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Castillo Grau & Asociados
ABOGADOS

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Señores
DIVISIÓN DE NUEVAS CREACIONES
SUPERINTENDENCIA DE INDUSTRIA Y COM
Bogotá, D.C.

SUPERINTENDENCIA DE INDUSTRIA Y COMERCIO
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Act: 444 RESPUESTAREQUE Folios: 7

Re.: Código 011-379-444
Expediente No. 03-69.557
Fase nacional de Solicitud
de Patente PCT
SCHLUMBERGER TECHNOLOGY B.V.

En relación con el expediente de la referencia y dando cumplimiento a la última providencia recaída sobre este asunto por medio del presente escrito me permito manifestarles lo siguiente:

1. Se modifican y se adjuntan las páginas 8 y 12 con el fin de hacer mayor claridad en algunos términos.
2. Igualmente se acompaña un nuevo capítulo reivindicatorio revisado y modificado.
3. Haciendo referencia al punto 3 del concepto técnico, el examinador parece pensar que existe un error en la ortografía de los términos que se resaltaron en negrilla. No se trata de un error de ortografía, la explicación más detallada es la siguiente:

   Existe un sistema de nomenclatura que se utiliza en algunas industrias y que emplea "*laureth*" para referirse a "lauril poly(oxietileno)". El compuesto que se muestra en la primera fórmula de la página 3 contenía un grupo lauril tri(oxietileno). La página 12 y la reivindicación 15 han sido modificadas para emplear este término.

   Las dos fórmulas en la página 12 estaban incorrectas ya que mostraban un – CH_{11}- que no tiene sentido y que debe corregirse por –$(CH_2)_{11}$- tal como se muestra en la versión corregida en la página 12 adjunta.

El término "esterquat" es un nombre abreviado de un compuesto que es un éster de un compuesto de nitrógeno cuaternario. Esto es aparente de la explicación en las páginas 9 y 10. La palabra Esterquat es aún parte del título de un libro que se menciona en la línea 25 de la página 12 del texto PCT. Se ha insertado un paréntesis como explicación cuando se emplea esterquat por primera vez, tal como se muestra en la página 8, y se solicita al examinador que permita el uso subsiguiente de los términos esterquat y quat, ya que ellos están explicados en el texto.

4. El propósito de las modificaciones a las reivindicaciones es superar las objeciones del examinador en el concepto técnico. La reivindicación 1 modificada ahora define el primer surfactante viscoelástico por medio de una fórmula y definiciones copiadas de la reivindicación 2 anterior, salvo el texto final "que posiblemente comprende un grupo hidroxilo terminal" de la reivindicación 2 anterior. Esta propiedad opcional es el objeto de la reivindicación 2 modificada. La reivindicación 1 modificada define el segundo surfactante por medio de una fórmula y definiciones copiadas de la reivindicación 8, con algún cambio. El texto final "que posiblemente comprende un grupo hidroxilo terminal" de la reivindicación 8 es el objeto de la reivindicación 8 modificada.

5. En la reivindicación 1 modificada, X se refiere a un *grupo* y no a un enlace. Segundo, la longitud de la cadena del grupo R en el segundo surfactante ha sido cambiada a "al menos 3 átomos de carbono". Esto se encuentra apoyado en la página 12 del texto PCT original que explica que la hendidura hidrolítica del segundo surfactante en el grupo X libera un compuesto que contiene el grupo R de este surfactante, donde R es al menos 3 átomos de carbono, posiblemente 8 a 18 átomos de carbono, o posiblemente más.

   Las reivindicaciones 17 y 18 anteriores concordaban con esto. Los compuestos que se nombran en la página 17 son ejemplos de compuestos en los que R contiene 12 átomos de carbono.

6. Las reivindicaciones 12 y 15 han sido modificadas. La reivindicación 16 anterior ha sido eliminada. Las reivindicaciones 17, 18 y 19 han sido renumeradas y modificadas para que sean dependientes de las reivindicaciones de la composición. Las reivindicaciones 20 y 21 han sido eliminadas. A las reivindicaciones dependientes se le han dado múltiples subdependencias.
7. El documento D1 (WO 94/09852) divulga composiciones acuosas que contienen un surfactante viscoelástico. Sin embargo, este documento no menciona un segundo surfactante que contenga un grupo X éster, amida o acetal hendible. Por lo tanto, las reivindicaciones son novedosas, y nada en la técnica anterior sugiere los requerimientos de la reivindicación 1 según ha sido modificada.
8. Teniendo en cuenta lo dispuesto por el Consejo de Estado en sentencia proferida dentro del Expediente No. 7684 el 22 de Octubre de 2004 y acogida por esa Superintendencia mediante memorando interno de fecha 22 de Diciembre de 2004 dirigido a los funcionarios de la Delegatura de Propiedad Industrial, no se hace necesario acompañar comprobante de pago por concepto de modificación de la solicitud por cuanto el nuevo pliego reivindicatorio se presenta a instancia de la Superintendencia en cumplimiento de lo ordenado por el artículo 45 de la Decisión 486.

Renuncio al término faltante de traslado, y les solicito conceder el privilegio de patente de invención aquí tramitado.

De ustedes Atentamente,

LUIS FELIPE CASTILLO GIBSONE
T. P. No. 68.995 del C.S.J.

viscoelásticos cuando están en una solución alcalina en la presencia de sales agregadas tales como cloruro de potasio o cloruro de sodio. Las micelas en forma de lombriz de dicho gel se degradan a micelas esféricas cuando el hidrocarburo rompe el gel.

El fluido de la invención comprende un segundo surfactante. Este surfactante es viscoelástico o no. Es fragmentable. Como tal, se descompone en condiciones pozo abajo para liberar los productos de degradación. Los surfactantes fragmentables para la implementación de la invención se divulgan en la solicitud de patente radicada el 13 de febrero de 2001 bajo el No. GB 0103449-5. Estos surfactantes son viscoelásticos de la siguiente fórmula:

R-X-Y-Z-

donde R es la cola hidrofóbica del surfactante, el cual es una cadena de hidrocarburos, total o parcialmente saturada, lineal o ramificada de al menos 18 átomos de carbono, X es el grupo fragmentable o degradable del surfactante el cual es un enlace de acetal, amida, éter o éster, Y es un grupo espaciador el cual es constituido por una cadena corta saturada o parcialmente saturada de hidrocarburos de **n** átomos de carbono, donde **n** es al menos igual a 1, preferiblemente 2 y, cuando **n** es ≥ 3, puede ser una cadena de alquilo recta o ramificada, y Z es el grupo delantero hidrofílico del surfactante el cual puede ser $NR_1R_2R_3+$, $-SO_3^-$, $-COO^-$ o, en el caso en que el surfactante sea zwitteriónico, $-N+(R_1R_2R_3)-COO^-$), donde R_1, R_2 y R_3 son cada uno independientemente hidrógeno o una cadena alifática total o parcialmente saturada, lineal o ramificada de al menos un átomo de carbono, que comprende posiblemente un grupo terminal.

Por lo tanto, los segundos surfactantes típicos son carboxilatos de éster, sulfonatos de éster, por ejemplo, donde Y = CH_2CH_2, isetionatos, y quats de ésteres (de compuestos que contienen nitrógeno cuaternario). Los surfactantes equivalentes de amida inversa y delantera, es decir, carboxilatos de amida inversos, carboxilatos de amida delanteros, por ejemplo sarcosinatos ($RCON(CH_3)CH_2COO^-$), sulfonatos de amida inversos, sulfonatos de amida delanteros, por ejemplo tauratos ($RCON(R'CH_2CH_2SO_3^-$), quats de amida inversa y quats de amida delantera también son típicos segundos surfactantes según la invención.

Debido en particular a la presencia del grupo delantero hidrofílico, las concentraciones peso/porcentaje de los surfactantes R-X-Y-Z son compatibles con el gel del surfactante viscoelástico aún cuando R sea una cadena saturada o parcialmente insaturada con 18 átomos de carbono o más.

Por ejemplo, cuando X es un grupo éster, el surfactante fragmentable puede descomponerse en condiciones pozo abajo para liberar un separador de alcohol de acuerdo con la siguiente reacción:

Sin embargo, otros surfactantes fragmentables pueden ser indicados para romper geles del surfactante de oleato o geles dimeros/trimeros de carboxilato. Estos se basan en surfactantes de sulfosuccinato y sulfoacetato.

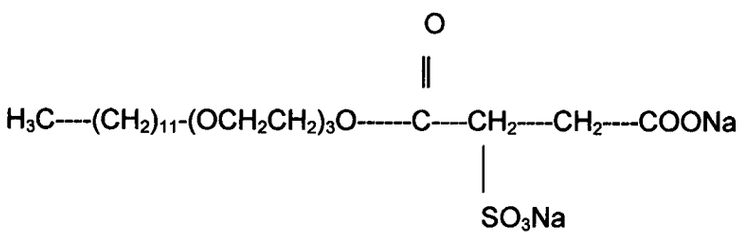
Por ejemplo, los sulfosuccinatos de alquilo son mono o di-ésteres de ácido sulfosuccínico: $HOOCCH_2CH(SO_3H)COOH$. La fórmula de estos mono y di-ésteres de ácido sulfosuccínico son las siguientes:

$ROOCCH_2\text{-}CH(SO_3Na)COONa$ (monoéster)

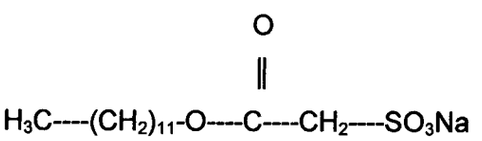
$ROOCCH_2\text{-}CH(SO_3Na)COOR$ (diéster)

donde R es una cadena de alquilo.

Dos segundos surfactantes diferentes indicados para la implementación de la invención se consiguen de la Compañía Stepan™. El primero es lauril tri(oxietileno) sulfosuccinato disódico:



El Segundo es un surfactante de sulfoacetato, lauril sulfoacetato sódico:



STEPAN-MILD LSM™ es un producto líquido que contiene tanto surfactantes de laureth sulfosuccinato disódico como de lauril sulfoacetato sódico en agua, siendo 25%/peso la actividad total del surfactante. Este surfactante tolera agua dura y es fácilmente biodegradable. La temperatura recomendada de almacenamiento es entre 7°C y 43°C. STEPAN.MILD SL3™ es también un líquido que contiene 30%/peso de laureth sulfosuccinato disódico. Ambos surfactantes se pueden descomponer para liberar alcoholes de cadena larga tal como se ilustra en las Figuras 3 y 4. Esta descomposición viene acompañada por una reducción en el pH del fluido debido al consumo del ión OH-. Además, la presencia del grupo sulfonato acelera la velocidad de la hidrólisis de éster de modo que $ROOCH_2\text{-}CH(SO_3Na)COONa$ se degrada más fácilmente que su equivalente no sulfonato: $ROOCCH_2\text{-}CH2COONa$ y $ROOCCH_2\text{-}SO_3Na$ se degradará más rápidamente que $ROOCH_3$. En ambos casos, la presencia del grupo sulfonato aumenta la hidrofilicidad y la solubilidad en agua del compuesto, y esto aumenta la compatibilidad con el gel.

REIVINDICACIONES

1. Un fluido viscoelástico acuoso para uso en la recuperación de hidrocarburos, que comprende:

un primer surfactante, siendo dicho surfactante viscoelástico, el cual es de las siguientes fórmulas:

R-Z

en donde R es la cola hidrofóbica del surfactante, la cual es una cadena de hidrocarburos lineal o ramificada, total o parcialmente saturada, de al menos 18 átomos de carbono, y Z es el grupo delantero del surfactante el cual es $-NR_1R_2R_3^+$, $-SO_3^-$, $-COO^-$ o, en el caso en que el surfactante sea zwiteriónico, $-N^+(R_1R_2R_3\text{-}COO^-)$, donde R_1, R_2 y R_3 son cada uno independientemente hidrógeno o una cadena alifática, lineal o ramificada, total o parcialmente saturada de al menos un átomo de carbono;

un segundo surfactante de las siguientes fórmulas:

R-X-Y-Z

donde R es la cola hidrofóbica del surfactante, la cual es una cadena de hidrocarburos lineal o ramificada, total o parcialmente saturada, de al menos 3 átomos de carbono, X es un grupo acetal, amida, éter o éster, Y es un grupo espaciador constituido por una cadena de hidrocarburos, saturada corta o saturada parcialmente, de átomos de carbono **n** donde **n** es al menos igual a 1, y cuando **n** es ≥ 3, puede ser una cadena de alquilo recta o ramificada, y **Z** es el grupo de cabeza hidrofílica del surfactante que puede ser $-NR_1R_2R_3^+$, $-SO_3^-$, $-COO^-$ o, en el caso en que el surfactante sea zwiteriónico, $-N^+(R_1R_2R_3\text{-}COO^-)$, donde R_1, R_2 y R_3 son cada uno independientemente hidrógeno o una cadena alifática, lineal o ramificada, total o parcialmente saturada de al menos un átomo de carbono.

2. El fluido de la reivindicación 1, en donde:

R_2 y R_3 del primer surfactante son cada uno independientemente, una cadena alifática, lineal o ramificada, total o parcialmente saturada de al menos un átomo de carbono y que comprende un grupo hidroxilo terminal.

3. El fluido de la reivindicación 1, o la reivindicación 2, en donde el primer surfactante es hendible.

4. El fluido de la reivindicación 1 o la reivindicación 2, en donde el primer surfactante viscoelástico es N-erucil-N,N-bis(2-hidroxietil)-N- metil amonio cloruro.

5. El fluido de la reivindicación 1 o la reivindicación 2, en donde el primer surfactante es un carboxilato mono-, di- u oligomérico.

6. El fluido de la reivindicación 1 5, en donde el primer surfactante es oleato.

7. El fluido según cualquiera de las reivindicaciones 1 a 6, en donde el segundo surfactante es un surfactante viscoelástico.

8. El fluido según cualquiera de las reivindicaciones 1 a 76, en donde R_2 y R_3 del segundo surfactante son cada uno independientemente, una cadena alifática lineal o ramificada, total o parcialmente saturada de al menos un átomo de carbono, y comprende un grupo hidroxilo terminal.

9. El fluido según cualquiera de las reivindicaciones 1 a 8 en donde el segundo surfactante es un éster carboxilato, un éster sulfonato, un carboxilato amida hacia atrás, un carboxilato amida hacia adelante, un sulfonato amida hacia atrás o un sulfonato amida hacia delante.

10. El fluido según cualquiera de las reivindicaciones 1 a 8, en donde el grupo cabeza Z en el segundo surfactante es $-NR_1R_2R_3+$ y X en el segundo surfactante es un grupo éster.

11. El fluido según cualquiera de las reivindicaciones 1 a 8, en donde el segundo surfactante es éster de betaína.

12. El fluido según cualquiera de las reivindicaciones 1 a 8, en donde el segundo surfactante es di(palmitoiletil) hidroxietilmetil-amonio o erucil éster metilen dimetil etil amonio.

13. El fluido según la reivindicación 9, en donde el segundo surfactante es mono-oleil éster succinato.

14. El fluido según la reivindicación 9, en donde el segundo surfactante es un surfactante sulfosuccinato o sufoacetato.

15. El fluido según la reivindicación 14, en donde el segundo surfactante es lauril sulfosuccinato disódico o lauril sulfoacetato sódico.

16. El fluido según cualquiera de las reivindicaciones 1 a 15, en donde el grupo R en el segundo surfactante es una cadena alquilo de al menos 3 átomos de carbono.

17. El fluido según cualquiera de las reivindicaciones 1 a 15, en donde el grupo R en el segundo surfactante comprende de 8 a 18 átomos de carbono o más.

18. El fluido según cualquiera de las reivindicaciones 1 a 15, , en donde el grupo R en el segundo surfactante es olelil y X en el segundo surfactante es –COC.

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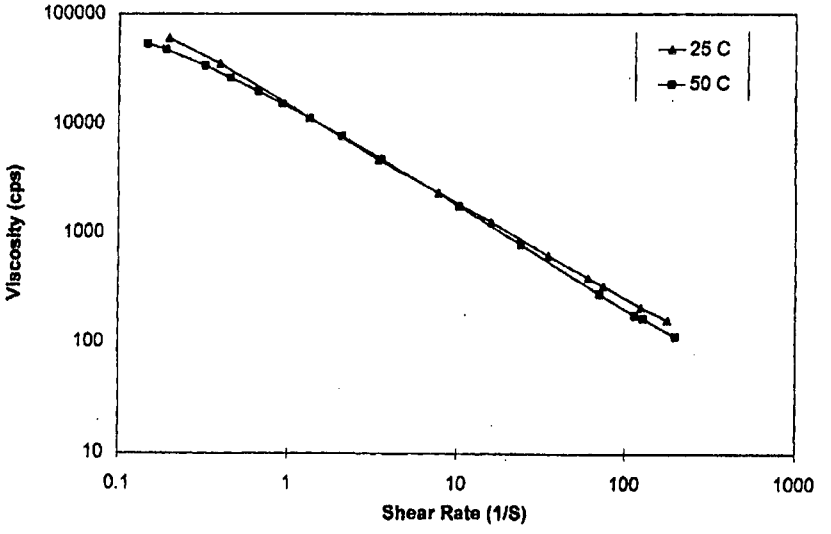
(54) Title: FLUIDS CONTAINING VISCOELASTIC SURFACTANT AND METHODS FOR USING THE SAME



5% disodium tallowiminodipropionate with 2.25% phthalic acid at 25 and 50 degree C

(57) Abstract

Viscoelastic surfactant based aqueous fluid systems useful as thickening agents in various applications, e.g. to suspend particles produced during the excavation of geologic formations. The surfactants are zwitterionic/amphoteric surfactants such as dihydroxyl alkyl glycinate, alkyl ampho acetate or propionate, alkyl betaine, alkyl amidopropyl betaine and alkylamino mono– or di–propionates derived from certain waxes, fats and oils. The thickening agent is used in conjunction with an inorganic water–soluble salt or organic additive such as phthalic acid, salicylic acid or their salts.

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(12) **United States Patent**
Dahayanake et al.

(10) **Patent No.: US 6,258,859 B1**
(45) **Date of Patent: Jul. 10, 2001**

(54) **VISCOELASTIC SURFACTANT FLUIDS AND RELATED METHODS OF USE**

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(73) Assignee: **Rhodia, Inc.**, Cranbury, NJ (US)

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(22) Filed: **Jun. 8, 1998**

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(51) **Int. Cl.**[7] **B01J 17/22**; B01J 17/28; C11D 1/10; C11D 1/90

(52) **U.S. Cl.** **516/77**; 252/77; 166/308; 405/128; 424/401; 507/922; 507/924; 510/480; 510/490; 510/502; 510/503

(58) **Field of Search** 516/77; 507/922, 507/924; 252/77; 510/490, 502, 503, 480

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Primary Examiner—Richard D. Lovering
(74) *Attorney, Agent, or Firm*—Ohlandt, Greeley, Ruggiero & Perle, L.L.P.

(57) **ABSTRACT**

Viscoelastic surfactant based aqueous fluid systems useful as thickening agents in various applications, e.g. to suspend particles produced during the excavation of geologic formations. The surfactants are zwitterionic/amphoteric surfactants such as dihydroxyl alkyl glycinate, alkyl ampho acetate or propionate, alkyl betaine, alkyl amidopropyl betaine and alkylimino mono- or di-propionates derived from certain waxes, fats and oils. The thickening agent is used in conjunction with an inorganic water-soluble salt or organic additive such as phthalic acid, salicylic acid or their salts.

5 Claims, 5 Drawing Sheets

VISCOELASTIC SURFACTANT FLUIDS AND RELATED METHODS OF USE

This application claims the benefit of the disclosure of U.S. Provisional Patent Application Serial Nos. 60/049,045, filed on Jun. 10, 1997, and Ser. No. 60/054,455, filed on Aug. 5, 1997.

FIELD OF THE INVENTION

This invention relates to viscoelastic fluids which contain a surfactant and to methods of suspending particles using such viscoelastic fluids.

BACKGROUND OF THE INVENTION

It is known to thicken the aqueous phase of a suspension of solid particles or emulsified droplets. The addition of thickeners increases the viscosity of the aqueous phase and thereby retards settling of the particles or droplets. Such retardation is useful to maintain the particles or droplets in suspension during the storage, use, and/or transport of the suspension.

Polymeric thickeners, e.g. starches, which thicken by entanglement of the polymeric chains, have been used to viscosify the aqueous phase of suspensions. Such thickeners can degrade under the influence of mechanical shear or chemical scission (e.g. by oxidation or hydrolysis) of the polymeric chains which results in a loss of viscosity and, thus, suspension stability.

Cationic surfactants have been found which form rod-like micelles under certain conditions. The presence of the rod-like micelles imparts to the fluid viscoelastic properties. However, cationic surfactants tend to have high toxicity and very low biodegradability.

SUMMARY OF THE INVENTION

The present invention provides a viscoelastic fluid useful as a thickener for the suspension of particles. The viscoelastic fluids consist of an amphoteric/zwitterionic surfactant and an organic acid/salt and/or inorganic salts.

Thus, this invention specifically relates to a viscoelastic fluid comprising:

(1) an aqueous medium;

(2) an amount of a surfactant selected from the group consisting of amphoteric surfactants, zwitterionic surfactants, and mixtures thereof, effective to render said aqueous medium viscoelastic; and

(3) a member selected from the group consisting of organic acids, organic acid salts, inorganic salts, and combinations of one or more organic acids or organic acid salts with one or more inorganic salts.

In yet another embodiment of the present invention, the invention relates to a viscoelastic fluid consisting essentially of:

(1) an aqueous medium;

(2) an amount of a surfactant comprising an amine oxide surfactant; and

(3) an anionic surfactant containing a hydrophobe having at least 14 carbon atoms.

The term "viscoelastic" refers to those viscous fluids having elastic properties, i.e., the liquid at least partially returns to its original form when an applied stress is released. The thickened aqueous viscoelastic fluids are useful as water-based hydraulic fluids in lubricant and hydraulic fracturing fluids to increase permeability in oil production.

The present invention also relates to a method for distributing suspended solid particles such as excavation by-products in a fluid comprised of the viscoelastic fluid of this invention, wherein the solid particles remain suspended for an extended period of time to a side, by transporting the fluid to a site while the solid particles remain suspended in the fluid and depositing the fluid to such site.

This invention also relates to a method for fracturing a subterranean formation comprising pumping the inventive viscoelastic fluid through a wellbore and into a subterranean formation at a pressure sufficient to fracture the formation.

This invention also relates to a detergent formulation comprising a detersive surfactant in admixture with a viscoelastic fluid of this invention.

This invention also relates to the use of the viscoelastic fluid as a drift control agent for agricultural formulations. In this regard, this invention relates to an aqueous formulation of an agricultural chemical and an amount of the viscoelastic fluid of this invention sufficient to increase the average droplet size of a spray of said formulation.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 shows viscosity versus shear rate for a viscoelastic surfactant solution prepared by adding 5 percent of disodium tallowiminodipropionate (Mirataine T2C®) and 2.25 percent of phthalic acid to water.

FIG. 2 shows the dynamic modulus G' (storage modulus) and G" (loss modulus) at 25° C. and 50° C. of the same solution as FIG. 1.

FIG. 3 shows the viscosity versus shear rate for a viscoelastic surfactant solution prepared by adding 5 percent of disodium tallowiminodipropionate (Mirataine T2C®), 4 percent of NH_4Cl and 1.75~2.0 percent of phthalic acid to water.

FIG. 4 shows the viscosity versus shear rate for viscoelastic surfactant solutions prepared by adding 4 or 5 percent of disodium oleamidopropyl betaine (Mirataine BET-O®), 3 percent of KCl and 0.5 percent of phthalic acid to water.

FIG. 5 shows the dynamic modulus G' (storage modulus) and G" (loss modulus) at 25° C. and 50° C. of the same solution as FIG. 4.

DETAILED DESCRIPTION OF THE INVENTION

The property of viscoelasticity in general is well known and reference is made to S. Gravsholt, *Journal of Coll. And Interface Sci.*, 57(3), 575 (1976); Hoffmann et al., "Influence of Ionic Surfactants on the Viscoelastic Properties of Zwitterionic Surfactant Solutions", *Langmuir*, 8, 2140–2146 (1992); and Hoffmann et al., The Rheological Behaviour of Different Viscoelastic Surfactant Solutions, *Tenside Surf. Det.*, 31, 389–400, 1994. Of the test methods specified by these references to determine whether a liquid possesses viscoelastic properties, one test which has been found to be useful in determining the viscoelasticity of an aqueous solution consists of swirling the solution and visually observing whether the bubbles created by the swirling recoil after the swirling is stopped. Any recoil of the bubbles indicates viscoelasticity. Another useful test is to measure the storage modulus (G') and the loss modulus (G") at a given temperature. If G'>G" at some point or over some range of points below about 10 rad/sec, typically between about 0.001 to about 10 rad/sec, more typically between about 0.1 and about 10 rad/sec, at a given temperature and if G'>10^{-2} Pascals, preferably 10^{-1} Pascals, the fluid is typically considered viscoelastic at that temperature. Rheological measurements such as G' and G" are discussed more fully in "Rheological Measurements", *Encyclopedia of Chemical Technology*, vol. 21, pp. 347–372, (John Wiley & Sons, Inc., N.Y., N.Y., 1997, 4th ed.). To the extent necessary for completion, the above disclosures are expressly incorporated herein by reference.

Viscoelasticity is caused by a different type of micelle formation than the usual spherical micelles formed by most surfactants. Viscoelastic surfactant fluids form worm-like, rod-like or cylindrical micelles in solution. The formation of long, cylindrical micelles creates useful rheological properties. The viscoelastic surfactant solution exhibits shear thinning behavior, and remains stable despite repeated high shear applications. By comparison, the typical polymeric thickener will irreversibly degrade when subjected to high shear.

In the summary of the invention and this detailed description, each numerical value should be read once as modified by the term "about" (unless already expressly so modified), and then read again as not so modified, unless otherwise indicated in context.

The viscoelastic surfactants can be either ionic or nonionic. The present invention comprises an aqueous viscoelastic surfactant based on amphoteric or zwitterionic surfactants. The amphoteric surfactant is a class of surfactant that has both a positively charged moiety and a negatively charged moiety over a certain pH range (e.g. typically slightly acidic), only a negatively charged moiety over a certain pH range (e.g. typically slightly alkaline) and only a positively charged moiety at a different pH range (e.g. typically moderately acidic); while a zwitterionic surfactant has a permanently positively charged moiety in the molecule regardless of pH and a negatively charged moiety at alkaline pH.

The viscoelastic fluid comprises water, surfactant, and a water-soluble compound selected from the group consisting of organic acids, organic acid salts, inorganic salts, and mixtures thereof. Alternatively, the viscoelastic fluid can comprise water, an amine oxide surfactant, and an anionic surfactant containing a hydrophobe having at least about 14 carbon atoms. The viscoelastic surfactant solution is useful as a fracturing fluid or water-based hydraulic fluid. The viscoelastic fluid used as a fracturing fluid may optionally contain a gas such as air, nitrogen or carbon dioxide to provide an energized fluid or a foam.

The component of the fluid which will be present in the greatest concentration is water, i.e. typically water will be a major amount by weight of the viscoelastic fluid. Water is typically present in an amount by weight greater than or equal to about 50% by weight of the fluid. The water can be from any source so long as the source contains no contaminants which are incompatible with the other components of the viscoelastic fluid (e.g., by causing undesirable precipitation). Thus, the water need not be potable and may be brackish or contain other materials typical of sources of water found in or near oil fields.

Examples of zwitterionic surfactants useful in the present invention are represented by the formula:

wherein R_1 represents a hydrophobic moiety of alkyl, alkylarylalkyl, alkoxyalkyl, alkylaminoalkyl and

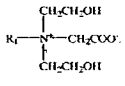
alkylamidoalkyl, wherein alkyl represents a group that contains from about 12 to about 24 carbon atoms which may be branched or straight chained and which may be saturated or unsaturated. Representative long chain alkyl groups include tetradecyl (myristyl), hexadecyl (cetyl), octadecentyl (oleyl), octadecyl (stearyl), docosenoic (erucyl) and the derivatives of tallow, coco, soya and rapeseed oils. The preferred alkyl and alkenyl groups are alkyl and alkenyl groups having from about 16 to about 22 carbon atoms. Representative of alkylamidoalkyl is alkylamidopropyl with alkyl being as described above.

R_2 and R_3 are independently an aliphatic chain (i.e. as opposed to aromatic at the atom bonded to the quaternary nitrogen, e.g., alkyl, alkenyl, arylalkyl, hydroxyalkyl, carboxyalkyl, and hydroxyalkyl-polyoxyalkylene, e.g. hydroxyethyl-polyoxyethylene or hydroxypropyl-polyoxypropylene) having from 1 to about 30 atoms, preferably from about 1 to about 20 atoms, more preferably from about 1 to about 10 atoms and most preferably from about 1 to about 6 atoms in which the aliphatic group can be branched or straight chained, saturated or unsaturated. Preferred alkyl chains are methyl, ethyl, preferred arylalkyl is benzyl, and preferred hydroxyalkyls are hydroxyethyl or hydroxypropyl, while preferred carboxyalkyls are acetate and propionate.

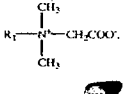
R_4 is a hydrocarbyl radical (e.g. alkylene) with chain length 1 to 4. Preferred are methylene or ethylene groups.

Specific examples of zwitterionic surfactants include the following structures:

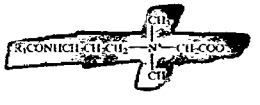
II



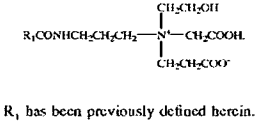
III



IV



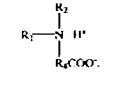
V



wherein R_1 has been previously defined herein.

Examples of amphoteric surfactants include those represented by formula VI:

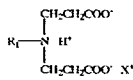
VI



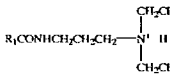
wherein R_1, R_2, and R_4 are the same as defined above.

Other specific examples of amphoteric surfactants include the following structures:

VII

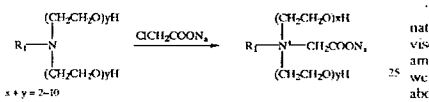


VIII



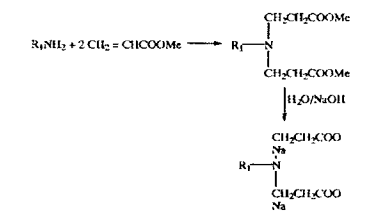
wherein R_1 has been previously defined herein, and X^+ is an inorganic cation such as Na^+, K^+, NH_4^+ associated with a carboxylate group or hydrogen atom in an acidic medium.

A typical chemical process to synthesize dihydroxy ethoxylate glycinate starting from ethoxylated alkylamine is as follows:



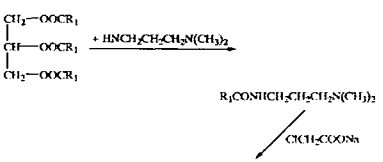
The final products may also include some unreacted starting dihydroxy ethyl alkyl amine, and small amounts of sodium glycolate, diglycolate and sodium chloride as by products. A similar process can be used to prepare propoxylated analogues.

A typical chemical process to synthesize alkyliminiodipropionate from alkyl amine is as follows:

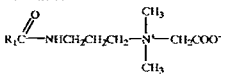


The final products will also include a small amount of methanol, unreacted acrylic acid, alkylamine and some oligomeric acrylate or acid as by products.

A typical chemical process to synthesize alkylamidopropyl betaine from alkyl amine is as follows:



-continued



The final products will also include a small amount of sodium glycolate, diglycolate, sodium chloride and glycerine as by products.

In still another embodiment of the invention, the zwitterionic surfactant selected is an amine oxide. This material has the following structure:

where R_1, R_2 and R_3 are as defined above.

The surfactants are used in an amount which in combination with the other ingredients is sufficient to form a viscoelastic fluid, which amount will typically be a minor amount by weight of the fluid (e.g. less than about 50% by weight). The concentration of surfactant can range from about 0.5% to about 10% percent by weight of the fluid, more typically from about 0.5% to about 8%, and even more typically from about 0.5% to about 6%. Optimum concentrations for any particular set of parameters can be determined experimentally.

The fluid also comprises one or more members from the group of organic acids, organic acid salts, and inorganic salts. Mixtures of the above members are specifically contemplated as falling within the scope of the invention. This member will typically be present in only a minor amount (e.g. less than about 20% by weight of the fluid).

The organic acid is typically a sulfonic acid or a carboxylic acid and the anionic counter-ion of the organic acid salts are typically sulfonates or carboxylates. Representative of such organic molecules include various aromatic sulfonates and carboxylates such as p-toluene sulfonate, naphthalene sulfonate, chlorobenzoic acid, salicylic acid, phthalic acid and the like, where such counter-ions are water-soluble. Most preferred are salicylate, phthalate, p-toluene sulfonate, hydroxynaphthalene carboxylates, e.g. 5-hydroxy-1-naphthoic acid, 6-hydroxy-1-naphthoic acid, 7-hydroxy-1-naphthoic acid, 1-hydroxy-2-naphthoic acid, preferably 3-hydroxy-2-naphthoic acid, 5-hydroxy-2-naphthoic acid, 7-hydroxy-2-naphthoic acid, and 1,3-dihydroxy-2-naphthoic acid and 3,4-dichlorobenzoate. The organic acid or salt thereof typically aids the development of increased viscosity which is characteristic of preferred fluids. Without wishing to be bound by any theory unless expressly noted otherwise in context, it is thought that association of the organic acid or salt thereof with the micelle decreases the aggregation curvature of the micelle and thus promotes the formation of a worm-like or rod-like micelle. The organic acid or salt thereof will typically be present in the viscoelastic fluid at a weight concentration of from about 0.1% to about 10%, more typically from about 0.1% to about 7%, and even more typically from about 0.1% to about 6%.

The inorganic salts that are particularly suitable for use in the viscoelastic fluid include water-soluble potassium, sodium, and ammonium salts, such as potassium chloride and ammonium chloride. Additionally, calcium chloride, calcium bromide and zinc halide salts may also be used. The inorganic salts may aid in the development of increased

viscosity which is characteristic of preferred fluids. Further, the inorganic salt may assist in maintaining the stability of a geologic formation to which the fluid is exposed. Formation stability and in particular clay stability (by inhibiting hydration of the clay) is achieved at a concentration level of a few percent by weight and as such the density of fluid is not significantly altered by the presence of the inorganic salt unless fluid density becomes an important consideration, at which point, heavier inorganic salts may be used. The inorganic salt will typically be present in the viscoelastic fluid at a weight concentration of from about 0.1% to about 30%, more typically from about 0.1% to about 10%, and even more typically from about 0.1% to about 8%. Organic salts, e.g. trimethylammonium hydrochloride and tetramethylammonium chloride, may also be useful in addition to, or as a replacement for, the inorganic salts.

As an alternative to the organic salts and inorganic salts, or as a partial substitute therefor, one can use a medium to long chain alcohol (preferably an alkanol), preferably having five to ten carbon atoms, or an alcohol ethoxylate (preferably an alkanol ethoxylate) preferably of a 12 to 16 carbon alcohol and having 1 to 6, preferably 1–4, oxyethylene units.

In the embodiment where the surfactant selected is an amine oxide, it is preferably used in combination with an anionic surfactant containing a hydrophobe having at least about 14 carbon atoms. Examples of suitable anionic surfactants include alkyl sulfates or sulfonates having alkali metal counter ions or alkyl carboxylates, wherein alkyl represents a group that contains from about 14 to about 24 carbon atoms which may be branched or straight chained and which may be saturated or unsaturated, and more preferably contains between about 16 and about 22 carbon atoms.

For this embodiment (amine oxide/anionic surfactant) the weight ratio of the amine oxide to anionic surfactant is from about 100:1 to about 50:50.

In addition to the water-soluble salts and thickening agents described hereinbefore, the viscoelastic fluid used as a hydraulic fracturing fluid may contain other conventional constituents which perform specific desired functions, e.g., corrosion inhibitors, fluid-loss additives and the like. A proppant can be suspended in the fracturing fluid. The pH of the fluid will typically range from strongly acidic (e.g. less than a pH of about 3) to slightly alkaline (e.g. from a pH just greater than 7.0 to about 8.5, more typically to about 8.0) or moderately alkaline (e.g. a pH of about 8.5 to about 9.5). Strongly alkaline pHs (e.g. above a pH of about 10) should be avoided.

It is also conceivable to combine the above amphoteric/zwitterionic surfactants with conventional anionic, nonionic and cationic surfactants to get the desired viscoelastic fluid for a skilled worker. In typical embodiments, the amphoteric/zwitterionic surfactant is typically present in a major amount by weight of all surfactants, and more typically is essentially the only surfactant present. Typically, the viscoelastic fluid will be essentially free of anionic surfactants, e.g. it will contain less than about 0.5%, more typically less than about 0.2%, even more typically less than 0.1% by weight of anionic surfactants.

To prepare the aqueous fluids in accordance with the present invention, the surfactant is added to an aqueous solution in which has been dissolved a water-soluble inorganic salt, e.g. potassium chloride or ammonium chloride and/or at least one organic acid or water-soluble organic acid salt to provide selective control of the loss of particle suspension properties. In the embodiment wherein the fluid is a mixture of water, and amine oxide surfactant and an anionic surfactant, a simple mixture of the three components is utilized. Standard mixing procedures known in the art can be employed since heating of the solution and special agitation conditions are normally not necessary. Of course, if used under conditions of extreme cold such as found in Alaska, normal heating procedures should be employed. It has been found in some instances preferable to dissolve the thickener into a lower molecular weight alcohol prior to mixing it with the aqueous solution. The lower molecular weight alcohol, for instance isopropanol, functions as an aid to solubilize the thickener. Other similar agents may also be employed. Further, a defoaming agent such as a polyglycol may be employed to prevent undesirable foaming during the preparation of the viscoelastic fluid if a foam is not desirable under the conditions of the treatment. If a foam or gas-energized fluid is desired, any gas such as air, nitrogen, carbon dioxide and the like may be added.

The fluid of this invention is particularly useful in the handling of particles generated during the excavation of a geologic formation, e.g. digging, drilling, blasting, dredging, tunneling, and the like, for example in the course of constructing roads, bridges, buildings, mines, tunnels and the like. The particles are mixed with the viscoelastic fluid by means which are effective to disperse the particles in the fluid. The particles generally have a particle size ranging from a fine powder to coarse gravel, e.g. dust, sand, and gravel. Particle size affects the suspendability of excavation processing wastes. For example, small particles suspend better than large particles, and very fine particles suspend so well that the mixture may become too thick to transport by pump or similar means. The distribution of excavation processing waste sizes is also important, as waste which contains particles which span a wide range of sizes is more easily suspended than waste wherein the particles are of about the same size. Therefore, it may be preferred to screen the waste particles prior to applying the present method to scalp off the particles that are too large to suspend to obtain a better particle size distribution.

The viscoelastic fluids of the present invention can be utilized to carry earth or materials excavated during boring, excavating and trenching operations in the deep foundation construction industry, the subterranean construction industry and in tunneling, in well drilling and in other applications of earth support fluids. The ability of the excavation tools or systems to hold and remove increased loading of earth is improved by the suspending properties and lubricating properties of the surfactant viscoelastic fluids.

In one preferred embodiment of this invention, the surfactant can be combined with some fluid-loss control additives known in the industry like water-soluble or water-dispersible polymers (guar and guar derivatives, xanthan, polyacrylamide, starch and starch derivatives, cellulosic derivatives, polyacrylates, polyDADMAC, [poly(diallyl dimethyl ammonium chloride] and combinations thereof), clay (Bentonite and attapulgite) in order to give fluid-loss control properties to the excavating fluid and contribute to the stabilization of the wall of the excavation.

More comprehensive information can be found in The University of Houston, Department of Chemical Engineering, Publication No UHCE 93-1 entitled, Effect of Mineral and Polymer slurries on Perimeter Load Transfer in Drilled shafts, published in January 1993, and PCT WO 96/23849, the disclosures of which are incorporated by reference.

The above method for suspending solids has many applications, particularly in mining and the handling of mine

tailings. The disclosure of U.S. Pat. No. 5,439,317 (Bishop et al.) is incorporated by reference in this regard. One application is to transport and place mineral processing waste in underground caverns or below grade cavities. Another application is for backfilling of open pits or quarries without the use of costly and labor intensive equipment for deployment. Additionally, the method can be used to place clay or other liners in holding or storage ponds that are used to hold liquids and to prevent the entry of these liquids into the ground water regime and/or to place liners in landfills for a similar purpose. Another application of the method, is for the extinguishing and/or containment of coal mine fires by deploying quantities of solids below ground to seal the fire from sources of oxygen. Still another application of the method is to place solids in previously mined cavities to prevent surface subsidence.

The hydraulic fracturing method of this invention uses otherwise conventional techniques. The disclosure of U.S. Pat. No. 5,551,516 (Norman et al.) is incorporated by reference in this regard. Oil-field applications of various materials are described in "Oil-field Applications", *Encyclopedia of Polymer Science and Engineering*, vol. 10, pp. 328–366 (John Wiley & Sons, Inc., New York, N.Y., 1987) and references cited therein, the disclosures of which are incorporated herein by reference thereto.

Hydraulic fracturing is a term that has been applied to a variety of methods used to stimulate the production of fluids such as oil, natural gas etc., from subterranean formations. In hydraulic fracturing, a fracturing fluid is injected through a wellbore and against the face of the formation at a pressure and flow rate at least sufficient to overcome the overburden pressure and to initiate and/or extend a fracture(s) into the formation. The fracturing fluid usually carries a proppant such as 20–40 mesh sand, bauxite, glass beads, etc., suspended in the fracturing fluid and transported into a fracture. The proppant then keeps the formation from closing back down upon itself when the pressure is released. The proppant filled fractures provide permeable channels through which the formation fluids can flow to the wellbore and thereafter be withdrawn. Viscoelastic fluids have also been extensively used in gravel pack treatment.

In addition to the applications discussed above, the viscoelastic fluids may also be used as an industrial drift control agent, or as a rheology modifier for personal care formulations (e.g. cleansers, conditioners, etc.) and household cleansers (e.g. detergent formulations). A detergent formulation of the viscoelastic fluids of this invention will further comprise a detersive surfactant. Examples of detersive surfactants and other conventional ingredients of detergent and/or personal care formulations are disclosed in U.S. Ser. No. 08/726,437, filed Oct. 4, 1996, now U.S. Pat. No. 5,922,663 the disclosure of which is incorporated herein by reference.

Typically, the detersive surfactant will be cationic or nonionic. Preferred water-soluble anionic organic surfactants herein include linear alkyl benzene sulfonates containing from about 10 to about 18 carbon atoms in the alkyl group; branched alkyl benzene sulfonates containing from about 10 to about 18 carbon atoms in the alkyl group; the tallow range alkyl sulfates; the coconut range alkyl glyceryl sulfonates; alkyl ether (ethoxylated) sulfates wherein the alkyl moiety contains from about 12 to 18 carbon atoms and wherein the average degree of ethoxylation varies between 1 and 12, especially 3 to 9; the sulfated condensation products of tallow alcohol with from about 3 to 12, especially 6 to 9, moles of ethylene oxide; and olefin sulfonates containing from about 14 to 16 carbon atoms.

Specific preferred anionics for use herein include: the linear C_{10}–C_{14} alkyl benzene sulfonates (LAS); the branched C_{10}–C_{14} alkyl benzene sulfonates (ABS); the tallow alkyl sulfates, the coconut alkyl glyceryl ether sulfonates; the sulfated condensation products of mixed C_{10}–C_{18} tallow alcohols with from about 1 to about 14 moles of ethylene oxide; and the mixtures of higher fatty acids containing from 10 to 18 carbon atoms.

Particularly preferred nonionic surfactants for use in liquid, powder, and gel applications include the condensation product of C_{10} alcohol with 3 moles of ethylene oxide; the condensation product of tallow alcohol with 9 moles of ethylene oxide; the condensation product of coconut alcohol with 5 moles of ethylene oxide; the condensation product of coconut alcohol with 6 moles of ethylene oxide; the condensation product of C_{12} alcohol with 5 moles of ethylene oxide; the condensation product of C_{12-13} alcohol with 6.5 moles of ethylene oxide, and the same condensation product which is stripped so as to remove substantially all lower ethoxylate and non-ethoxylated fractions; the condensation product of C_{12-13} alcohol with 2.3 moles of ethylene oxide, and the same condensation product which is stripped so as to remove substantially all lower ethoxylated and non-ethoxylated fractions; the condensation product of C_{12-13} alcohol with 9 moles of ethylene oxide; the condensation product of C_{14-15} alcohol with 2.25 moles of ethylene oxide; the condensation product of C_{14-15} alcohol with 4 moles of ethylene oxide; the condensation product of C_{14-15} alcohol with 7 moles of ethylene oxide; and the condensation product of C_{14-15} alcohol with 9 moles of ethylene oxide.

Particular detersive applications for which the viscoelastic fluid will be useful include as a thickener for acidic bathroom cleaners, such as those disclosed in U.S. Pat. No. 5,639,722 (Kong et al.) and shower gels such as those disclosed in U.S. Pat. No. 5,607,678 (Moore et al.), the disclosures of which are incorporated by reference. The viscoelastic fluids will also be useful in the manufacture of building products based on plaster, plaster/lime, lime/cement or cement such as those disclosed in U.S. Pat. No. 5,470,383 (Schermann et al.) and foam fluids such as those disclosed in U.S. Pat. No. 5,258,137 (Bonekamp et al.), the disclosures of which are incorporated by reference. In particular, the fluid will be useful for improving the water retention of cement slurries and grouts allowing better pumpability and workability with minimal free water. The fluids will also be useful as thickeners for acidic (e.g. a pH of less than about 5) aqueous slurries of mineral carbonates or oxides, e.g. iron oxide, cerium oxide, silica suspensions, titanium oxide, calcium carbonate, and zirconium oxide. In this regard, the disclosure of U.S. Pat. No. 4,741,781 (De Witte) is incorporated by reference.

The viscoelastic fluid of this invention will also be useful in formulations for the agricultural delivery of solid fertilizers and pesticides such as micronutrients, biologicals, insecticides, herbicides, fungicides, and plant growth regulators. Such formulations are typically aqueous suspensions or solutions comprised of a major amount of water and an agriculturally effective amount of an agriculturally useful chemical. The viscoelastic fluid is typically combined with the other ingredients of the formulation in an amount that effectively reduces the number of droplets below about 150 microns, i.e. the droplets most responsible for drift problems.

The following examples are presented to illustrate the preparation and properties of aqueous viscoelastic surfactant based hydraulic fluids and should not be construed to limit the scope of the invention, unless otherwise expressly indicated in the appended claims. All percentages, concentrations, ratios, parts, etc. are by weight unless otherwise noted or apparent from the context of their use.

EXAMPLES

Example 1

Viscoelastic surfactant solutions are prepared by adding 5 percent of ammonium chloride and 3 to 5 percent of dihydroxyethyl tallow glycinate (Mirataine TM®) to water. The systems were stirred until all of the surfactant dissolved. All of the samples were observed to be viscoelastic by the bubble recoil test. Rheology of solution was measured by Rheometric ARES at 25° C. The results are given below in Table 1.

TABLE 1

Shear rate	Viscosity (cps) in 5% NH_4Cl		
(sec^{-1})	3% Surfactant	4% Surfactant	5% Surfactant
10	1692.4	2619.8	3774.7
18	967.7	1490.5	2144
32	555.5	851.6	1214.3
56	319.2	483.2	688.1
100	184.6	278	393.6
178	107.5	159.3	225.4

Example 2

In a manner similar to Example 1, 0.3 percent of phthalic acid and 2 to 4 percent of dihydroxyethyl tallow glycinate (Mirataine TM®) were put into solution. All of the samples were observed to be viscoelastic by the bubble recoil test. Rheological measurements were performed in the manner described in Example 1 at 25° C. The results are shown below in Table 2:

TABLE 2

Shear rate	Viscosity (cps) in 0.3% phthalic acid		
(sec^{-1})	2% Surfactant	3% Surfactant	4% Surfactant
10	791.5	1474.6	1968.7
18	455.3	840.9	1101.5
32	262.4	490	564.5
56	152	279.2	361.7
100	88	160.9	356.6
178	53	91.6	342.3

EXAMPLE 3

The rheological measurements were also performed at higher temperatures by FANN Rheometer. The results for 4 percent dihydroxyethyl tallow glycinate (Mirataine TM®) and 0.3 percent of phthalic acid solution are shown below in Table 3:

TABLE 3

Temperature (° F.)	Viscosity at 100 rpm (cps)
82	170
129	51
189	30
239	22
288	15

Example 4

The viscoelastic surfactant solutions are prepared by adding 5 percent of disodium tallowiminodipropionate (Mirataine T2C®) and 2.25 percent of phthalic acid to water. The systems were stirred and warmed up to 50° C. until all of the phthalic acid dissolved. All of the samples were observed to be viscoelastic by the bubble recoil test. Rheology was measured for viscosity and dynamic modulus G' (storage modulus) and G" (loss modulus) by a Rheometric SR-200 at 25° C. and 50° C. The results are shown in FIGS. 1 and 2.

Example 5

In a manner similar to Example 4, 5 percent of disodium tallowiminodipropionate (Mirataine T2C®), 4 percent of NH_4Cl and 1.75–2.0 percent of phthalic acid in water were mixed together. All of the samples were observed to be viscoelastic by the bubble recoil test. rheological measurements were performed in the manner described in Example 4 at 25° C. The results are shown in FIG. 3.

Example 6

The viscoelastic surfactant solutions are prepared by addition of 4–5% percent of oleamidopropyl betaine (Mirataine BET-O®), 3% KCl and 0.5% phthalic acid to water. The system was stirred until all phthalic acid dissolved. Rheology was measured for steady viscosity and ynamic modulus G'/G" by Rheometric ARES at 25° C. The results are shown in FIGS. 4 and 5.

Example 7

A viscoelastic surfactant solution is prepared by mixing together in 95.65 parts of water 4 parts of euricic amido propylene dimethyl amine oxide and 0.35 parts of sodium oleyl sulfate. The pH is adjusted to 8 by the addition of NaOH. Its temperature stability is determined by measuring its viscosity in cps (at shear rate of 100 sec^{-1}). The results are shown in Table 4.

Example 8

A viscoelastic surfactant solution is prepared by mixing together in 95.50 parts of water 4.0 parts of euricic amido propylene dimethyl amine oxide and 0.50 parts of sodium oleyl sulfate. Its temperature stability is determined by measuring its viscosity in cps(at shear rate of 100sec^{-1}). The results are shown in Table 4.

TABLE 4

Temperature (° F.)	Viscosity Example 8	Viscosity Example 7
100	282	247
120	302	293
140	308	305
160	168	237
180	162	166
200	230	231
220	119	193
240	50	63
250	36	36
260	30	27
270	16	10

Example 9

A viscoelastic surfactant solution is prepared by mixing together in 96.1 parts of water 3.0 parts of euricic amidopro-

pyl amine oxide and 0.9 parts of sodium behenyl sulfate. The pH is adjusted to 9 by the addition of NaOH. Its temperature stability is determined by measuring its viscosity in cps (at shear rate of 100 sec $^{-1}$). The results are shown in Table 5.

Example 10

A viscoelastic surfactant solution is prepared by mixing together in 94.8 parts of water 4.0 parts of euricic amidepropyl amine oxide and 1.2 parts of sodium behenyl sulfate. The pH is adjusted to 9 by the addition of NaOH. Its temperature stability is determined by measuring its viscosity in cps (at shear rate of 100 sec^{-1}). The results are shown in Table 5.

TABLE 5

Temperature (° F.)	Viscosity Example 9	Viscosity Example 10
100	175	234
120	168	226
140	169	297
160	256	518
180	309	454
200	276	173
220	140	214
240	154	284
260	94	351
270	52	215
280	31	90
290	25	40
300	17	4

What is claimed is:

1. A viscoelastic fluid comprising:

(1) an aqueous medium;

(2) a surfactant represented by the formula VI:

(VI)

wherein R_1 represents alkyl, alkenyl, alkylarylalkylene, alkenylarylalkylene, alkylaminoalkylene, alkenylaminoalkylene, alkylamidoalkylene or alkenylamidoalkylene wherein each of said alkyl groups contain from about 14 to about 24 carbon atoms and may be branched or straight chained and saturated or unsaturated and wherein said alkylene groups have from about 1 to about 6 carbon atoms,

R_2 is beta-carboxyethyl, and

R_4 is ethylene;

(2) a member selected from the group consisting of organic acids, organic acid salts, inorganic salts, and combinations of one or more organic acids or organic acid salts with one or more inorganic salts;

wherein said fluid exhibits the property of viscoelasticity.

2. A viscoelastic fluid comprising

(1) an aqueous medium;

(2) a surfactant represented by the formula VI:

(VI)

wherein R_1 is $RCONHCH_2CH_2CH_2$- and R is an alkyl group containing from about 14 to about 24 carbon atoms which may be branched or straight chained and which may be saturated or unsaturated,

R_2 is selected from the group of alkyl, alkenyl, arylalkyl, hydroxyalkyl, carboxyalkyl, and hydroxyalkyl polyoxyklene, each having from about 1 to about 10 carbon atoms, and

R_4 is a hydrocarbyl radical with chain length of about 1 to about 4;

(3) a member selected from the group consisting of organic acids, organic acid salts, inorganic salts, and combinations of one or more organic acids or organic acid salts with one or more inorganic salts;

wherein said fluid exhibits the property of viscoelasticity.

3. A viscoelastic fluid, comprising:

(1) an aqueous medium;

(2) a surfactant comprising dihydroxyethyl tallow glycinate;

(3) a member selected from the group consisting of organic acids, organic acid salts, inorganic salts, and combinations of one or more organic acids or organic acid salts with one or more inorganic salts;

wherein said fluid exhibits the property of viscoelasticity.

4. The fluid of claim 3 wherein the surfactant is present at about 0.5% to about 10%; the member comprising one or more organic acids ox salts thereof and being present at about 0.1% to about 30%.

5. A viscoelastic fluid comprising:

(1) an aqueous medium;

(2) from about 0.5% to about 6% of a surfactant selected from the group consisting of dihydroxyethyl tallow glycinate, tallowiminodipropionate, and oleamidopropyl betaine; and

(3) from about 0.1% to about 6% of a combination of a member selected from the group consisting of p-toluene sulfonate, naphthalene sulfonate, chlorobenzoic acid, salicylic acid, and phthalic acid, with a member comprising one or more water-soluble ammonium salts;

wherein said fluid exhibits the property of viscoelasticity.

* * * * *

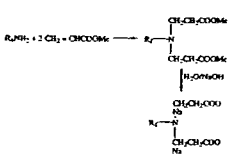
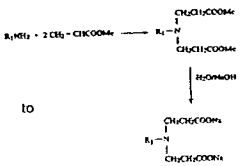
UNITED STATES PATENT AND TRADEMARK OFFICE

CERTIFICATE OF CORRECTION

PATENT NO. : 6,258,859 B1 Page 1 of 1
DATED : July 10, 2001
INVENTOR(S) : Dahanayake et al.

It is certified that error appears in the above-identified patent and that said Letters Patent is hereby corrected as shown below:

Column 5,
Lines 37 to 50, the structural formula of the product is to be corrected.

please change  to 

Column 14,
Line 19, "polyoxyklene" is to be deleted and -- polyalkylene -- is to be inserted

Signed and Sealed this

Ninth Day of July, 2002

Attest:

JAMES E. ROGAN
Director of the United States Patent and Trademark Office

Attesting Officer