil-based or invert emulsion-based drilling fluid can include between about 10:90 to about 95:5, or about 50:50 to about 95:5, by volume of oil phase to water phase. A substantially all oil mud includes about 100% liquid phase oil by volume (e.g., substantially no internal aqueous phase).

[00146] A pill is a relatively small quantity (e.g., less than about 500 bbl, or less than about 200 bbl) of drilling fluid used to accomplish a specific task that the regular drilling fluid cannot perform. For example, a pill can be a high-viscosity pill to, for example, help lift cuttings out of a vertical wellbore. In another example, a pill can be a freshwater pill to, for example, dissolve a salt formation. Another example is a pipe-freeing pill to, for example, destroy filter cake and relieve differential sticking forces. In another example, a pill is a lost circulation material pill to, for example, plug a thief zone. A pill can include any component described herein as a component of a drilling fluid.

[00147] A cement fluid can include an aqueous mixture of at least one of cement and cement kiln dust. The composition including the crosslinkable ampholyte polymer and the crosslinker, or a crosslinked reaction product thereof, can form a useful combination with cement or cement kiln dust. The cement kiln dust can be any suitable cement kiln dust. Cement kiln dust can be formed during the manufacture of cement and can be partially calcined kiln feed that is removed from the gas stream and collected in a dust collector during a manufacturing process. Cement kiln dust can be advantageously utilized in a cost-effective manner since kiln dust is often regarded as a low value waste product of the cement industry. Some embodiments of the cement fluid can include cement kiln dust but no cement, cement kiln dust and cement, or cement but no cement kiln dust. The cement can be any suitable cement. The cement can be a hydraulic cement. A variety of cements can be utilized in accordance with embodiments of the present invention; for example, those including calcium, aluminum, silicon, oxygen, iron, or sulfur, which can set and harden by reaction with water. Suitable cements can include Portland cements, pozzolana cements, gypsum cements, high alumina content cements, slag cements, silica cements, and combinations thereof. In some embodiments, the Portland cements that are suitable for use in embodiments of the present invention are classified as Classes A, C, H, and G cements according to the American Petroleum Institute, *API Specification for Materials and Testing for Well Cements*, API Specification 10, Fifth Ed., Jul. 1, 1990. A cement can be generally included in the cementing fluid in an amount sufficient to provide the desired compressive strength, density, or cost. In some embodiments, the hydraulic cement can be present in the cementing fluid in an amount in the range of from 0 wt% to about 100 wt%, 0-95 wt%, 20-95 wt%, or about 50-90 wt%. A cement kiln dust can be present in an amount of at least about 0.01 wt%, or about 5 wt% - 80 wt%, or about 10 wt% to about 50 wt%.

[00148] Optionally, other additives can be added to a cement or kiln dust-containing composition of embodiments of the present invention as deemed appropriate by one skilled in the art, with the benefit of this disclosure. Any optional ingredient listed in this paragraph can be either present or not present in the composition. For example, the composition can include fly ash, metakaolin, shale, zeolite, set retarding additive, surfactant, a gas, accelerators, weight

reducing additives, heavy-weight additives, lost circulation materials, filtration control additives, dispersants, and combinations thereof. In some examples, additives can include crystalline silica compounds, amorphous silica, salts, fibers, hydratable clays, microspheres, pozzolan lime, thixotropic additives, combinations thereof, and the like.

[00149] In various embodiments, the composition or mixture can include a proppant, a resin-coated proppant, an encapsulated resin, or a combination thereof. A proppant is a material that keeps an induced hydraulic fracture at least partially open during or after a fracturing treatment. Proppants can be transported into the subterranean formation and to the fracture using fluid, such as fracturing fluid or another fluid. A higher-viscosity fluid can more effectively transport proppants to a desired location in a fracture, especially larger proppants, by more effectively keeping proppants in a suspended state within the fluid. Examples of proppants can include sand, gravel, glass beads, polymer beads, ground products from shells and seeds such as walnut hulls, and manmade materials such as ceramic proppant, bauxite, tetrafluoroethylene materials (e.g., TEFLON^{TM} available from DuPont), fruit pit materials, processed wood, composite particulates prepared from a binder and fine grade particulates such as silica, alumina, fumed silica, carbon black, graphite, mica, titanium dioxide, meta-silicate, calcium silicate, kaolin, talc, zirconia, boron, fly ash, hollow glass microspheres, and solid glass, or mixtures thereof. In some embodiments, proppant can have an average particle size, wherein particle size is the largest dimension of a particle, of about 0.001 mm to about 3 mm, about 0.15 mm to about 2.5 mm, about 0.25 mm to about 0.43 mm, about 0.43 mm to about 0.85 mm, about 0.85 mm to about 1.18 mm, about 1.18 mm to about 1.70 mm, or about 1.70 to about 2.36 mm. In some embodiments, the proppant can have a distribution of particle sizes clustering around multiple averages, such as one, two, three, or four different average particle sizes. The composition or mixture can include any suitable amount of proppant, such as about 0.000,1 wt% to about 99.9 wt%, about 0.1 wt% to about 80 wt%, or about 10 wt% to about 60 wt%, or about 0.000,000,01 wt% or less, or about 0.000,001 wt%, 0.000,1, 0.001, 0.01, 0.1, 1, 2, 3, 4, 5, 10, 15, 20, 30, 40, 50, 60, 70, 80, 85, 90, 91, 92, 93, 94, 95, 96, 97, 98, 99, 99.9 wt%, or about 99.99 wt% or more.

Drilling assembly.

[00150] Embodiments of the composition including the crosslinkable ampholyte polymer and the crosslinker, or a crosslinked reaction product thereof, disclosed herein may directly or indirectly affect one or more components or pieces of equipment associated with the preparation, delivery, recapture, recycling, reuse, and/or disposal of the composition including crosslinkable ampholyte polymer and the crosslinker, or a crosslinked reaction product thereof,. For example, and with reference to FIG. 1, an embodiment of the composition including the crosslinkable ampholyte polymer and the crosslinker, or a crosslinked reaction product thereof, and optionally also including a drilling fluid, may directly or indirectly affect one or more components or pieces of equipment associated with an exemplary wellbore drilling assembly 100, according to one or more embodiments. It should be noted that while FIG. 1 generally depicts a land-based drilling assembly, those skilled in the art will readily recognize that the principles described herein are equally applicable to subsea drilling operations that employ floating or sea-based platforms and rigs, without departing from the scope of the disclosure.

[00151] As illustrated, the drilling assembly 100 may include a drilling platform 102 that supports a derrick 104 having a traveling block 106 for raising and lowering a drill string 108. The drill string 108 may include, but is not limited to, drill pipe and coiled tubing, as generally known to those skilled in the art. A kelly 110 supports the drill string 108 as it is lowered through a rotary table 112. A drill bit 114 is attached to the distal end of the drill string 108 and is driven either by a downhole motor and/or via rotation of the drill string 108 from the well surface. As the bit 114 rotates, it creates a wellbore 116 that penetrates various subterranean formations 118.

[00152] A pump 120 (e.g., a mud pump) circulates drilling fluid 122 through a feed pipe 124 and to the kelly 110, which conveys the drilling fluid 122 downhole through the interior of the drill string 108 and through one or more orifices in the drill bit 114. The drilling fluid 122 is then circulated back to the surface via an annulus 126 defined between the drill string 108 and the walls of the wellbore 116. At the surface, the recirculated or spent drilling fluid 122 exits the annulus 126 and may be conveyed to one or more fluid processing unit(s) 128 via an interconnecting flow line 130. After passing through the fluid

processing unit(s) 128, a "cleaned" drilling fluid 122 is deposited into a nearby retention pit 132 (e.g., a mud pit). While illustrated as being arranged at the outlet of the wellbore 116 via the annulus 126, those skilled in the art will readily appreciate that the fluid processing unit(s) 128 may be arranged at any other location in the drilling assembly 100 to facilitate its proper function, without departing from the scope of the disclosure.

[00153] The composition including the crosslinkable ampholyte polymer and the crosslinker, or a crosslinked reaction product thereof, may be added to the drilling fluid 122 via a mixing hopper 134 communicably coupled to or otherwise in fluid communication with the retention pit 132. The mixing hopper 134 may include, but is not limited to, mixers and related mixing equipment known to those skilled in the art. In other embodiments, however, the composition including the crosslinkable ampholyte polymer and the crosslinker, or a crosslinked reaction product thereof, may be added to the drilling fluid 122 at any other location in the drilling assembly 100. In at least one embodiment, for example, there could be more than one retention pit 132, such as multiple retention pits 132 in series. Moreover, the retention pit 132 may be representative of one or more fluid storage facilities and/or units where the composition including the crosslinkable ampholyte polymer and the crosslinker, or a crosslinked reaction product thereof, may be stored, reconditioned, and/or regulated until added to the drilling fluid 122.

[00154] As mentioned above, the composition including the crosslinkable ampholyte polymer and the crosslinker, or a crosslinked reaction product thereof, may directly or indirectly affect the components and equipment of the drilling assembly 100. For example, the composition including the crosslinkable ampholyte polymer and the crosslinker, or a crosslinked reaction product thereof, may directly or indirectly affect the fluid processing unit(s) 128, which may include, but is not limited to, one or more of a shaker (e.g., shale shaker), a centrifuge, a hydrocyclone, a separator (including magnetic and electrical separators), a desilter, a desander, a separator, a filter (e.g., diatomaceous earth filters), a heat exchanger, or any fluid reclamation equipment. The fluid processing unit(s) 128 may further include one or more sensors, gauges, pumps, compressors, and the like used to store, monitor, regulate, and/or recondition the

composition including the crosslinkable ampholyte polymer and the crosslinker, or a crosslinked reaction product thereof,.

[00155] The composition including the crosslinkable ampholyte polymer and the crosslinker, or a crosslinked reaction product thereof, may directly or indirectly affect the pump 120, which representatively includes any conduits, pipelines, trucks, tubulars, and/or pipes used to fluidically convey the composition including the crosslinkable ampholyte polymer and the crosslinker, or a crosslinked reaction product thereof, downhole, any pumps, compressors, or motors (e.g., topside or downhole) used to drive the composition into motion, any valves or related joints used to regulate the pressure or flow rate of the composition, and any sensors (e.g., pressure, temperature, flow rate, and the like), gauges, and/or combinations thereof, and the like. The composition including the crosslinkable ampholyte polymer and the crosslinker, or a crosslinked reaction product thereof, may also directly or indirectly affect the mixing hopper 134 and the retention pit 132 and their assorted variations.

[00156] The composition including the crosslinkable ampholyte polymer and the crosslinker, or a crosslinked reaction product thereof, may also directly or indirectly affect the various downhole equipment and tools that may come into contact with the composition including the crosslinkable ampholyte polymer and the crosslinker, or a crosslinked reaction product thereof, such as, but not limited to, the drill string 108, any floats, drill collars, mud motors, downhole motors, and/or pumps associated with the drill string 108, and any measurement while drilling (MWD)/logging while drilling (LWD) tools and related telemetry equipment, sensors, or distributed sensors associated with the drill string 108. The composition including the crosslinkable ampholyte polymer and the crosslinker, or a crosslinked reaction product thereof, may also directly or indirectly affect any downhole heat exchangers, valves and corresponding actuation devices, tool seals, packers and other wellbore isolation devices or components, and the like associated with the wellbore 116. The composition including the crosslinkable ampholyte polymer and the crosslinker, or a crosslinked reaction product thereof, may also directly or indirectly affect the drill bit 114, which may include, but is not limited to, roller cone bits, polycrystalline diamond compact (PDC) bits, natural diamond bits, any hole openers, reamers, coring bits, and the like.

[00157] While not specifically illustrated herein, the composition including the crosslinkable ampholyte polymer and the crosslinker, or a crosslinked reaction product thereof, may also directly or indirectly affect any transport or delivery equipment used to convey the composition including the crosslinkable ampholyte polymer and the crosslinker, or a crosslinked reaction product thereof, to the drilling assembly 100 such as, for example, any transport vessels, conduits, pipelines, trucks, tubulars, and/or pipes used to fluidically move the composition including the crosslinkable ampholyte polymer and the crosslinker, or a crosslinked reaction product thereof, from one location to another, any pumps, compressors, or motors used to drive the composition into motion, any valves or related joints used to regulate the pressure or flow rate of the composition, and any sensors (e.g., pressure and temperature), gauges, and/or combinations thereof, and the like.

System or apparatus.

[00158] In various embodiments, the present invention provides a system. The system can be any suitable system that can include the use of an embodiment of the composition including the crosslinkable ampholyte polymer and the crosslinker described herein, or a crosslinked reaction product thereof, in a subterranean formation, or that can include performance of an embodiment of a method of using the composition described herein. The system can include a composition including an embodiment of the crosslinkable ampholyte polymer and the crosslinker, or including a reaction product thereof. The system can also include a subterranean formation including the composition therein. In some embodiments, the composition in the system can also include a downhole fluid, such as at least one of an aqueous fracturing fluid and an aqueous drilling fluid.

[00159] In some embodiments, the system can include a drillstring disposed in a wellbore, the drillstring including a drill bit at a downhole end of the drillstring. The system can include an annulus between the drillstring and the wellbore. The system can also include a pump configured to circulate the composition through the drill string, through the drill bit, and back above-surface through the annulus. The system can include a fluid processing unit configured to process the composition exiting the annulus to generate a cleaned drilling fluid for recirculation through the wellbore. In some embodiments, the system

can include a tubular disposed in a wellbore, and a pump configured to pump the composition into the subterranean formation.

[00160] In various embodiments, the present invention provides an apparatus. The apparatus can be any suitable apparatus that can use an embodiment of the composition described herein or that can be used to perform an embodiment of a method described herein.

[00161] Various embodiments provide systems and apparatus configured for delivering the composition described herein to a subterranean location and for using the composition therein, such as for drilling or hydraulic fracturing. In various embodiments, the system can include a pump fluidly coupled to a tubular (e.g., any suitable type of oilfield pipe, such as pipeline, drill pipe, production tubing, and the like), the tubular containing a composition including the crosslinkable ampholyte polymer and the crosslinker, or a crosslinked reaction product thereof, described herein.

[00162] The pump can be a high pressure pump in some embodiments. As used herein, the term "high pressure pump" will refer to a pump that is capable of delivering a fluid downhole at a pressure of about 1000 psi or greater. A high pressure pump can be used when it is desired to introduce the composition to a subterranean formation at or above a fracture gradient of the subterranean formation, but it can also be used in cases where fracturing is not desired. In some embodiments, the high pressure pump can be capable of fluidly conveying particulate matter, such as proppant particulates, into the subterranean formation. Suitable high pressure pumps will be known to one having ordinary skill in the art and can include, but are not limited to, floating piston pumps and positive displacement pumps.

[00163] In other embodiments, the pump can be a low pressure pump. As used herein, the term "low pressure pump" will refer to a pump that operates at a pressure of about 1000 psi or less. In some embodiments, a low pressure pump can be fluidly coupled to a high pressure pump that is fluidly coupled to the tubular. That is, in such embodiments, the low pressure pump can be configured to convey the composition to the high pressure pump. In such embodiments, the low pressure pump can "step up" the pressure of the composition before it reaches the high pressure pump.

[00164] In some embodiments, the systems or apparatuses described herein can further include a mixing tank that is upstream of the pump and in which the composition is formulated. In various embodiments, the pump (e.g., a low pressure pump, a high pressure pump, or a combination thereof) can convey the composition from the mixing tank or other source of the composition to the tubular. In other embodiments, however, the composition can be formulated offsite and transported to a worksite, in which case the composition can be introduced to the tubular via the pump directly from its shipping container (e.g., a truck, a railcar, a barge, or the like) or from a transport pipeline. In either case, the composition can be drawn into the pump, elevated to an appropriate pressure, and then introduced into the tubular for delivery downhole.

[00165] FIG. 2 shows an illustrative schematic of systems and apparatuses that can deliver embodiments of the compositions of the present invention to a subterranean location, according to one or more embodiments. It should be noted that while FIG. 2 generally depicts a land-based system or apparatus, it is to be recognized that like systems and apparatuses can be operated in subsea locations as well. Embodiments of the present invention can have a different scale than that depicted in FIG. 2. As depicted in FIG. 2, system or apparatus 1 can include mixing tank 10, in which an embodiment of the composition can be formulated. The composition can be conveyed via line 12 to wellhead 14, where the composition enters tubular 16, with tubular 16 extending from wellhead 14 into subterranean formation 18. Upon being ejected from tubular 16, the composition can subsequently penetrate into subterranean formation 18. Pump 20 can be configured to raise the pressure of the composition to a desired degree before its introduction into tubular 16. It is to be recognized that system or apparatus 1 is merely exemplary in nature and various additional components can be present that have not necessarily been depicted in FIG. 2 in the interest of clarity. Non-limiting additional components that can be present include, but are not limited to, supply hoppers, valves, condensers, adapters, joints, gauges, sensors, compressors, pressure controllers, pressure sensors, flow rate controllers, flow rate sensors, temperature sensors, and the like.

[00166] Although not depicted in FIG. 2, at least part of the composition can, in some embodiments, flow back to wellhead 14 and exit subterranean formation 18. In some embodiments, the composition that has flowed back to

wellhead 14 can subsequently be recovered, and in some examples reformulated, and recirculated to subterranean formation 18.

[00167] It is also to be recognized that the disclosed composition can also directly or indirectly affect the various downhole equipment and tools that can come into contact with the composition during operation. Such equipment and tools can include, but are not limited to, wellbore casing, wellbore liner, completion string, insert strings, drill string, coiled tubing, slickline, wireline, drill pipe, drill collars, mud motors, downhole motors and/or pumps, surface-mounted motors and/or pumps, centralizers, turbolizers, scratchers, floats (e.g., shoes, collars, valves, and the like), logging tools and related telemetry equipment, actuators (e.g., electromechanical devices, hydromechanical devices, and the like), sliding sleeves, production sleeves, plugs, screens, filters, flow control devices (e.g., inflow control devices, autonomous inflow control devices, outflow control devices, and the like), couplings (e.g., electro-hydraulic wet connect, dry connect, inductive coupler, and the like), control lines (e.g., electrical, fiber optic, hydraulic, and the like), surveillance lines, drill bits and reamers, sensors or distributed sensors, downhole heat exchangers, valves and corresponding actuation devices, tool seals, packers, cement plugs, bridge plugs, and other wellbore isolation devices or components, and the like. Any of these components can be included in the systems and apparatuses generally described above and depicted in FIG. 2.

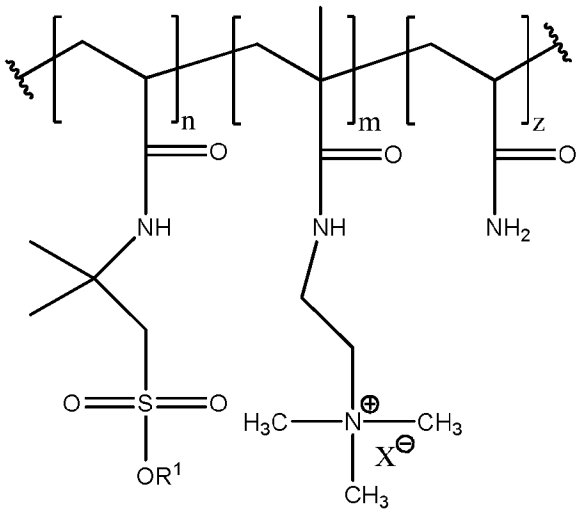
Composition for treatment of a subterranean formation.

[00168] Various embodiments provide a composition for treatment of a subterranean formation. The composition can be any suitable composition including an embodiment of the crosslinkable ampholyte polymer and the crosslinker, or a crosslinked reaction product thereof, that can be used to perform an embodiment of the method for treatment of a subterranean formation described herein. Various embodiments provide a crosslinked reaction product of an embodiment of the composition herein, wherein at least some of the crosslinkable ampholyte polymer has reacted with at least some of the crosslinker to form a crosslinked product.

[00169] For example, the composition can include a crosslinkable ampholyte polymer having about Z^{wt} wt% of an ethylene repeating unit

including the -C(O)NH_2 group, about N^{wt} wt% of an ethylene repeating unit including a -$S(O)_2OR^1$ group, and about M^{wt} wt% of an ethylene repeating unit including an -$N^+R^2{}_3X^-$ group. At each occurrence R^1 can be independently selected from the group consisting of -H and a counterion. At each occurrence, R^2 can be independently substituted or unsubstituted (C_1-C_{20})hydrocarbyl. At each occurrence, X^- can be independently a counterion. The repeating units are in block, alternate, or random configuration. The variable Z^{wt} can be about 10% to about 70%, N^{wt} can be about 1% to about 40%, and M^{wt} can be about 20% to about 80%. The crosslinkable ampholyte polymer can have a molecular weight of about 100,000 g/mol to about 20,000,000 g/mol. The composition can include at least one crosslinker. The composition can also include a downhole fluid. Additionally or alternatively to the composition including the crosslinkable ampholyte polymer and the crosslinker, the composition can include a reaction product of the crosslinkable ampholyte polymer and the crosslinker (e.g., a reaction product of a crosslinking reaction between the crosslinkable ampholyte polymer and the crosslinker).

[00170] In some embodiments, the crosslinkable ampholyte polymer includes repeating units having the structure:



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At each occurrence R^1 can be independently selected from the group consisting of -H and a counterion. The repeating units are in a block, alternate, or random configuration, and each repeating unit is independently in the orientation shown or in the opposite orientation. The crosslinkable ampholyte polymer can have a molecular weight of about 100,000 g/mol to about 20,000,000 g/mol. The

crosslinkable ampholyte polymer can have about 30 wt% to about 50 wt% of the ethylene repeating unit including the $-C(O)NH_2$ group, about 5 wt% to about 15 wt% of the ethylene repeating unit including the $-S(O)_2OR^1$ group, and about 40 wt% to about 60 wt% of the ethylene repeating unit including the $-N^+R^2{}_3X^-$ group. The composition can include a crosslinker including polyethyleneimine. The composition can also include a downhole fluid including at least one of a drilling fluid, a fracturing fluid, a diverting fluid, and a lost circulation treatment fluid. About 0.001 wt% to about 30 v/v% of the composition is the crosslinkable ampholyte polymer and the crosslinker, with the remainder being the downhole fluid and other optional components. Additionally or alternatively to the composition including the crosslinkable ampholyte polymer and the crosslinker, the composition can include a reaction product of the crosslinkable ampholyte polymer and the crosslinker (e.g., a reaction product of a crosslinking reaction between the crosslinkable ampholyte polymer and the crosslinker).

Method for preparing a composition for treatment of a subterranean formation.

[00171] In various embodiments, the present invention provides a method for preparing a composition for treatment of a subterranean formation. The method can be any suitable method that produces an embodiment of the composition including the crosslinkable ampholyte polymer and the crosslinker, or a reaction product thereof, described herein. For example, the method can include forming a composition including an embodiment of the crosslinkable ampholyte polymer and the crosslinker, or a reaction product thereof. In some embodiments, the composition further includes a downhole fluid.

Examples

[00172] Various embodiments of the present invention can be better understood by reference to the following Examples which are offered by way of illustration. The present invention is not limited to the Examples given herein.

Part I. Viscosifier.

Example 1.

[00173] Two samples of an ampholyte polymeric compound including a terpolymer of acrylamide, 2-acrylamido-2-methylpropane sulfonic acid, and acryloyloxy ethyl trimethyl ammonium chloride in water were prepared at 5 gal/1,000 gal and 20 gal/1,000 gal. The ampholyte terpolymer had 40 wt% monomers from acrylamide, 10 wt% monomers from 2-acrylamido-2-methylpropane sulfonic acid, and 50 wt% monomers from acryloyloxy ethyl trimethyl ammonium chloride (AETAC). The samples were heated from 77°F to 150°F at a rate of 10°F/min and then held at a constant temperature of 150°F at a shear rate of 40 s^{-1}. As shown in FIG. 3, the viscosity at the higher concentration reduces from about 155 cP to less than about 5 cP in about 90 minutes, while at the lower concentration from about 35 cP to less than about 5 cP in about 20-25 minutes.

[00174] This example illustrates that treatment fluids including the ampholyte polymeric compounds described herein can reduce in viscosity over time (e.g., can break over time), which can advantageously allow for the use of little to no breaker in the treatment fluids or in subsequent wellbore operations.

Example 2.

[00175] Samples were prepared with (1) linear xanthan (known to viscosify high TDS fluids) at 60 lb/1,000 gal and (2) an ampholyte polymeric compound including a terpolymer of acrylamide, 2-acrylamido-2-methylpropane sulfonic acid, and acryloyloxy ethyl trimethyl ammonium chloride at 60 gal/1,000 gal, each in base fluids of (1) water and (2) salt water with an additional 3% KCl. The ampholyte terpolymer had the same wt% distribution of monomers as the ampholyte terpolymer used in Example 1. The viscosity of each sample was analyzed at 77°F and 150°F at a shear rate of 40 s^{-1}. FIG. 4 (water samples) illustrates that the ampholyte polymeric compound provides higher viscosity than linear xanthan in water. While FIG. 5 (salt water samples) illustrates that in a high TDS environment the ampholyte polymeric compound provides for a comparable viscosity to linear xanthan.

[00176] This example illustrates that treatment fluids can be viscosified to levels comparable to that of traditional viscosifying agents, including in high TDS fluids.

Part II. Friction reduction.

Example 3.

[00177] Samples were prepared with individual friction reducers at a concentration of 1 gallon per thousand gallons (e.g., 0.1% by volume) in water:

(1) a commercially available friction reducing agent containing partially hydrolyzed polyacrylamide;

(2) a multi-component, cationic friction reducing agent; and

(3) an ampholyte polymeric compound including a terpolymer of acrylamide, 2-acrylamido-2-methylpropane sulfonic acid, and acryloyloxy ethyl trimethyl ammonium chloride. The ampholyte terpolymer had the same wt% distribution of monomers as the ampholyte terpolymer used in Example 1.

[00178] The salinity of the samples (measured as ppm of TDS) was then increased as the percent friction reduction ("%FR") was analyzed by pumping the sample through a test pipe while measuring the pressure drop with a pressure transducer. The %FR was calculated based on the ratio between the measured pressure drop of the sample and the pressure drop of a fresh water control sample at the same tested flow rate and ambient temperature and pressure.

[00179] As shown in FIG. 6, the Sample 1 showed an immediate decline in the %FR with increased salinity and a dramatic drop in %FR to essentially no friction reduction from about 100,000 to about 150,000 ppm TDS. Samples 2 and 3 showed similar performance over the salinity range tested with only about a 5%-10% variations in the %FR from 0 ppm to about 250,000 ppm TDS.

[00180] This example demonstrates that the one-component friction reducing agent of an ampholyte polymeric compound outperforms other polymeric friction reducing agents with increased TDS and provides comparable performance to the more complex friction reducing agents, which tend to be expensive and complicated to implement.

Example 4.

[00181] Samples of an ampholyte polymeric compound including a terpolymer of acrylamide, 2-acrylamido-2-methylpropane sulfonic acid, and acryloyloxy ethyl trimethyl ammonium chloride in water were analyzed for degradation rates by analyzing the viscosity of the fluid over time at various temperatures:

(1) room temperature;

(2) ramp to 150°F; and

(3) ramp to 190°F.

[00182] The ampholyte terpolymer had the same wt% distribution of monomers as the ampholyte terpolymer used in Example 1. As shown in FIG. 7, the viscosity of the room temperature sample decreased from about 4.75 cP to about 1 cP over about 6 hours while the 150°F sample decreased from about 5 cP to about 0.4 cP over about 25 minutes and the 190°F sample decreased from about 5 cP to about 0.4 cP over about 15 minutes. Reduction in viscosity to such levels indicates that the polymer was partially hydrolyzed and contracted. As shown, the hydrolysis was temperature dependent, indicating that in some instances the native temperature of the subterranean formation may be such that an ampholyte polymeric compound may be capable of breaking with minimal to no additional breaker.

Example 5.

[00183] Samples were prepared with (1) partially hydrolyzed polyacrylamide in water (2) an ampholyte polymeric compound including a terpolymer of acrylamide, 2-acrylamido-2-methylpropane sulfonic acid, and acryloyloxy ethyl trimethyl ammonium chloride in water. The ampholyte terpolymer had the same wt% distribution of monomers as the ampholyte terpolymer used in Example 1. The concentration of each of the polymers was at infinite dilution. The intrinsic viscosity of the samples were measured over about 75 hours. As illustrated in FIG. 8, the ampholyte polymeric compound sample reduced in intrinsic viscosity from about 95 dL/g to about 2 dL/g, while the polyacrylamide sample had a relatively steady intrinsic viscosity of about 100 dL/g over the 75 hour time frame. This demonstrates that the ampholyte polymeric compounds may be capable of breaking over time without the use of

chemical breakers due, at least in part, to the partial hydrolysis of the ampholyte polymeric compound (e.g., the acryloyloxy ethyl trimethyl ammonium chloride to acrylic acid).

Example 6.

[00184] Samples were prepared with an ampholyte polymeric compound including a terpolymer of acrylamide, 2-acrylamido-2-methylpropane sulfonic acid, and acryloyloxy ethyl trimethyl ammonium chloride at 0.1 vol% in (1) water, (2) 50,000 ppm brine, and (3) 250,000 ppm brine. The ampholyte terpolymer had the same wt% distribution of monomers as the ampholyte terpolymer used in Example 1. The samples were heated to 150°F, and the viscosity of each sample was analyzed at a shear rate of 40 s^{-1}. FIG. 9 illustrates that the sample in water achieved the highest initial viscosity, while both of the brine samples achieved about 1/3 the initial viscosity as the water sample. However, over time, the higher the TDS of the sample the less reduction in the viscosity (e.g., less hydrolysis and contraction of the ampholyte polymeric compound).

Example 7.

[00185] Samples were prepared with (1) 0.1 vol% polyacrylamide, (2) 0.1 vol% polyacrylamide and 1 lb/1,000 gal of a chemical breaker, and (3) 0.1 vol% of an ampholyte polymeric compound including a terpolymer of acrylamide, 2-acrylamido-2-methylpropane sulfonic acid, and acryloyloxy ethyl trimethyl ammonium chloride in water. The ampholyte terpolymer had the same wt% distribution of monomers as the ampholyte terpolymer used in Example 1. Samples were run through various core/sand pack samples to determine the regain permeability of the core/sand pack samples after treatment.

[00186] In the regain permeability tests, the initial permeability was measured by flowing 7% KCl through the core/sand pack sample. Then, the samples were pumped through the core/sand pack sample at a rate of five pore volumes. The treated core/sand pack sample was shut-in overnight at 150°F. The permeability was once again tested by flowing 7% KCl through the core/sand pack sample. Table 1 provides the initial permeability and percent of permeability regained.

[00187] Table 1. Initial permeability and percent of permeability regained.

Fluid Sample	Core/Sand Pack	Initial Permeability	Regain Permeability
(2)	100 mesh sand pack	1.5 D	96%
(3)	100 mesh sand pack	1.6 D	98%
(1)	Berea core	91 mD	29%
(2)	Berea core	106 mD	83%
(3)	Berea core	77 mD	80%
(2)	Nugget	2.5 mD	54%
(3)	Nugget	1.8 mD	61%

[00188] This example demonstrates that the ampholyte polymeric compound, with no additional chemical breaker, provides for similar or better regain in permeability to a traditional friction reducer with a chemical breaker.

Part III. Crosslinked polymer.

Example 8.

[00189] An aqueous solution with 40 gpt ampholyte terpolymer and 10 gpt polyethyleneimine was prepared. The ampholyte terpolymer had the same wt% distribution of monomers as the ampholyte terpolymer used in Example 1. The terpolymer was crosslinked by exposing it to elevated temperature (150 °F for about 2 h). FIG.10 shows a photo of the crosslinked ampholyte terpolymer.

[00190] As a comparative sample, an aqueous solution of 25 ppt (parts per thousand) guar gum and 2 gpt crosslinker (an instant borate crosslinker) was crosslinked at room temperature.

Example 9. Viscosity measurement.

[00191] FIG. 11 shows the viscosity curve for the crosslinked ampholyte terpolymer of Example 8 at room temperature. It was a pseudoplastic fluid and exhibited a strong yield-stress. These properties can be helpful for fluid loss and diverting applications. The n and K value were 0.2 and 107.1 $Pa*s^{0.2}$ respectively.

Example 10. Small amplitude oscillation shear testing.

[00192] Small amplitude oscillation shear (SAOS) testing was performed to further investigate the structure of the crosslinked materials of Example 8. FIG. 12 illustrates the results for the crosslinked ampholyte terpolymer and crosslinked guar gum at room temperature, with a strain of 10% for each test.

[00193] FIG. 12 shows that the storage modulus G' of the crosslinked ampholyte terpolymer was relatively constant over a wide range of frequency and no crossover was observed, indicating a solid-like material, and its G' was about 10 times higher than the crosslinked guar.

[00194] FIG. 13 illustrates the SAOS test results for the crosslinked materials at 150 °F, again using 10% strain. At high temperatures, crosslinked guar became a viscous fluid. As shown in FIG. 13, the G'' of the crosslinked guar gum was greater than G' over the tested frequency, illustrating that the proppant transport capability decreases due to the reduction in elasticity. In contrast, not much change was observed for the crosslinked ampholyte terpolymer. Two conclusions can be drawn from this result. First, crosslinked ampholyte terpolymer had a much higher elasticity than crosslinked guar, which can help to suspend the proppant. Second, the crosslinked ampholyte polymer can tolerate higher temperatures than crosslinked guar, e.g., the gel has better temperature stability.

Example 11. Core flow testing.

[00195] Core flow testing was conducted to check the regain permeability for crosslinked polyacrylamide and the crosslinked ampholyte terpolymer of Example 8. The treatment fluid was flown through the core at 5 pore volume, and the cell was shut-in at 150 °F overnight. 7%KCl brine was used to flow through the core and obtain the permeability data. FIG. 14 illustrates the permeability profile for a crosslinked mixture of 40 gpt polyacrylamide (having 30 mol% hydrolyzed acrylamide units, having a molecular weight of about 10,000,000) with 10 gpt polyethyleneimine. FIG. 15 illustrates the permeability profile for a crosslinked mixture of 40 gpt ampholyte terpolymer with 10 gpt PEI, where 5PV refers to 5 pore volume, wherein the volume of the fluid is 5 times the pore volume of the core. Table 2 summarizes the results for both tests.

[00196] Table 2. Summary of regain permeability for crosslinked polyacrylamide and crosslinked ampholyte terpolymer

Fluid	Initial permeability	Regain permeability
40 gpt polyacrylamide + 10 gpt PEI, crosslinked	2.1 Darcy	1.21%
40 gpt ampholyte terpolymer + 10 gpt PEI, crosslinked	7.3 Darcy	0.01%

[00197] Though the initial permeability for the crosslinked ampholyte terpolymer test was three times higher than the crosslinked polyacrylamide test, it still showed almost 0% regain permeability after the treatment whereas the crosslinked polyacrylamide showed 1.2% regain permeability. The crosslinked ampholyte terpolymer was more effective in reducing the permeability of a formation.

[00198] The terms and expressions that have been employed are used as terms of description and not of limitation, and there is no intention in the use of such terms and expressions of excluding any equivalents of the features shown and described or portions thereof, but it is recognized that various modifications are possible within the scope of the embodiments of the present invention. Thus, it should be understood that although the present invention has been specifically disclosed by specific embodiments and optional features, modification and variation of the concepts herein disclosed may be resorted to by those of ordinary skill in the art, and that such modifications and variations are considered to be within the scope of embodiments of the present invention.

Additional Embodiments.

[00199] The following exemplary embodiments are provided, the numbering of which is not to be construed as designating levels of importance:

[00200] Embodiment 1 provides a method of treating a subterranean formation, the method comprising:

obtaining or providing a composition comprising

a crosslinkable ampholyte polymer comprising an ethylene repeating unit comprising a $-C(O)NH_2$ group, an ethylene repeating unit comprising an $-S(O)_2OR^1$ group, and an ethylene repeating unit comprising an $-N^+R^2{}_3X^-$ group, wherein

at each occurrence, R^1 is independently selected from the group consisting of -H and a counterion,

at each occurrence, R^2 is independently substituted or unsubstituted (C_1-C_{20})hydrocarbyl, and

at each occurrence, X^- is independently a counterion; and

at least one crosslinker; and

placing the composition in a subterranean formation.

[00201] Embodiment 2 provides the method of Embodiment 1, wherein the obtaining or providing of the composition occurs above-surface.

[00202] Embodiment 3 provides the method of any one of Embodiments 1-2, wherein the obtaining or providing of the composition occurs in the subterranean formation.

[00203] Embodiment 4 provides the method of any one of Embodiments 1-3, wherein the method is a method of drilling the subterranean formation.

[00204] Embodiment 5 provides the method of any one of Embodiments 1-4, wherein the method is a method of fracturing the subterranean formation.

[00205] Embodiment 6 provides the method of any one of Embodiments 1-5, wherein the method is a method of fluid loss control or diverting.

[00206] Embodiment 7 provides the method of any one of Embodiments 1-6, wherein the composition comprises an aqueous liquid.

[00207] Embodiment 8 provides the method of Embodiment 7, wherein the method further comprises mixing the aqueous liquid with the crosslinkable ampholyte polymer and the crosslinker.

[00208] Embodiment 9 provides the method of Embodiment 8, wherein the mixing occurs above surface.

[00209] Embodiment 10 provides the method of Embodiment 9, wherein the mixing occurs in the subterranean formation.

[00210] Embodiment 11 provides the method of any one of Embodiments 7-10, wherein the aqueous liquid comprises at least one of water, brine, produced water, flowback water, brackish water, and sea water.

[00211] Embodiment 12 provides the method of any one of Embodiments 7-11, wherein the aqueous liquid comprises salt water having a total dissolved solids level of about 1,000 mg/L to about 300,000 mg/L.

[00212] Embodiment 13 provides the method of any one of Embodiments 7-12, wherein the aqueous liquid comprises at least one of a drilling fluid, a fracturing fluid, a diverting fluid, and a lost circulation treatment fluid.

[00213] Embodiment 14 provides the method of any one of Embodiments 1-13, further comprising at least partially crosslinking the crosslinkable ampholyte polymer to provide a crosslinked ampholyte polymer.

[00214] Embodiment 15 provides the method of Embodiment 14, wherein the crosslinking occurs at least partially above-surface.

[00215] Embodiment 16 provides the method of any one of Embodiments 14-15, wherein the crosslinking occurs at least partially in the subterranean formation.

[00216] Embodiment 17 provides the method of any one of Embodiments 14-16, wherein the crosslinking is at least partially triggered by an increase in temperature.

[00217] Embodiment 18 provides the method of Embodiment 17, wherein the increase in temperature is at least partially due to placement of the composition in the subterranean formation.

[00218] Embodiment 19 provides the method of any one of Embodiments 14-18, wherein the crosslinking comprises exposing the composition to a temperature of about 100 °F to about 450 °F.

[00219] Embodiment 20 provides the method of any one of Embodiments 14-19, wherein the crosslinking comprises exposing the composition to a temperature of about 125 °F to about 250 °F.

[00220] Embodiment 21 provides the method of any one of Embodiments 14-20, wherein after the crosslinking, a viscosity of the composition, at standard temperature and pressure and at a shear rate of about 50 s^{-1} to about 500 s^{-1}, is about 10 cP to about 1,000,000 cP.

[00221] Embodiment 22 provides the method of any one of Embodiments 14-21, wherein after the crosslinking, a viscosity of the composition, at standard temperature and pressure and at a shear rate of about 50 s^{-1} to about 500 s^{-1}, is about 1,000 cP to about 500,000 cP.

[00222] Embodiment 23 provides the method of any one of Embodiments 14-22, wherein after the crosslinking, a viscosity of the composition, at standard temperature and pressure and at a shear rate of about 0 s^{-1} to about 1 s^{-1}, is about 10 cP to about 10,000,000 cP.

[00223] Embodiment 24 provides the method of any one of Embodiments 14-23, wherein after the crosslinking, a yield stress of the composition, at standard temperature and pressure, is about 0.1 Pa and about 1,000 Pa.

[00224] Embodiment 25 provides the method of any one of Embodiments 14-24, wherein after the crosslinking, a yield stress of the composition, at standard temperature and pressure, is about 1 Pa to about 500 Pa.

[00225] Embodiment 26 provides the method of any one of Embodiments 14-25, wherein prior to the crosslinking, a viscosity of the composition, at standard temperature and pressure and at a shear rate of about 50 s^{-1} to about 500 s^{-1}, is about 0.01 cP to about 1,000,000 cP.

[00226] Embodiment 27 provides the method of any one of Embodiments 14-26, wherein prior to the crosslinking, a viscosity of the composition, at standard temperature and pressure and at a shear rate of about 50 s^{-1} to about 500 s^{-1}, is about 0.01 cP to about 10,000 cP.

[00227] Embodiment 28 provides the method of any one of Embodiments 1-27, wherein the crosslinkable ampholyte polymer is sufficient such that, when crosslinked in an aqueous solution at a concentration of about 40 gpt with a polyethyleneimine crosslinker at a concentration of about 10 ppt to form a crosslinked ampholyte polymer, at 77 °F and standard pressure, with a strain of about 10%, at a frequency of about 0.1 rad/s to about 100 rad/s, the aqueous solution comprising the crosslinked ampholyte polymer has a loss modulus G'' of about 0.1 Pa to about 100 Pa.

[00228] Embodiment 29 provides the method of any one of Embodiments 1-28, wherein the crosslinkable ampholyte polymer is sufficient such that, when crosslinked in an aqueous solution at a concentration of about 40 gpt with a polyethyleneimine crosslinker at a concentration of about 10 ppt to form a crosslinked ampholyte polymer, at 150 °F and standard pressure, with a strain of about 10%, at a frequency of about 0.1 rad/s to about 100 rad/s, the aqueous solution comprising the crosslinked polymer has a storage modulus G' of about 10 Pa to about 1000 Pa.

[00229] Embodiment 30 provides the method of any one of Embodiments 1-29, wherein the crosslinkable ampholyte polymer is sufficient such that, when crosslinked in an aqueous solution at a concentration of about 40 gpt with a polyethyleneimine crosslinker at a concentration of about 10 ppt to form a crosslinked ampholyte polymer, at 150 °F and standard pressure, with a strain of about 10%, at a frequency of about 0.1 rad/s to about 100 rad/s, the aqueous solution comprising the crosslinked polymer has a loss modulus G'' of about 0.5 Pa to about 10 Pa.

[00230] Embodiment 31 provides the method of any one of Embodiments 1-30, wherein about 0.001 wt% to about 95 wt% of the composition is the crosslinkable ampholyte polymer.

[00231] Embodiment 32 provides the method of any one of Embodiments 1-31, wherein about 70 wt% to about 90 wt% of the composition is the crosslinkable ampholyte polymer.

[00232] Embodiment 33 provides the method of any one of Embodiments 7-32, wherein about 0.01 wt% to about 50 wt% of the composition is the crosslinkable ampholyte polymer.

[00233] Embodiment 34 provides the method of any one of Embodiments 7-33, wherein about 0.001 to about 30 v/v% of the composition is the crosslinkable ampholyte polymer.

[00234] Embodiment 35 provides the method of any one of Embodiments 1-34, wherein the crosslinkable ampholyte polymer has about Z^{wt} wt% of the ethylene repeating unit comprising the $-C(O)NH_2$ group, about N^{wt} wt% of the ethylene repeating unit comprising the $-S(O)_2OR^1$ group, and about M^{wt} wt% of the ethylene repeating unit comprising the $-N^+R^2{}_3X^-$ group, wherein Z^{wt} is about 10% to about 70%, N^{wt} is about 1% to about 40%, and M^{wt} is about 20% to about 80%.

[00235] Embodiment 36 provides the method of Embodiment 35, wherein Z^{wt} is about 30% to about 50%, N^{wt} is about 5% to about 15%, and M^{wt} is about 40% to about 60%.

[00236] Embodiment 37 provides the method of any one of Embodiments 35-36, wherein $Z^{wt} + N^{wt} + M^{wt}$ is about 100%.

[00237] Embodiment 38 provides the method of any one of Embodiments 1-37, wherein the crosslinkable ampholyte polymer has about Z^{mol} mol% of the

ethylene repeating unit comprising the -C(O)NH_2 group, about N^{mol} mol% of the ethylene repeating unit comprising the -$S(O)_2OR^1$ group, and about M^{mol} mol% of the ethylene repeating unit comprising the -$N^+R^2{}_3X^-$ group, wherein Z^{mol} is about 5% to about 50%, N^{mol} is about 1% to about 40%, and M^{mol} is about 40% to about 90%.

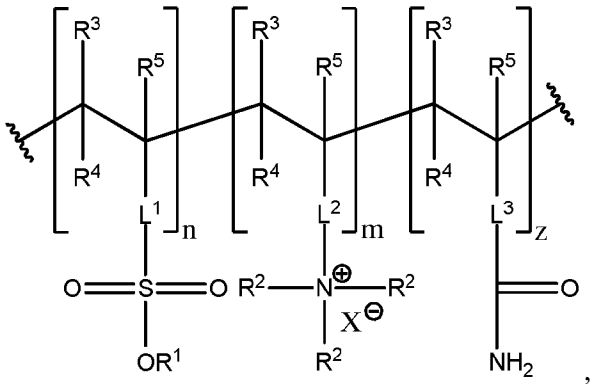
[00238] Embodiment 39 provides the method of Embodiment 38, wherein Z^{mol} is about 10% to about 25%, N^{mol} is about 5% to about 20%, and M^{mol} is about 55% to about 70%.

[00239] Embodiment 40 provides the method of any one of Embodiments 38-39, wherein $Z^{mol} + N^{mol} + M^{mol}$ is about 100%.

[00240] Embodiment 41 provides the method of any one of Embodiments 1-40, wherein the crosslinkable ampholyte polymer has a molecular weight of about 100,000 g/mol to about 20,000,000 g/mol.

[00241] Embodiment 42 provides the method of any one of Embodiments 1-41, wherein the crosslinkable ampholyte polymer has a molecular weight of about 5,000,000 g/mol to about 15,000,000 g/mol.

[00242] Embodiment 43 provides the method of any one of Embodiments 1-42, wherein the crosslinkable ampholyte polymer comprises repeating units having the structure:



,

wherein

at each occurrence R^3, R^4, and R^5 are each independently selected from the group consisting of -H and a substituted or unsubstituted C_1-C_5 hydrocarbyl,

at each occurrence L^1, L^2, and L^3 are each independently selected from the group consisting of a bond and a substituted or unsubstituted C_1-C_{20}

hydrocarbyl interrupted or terminated with 0, 1, 2, or 3 of at least one of -NR^3-, -S-, and -O-, and

the repeating units are in a block, alternate, or random configuration, and each repeating unit is independently in the orientation shown or in the opposite orientation.

[00243] Embodiment 44 provides the method of Embodiment 43, wherein at each occurrence L^1 is independently selected from the group consisting of a bond and -(substituted or unsubstituted C_1-C_{20} hydrocarbyl)-NR^3-(substituted or unsubstituted C_1-C_{20} hydrocarbyl)-.

[00244] Embodiment 45 provides the method of any one of Embodiments 43-44, wherein at each occurrence L^1 is independently -C(O)-NH-(substituted or unsubstituted C_1-C_{19} hydrocarbyl)-.

[00245] Embodiment 46 provides the method of any one of Embodiments 43-45, wherein at each occurrence L^1 is independently -C(O)-NH-(C_1-C_5 hydrocarbyl)-.

[00246] Embodiment 47 provides the method of any one of Embodiments 43-46, wherein L^1 is -C(O)-NH-$CH(CH_3)_2$-CH_2-.

[00247] Embodiment 48 provides the method of any one of Embodiments 43-47, wherein at each occurence L^2 is independently selected from the group consisting of -O-(C_1-C_{20})hydrocarbyl- and -NR^3-(C_1-C_{20})hydrocarbyl-.

[00248] Embodiment 49 provides the method of any one of Embodiments 43-48, wherein at each occurrence L^2 is independently selected from -O-(C_1-C_{10})alkyl- and -NH-(C_1-C_{10})alkyl-.

[00249] Embodiment 50 provides the method of any one of Embodiments 43-49, wherein at each occurrence L^2 is independently selected from -O-CH_2-CH_2- and -NH-CH_2-CH_2.

[00250] Embodiment 51 provides the method of any one of Embodiments 43-50, wherein at each occurrence L^3 is independently selected from the group consisting of a bond and C_1-C_{20} hydrocarbyl.

[00251] Embodiment 52 provides the method of any one of Embodiments 43-51, wherein at each occurrence L^3 is independently selected from the group consisting of a bond and C_1-C_5 alkyl.

[00252] Embodiment 53 provides the method of any one of Embodiments 43-52, wherein at each occurrence L^3 is a bond.

[00253] Embodiment 54 provides the method of any one of Embodiments 43-53, wherein at each occurrence R^3, R^4, and R^5 are independently selected from the group consisting of -H and a C_1-C_5 alkyl.

[00254] Embodiment 55 provides the method of any one of Embodiments 43-54, wherein at each occurrence R^3, R^4, and R^5 are independently selected from the group consisting of -H and a C_1-C_3 alkyl.

[00255] Embodiment 56 provides the method of any one of Embodiments 43-55, wherein at each occurrence R^3, R^4, and R^5 are each -H.

[00256] Embodiment 57 provides the method of any one of Embodiments 43-56, wherein at each occurrence R^1 is independently selected from the group consisting of -H, Na^+, K^+, Li^+, NH_4^+, Zn^+, Ca^{2+}, Zn^{2+}, Al^{3+}, and Mg^{2+}.

[00257] Embodiment 58 provides the method of any one of Embodiments 43-57, wherein at each occurrence R^1 is -H.

[00258] Embodiment 59 provides the method of any one of Embodiments 43-58, wherein at each occurrence R^2 is independently (C_1-C_{20})alkyl.

[00259] Embodiment 60 provides the method of any one of Embodiments 43-59, wherein at each occurrence R^2 is independently (C_1-C_{10})alkyl.

[00260] Embodiment 61 provides the method of any one of Embodiments 43-60, wherein at each occurrence R^2 is independently selected from the group consisting of methyl, ethyl, propyl, butyl, and pentyl.

[00261] Embodiment 62 provides the method of any one of Embodiments 43-61, wherein X^- is Cl^-.

[00262] Embodiment 63 provides the method of any one of Embodiments 43-62, wherein n is about 4 to about 40,000.

[00263] Embodiment 64 provides the method of any one of Embodiments 43-63, wherein n is about 450 to about 14,500.

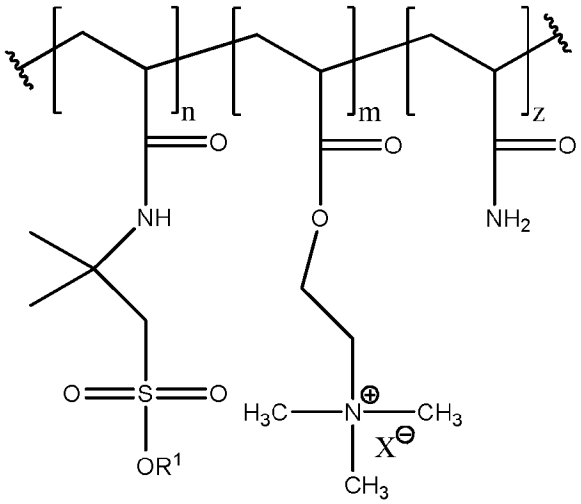
[00264] Embodiment 65 provides the method of any one of Embodiments 43-64, wherein m is about 100 to about 83,000.

[00265] Embodiment 66 provides the method of any one of Embodiments 43-65, wherein m is about 4,000 to about 62,000.

[00266] Embodiment 67 provides the method of any one of Embodiments 43-66, wherein z is about 125 to about 200,000.

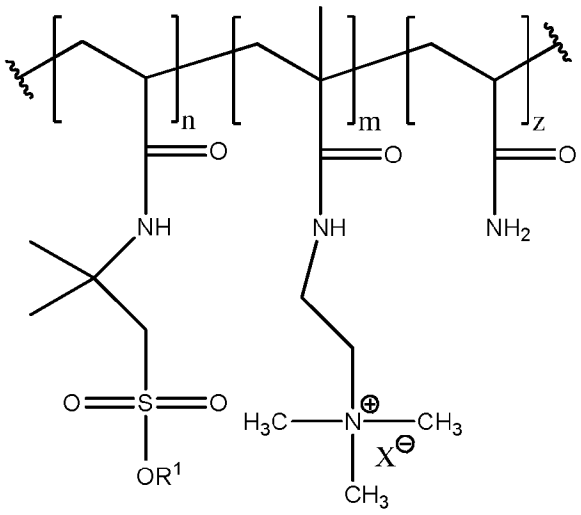
[00267] Embodiment 68 provides the method of any one of Embodiments 43-67, wherein z is about 8,500 to about 140,000.

[00268] Embodiment 69 provides the method of any one of Embodiments 1-68, wherein the crosslinkable ampholyte polymer comprises repeating units having the structure:



wherein the repeating units are in a block, alternate, or random configuration, and each repeating unit is independently in the orientation shown or in the opposite orientation.

[00269] Embodiment 70 provides the method of any one of Embodiments 1-69, wherein the crosslinkable ampholyte polymer comprises repeating units having the structure:



wherein the repeating units are in a block, alternate, or random configuration, and each repeating unit is independently in the orientation shown or in the opposite orientation.

[00270] Embodiment 71 provides the method of any one of Embodiments 1-70, wherein about 0.000,1 wt% to about 80 wt% of the composition is the crosslinker.

[00271] Embodiment 72 provides the method of any one of Embodiments 1-71, wherein about 1 wt% to about 30 wt% of the composition is the crosslinker.

[00272] Embodiment 73 provides the method of any one of Embodiments 7-72, wherein about 0.000,1 wt% to about 50 wt% of the composition is the crosslinker.

[00273] Embodiment 74 provides the method of any one of Embodiments 7-73, wherein about 0.001 wt% to about 5 wt% of the composition is the crosslinker.

[00274] Embodiment 75 provides the method of any one of Embodiments 1-74, wherein the crosslinker comprises at least one of chromium, aluminum, antimony, zirconium, titanium, calcium, boron, iron, silicon, copper, zinc, magnesium, and an ion thereof.

[00275] Embodiment 76 provides the method of any one of Embodiments 1-75, wherein the crosslinker comprises at least one of a poly(amino(C_2-C_{10})hydrocarbylene) crosslinker and a (C_6-C_{20})aryl alcohol-(C_1-C_{20})aldehyde crosslinker.

[00276] Embodiment 77 provides the method of any one of Embodiments 1-76, wherein the crosslinker comprises at least one of polyethyleneimine, phenol-formaldehyde, and glyoxal.

[00277] Embodiment 78 provides the method of any one of Embodiments 1-77, wherein the crosslinker comprises at least one of boric acid, borax, a borate, a (C_1-C_{30})hydrocarbylboronic acid, a (C_1-C_{30})hydrocarbyl ester of a (C_1-C_{30})hydrocarbylboronic acid, a (C_1-C_{30})hydrocarbylboronic acid-modified polyacrylamide, ferric chloride, disodium octaborate tetrahydrate, sodium metaborate, sodium diborate, sodium tetraborate, disodium tetraborate, a pentaborate, ulexite, colemanite, magnesium oxide, zirconium lactate, zirconium triethanol amine, zirconium lactate triethanolamine, zirconium carbonate, zirconium acetylacetonate, zirconium malate, zirconium citrate, zirconium diisopropylamine lactate, zirconium glycolate, zirconium triethanol amine glycolate, zirconium lactate glycolate, titanium lactate, titanium malate, titanium

citrate, titanium ammonium lactate, titanium triethanolamine, titanium acetylacetonate, aluminum lactate, and aluminum citrate.

[00278] Embodiment 79 provides the method of any one of Embodiments 1-78, wherein the composition further comprises a fluid comprising at least one of water, an organic solvent, and an oil.

[00279] Embodiment 80 provides the method of any one of Embodiments 1-79, wherein the composition further comprises a fluid comprising at least one of dipropylene glycol methyl ether, dipropylene glycol dimethyl ether, dimethyl formamide, diethylene glycol methyl ether, ethylene glycol butyl ether, diethylene glycol butyl ether, propylene carbonate, D-limonene, a C_2-C_{40} fatty acid C_1-C_{10} alkyl ester, 2-butoxy ethanol, butyl acetate, furfuryl acetate, dimethyl sulfoxide, dimethyl formamide, diesel, kerosene, mineral oil, a hydrocarbon comprising an internal olefin, a hydrocarbon comprising an alpha olefin, xylenes, an ionic liquid, methyl ethyl ketone, and cyclohexanone.

[00280] Embodiment 81 provides the method of any one of Embodiments 1-80, wherein the composition further comprises a secondary viscosifier.

[00281] Embodiment 82 provides the method of Embodiment 81, wherein the secondary viscosifier comprises at least one of a substituted or unsubstituted polysaccharide, and a substituted or unsubstituted polyalkenylene, wherein the polysaccharide or polyalkenylene is crosslinked or uncrosslinked.

[00282] Embodiment 83 provides the method of any one of Embodiments 81-82, wherein the secondary viscosifier comprises a polymer comprising at least one monomer selected from the group consisting of ethylene glycol, acrylamide, vinyl acetate, 2-acrylamidomethylpropane sulfonic acid or its salts, trimethylammoniumethyl acrylate halide, and trimethylammoniumethyl methacrylate halide.

[00283] Embodiment 84 provides the method of any one of Embodiments 81-83, wherein the secondary viscosifier comprises a crosslinked gel or a crosslinkable gel.

[00284] Embodiment 85 provides the method of any one of Embodiments 81-84, wherein the secondary viscosifier comprises at least one of a linear polysaccharide, and poly((C_2-C_{10})alkenylene), wherein the (C_2-C_{10})alkenylene is substituted or unsubstituted.

[00285] Embodiment 86 provides the method of any one of Embodiments 81-85, wherein the secondary viscosifier comprises at least one of poly(acrylic acid) or (C_1-C_5)alkyl esters thereof, poly(methacrylic acid) or (C_1-C_5)alkyl esters thereof, poly(vinyl acetate), poly(vinyl alcohol), poly(ethylene glycol), poly(vinyl pyrrolidone), polyacrylamide, poly (hydroxyethyl methacrylate), alginate, chitosan, curdlan, dextran, emulsan, a galactoglucopolysaccharide, gellan, glucuronan, N-acetyl-glucosamine, N-acetyl-heparosan, hyaluronic acid, kefiran, lentinan, levan, mauran, pullulan, scleroglucan, schizophyllan, stewartan, succinoglycan, xanthan, welan, derivatized starch, tamarind, tragacanth, guar gum, derivatized guar, gum ghatti, gum arabic, locust bean gum, derivatized cellulose, carboxymethyl cellulose, hydroxyethyl cellulose, carboxymethyl hydroxyethyl cellulose, hydroxypropyl cellulose, methyl hydroxyl ethyl cellulose, guar, hydroxypropyl guar, carboxy methyl guar, and carboxymethyl hydroxylpropyl guar.

[00286] Embodiment 87 provides the method of any one of Embodiments 81-86, wherein the secondary viscosifier comprises poly(vinyl alcohol) homopolymer, poly(vinyl alcohol) copolymer, a crosslinked poly(vinyl alcohol) homopolymer, and a crosslinked poly(vinyl alcohol) copolymer.

[00287] Embodiment 88 provides the method of any one of Embodiments 1-87, wherein the composition further comprises a secondary crosslinker comprising at least one of chromium, aluminum, antimony, zirconium, titanium, calcium, boron, iron, silicon, copper, zinc, magnesium, and an ion thereof.

[00288] Embodiment 89 provides the method of Embodiment 88, wherein the secondary crosslinker comprises at least one of boric acid, borax, a borate, a (C_1-C_{30})hydrocarbylboronic acid, a (C_1-C_{30})hydrocarbyl ester of a (C_1-C_{30})hydrocarbylboronic acid, a (C_1-C_{30})hydrocarbylboronic acid-modified polyacrylamide, ferric chloride, disodium octaborate tetrahydrate, sodium metaborate, sodium diborate, sodium tetraborate, disodium tetraborate, a pentaborate, ulexite, colemanite, magnesium oxide, zirconium lactate, zirconium triethanol amine, zirconium lactate triethanolamine, zirconium carbonate, zirconium acetylacetonate, zirconium malate, zirconium citrate, zirconium diisopropylamine lactate, zirconium glycolate, zirconium triethanol amine glycolate, zirconium lactate glycolate, titanium lactate, titanium malate, titanium

citrate, titanium ammonium lactate, titanium triethanolamine, titanium acetylacetonate, aluminum lactate, and aluminum citrate.

[00289] Embodiment 90 provides the method of any one of Embodiments 1-89, further comprising combining the composition, or a crosslinked reaction product thereof, with an aqueous or oil-based fluid comprising a drilling fluid, stimulation fluid, fracturing fluid, spotting fluid, clean-up fluid, completion fluid, remedial treatment fluid, abandonment fluid, pill, acidizing fluid, cementing fluid, packer fluid, or a combination thereof, to form a mixture, wherein the placing the composition in the subterranean formation comprises placing the mixture in the subterranean formation.

[00290] Embodiment 91 provides the method of any one of Embodiments 1-90, wherein at least one of prior to, during, and after the placing of the composition in the subterranean formation, the composition, or a crosslinked reaction product thereof, is used in the subterranean formation, at least one of alone and in combination with other materials, as a drilling fluid, stimulation fluid, fracturing fluid, spotting fluid, clean-up fluid, completion fluid, remedial treatment fluid, abandonment fluid, pill, acidizing fluid, cementing fluid, packer fluid, or a combination thereof.

[00291] Embodiment 92 provides the method of any one of Embodiments 1-91, wherein the composition further comprises water, saline, aqueous base, oil, organic solvent, synthetic fluid oil phase, aqueous solution, alcohol or polyol, cellulose, starch, alkalinity control agent, acidity control agent, density control agent, density modifier, emulsifier, dispersant, polymeric stabilizer, crosslinking agent, polyacrylamide, polymer or combination of polymers, antioxidant, heat stabilizer, foam control agent, foaming agent, solvent, diluent, plasticizer, filler or inorganic particle, pigment, dye, precipitating agent, rheology modifier, oil-wetting agent, set retarding additive, surfactant, corrosion inhibitor, gas, weight reducing additive, heavy-weight additive, lost circulation material, filtration control additive, salt, fiber, thixotropic additive, breaker, crosslinker, gas, rheology modifier, curing accelerator, curing retarder, pH modifier, chelating agent, scale inhibitor, enzyme, resin, water control material, polymer, oxidizer, a marker, Portland cement, pozzolana cement, gypsum cement, high alumina content cement, slag cement, silica cement, fly ash, metakaolin, shale, zeolite, a

crystalline silica compound, amorphous silica, fibers, a hydratable clay, microspheres, pozzolan lime, or a combination thereof.

[00292] Embodiment 93 provides the method of any one of Embodiments 1-92, wherein placing the composition in the subterranean formation comprises fracturing at least part of the subterranean formation to form at least one subterranean fracture.

[00293] Embodiment 94 provides the method of any one of Embodiments 1-93, wherein the composition further comprises a proppant, a resin-coated proppant, or a combination thereof.

[00294] Embodiment 95 provides the method of any one of Embodiments 1-94, wherein the placing of the composition in the subterranean formation in the subterranean formation comprises pumping the composition through a drill string disposed in a wellbore, through a drill bit at a downhole end of the drill string, and back above-surface through an annulus.

[00295] Embodiment 96 provides the method of Embodiment 95, further comprising processing the composition exiting the annulus with at least one fluid processing unit to generate a cleaned composition and recirculating the cleaned composition through the wellbore.

[00296] Embodiment 97 provides a system configured to perform the method of any one of Embodiments 1-96, the system comprising:

the composition comprising the crosslinkable ampholyte polymer and the crosslinker; and

the subterranean formation comprising the composition therein.

[00297] Embodiment 98 provides the system of Embodiment 97, further comprising

a drillstring disposed in a wellbore, the drillstring comprising a drill bit at a downhole end of the drillstring;

an annulus between the drillstring and the wellbore; and

a pump configured to circulate the composition through the drill string, through the drill bit, and back above-surface through the annulus.

[00298] Embodiment 99 provides the system of Embodiment 98, further comprising a fluid processing unit configured to process the composition exiting the annulus to generate a cleaned composition for recirculation through the wellbore.

[00299] Embodiment 100 provides a method of treating a subterranean formation, the method comprising:

obtaining or providing a composition comprising

a reaction product of a mixture comprising

a crosslinkable ampholyte polymer comprising an ethylene repeating unit comprising a $-C(O)NH_2$ group, an ethylene repeating unit comprising an $-S(O)_2OR^1$ group, and an ethylene repeating unit comprising an $-N^+R^2{}_3X^-$ group, wherein

at each occurrence, R^1 is independently selected from the group consisting of -H and a counterion,

at each occurrence, R^2 is independently substituted or unsubstituted $(C_1\text{-}C_{20})$hydrocarbyl, and

at each occurrence, X^- is independently a counterion; and

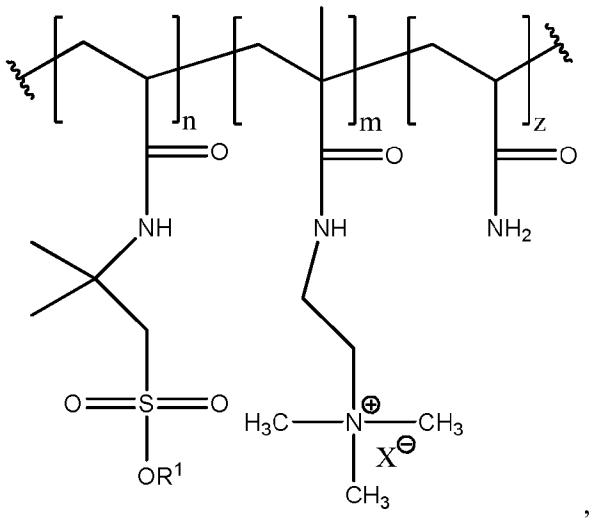
at least one crosslinker; and

placing the composition in a subterranean formation.

[00300] Embodiment 101 provides a method of treating a subterranean formation, the method comprising:

obtaining or providing a composition comprising

a crosslinkable ampholyte polymer comprising repeating units having the structure:



,

wherein

at each occurrence, R^1 is independently selected from the group consisting of -H and a counterion,

the repeating units are in a block, alternate, or random configuration, and each repeating unit is independently in the orientation shown or in the opposite orientation,

the crosslinkable ampholyte polymer has a molecular weight of about 100,000 g/mol to about 20,000,000 g/mol, and

the crosslinkable ampholyte polymer has about 30 wt% to about 50 wt% of the ethylene repeating unit comprising the $-C(O)NH_2$ group, about 5 wt% to about 15 wt% of the ethylene repeating unit comprising the $-S(O)_2OR^1$ group, and about 40 wt% to about 60 wt% of the ethylene repeating unit comprising the $-N^+R^2{}_3X^-$ group;

a crosslinker comprising polyethyleneimine; and

a downhole fluid comprising at least one of a drilling fluid, a fracturing fluid, a diverting fluid, and a lost circulation treatment fluid; and

placing the composition in a subterranean formation, wherein about 0.001 wt% to about 30 v/v% of the composition is the crosslinkable ampholyte polymer and the crosslinker.

[00301] Embodiment 102 provides a system comprising:

a composition comprising

a crosslinkable ampholyte polymer having about Z^{wt} wt% of an ethylene repeating unit comprising the $-C(O)NH_2$ group, about N^{wt} wt% of an ethylene repeating unit comprising a $-S(O)_2OR^1$ group, and about M^{wt} wt% of an ethylene repeating unit comprising an $-N^+R^2{}_3X^-$ group, wherein

at each occurrence R^1 is independently selected from the group consisting of -H and a counterion,

at each occurrence, R^2 is independently substituted or unsubstituted $(C_1\text{-}C_{20})$hydrocarbyl,

at each occurrence, X^- is independently a counterion,

the repeating units are in block, alternate, or random configuration,

Z^{wt} is about 10% to about 70%, N^{wt} is about 1% to about 40%, and M^{wt} is about 20% to about 80%, and

the crosslinkable ampholyte polymer has a molecular weight of about 100,000 g/mol to about 20,000,000 g/mol; and

at least one crosslinker; and

a subterranean formation comprising the composition therein.

[00302] Embodiment 103 provides the system of Embodiment 102, further comprising

a drillstring disposed in a wellbore, the drillstring comprising a drill bit at a downhole end of the drillstring;

an annulus between the drillstring and the wellbore; and

a pump configured to circulate the composition through the drill string, through the drill bit, and back above-surface through the annulus.

[00303] Embodiment 104 provides the system of Embodiment 103, further comprising a fluid processing unit configured to process the composition exiting the annulus to generate a cleaned drilling fluid for recirculation through the wellbore.

[00304] Embodiment 105 provides the system of any one of Embodiments 102-104, further comprising

a tubular disposed in the subterranean formation; and

a pump configured to pump the composition into the subterranean formation through the tubular.

[00305] Embodiment 106 provides a composition for treatment of a subterranean formation, the composition comprising:

a crosslinkable ampholyte polymer having about Z^{wt} wt% of an ethylene repeating unit comprising the $-C(O)NH_2$ group, about N^{wt} wt% of an ethylene repeating unit comprising a $-S(O)_2OR^1$ group, and about M^{wt} wt% of an ethylene repeating unit comprising an $-N^+R^2{}_3X^-$ group, wherein

at each occurrence R^1 is independently selected from the group consisting of -H and a counterion,

at each occurrence, R^2 is independently substituted or unsubstituted $(C_1\text{-}C_{20})$hydrocarbyl,

at each occurrence, X^- is independently a counterion,

the repeating units are in block, alternate, or random configuration,

Z^{wt} is about 10% to about 70%, N^{wt} is about 1% to about 40%, and M^{wt} is about 20% to about 80%, and

the crosslinkable ampholyte polymer has a molecular weight of about 100,000 g/mol to about 20,000,000 g/mol;

at least one crosslinker; and

a downhole fluid.

[00306] Embodiment 107 provides the composition of Embodiment 106, wherein the downhole fluid comprises at least one of a a drilling fluid, a fracturing fluid, a diverting fluid, and a lost circulation treatment fluid.

[00307] Embodiment 108 provides a crosslinked reaction product of the composition of Embodiment 106.

[00308] Embodiment 109 provides a composition for treatment of a subterranean formation, the composition comprising:

a reaction product of a mixture comprising

a crosslinkable ampholyte polymer having about Z^{wt} wt% of an ethylene repeating unit comprising the $-C(O)NH_2$ group, about N^{wt} wt% of an ethylene repeating unit comprising a $-S(O)_2OR^1$ group, and about M^{wt} wt% of an ethylene repeating unit comprising an $-N^+R^2{}_3X^-$ group, wherein

at each occurrence R^1 is independently selected from the group consisting of -H and a counterion,

at each occurrence, R^2 is independently substituted or unsubstituted $(C_1\text{-}C_{20})$hydrocarbyl,

at each occurrence, X^- is independently a counterion,

the repeating units are in block, alternate, or random configuration,

Z^{wt} is about 10% to about 70%, N^{wt} is about 1% to about 40%, and M^{wt} is about 20% to about 80%, and

the crosslinkable ampholyte polymer has a molecular weight of about 100,000 g/mol to about 20,000,000 g/mol; and

at least one crosslinker; and

a downhole fluid.

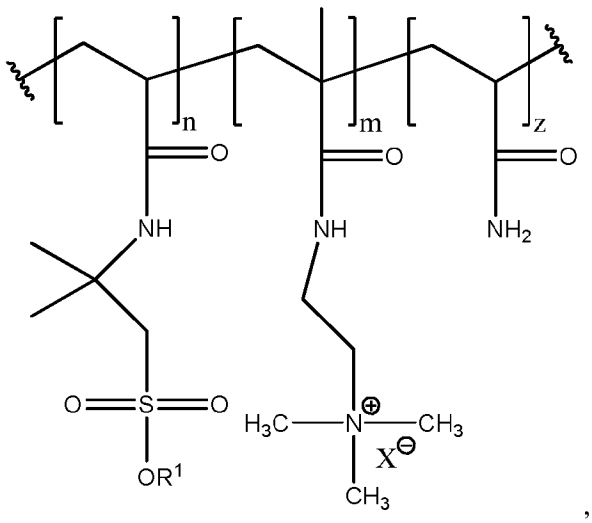
[00309] Embodiment 110 provides a system comprising:

the reaction product of the composition of Embodiment 109; and

a subterranean formation comprising the reaction product therein.

[00310] Embodiment 111 provides a composition for treatment of a subterranean formation, the composition comprising:

a crosslinkable ampholyte polymer comprising repeating units having the structure:



wherein

at each occurrence R^1 is independently selected from the group consisting of -H and a counterion,

the repeating units are in a block, alternate, or random configuration, and each repeating unit is independently in the orientation shown or in the opposite orientation,

the crosslinkable ampholyte polymer has a molecular weight of about 100,000 g/mol to about 20,000,000 g/mol, and

the crosslinkable ampholyte polymer has about 30 wt% to about 50 wt% of the ethylene repeating unit comprising the $-C(O)NH_2$ group, about 5 wt% to about 15 wt% of the ethylene repeating unit comprising the $-S(O)_2OR^1$ group, and about 40 wt% to about 60 wt% of the ethylene repeating unit comprising the $-N^+R^2{}_3X^-$ group; and

a crosslinker comprising polyethyleneimine; and

a downhole fluid comprising at least one of a drilling fluid, a fracturing fluid, a diverting fluid, and a lost circulation treatment fluid, wherein about 0.001 wt% to about 30 v/v% of the composition is the crosslinkable ampholyte polymer and the crosslinker.

[00311] Embodiment 112 provides a crosslinked reaction product of the composition of Embodiment 111.

[00312] Embodiment 113 provides a method of preparing a composition for treatment of a subterranean formation, the method comprising:

forming a composition comprising

a crosslinkable ampholyte polymer comprising an ethylene repeating unit comprising a $-C(O)NH_2$ group, an ethylene repeating unit comprising an $-S(O)_2OR^1$ group, and an ethylene repeating unit comprising an $-N^+R^2{}_3X^-$ group, wherein

at each occurrence, R^1 is independently selected from the group consisting of -H and a counterion,

at each occurrence, R^2 is independently substituted or unsubstituted (C_1-C_{20})hydrocarbyl, and

at each occurrence, X^- is independently a counterion; and

at least one crosslinker.

[00313] Embodiment 114 provides the composition, apparatus, method, or system of any one or any combination of Embodiments 1-113 optionally configured such that all elements or options recited are available to use or select from.

CLAIMS

What is claimed is:

1. A method of treating a subterranean formation, the method comprising:

obtaining or providing a composition comprising

a crosslinkable ampholyte polymer comprising an ethylene repeating unit comprising a $-C(O)NH_2$ group, an ethylene repeating unit comprising an $-S(O)_2OR^1$ group, and an ethylene repeating unit comprising an $-N^+R^2{}_3X^-$ group, wherein

at each occurrence, R^1 is independently selected from the group consisting of -H and a counterion,

at each occurrence, R^2 is independently substituted or unsubstituted $(C_1\text{-}C_{20})$hydrocarbyl, and

at each occurrence, X^- is independently a counterion; and

at least one crosslinker; and

placing the composition in a subterranean formation.

2. The method of claim 1, wherein the obtaining or providing of the composition occurs above-surface.

3. The method of claim 1, wherein the obtaining or providing of the composition occurs in the subterranean formation.

4. The method of claim 1, wherein the method is a method of drilling the subterranean formation.

5. The method of claim 1, wherein the method is a method of fracturing the subterranean formation.

6. The method of claim 1, wherein the method is a method of fluid loss control or diverting.

7. The method of claim 1, wherein the composition comprises an aqueous liquid.

8. The method of claim 7, wherein the method further comprises mixing the aqueous liquid with the crosslinkable ampholyte polymer and the crosslinker.

9. The method of claim 8, wherein the mixing occurs above surface.

10. The method of claim 9, wherein the mixing occurs in the subterranean formation.

11. The method of claim 7, wherein the aqueous liquid comprises at least one of water, brine, produced water, flowback water, brackish water, and sea water.

12. The method of claim 7, wherein the aqueous liquid comprises salt water having a total dissolved solids level of about 1,000 mg/L to about 300,000 mg/L.

13. The method of claim 7, wherein the aqueous liquid comprises at least one of a drilling fluid, a fracturing fluid, a diverting fluid, and a lost circulation treatment fluid.

14.. The method of claim 1, further comprising at least partially crosslinking the crosslinkable ampholyte polymer to provide a crosslinked ampholyte polymer.

15. The method of claim 14, wherein the crosslinking occurs at least partially above-surface.

16. The method of claim 14, wherein the crosslinking occurs at least partially in the subterranean formation.

17. The method of claim 14, wherein the crosslinking is at least partially triggered by an increase in temperature.

18. The method of claim 17, wherein the increase in temperature is at least partially due to placement of the composition in the subterranean formation.

19. The method of claim 14, wherein the crosslinking comprises exposing the composition to a temperature of about 100 °F to about 450 °F.

20. The method of claim 14, wherein the crosslinking comprises exposing the composition to a temperature of about 125 °F to about 250 °F.

21. The method of claim 14, wherein after the crosslinking, a viscosity of the composition, at standard temperature and pressure and at a shear rate of about 50 s^{-1} to about 500 s^{-1}, is about 10 cP to about 1,000,000 cP.

22. The method of claim 14, wherein after the crosslinking, a viscosity of the composition, at standard temperature and pressure and at a shear rate of about 50 s^{-1} to about 500 s^{-1}, is about 1,000 cP to about 500,000 cP.

23. The method of claim 14, wherein after the crosslinking, a viscosity of the composition, at standard temperature and pressure and at a shear rate of about 0 s^{-1} to about 1 s^{-1}, is about 10 cP to about 10,000,000 cP.

24. The method of claim 14, wherein after the crosslinking, a yield stress of the composition, at standard temperature and pressure, is about 0.1 Pa and about 1,000 Pa.

25. The method of claim 14, wherein after the crosslinking, a yield stress of the composition, at standard temperature and pressure, is about 1 Pa to about 500 Pa.

26. The method of claim 14, wherein prior to the crosslinking, a viscosity of the composition, at standard temperature and pressure and at a shear rate of about 50 s^{-1} to about 500 s^{-1}, is about 0.01 cP to about 1,000,000 cP.

27. The method of claim 14, wherein prior to the crosslinking, a viscosity of the composition, at standard temperature and pressure and at a shear rate of about 50 s^{-1} to about 500 s^{-1}, is about 0.01 cP to about 10,000 cP.

28. The method of claim 1, wherein the crosslinkable ampholyte polymer is sufficient such that, when crosslinked in an aqueous solution at a concentration of about 40 gpt with a polyethyleneimine crosslinker at a concentration of about 10 ppt to form a crosslinked ampholyte polymer, at 77 °F and standard pressure, with a strain of about 10%, at a frequency of about 0.1 rad/s to about 100 rad/s, the aqueous solution comprising the crosslinked ampholyte polymer has a loss modulus G'' of about 0.1 Pa to about 100 Pa.

29. The method of claim 1, wherein the crosslinkable ampholyte polymer is sufficient such that, when crosslinked in an aqueous solution at a concentration of about 40 gpt with a polyethyleneimine crosslinker at a concentration of about 10 ppt to form a crosslinked ampholyte polymer, at 150 °F and standard pressure, with a strain of about 10%, at a frequency of about 0.1 rad/s to about 100 rad/s, the aqueous solution comprising the crosslinked polymer has a storage modulus G' of about 10 Pa to about 1000 Pa.

30. The method of claim 1, wherein the crosslinkable ampholyte polymer is sufficient such that, when crosslinked in an aqueous solution at a concentration of about 40 gpt with a polyethyleneimine crosslinker at a concentration of about 10 ppt to form a crosslinked ampholyte polymer, at 150 °F and standard pressure, with a strain of about 10%, at a frequency of about 0.1 rad/s to about 100 rad/s, the aqueous solution comprising the crosslinked polymer has a loss modulus G'' of about 0.5 Pa to about 10 Pa.

31. The method of claim 1, wherein about 0.001 wt% to about 95 wt% of the composition is the crosslinkable ampholyte polymer.

32. The method of claim 1, wherein about 70 wt% to about 90 wt% of the composition is the crosslinkable ampholyte polymer.

33. The method of claim 7, wherein about 0.01 wt% to about 50 wt% of the composition is the crosslinkable ampholyte polymer.

34. The method of claim 7, wherein about 0.001 to about 30 v/v% of the composition is the crosslinkable ampholyte polymer.

35. The method of claim 1, wherein the crosslinkable ampholyte polymer has about Z^{wt} wt% of the ethylene repeating unit comprising the $-C(O)NH_2$ group, about N^{wt} wt% of the ethylene repeating unit comprising the $-S(O)_2OR^1$ group, and about M^{wt} wt% of the ethylene repeating unit comprising the $-N^+R^2{}_3X^-$ group, wherein Z^{wt} is about 10% to about 70%, N^{wt} is about 1% to about 40%, and M^{wt} is about 20% to about 80%.

36. The method of claim 35, wherein Z^{wt} is about 30% to about 50%, N^{wt} is about 5% to about 15%, and M^{wt} is about 40% to about 60%.

37. The method of claim 35, wherein $Z^{wt} + N^{wt} + M^{wt}$ is about 100%.

38. The method of claim 1, wherein the crosslinkable ampholyte polymer has about Z^{mol} mol% of the ethylene repeating unit comprising the $-C(O)NH_2$ group, about N^{mol} mol% of the ethylene repeating unit comprising the $-S(O)_2OR^1$ group, and about M^{mol} mol% of the ethylene repeating unit comprising the $-N^+R^2{}_3X^-$ group, wherein Z^{mol} is about 5% to about 50%, N^{mol} is about 1% to about 40%, and M^{mol} is about 40% to about 90%.

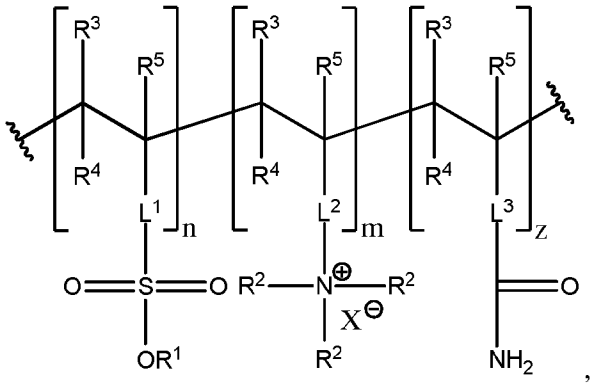
39. The method of claim 38, wherein Z^{mol} is about 10% to about 25%, N^{mol} is about 5% to about 20%, and M^{mol} is about 55% to about 70%.

40. The method of claim 38, wherein $Z^{mol} + N^{mol} + M^{mol}$ is about 100%.

41. The method of claim 1, wherein the crosslinkable ampholyte polymer has a molecular weight of about 100,000 g/mol to about 20,000,000 g/mol.

42. The method of claim 1, wherein the crosslinkable ampholyte polymer has a molecular weight of about 5,000,000 g/mol to about 15,000,000 g/mol.

43. The method of claim 1, wherein the crosslinkable ampholyte polymer comprises repeating units having the structure:



wherein

at each occurrence R^3, R^4, and R^5 are each independently selected from the group consisting of -H and a substituted or unsubstituted C_1-C_5 hydrocarbyl,

at each occurrence L^1, L^2, and L^3 are each independently selected from the group consisting of a bond and a substituted or unsubstituted C_1-C_{20} hydrocarbyl interrupted or terminated with 0, 1, 2, or 3 of at least one of -NR^3-, -S-, and -O-, and

the repeating units are in a block, alternate, or random configuration, and each repeating unit is independently in the orientation shown or in the opposite orientation.

44. The method of claim 43, wherein at each occurrence L^1 is independently selected from the group consisting of a bond and -(substituted or unsubstituted C_1-C_{20} hydrocarbyl)-NR^3-(substituted or unsubstituted C_1-C_{20} hydrocarbyl)-.

45. The method of claim 43, wherein at each occurrence L^1 is independently -C(O)-NH-(substituted or unsubstituted C_1-C_{19} hydrocarbyl)-.

46. The method of claim 43, wherein at each occurrence L^1 is independently -C(O)-NH-(C_1-C_5 hydrocarbyl)-.

47. The method of claim 43, wherein L^1 is -C(O)-NH-$CH(CH_3)_2$-CH_2-.

48. The method of claim 43, wherein at each occurence L^2 is independently selected from the group consisting of -O-(C_1-C_{20})hydrocarbyl- and -NR^3-(C_1-C_{20})hydrocarbyl-.

49. The method of claim 43, wherein at each occurrence L^2 is independently selected from -O-(C_1-C_{10})alkyl- and -NH-(C_1-C_{10})alkyl-.

50. The method of claim 43, wherein at each occurrence L^2 is independently selected from -O-CH_2-CH_2- and -NH-CH_2-CH_2.

51. The method of claim 43, wherein at each occurrence L^3 is independently selected from the group consisting of a bond and C_1-C_{20} hydrocarbyl.

52. The method of claim 43, wherein at each occurrence L^3 is independently selected from the group consisting of a bond and C_1-C_5 alkyl.

53. The method of claim 43, wherein at each occurrence L^3 is a bond.

54. The method of claim 43, wherein at each occurrence R^3, R^4, and R^5 are independently selected from the group consisting of -H and a C_1-C_5 alkyl.

55. The method of claim 43, wherein at each occurrence R^3, R^4, and R^5 are independently selected from the group consisting of -H and a C_1-C_3 alkyl.

56. The method of claim 43, wherein at each occurrence R^3, R^4, and R^5 are each -H.

57. The method of claim 43, wherein at each occurrence R^1 is independently selected from the group consisting of -H, Na^+, K^+, Li^+, NH_4^+, Zn^+, Ca^{2+}, Zn^{2+}, Al^{3+}, and Mg^{2+}.

58. The method of claim 43, wherein at each occurrence R^1 is -H.

59. The method of claim 43, wherein at each occurrence R^2 is independently $(C_1\text{-}C_{20})$alkyl.

60. The method of claim 43, wherein at each occurrence R^2 is independently $(C_1\text{-}C_{10})$alkyl.

61. The method of claim 43, wherein at each occurrence R^2 is independently selected from the group consisting of methyl, ethyl, propyl, butyl, and pentyl.

62. The method of claim 43, wherein X^- is Cl^-.

63. The method of claim 43, wherein n is about 4 to about 40,000.

64. The method of claim 43, wherein n is about 450 to about 14,500.

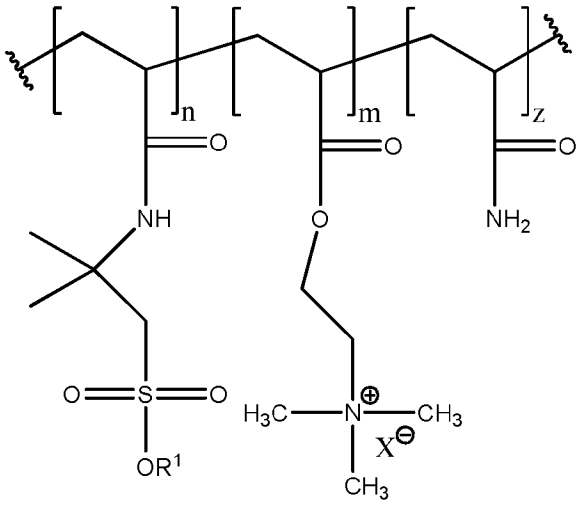
65. The method of claim 43, wherein m is about 100 to about 83,000.

66. The method of claim 43, wherein m is about 4,000 to about 62,000.

67. The method of claim 43, wherein z is about 125 to about 200,000.

68. The method of claim 43, wherein z is about 8,500 to about 140,000.

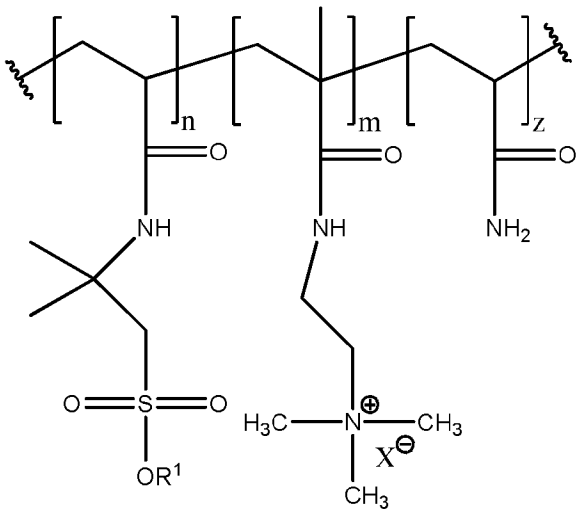
69. The method of claim 1, wherein the crosslinkable ampholyte polymer comprises repeating units having the structure:



,

wherein the repeating units are in a block, alternate, or random configuration, and each repeating unit is independently in the orientation shown or in the opposite orientation.

70. The method of claim 1, wherein the crosslinkable ampholyte polymer comprises repeating units having the structure:



,

wherein the repeating units are in a block, alternate, or random configuration, and each repeating unit is independently in the orientation shown or in the opposite orientation.

71. The method of claim 1, wherein about 0.000,1 wt% to about 80 wt% of the composition is the crosslinker.

72. The method of claim 1, wherein about 1 wt% to about 30 wt% of the composition is the crosslinker.

73. The method of claim 7, wherein about 0.000,1 wt% to about 50 wt% of the composition is the crosslinker.

74. The method of claim 7, wherein about 0.001 wt% to about 5 wt% of the composition is the crosslinker.

75. The method of claim 1, wherein the crosslinker comprises at least one of chromium, aluminum, antimony, zirconium, titanium, calcium, boron, iron, silicon, copper, zinc, magnesium, and an ion thereof.

76. The method of claim 1, wherein the crosslinker comprises at least one of a poly(amino(C_2-C_{10})hydrocarbylene) crosslinker and a (C_6-C_{20})aryl alcohol-(C_1-C_{20})aldehyde crosslinker.

77. The method of claim 1, wherein the crosslinker comprises at least one of polyethyleneimine, phenol-formaldehyde, and glyoxal.

78. The method of claim 1, wherein the crosslinker comprises at least one of boric acid, borax, a borate, a (C_1-C_{30})hydrocarbylboronic acid, a (C_1-C_{30})hydrocarbyl ester of a (C_1-C_{30})hydrocarbylboronic acid, a (C_1-C_{30})hydrocarbylboronic acid-modified polyacrylamide, ferric chloride, disodium octaborate tetrahydrate, sodium metaborate, sodium diborate, sodium tetraborate, disodium tetraborate, a pentaborate, ulexite, colemanite, magnesium oxide, zirconium lactate, zirconium triethanol amine, zirconium lactate triethanolamine, zirconium carbonate, zirconium acetylacetonate, zirconium malate, zirconium citrate, zirconium diisopropylamine lactate, zirconium glycolate, zirconium triethanol amine glycolate, zirconium lactate glycolate, titanium lactate, titanium malate, titanium citrate, titanium ammonium lactate, titanium triethanolamine, titanium acetylacetonate, aluminum lactate, and aluminum citrate.

79. The method of claim 1, wherein the composition further comprises a fluid comprising at least one of water, an organic solvent, and an oil.

80. The method of claim 1, wherein the composition further comprises a fluid comprising at least one of dipropylene glycol methyl ether, dipropylene glycol dimethyl ether, dimethyl formamide, diethylene glycol methyl ether, ethylene glycol butyl ether, diethylene glycol butyl ether, propylene carbonate, D-limonene, a C_2-C_{40} fatty acid C_1-C_{10} alkyl ester, 2-butoxy ethanol, butyl acetate, furfuryl acetate, dimethyl sulfoxide, dimethyl formamide, diesel, kerosene, mineral oil, a hydrocarbon comprising an internal olefin, a hydrocarbon comprising an alpha olefin, xylenes, an ionic liquid, methyl ethyl ketone, and cyclohexanone.

81. The method of claim 1, wherein the composition further comprises a secondary viscosifier.

82. The method of claim 81, wherein the secondary viscosifier comprises at least one of a substituted or unsubstituted polysaccharide, and a substituted or unsubstituted polyalkenylene, wherein the polysaccharide or polyalkenylene is crosslinked or uncrosslinked.

83. The method of claim 81, wherein the secondary viscosifier comprises a polymer comprising at least one monomer selected from the group consisting of ethylene glycol, acrylamide, vinyl acetate, 2-acrylamidomethylpropane sulfonic acid or its salts, trimethylammoniumethyl acrylate halide, and trimethylammoniumethyl methacrylate halide.

84. The method of claim 81, wherein the secondary viscosifier comprises a crosslinked gel or a crosslinkable gel.

85. The method of claim 81, wherein the secondary viscosifier comprises at least one of a linear polysaccharide, and poly((C_2-C_{10})alkenylene), wherein the (C_2-C_{10})alkenylene is substituted or unsubstituted.

86. The method of claim 81, wherein the secondary viscosifier comprises at least one of poly(acrylic acid) or (C_1-C_5)alkyl esters thereof, poly(methacrylic acid) or (C_1-C_5)alkyl esters thereof, poly(vinyl acetate), poly(vinyl alcohol), poly(ethylene glycol), poly(vinyl pyrrolidone), polyacrylamide, poly (hydroxyethyl methacrylate), alginate, chitosan, curdlan, dextran, emulsan, a galactoglucopolysaccharide, gellan, glucuronan, N-acetyl-glucosamine, N-acetyl-heparosan, hyaluronic acid, kefiran, lentinan, levan, mauran, pullulan, scleroglucan, schizophyllan, stewartan, succinoglycan, xanthan, welan, derivatized starch, tamarind, tragacanth, guar gum, derivatized guar, gum ghatti, gum arabic, locust bean gum, derivatized cellulose, carboxymethyl cellulose, hydroxyethyl cellulose, carboxymethyl hydroxyethyl cellulose, hydroxypropyl cellulose, methyl hydroxyl ethyl cellulose, guar, hydroxypropyl guar, carboxy methyl guar, and carboxymethyl hydroxylpropyl guar.

87. The method of claim 81, wherein the secondary viscosifier comprises poly(vinyl alcohol) homopolymer, poly(vinyl alcohol) copolymer, a crosslinked poly(vinyl alcohol) homopolymer, and a crosslinked poly(vinyl alcohol) copolymer.

88. The method of claim 1, wherein the composition further comprises a secondary crosslinker comprising at least one of chromium, aluminum, antimony, zirconium, titanium, calcium, boron, iron, silicon, copper, zinc, magnesium, and an ion thereof.

89. The method of claim 88, wherein the secondary crosslinker comprises at least one of boric acid, borax, a borate, a (C_1-C_{30})hydrocarbylboronic acid, a (C_1-C_{30})hydrocarbyl ester of a (C_1-C_{30})hydrocarbylboronic acid, a (C_1-C_{30})hydrocarbylboronic acid-modified polyacrylamide, ferric chloride, disodium octaborate tetrahydrate, sodium metaborate, sodium diborate, sodium tetraborate, disodium tetraborate, a pentaborate, ulexite, colemanite, magnesium oxide, zirconium lactate, zirconium triethanol amine, zirconium lactate triethanolamine, zirconium carbonate, zirconium acetylacetonate, zirconium malate, zirconium citrate, zirconium diisopropylamine lactate, zirconium glycolate, zirconium triethanol amine glycolate, zirconium lactate glycolate,

titanium lactate, titanium malate, titanium citrate, titanium ammonium lactate, titanium triethanolamine, titanium acetylacetonate, aluminum lactate, and aluminum citrate.

90. The method of claim 1, further comprising combining the composition, or a crosslinked reaction product thereof, with an aqueous or oil-based fluid comprising a drilling fluid, stimulation fluid, fracturing fluid, spotting fluid, clean-up fluid, completion fluid, remedial treatment fluid, abandonment fluid, pill, acidizing fluid, cementing fluid, packer fluid, or a combination thereof, to form a mixture, wherein the placing the composition in the subterranean formation comprises placing the mixture in the subterranean formation.

91. The method of claim 1, wherein at least one of prior to, during, and after the placing of the composition in the subterranean formation, the composition, or a crosslinked reaction product thereof, is used in the subterranean formation, at least one of alone and in combination with other materials, as a drilling fluid, stimulation fluid, fracturing fluid, spotting fluid, clean-up fluid, completion fluid, remedial treatment fluid, abandonment fluid, pill, acidizing fluid, cementing fluid, packer fluid, or a combination thereof.

92. The method of claim 1, wherein the composition further comprises water, saline, aqueous base, oil, organic solvent, synthetic fluid oil phase, aqueous solution, alcohol or polyol, cellulose, starch, alkalinity control agent, acidity control agent, density control agent, density modifier, emulsifier, dispersant, polymeric stabilizer, crosslinking agent, polyacrylamide, polymer or combination of polymers, antioxidant, heat stabilizer, foam control agent, foaming agent, solvent, diluent, plasticizer, filler or inorganic particle, pigment, dye, precipitating agent, rheology modifier, oil-wetting agent, set retarding additive, surfactant, corrosion inhibitor, gas, weight reducing additive, heavy-weight additive, lost circulation material, filtration control additive, salt, fiber, thixotropic additive, breaker, crosslinker, gas, rheology modifier, curing accelerator, curing retarder, pH modifier, chelating agent, scale inhibitor, enzyme, resin, water control material, polymer, oxidizer, a marker, Portland cement, pozzolana cement, gypsum cement, high alumina content cement, slag

cement, silica cement, fly ash, metakaolin, shale, zeolite, a crystalline silica compound, amorphous silica, fibers, a hydratable clay, microspheres, pozzolan lime, or a combination thereof.

93. The method of claim 1, wherein placing the composition in the subterranean formation comprises fracturing at least part of the subterranean formation to form at least one subterranean fracture.

94. The method of claim 1, wherein the composition further comprises a proppant, a resin-coated proppant, or a combination thereof.

95. The method of claim 1, wherein the placing of the composition in the subterranean formation in the subterranean formation comprises pumping the composition through a drill string disposed in a wellbore, through a drill bit at a downhole end of the drill string, and back above-surface through an annulus.

96. The method of claim 95, further comprising processing the composition exiting the annulus with at least one fluid processing unit to generate a cleaned composition and recirculating the cleaned composition through the wellbore.

97. A system configured to perform the method of claim 1, the system comprising:

the composition comprising the crosslinkable ampholyte polymer and the crosslinker; and

the subterranean formation comprising the composition therein.

98. The system of claim 97, further comprising

a drillstring disposed in a wellbore, the drillstring comprising a drill bit at a downhole end of the drillstring;

an annulus between the drillstring and the wellbore; and

a pump configured to circulate the composition through the drill string, through the drill bit, and back above-surface through the annulus.

99. The system of claim 98, further comprising a fluid processing unit configured to process the composition exiting the annulus to generate a cleaned composition for recirculation through the wellbore.

100. A method of treating a subterranean formation, the method comprising:

obtaining or providing a composition comprising

a reaction product of a mixture comprising

a crosslinkable ampholyte polymer comprising an ethylene repeating unit comprising a $-C(O)NH_2$ group, an ethylene repeating unit comprising an $-S(O)_2OR^1$ group, and an ethylene repeating unit comprising an $-N^+R^2{}_3X^-$ group, wherein

at each occurrence, R^1 is independently selected from the group consisting of -H and a counterion,

at each occurrence, R^2 is independently substituted or unsubstituted $(C_1\text{-}C_{20})$hydrocarbyl, and

at each occurrence, X^- is independently a counterion; and

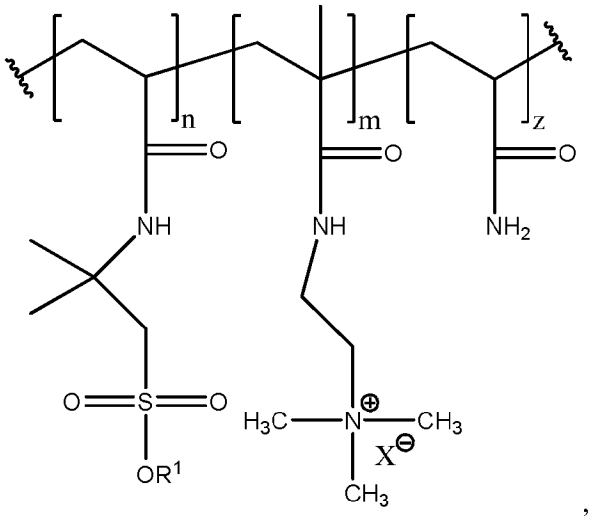
at least one crosslinker; and

placing the composition in a subterranean formation.

101. A method of treating a subterranean formation, the method comprising:

obtaining or providing a composition comprising

a crosslinkable ampholyte polymer comprising repeating units having the structure:



wherein

at each occurrence, R^1 is independently selected from the group consisting of -H and a counterion,

the repeating units are in a block, alternate, or random configuration, and each repeating unit is independently in the orientation shown or in the opposite orientation,

the crosslinkable ampholyte polymer has a molecular weight of about 100,000 g/mol to about 20,000,000 g/mol, and

the crosslinkable ampholyte polymer has about 30 wt% to about 50 wt% of the ethylene repeating unit comprising the $-C(O)NH_2$ group, about 5 wt% to about 15 wt% of the ethylene repeating unit comprising the $-S(O)_2OR^1$ group, and about 40 wt% to about 60 wt% of the ethylene repeating unit comprising the $-N^+R^2{}_3X^-$ group;

a crosslinker comprising polyethyleneimine; and

a downhole fluid comprising at least one of a drilling fluid, a fracturing fluid, a diverting fluid, and a lost circulation treatment fluid; and

placing the composition in a subterranean formation, wherein about 0.001 wt% to about 30 v/v% of the composition is the crosslinkable ampholyte polymer and the crosslinker.

102. A system comprising:

a composition comprising

a crosslinkable ampholyte polymer having about Z^{wt} wt% of an ethylene repeating unit comprising the -C(O)NH_2 group, about N^{wt} wt% of an ethylene repeating unit comprising a -$S(O)_2OR^1$ group, and about M^{wt} wt% of an ethylene repeating unit comprising an -$N^+R^2{}_3X^-$ group, wherein

at each occurrence R^1 is independently selected from the group consisting of -H and a counterion,

at each occurrence, R^2 is independently substituted or unsubstituted (C_1-C_{20})hydrocarbyl,

at each occurrence, X^- is independently a counterion,

the repeating units are in block, alternate, or random configuration,

Z^{wt} is about 10% to about 70%, N^{wt} is about 1% to about 40%, and M^{wt} is about 20% to about 80%, and

the crosslinkable ampholyte polymer has a molecular weight of about 100,000 g/mol to about 20,000,000 g/mol; and

at least one crosslinker; and

a subterranean formation comprising the composition therein.

103. The system of claim 102, further comprising

a drillstring disposed in a wellbore, the drillstring comprising a drill bit at a downhole end of the drillstring;

an annulus between the drillstring and the wellbore; and

a pump configured to circulate the composition through the drill string, through the drill bit, and back above-surface through the annulus.

104. The system of claim 103, further comprising a fluid processing unit configured to process the composition exiting the annulus to generate a cleaned drilling fluid for recirculation through the wellbore.

105. The system of claim 102, further comprising

a tubular disposed in the subterranean formation; and

a pump configured to pump the composition into the subterranean formation through the tubular.

106. A composition for treatment of a subterranean formation, the composition comprising:

a crosslinkable ampholyte polymer having about Z^{wt} wt% of an ethylene repeating unit comprising the $-C(O)NH_2$ group, about N^{wt} wt% of an ethylene repeating unit comprising a $-S(O)_2OR^1$ group, and about M^{wt} wt% of an ethylene repeating unit comprising an $-N^+R^2{}_3X^-$ group, wherein

at each occurrence R^1 is independently selected from the group consisting of -H and a counterion,

at each occurrence, R^2 is independently substituted or unsubstituted $(C_1\text{-}C_{20})$hydrocarbyl,

at each occurrence, X^- is independently a counterion,

the repeating units are in block, alternate, or random configuration,

Z^{wt} is about 10% to about 70%, N^{wt} is about 1% to about 40%, and M^{wt} is about 20% to about 80%, and

the crosslinkable ampholyte polymer has a molecular weight of about 100,000 g/mol to about 20,000,000 g/mol;

at least one crosslinker; and

a downhole fluid.

107. The composition of claim 106, wherein the downhole fluid comprises at least one of a a drilling fluid, a fracturing fluid, a diverting fluid, and a lost circulation treatment fluid.

108. A crosslinked reaction product of the composition of claim 106.

109. A composition for treatment of a subterranean formation, the composition comprising:

a reaction product of a mixture comprising

a crosslinkable ampholyte polymer having about Z^{wt} wt% of an ethylene repeating unit comprising the $-C(O)NH_2$ group, about N^{wt} wt% of an ethylene repeating unit comprising a $-S(O)_2OR^1$ group, and about M^{wt} wt% of an ethylene repeating unit comprising an $-N^+R^2{}_3X^-$ group, wherein

at each occurrence R^1 is independently selected from the group consisting of -H and a counterion,

at each occurrence, R^2 is independently substituted or unsubstituted (C_1-C_{20})hydrocarbyl,

at each occurrence, X^- is independently a counterion,

the repeating units are in block, alternate, or random configuration,

Z^{wt} is about 10% to about 70%, N^{wt} is about 1% to about 40%, and M^{wt} is about 20% to about 80%, and

the crosslinkable ampholyte polymer has a molecular weight of about 100,000 g/mol to about 20,000,000 g/mol; and

at least one crosslinker; and

a downhole fluid.

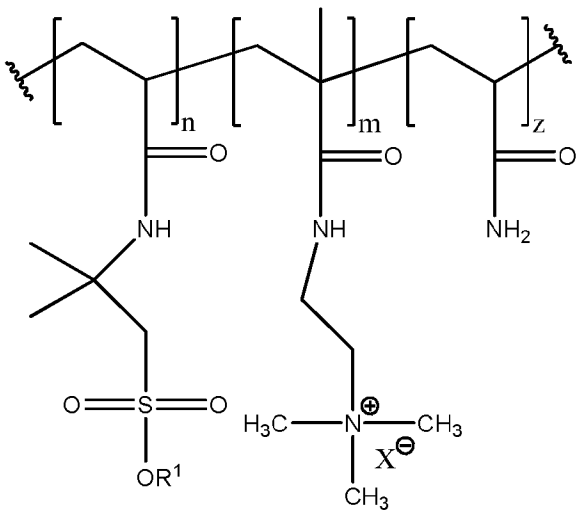
110. A system comprising:

the reaction product of the composition of claim 109; and

a subterranean formation comprising the reaction product therein.

111. A composition for treatment of a subterranean formation, the composition comprising:

a crosslinkable ampholyte polymer comprising repeating units having the structure:



,

wherein

at each occurrence R^1 is independently selected from the group consisting of -H and a counterion,

the repeating units are in a block, alternate, or random configuration, and each repeating unit is independently in the orientation shown or in the opposite orientation,

the crosslinkable ampholyte polymer has a molecular weight of about 100,000 g/mol to about 20,000,000 g/mol, and

the crosslinkable ampholyte polymer has about 30 wt% to about 50 wt% of the ethylene repeating unit comprising the $-C(O)NH_2$ group, about 5 wt% to about 15 wt% of the ethylene repeating unit comprising the $-S(O)_2OR^1$ group, and about 40 wt% to about 60 wt% of the ethylene repeating unit comprising the $-N^+R^2{}_3X^-$ group; and

a crosslinker comprising polyethyleneimine; and

a downhole fluid comprising at least one of a drilling fluid, a fracturing fluid, a diverting fluid, and a lost circulation treatment fluid, wherein about 0.001 wt% to about 30 v/v% of the composition is the crosslinkable ampholyte polymer and the crosslinker.

112. A crosslinked reaction product of the composition of claim 111.

113. A method of preparing a composition for treatment of a subterranean formation, the method comprising:

forming a composition comprising

a crosslinkable ampholyte polymer comprising an ethylene repeating unit comprising a $-C(O)NH_2$ group, an ethylene repeating unit comprising an $-S(O)_2OR^1$ group, and an ethylene repeating unit comprising an $-N^+R^2{}_3X^-$ group, wherein

at each occurrence, R^1 is independently selected from the group consisting of -H and a counterion,

at each occurrence, R^2 is independently substituted or unsubstituted $(C_1\text{-}C_{20})$hydrocarbyl, and

at each occurrence, X^- is independently a counterion; and

at least one crosslinker.

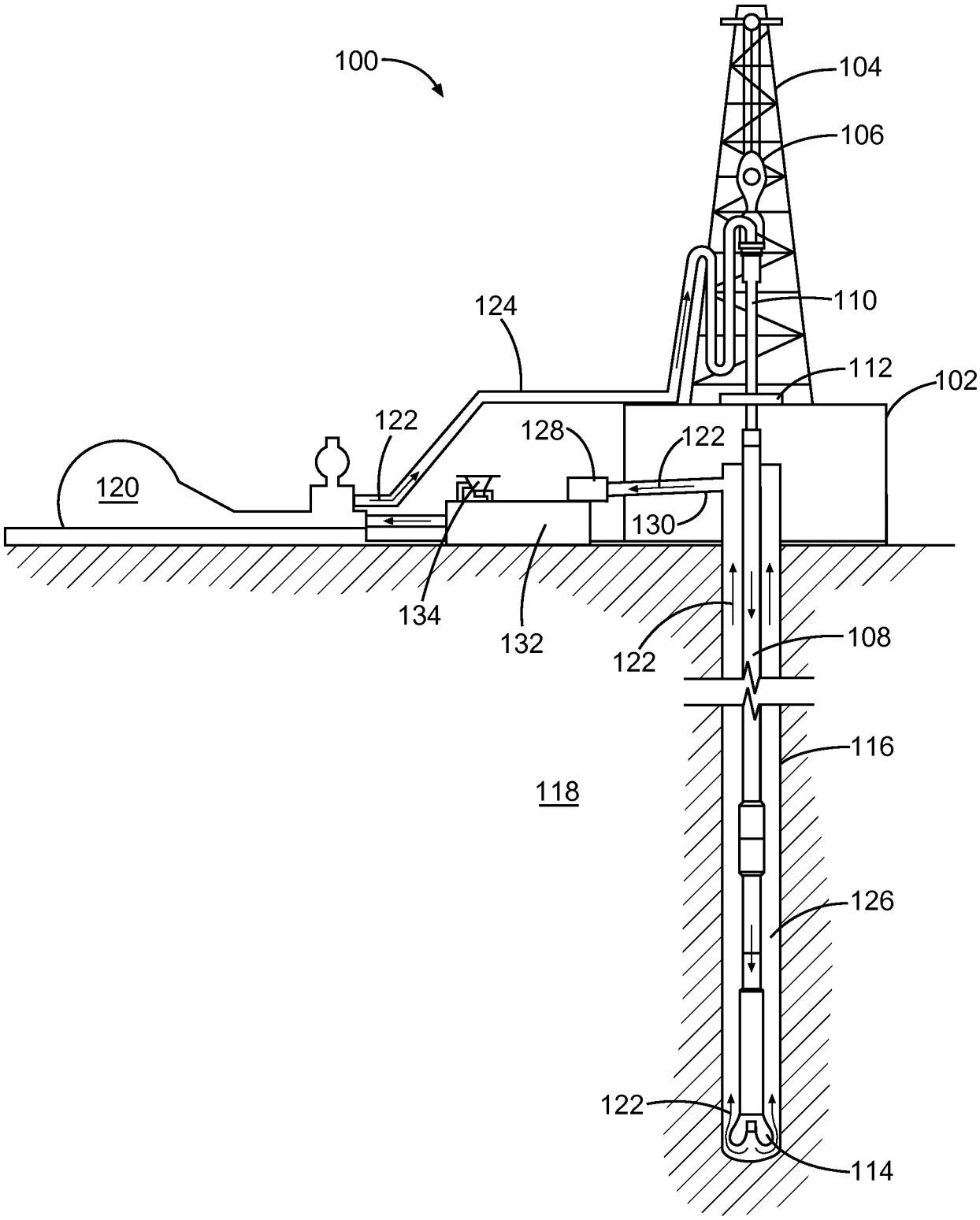

100
104
106
110
124
112
102
122
128
122
120
130
134
132
122
108
116
118
126
122
114

Fig. 1

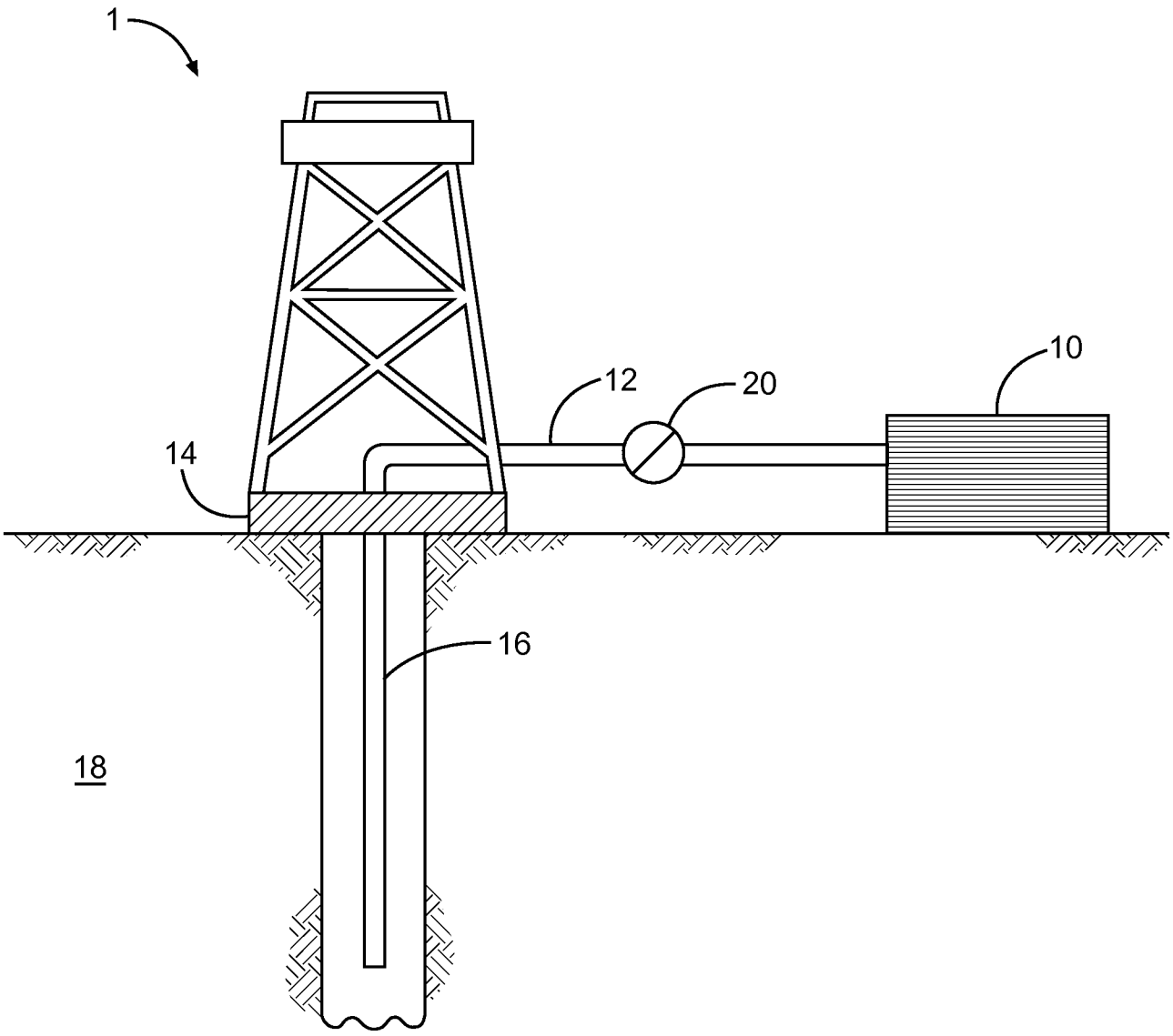


Fig. 2

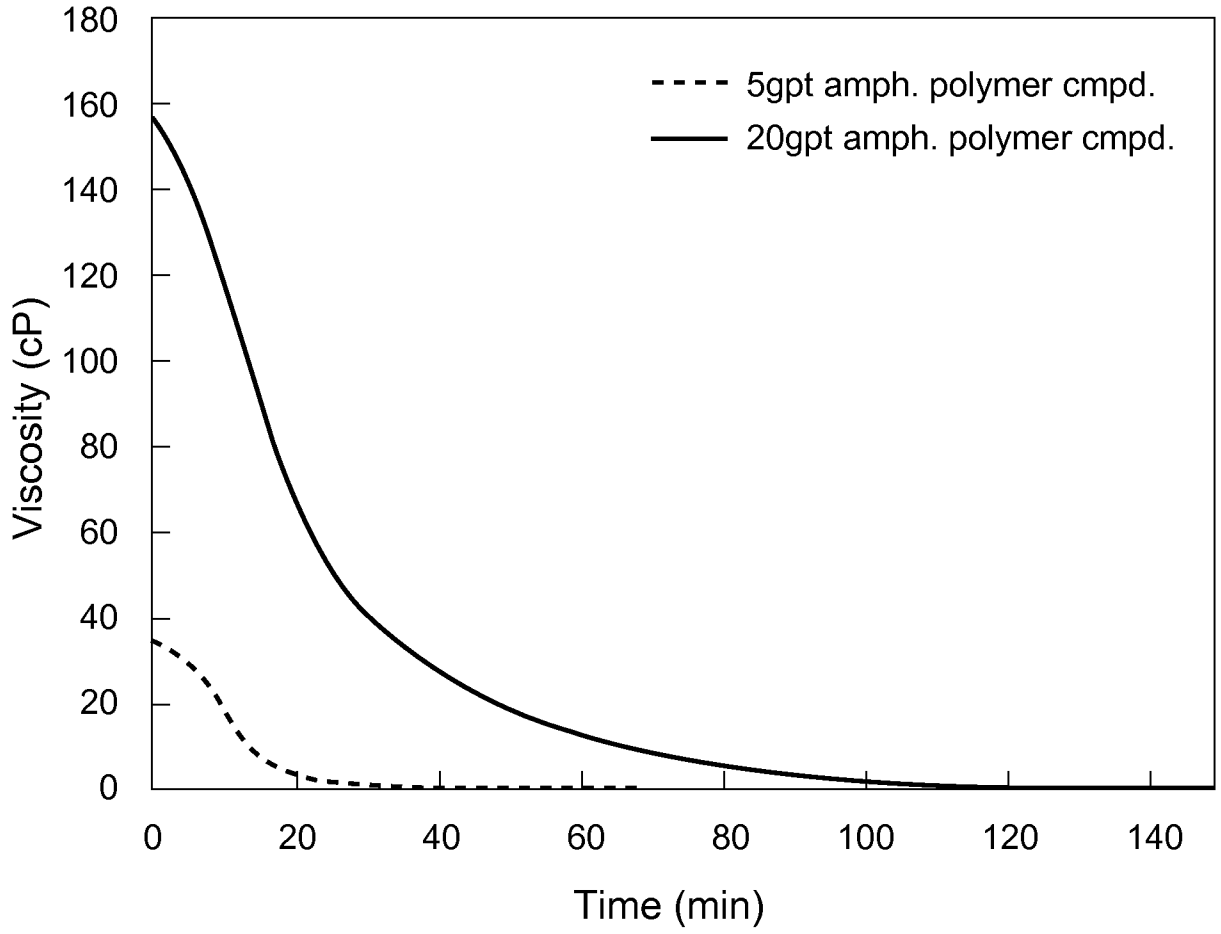

180
160
140
120
100
80
60
40
20
0
Viscosity (cP)
0
20
40
60
80
100
120
140
Time (min)
5gpt amph. polymer cmpd.
20gpt amph. polymer cmpd.

Fig. 3

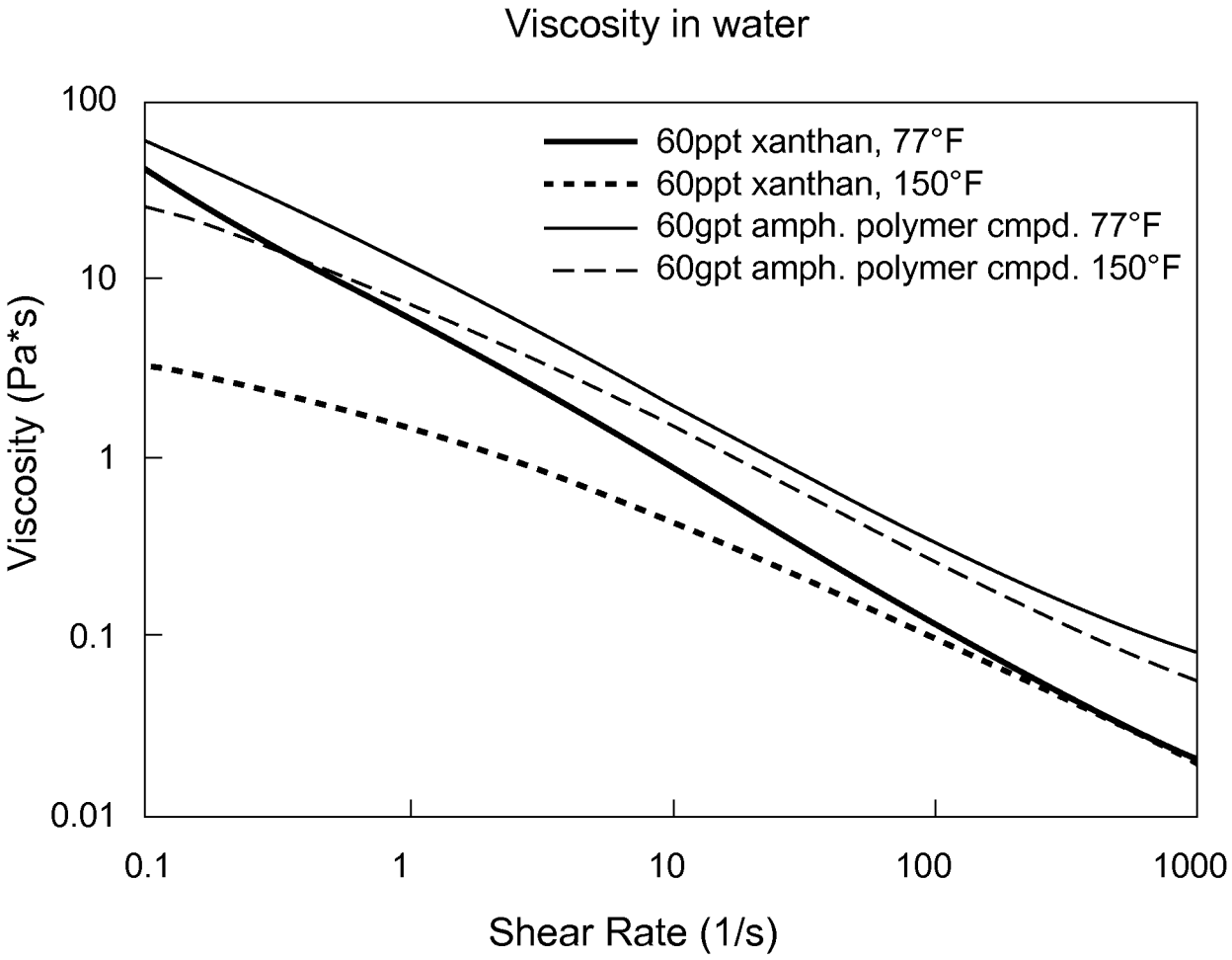

Viscosity in water
100
10
1
0.1
0.01
Viscosity (Pa*s)
0.1
1
10
100
1000
Shear Rate (1/s)
60ppt xanthan, 77°F
60ppt xanthan, 150°F
60gpt amph. polymer cmpd. 77°F
60gpt amph. polymer cmpd. 150°F

Fig. 4

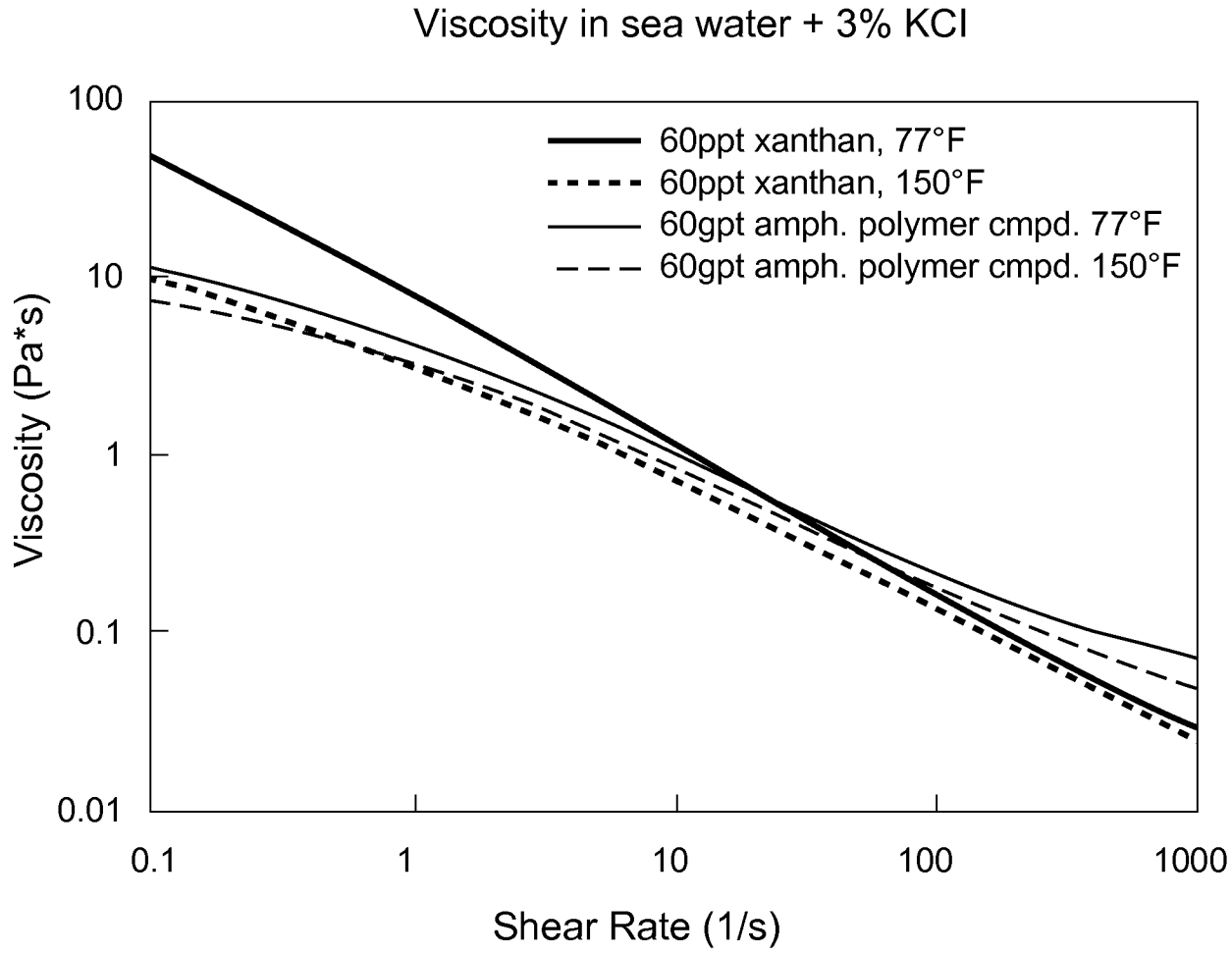

Viscosity in sea water + 3% KCl
100
10
1
0.1
0.01
Viscosity (Pa*s)
0.1
1
10
100
1000
Shear Rate (1/s)
60ppt xanthan, 77°F
60ppt xanthan, 150°F
60gpt amph. polymer cmpd. 77°F
60gpt amph. polymer cmpd. 150°F

Fig. 5

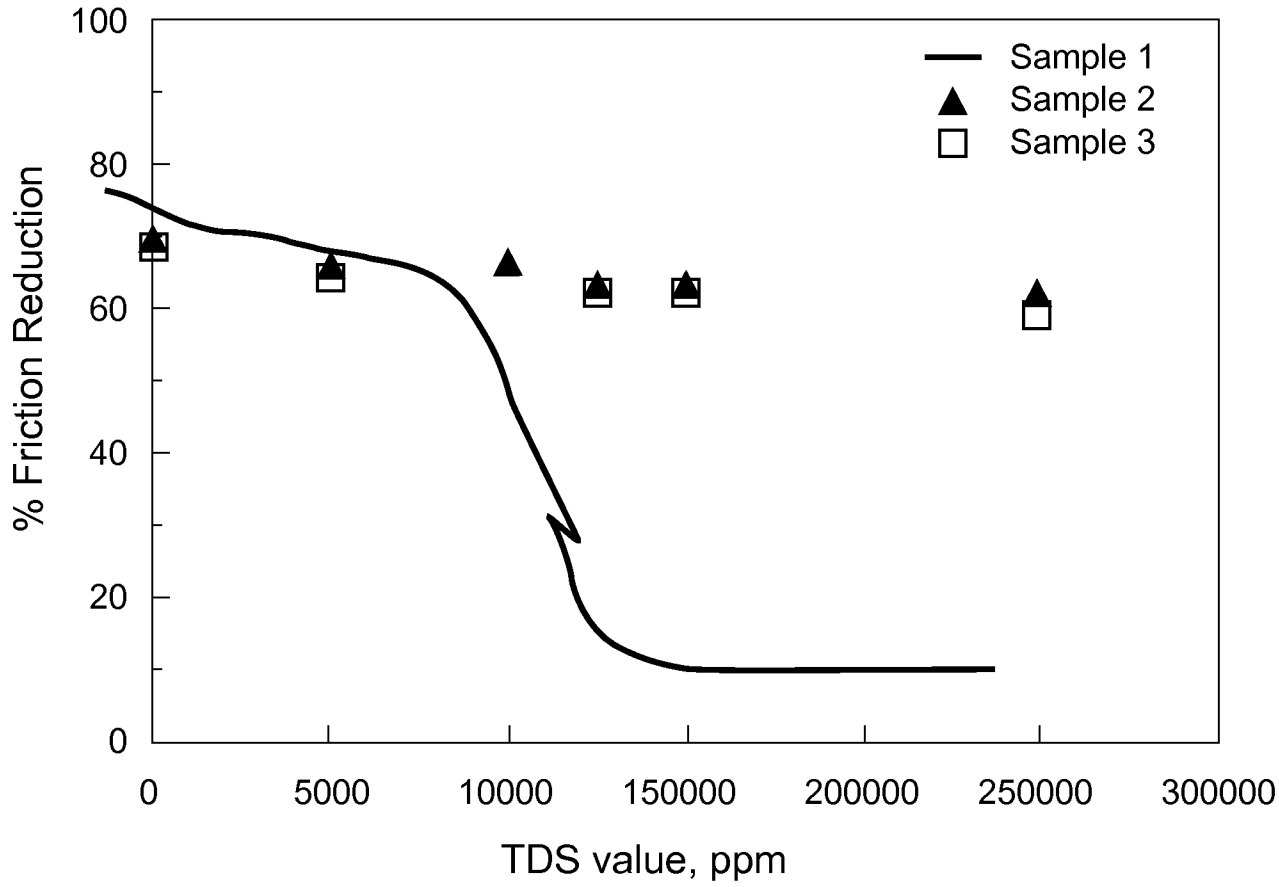

100
80
60
40
20
0
% Friction Reduction
Sample 1
Sample 2
Sample 3
0
5000
10000
150000
200000
250000
300000
TDS value, ppm

Fig. 6

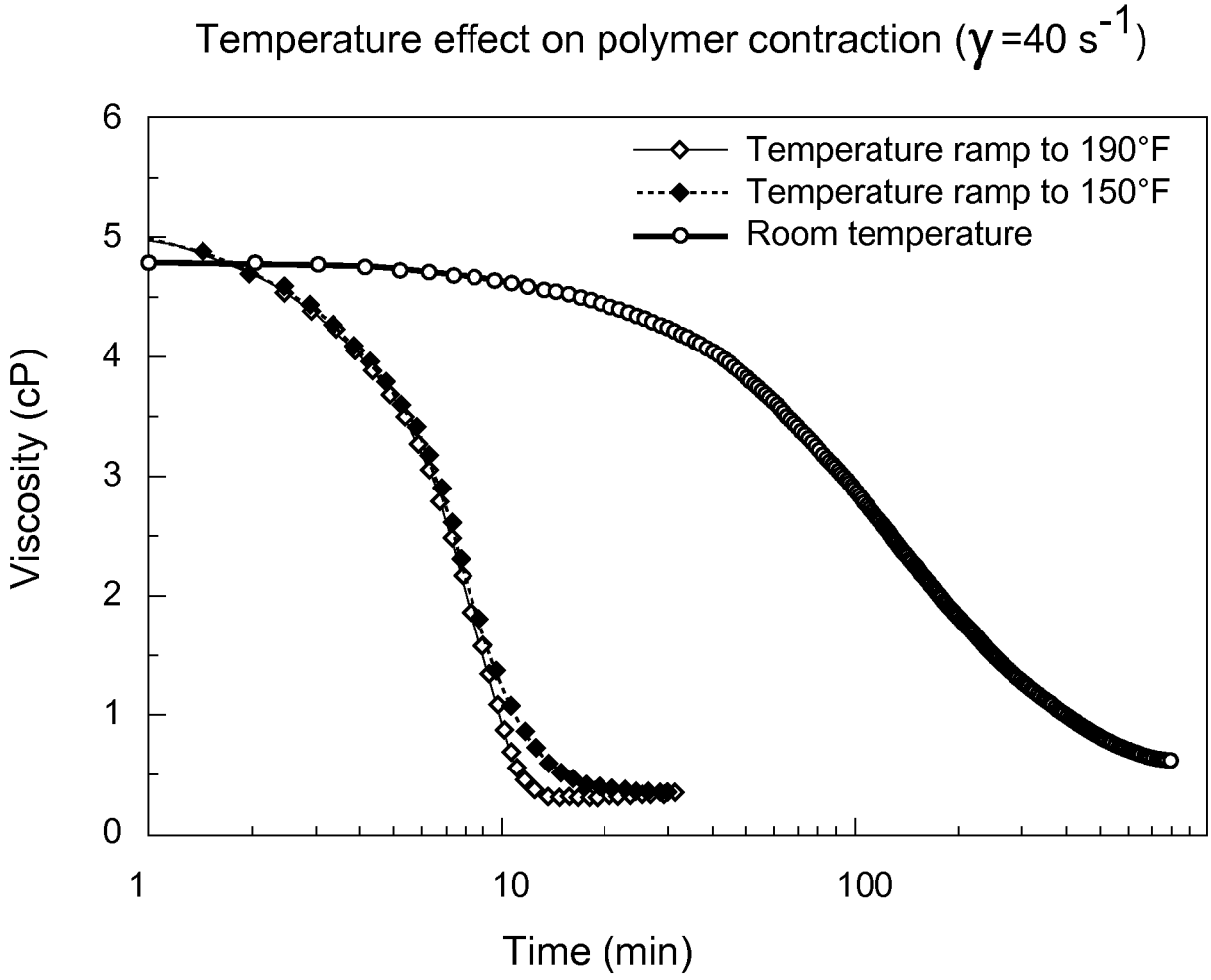

Temperature effect on polymer contraction (γ =40 s-1)
Temperature ramp to 190°F
Temperature ramp to 150°F
Room temperature
Viscosity (cP)
Time (min)
0
1
2
3
4
5
6
1
10
100

Fig. 7

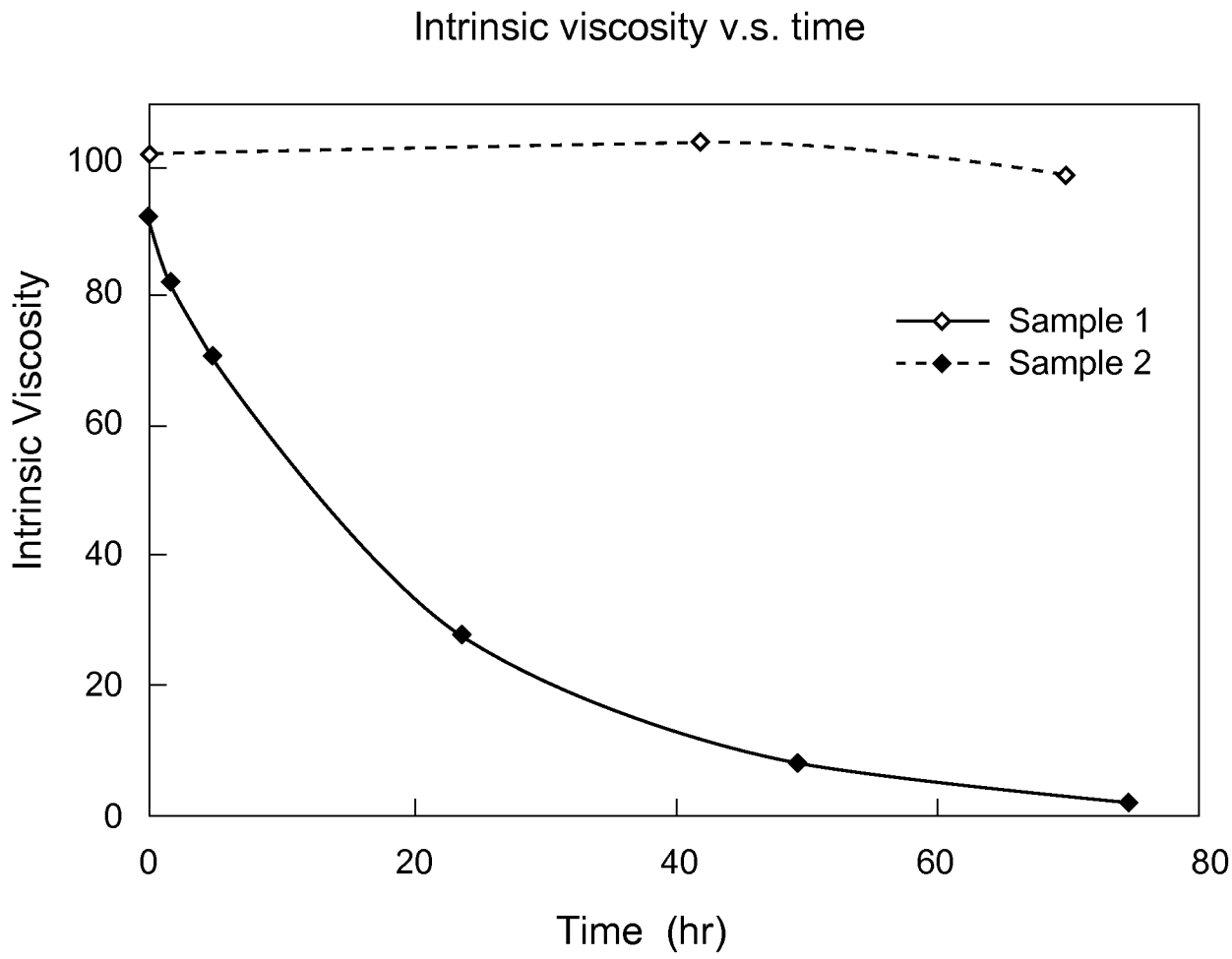

Intrinsic viscosity v.s. time
Intrinsic Viscosity
100
80
60
40
20
0
0
20
40
60
80
Time (hr)
Sample 1
Sample 2

Fig. 8

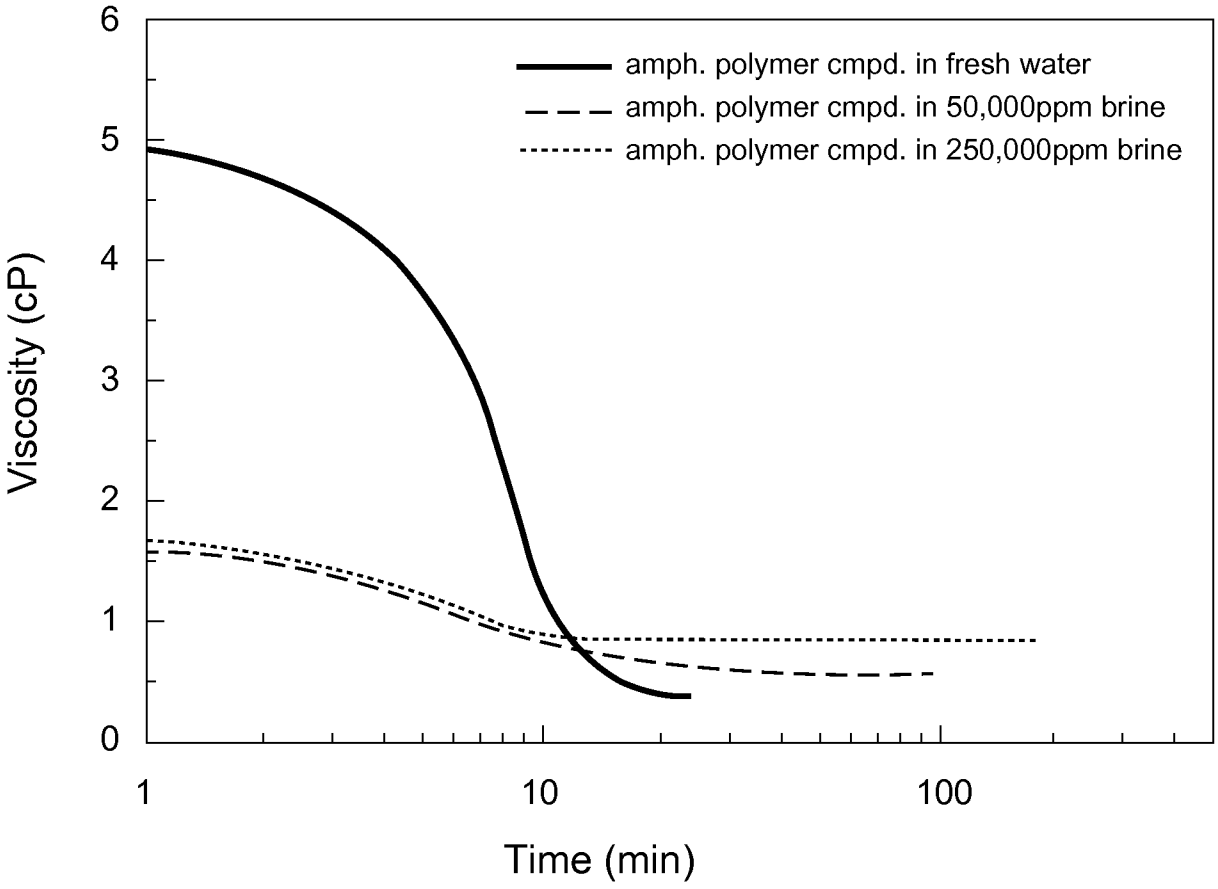

6
5
4
3
2
1
0
Viscosity (cP)
1
10
100
Time (min)
amph. polymer cmpd. in fresh water
amph. polymer cmpd. in 50,000ppm brine
amph. polymer cmpd. in 250,000ppm brine

Fig. 9



Fig. 10

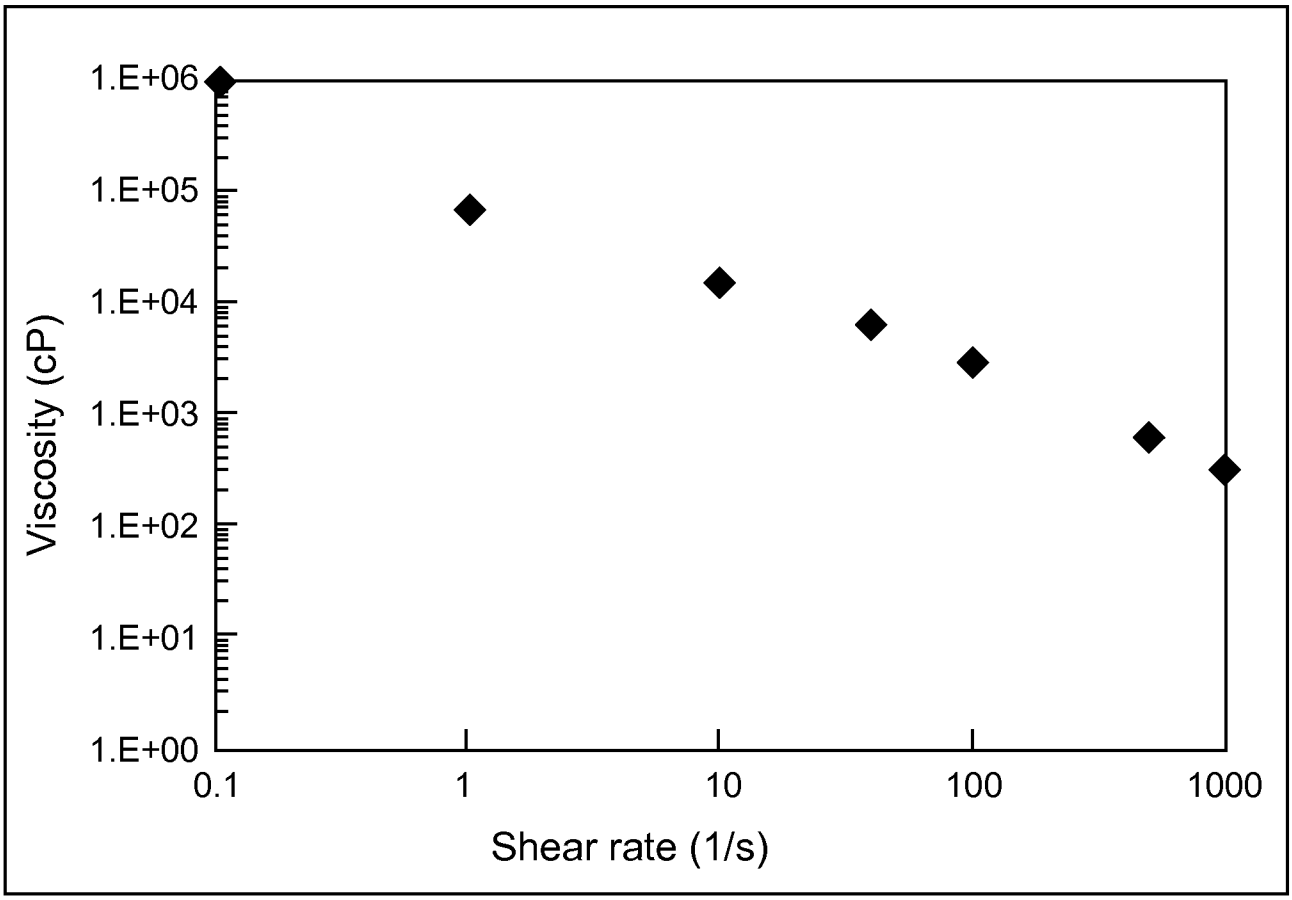

1.E+06
1.E+05
1.E+04
1.E+03
1.E+02
1.E+01
1.E+00
Viscosity (cP)
0.1
1
10
100
1000
Shear rate (1/s)

Fig. 11

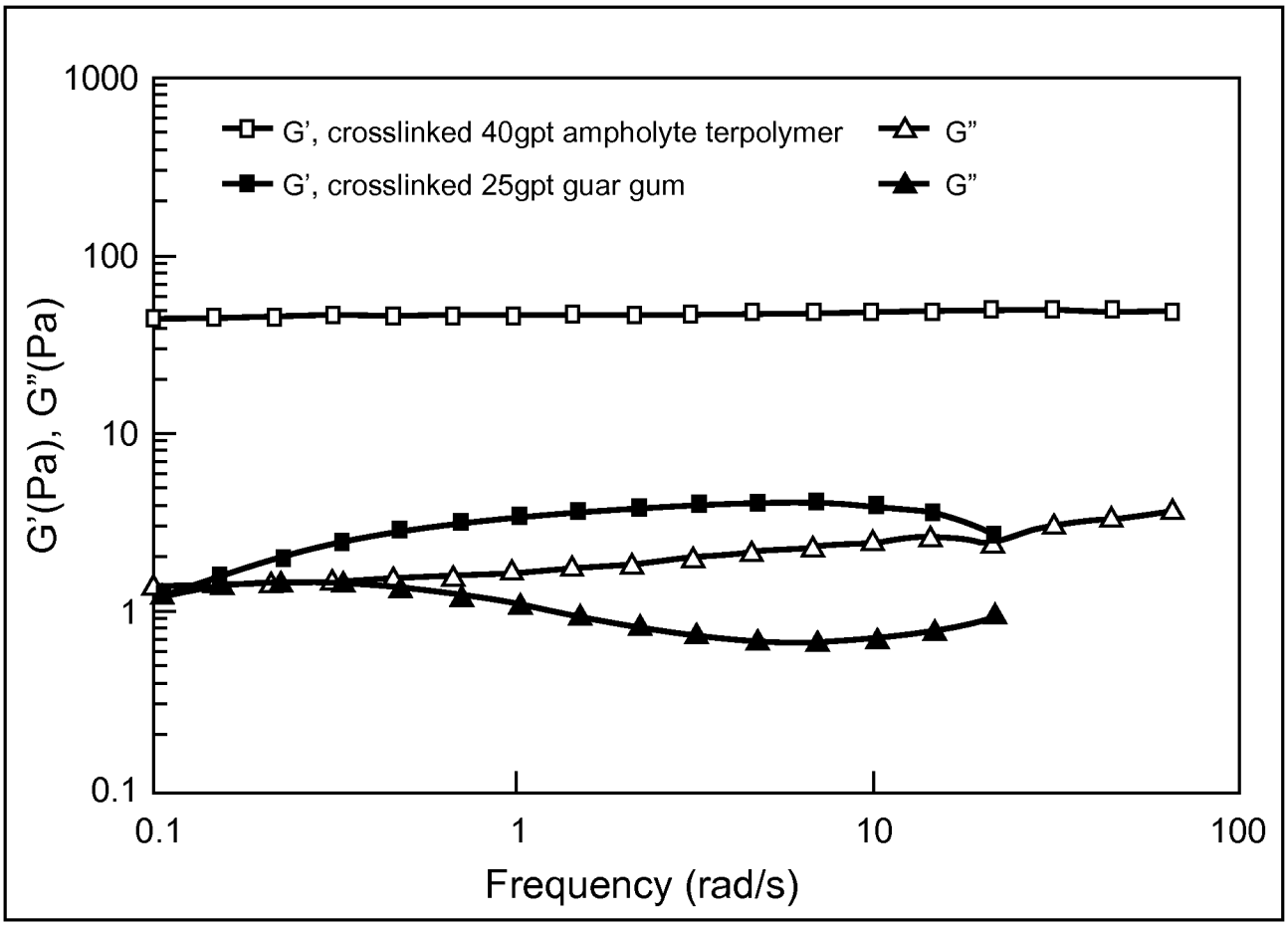

1000
100
10
1
0.1
G'(Pa), G"(Pa)
G', crosslinked 40gpt ampholyte terpolymer
G"
G', crosslinked 25gpt guar gum
G"
0.1
1
10
100
Frequency (rad/s)

Fig. 12

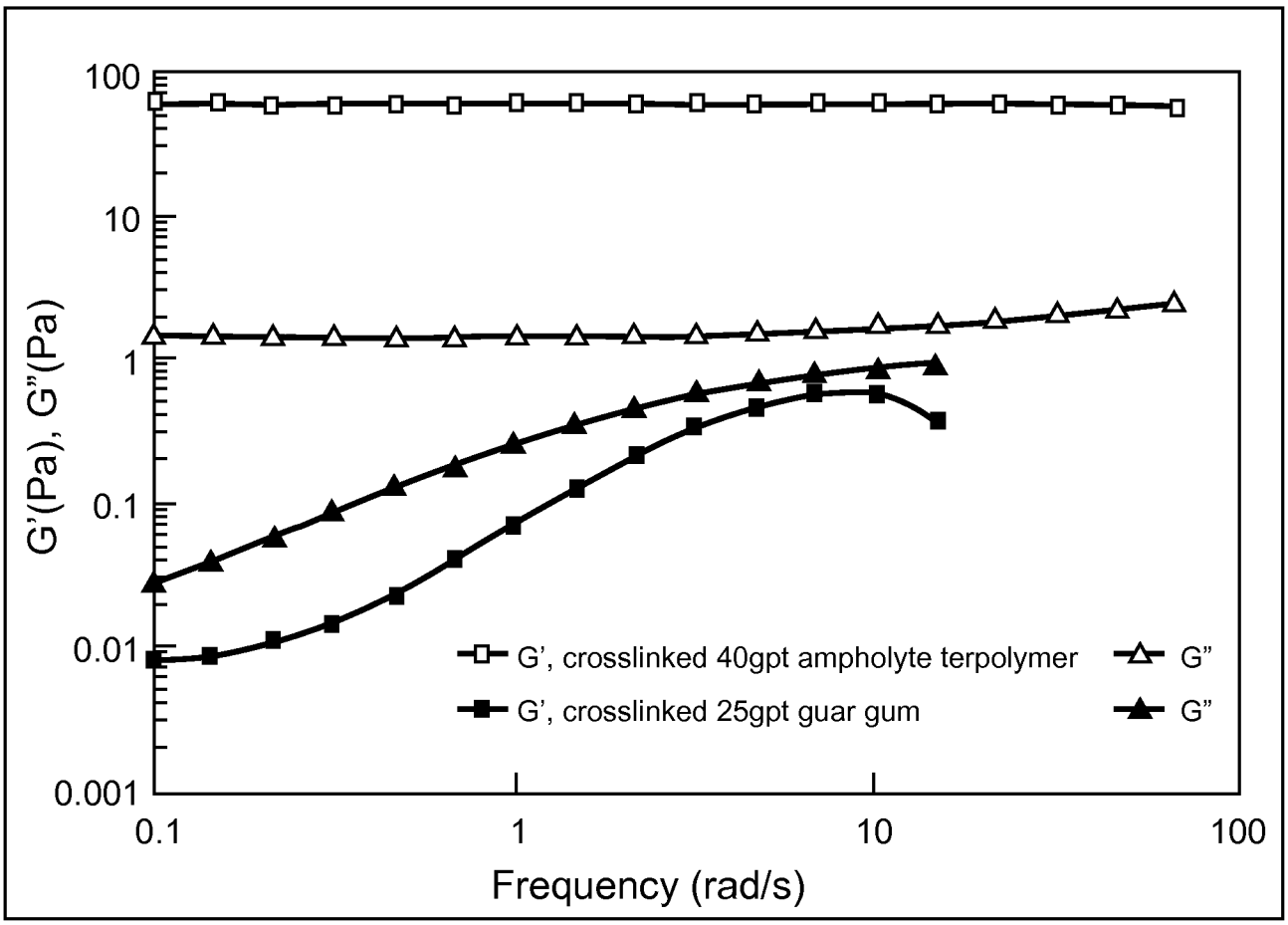

100
10
1
0.1
0.01
0.001
G'(Pa), G"(Pa)
0.1
1
10
100
Frequency (rad/s)
G', crosslinked 40gpt ampholyte terpolymer
G"
G', crosslinked 25gpt guar gum
G"

Fig. 13

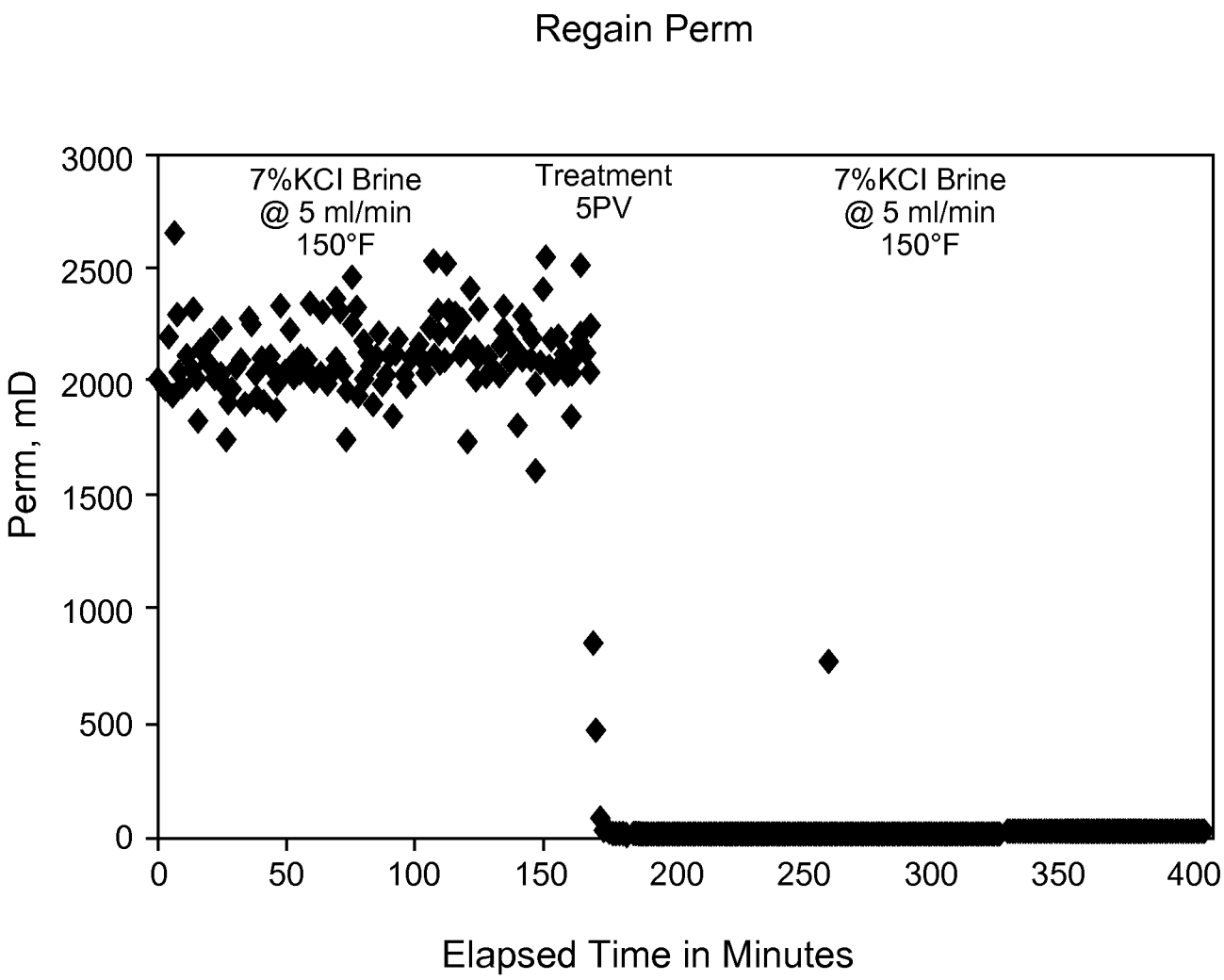

Regain Perm
7%KCl Brine
@ 5 ml/min
150°F
Treatment
5PV
7%KCl Brine
@ 5 ml/min
150°F
Perm, mD
3000
2500
2000
1500
1000
500
0
0
50
100
150
200
250
300
350
400
Elapsed Time in Minutes

Fig. 14

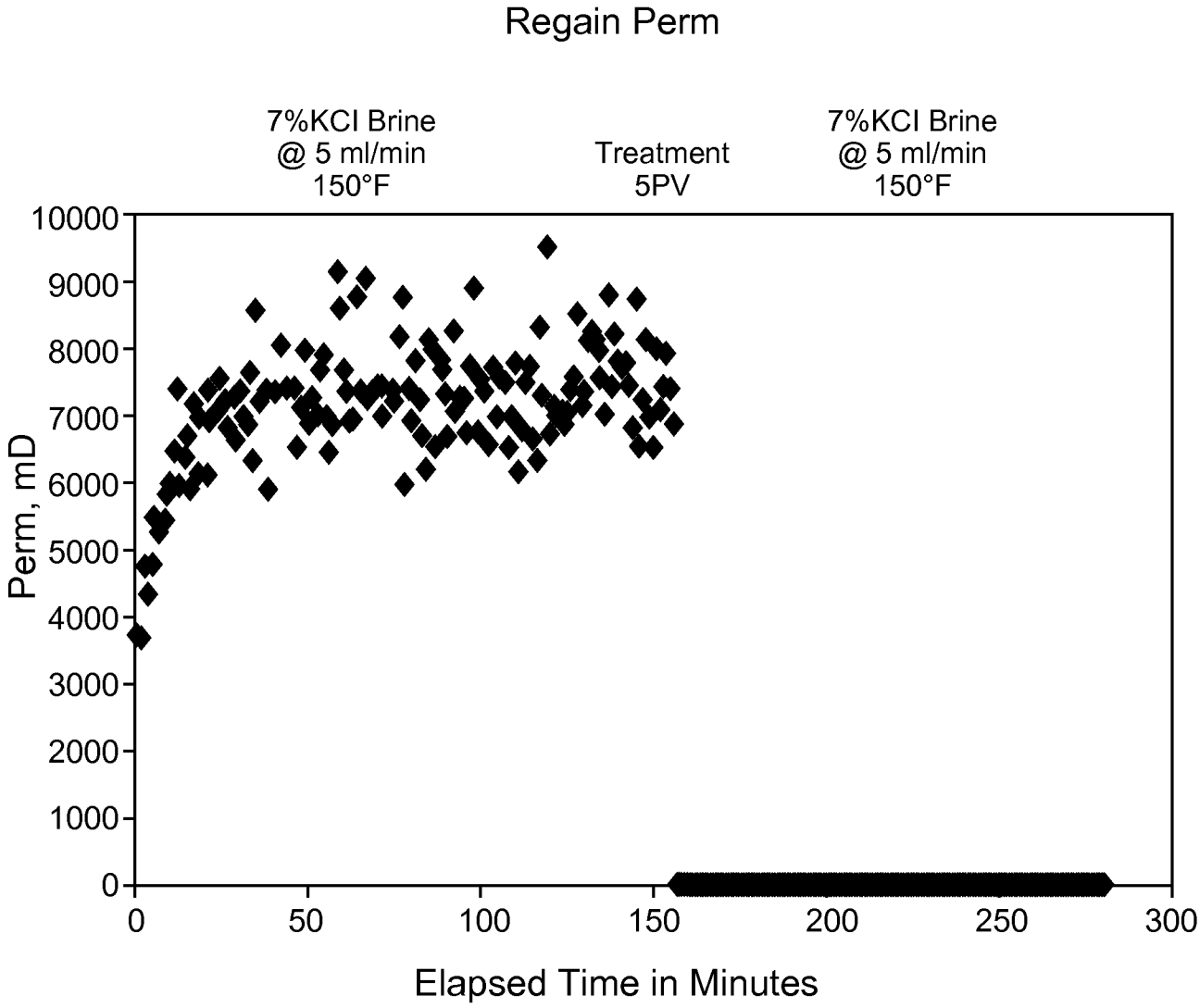

Regain Perm
7%KCl Brine
@ 5 ml/min
150°F
Treatment
5PV
7%KCl Brine
@ 5 ml/min
150°F
Perm, mD
10000
9000
8000
7000
6000
5000
4000
3000
2000
1000
0
0
50
100
150
200
250
300
Elapsed Time in Minutes

Fig. 15

INTERNATIONAL SEARCH REPORT

International application No.
PCT/US2014/069506

A. CLASSIFICATION OF SUBJECT MATTER

C09K 8/588(2006.01)i, C09K 8/035(2006.01)i, E21B 43/22(2006.01)i

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)
C09K 8/588; C08E 12/30; B01F 17/00; C09K 8/12; C09K 7/02; C08F 2/22; E21B 43/16; E21B 33/13; C09K 8/035; E21B 43/22

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched
Korean utility models and applications for utility models
Japanese utility models and applications for utility models

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)
eKOMPASS(KIPO internal) & Keywords: crosslinker, ampholyte polymer, drilling fluid, fracturing fluid, fluid loss control, acryloyloxy ethyl trimethyl ammonium chloride, methacrylamidopropyl trimethyl ammonium chloride, terpolymer

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	WO 2013-138156 A1 (ISP INVESTMENTS INC.) 19 September 2013 See paragraphs [0010], [0015], [0020]-[0040], [0051], [0078], [0083], [0087], [0092] and [0097]; claims 1-20; tables 3-8; and scheme 1.	1-113
Y	US 6482776 B1 (MATZ, GARY F. et al.) 19 November 2002 See column 6, lines 4-57; column 9, lines 5-32; and claims 1-9.	1-113
A	US 2005-0230113 A1 (EOFF, LARRY S. et al.) 20 October 2005 See abstract; paragraphs [0005]-[0007]; and claims 1-13.	1-113
A	US 2003-0155122 A1 (CHANG, KIN-TAI et al.) 21 August 2003 See abstract; paragraphs [0021]-[0027], [0037], [0056]-[0058] and [0073]; and claims 1-13.	1-113
A	US 7482310 B1 (REESE, RHYS R. et al.) 27 January 2009 See abstract; column 2, lines 37-47; column 6, line 56 - column 8, line 5; and claims 1-23.	1-113
PX	US 2014-0352969 A1 (CHUNG, HSINCHEN et al.) 04 December 2014 See abstract; and claims 1-20.	1-113

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

☒ See patent family annex.

* 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	Date of mailing of the international search report
20 March 2015 (20.03.2015)	**23 March 2015 (23.03.2015)**

Name and mailing address of the ISA/KR
International Application Division
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Facsimile No. ++82 42 472 7140

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LEE, Jeong A
Telephone No. +82-42-481-8740

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No.
PCT/US2014/069506

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
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		WO 01-96707 A8	04/04/2002
US 7482310 B1	27/01/2009	None	
US 2014-0352969 A1	04/12/2014	None	