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DIVISION DE NUEVAS CREACIONES

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Tramite : 002 PATENTES D 1 REGISTRO/ 329 COMPLEMEN

Dependencia: 2020 DIVISION DE NUEVAS CREACIONES

REF: INTEVEP, S.A.

Expediente No.02 076.282 - Solicitud de Patente

**Titulada: FLUIDO DE PERFORACIÓN ESPUMABLE MEJORADO DE
POLÍMERO**

RAMIRO CASTRO DUQUE, vecino de Bogotá, portador de la tarjeta profesional No. 1003, obrando como apoderado de la sociedad, INTEVEP, S.A., según lo acredita el documento de poder protocolizado en esa División bajo el No. 14558, me permito anexar al presente escrito los siguientes documentos:

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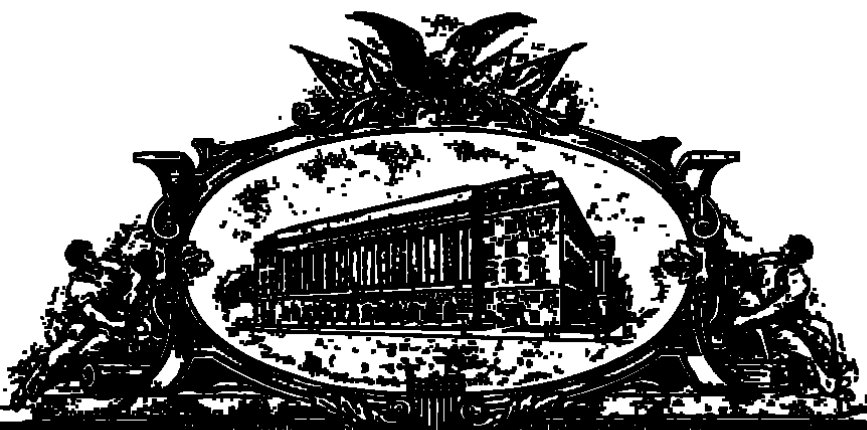


RAMIRO CASTRO DUQUE
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Bogotá, Noviembre 25, 2002
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September 09, 2002

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APPLICATION NUMBER: 09/941,508

FILING DATE: August 28, 2001

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UTILITY PATENT APPLICATION TRANSMITTAL

Attorney/Agent No. 00-340

First Invention Jerry V.R. Gonzalez et al.

Title POLYMER-ENHANCED FORMABLE DRILLING FLUIDS

Express Mail Label No. E1394336789US

(Only for new nonprovisional applications under 37 CFR 1.53(b))

APPLICATION ELEMENTS

See MPEP chapter 800 concerning utility patent application contents.

1. ☒ Fee Transmittal Form (e.g., PTO/55977)
(Indicate which fee is being transmitted)
2. ☐ Applicant claims small entity status.
See 37 CFR 1.57.
3. ☒ Specification (Total Pages 21)
(Indicate number of pages not being filed)
- Descriptive title of the invention
- Cross Reference to Related Applications
- Statement Regarding Fed sponsored R & D
- Reference to sequence listing, a table, or a computer program listing appendix
- Background of the invention
- Brief Summary of the invention
- Brief Description of the Drawings (if any)
- Detailed Description
- Claims
- Abstract of the Disclosure
4. ☐ Drawings (35 U.S.C. 113) (Total Sheets 2)
5. ☒ Oath or Declaration (Total Pages 7)
- Newly executed (original or copy)
- Copy from a prior application (37 CFR 1.53 (b))
(For continuation-in-part applications, see Box 18 completed)
6. ☐ DELETION OF INVENTOR(S)
(Signed statement attesting deletion of inventor(s) named in the prior application, see 37 CFR 1.53(d)(4) and 1.53(e))
7. ☐ Application Data Sheet, See 37 CFR 1.78

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7. ☐ CD-ROM or CD-R in duplicate, large table or
Computer Program (Appendix)
8. Machine-readable form (e.g., Sequence Listing)
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a. ☐ Computer Readable Form (CRF)
b. Specification Sequence Listing etc.
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ACCOMPANYING APPLICATION PARTS

9. ☒ Assignment Papers (power sheet & document(s))
10. ☐ 37 CFR 2.79(a) Statement of Invention (if not already on assignment) ☐ Power of Attorney
11. ☐ English Translation Document (if applicable)
12. ☒ Information Disclosure Statement (IDS) (PTO-449) ☒ Copies of IDS Claims
13. ☐ Preliminary Amendment
14. ☒ Return Receipt Postcard (MPEP 800)
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15. ☐ Certified Copy of Priority Document(s)
(If foreign priority is claimed)
16. ☐ Request and Confirmation under 35 U.S.C. 122
(42 CFR 1.53). Applicant must attach form PTO/5595
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☐ Continuation ☐ Division ☐ Continuation-in-part (CIP)

of prior application No. _____

Prior application information:

Number

Serial No.

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19. CORRESPONDENCE ADDRESS

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Signature [Signature] Date 8-28-01

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FEE TRANSMITTAL for FY 2001

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Application Number	
Filing Date	
First Named Inventor	Yenny Y.R. Gonzalez et al.
Examiner Name	
Group Art Unit	
Attorney/Agent No.	00-340

TOTAL AMOUNT OF PAYMENT

(8) 765

METHOD OF PAYMENT

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FEE CALCULATION

1. BASIC FILING FEE

Code	Fee	Fee	Fee	Fee	Description	Fee Paid
101	710	301	300		Utility filing fee	710
102	300	300	100		Design filing fee	
103	400	307	340		Plant filing fee	
104	710	300	300		Substantive filing fee	
105	100	314	70		Provisional filing fee	

SUBTOTAL (1) (8) 710

2. EXTRA CLAIM FEES

Total Claims	Independent Claims	Multiple Dependent	Utility Claims	Fee from Table	Fee Paid
21	2	0	0	0	0

Code	Fee	Fee	Fee	Fee	Description	Fee Paid
103	10	200	0		Claims in excess of 20	
108	50	202	40		Independent claims in excess of 5	
104	370	204	100		Multiple dependent claims, if not paid	
109	50	200	40		Multiple dependent claims over original patent	
110	10	210	0		Multiple claims in excess of 20 and over original patent	

SUBTOTAL (2) (8) 18

FEE CALCULATION (continued)

Code	Fee	Code	Fee	Code	Fee	Description	Fee Paid
106	710	300	00			Substance - info filing fee or fee	
107	50	207	20			Substance - info provisional filing fee or other filing	
109	100	100	100			Non-English specification	
147	2,000	147	2,000			Per filing a request for oral presentation	
113	500	113	500			Requesting publication of USPTO prior to examination	
115	1,540	115	1,540			Requesting publication of USPTO after examination	
116	110	210	00			Extension for reply within first month	
116	300	210	100			Extension for reply within second month	
117	500	217	400			Extension for reply within third month	
118	1,200	214	800			Extension for reply within fourth month	
130	1,000	220	040			Extension for reply within 18th month	
110	310	210	100			Notice of Appeal	
120	310	200	100			Filing a brief in support of an appeal	
121	270	221	100			Request for oral hearing	
120	1,510	120	1,510			Petition to institute a public use proceeding	
140	110	340	00			Petition to revoke - unavailability	
141	1,240	341	000			Petition to revoke - substantial	
142	1,240	342	000			Utility issue fee (for relevant)	
143	440	340	000			Design issue fee	
144	000	344	000			Plant issue fee	
125	120	120	120			Petitions to the Commissioner	
126	120	120	120			Petitions related to provisional applications	
126	100	126	100			Submission of Information Electronic Data	
001	40	001	40			Reexamining main patent assignment per properly (issue number of prosecution)	40
140	710	340	000			Filing a petition after final rejection (37 CFR 1.100(a))	
140	710	340	000			Per apply additional invention to the standard (37 CFR 1.100(a))	
170	710	270	300			Request for Continued Examination (RCE)	
100	000	100	000			Request for extended examination of a design application	

Other fee (specify):

Reduced by Basic Filing Fee Paid

SUBTOTAL (3) (8) 40

SUBMITTED BY

Name (Print/Type)

CHRISTOPHER D. LARONTE

Signature

[Signature]

Complete if known

Application No.

28,395

Telephone

203-777-6628

Date

8-28-01

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August 28, 2001

Janice T. Statton

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Date of Signature
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APPLICATIONS FOR LETTERS PATENT

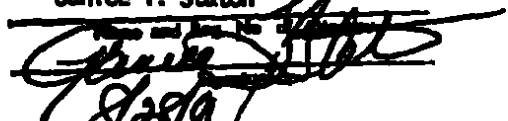
TO WHOM IT MAY CONCERN

BE IT KNOWN THAT Yenny Virginia Rojas and Alida del Carmen Aponte, citizens and residents of Venezuela, have invented new and useful improvements in POLYMER-ENHANCED FOAMABLE DRILLING FLUID, of which the following is a specification.

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August 28, 2001

(Date of Deposit)
Janice T. Staton

Name and Address of Inventor

Date of Signature
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FOR 280-80514650

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BACKGROUND OF THE INVENTION

The invention relates to a drilling fluid and, more particularly, to a stable and environmentally safe foamable drilling fluid.

In the course of drilling a subterranean well, drilling fluids are needed in order to lubricate the drill bit and to carry formation cuttings to the surface. In addition, the drilling fluid is needed in order to balance high-pressures encountered in subterranean formation.

Foamed drilling fluids are known and used in situations wherein reduced density is desired, for example in low-pressure formations, wherein the other functions of a drilling fluid are still needed. In low-pressure formations, the use of fluids having higher density can result in a partial or total fluid loss into the formation, which can result in increased drilling cost, formation fracturing and/or damage, and even well loss.

In such instances, under-balanced drilling is typically performed in order to avoid such undesirable occurrences and, if necessary, permit a short influx from the formation.

A number of problems are experienced with known foamable drilling fluids. These include short stability periods in the presence of formation contaminants, poor transportation capability, short reutilization cycles and environmental issues.

It is clear that the need remains for a foamable drilling fluid, which is stable in the presence of formation contaminants such as crude oil and/or salt, which has effective cutting transport capability, which exhibits good reutilization cycles through re-generation of foam at the surface, and which is environmentally friendly.

It is therefore the primary object of the present invention to provide a foamable drilling fluid having these properties.

Other objects and advantages of the present invention will appear hereinbelow.

SUMMARY OF THE INVENTION

In accordance with the present invention, the foregoing objects and advantages have been readily attained.

According to the invention, a foamable drilling fluid is provided which comprises an aqueous solvent, a surfactant, and a guar polysaccharide preferably derived from a galactomannan gum, and most preferably guar gum.

In accordance with a further aspect of the present invention, a foamed drilling fluid is provided, which comprises a liquid phase comprising an aqueous solvent, a polysaccharide preferably derived from a galactomannan gum and a surfactant; and a gas phase selected from the group consisting of nitrogen, air, natural gas, CO₂ and combinations thereof.

The polysaccharide additive of the present invention has been found to advantageously provide for excellent stability and cutting transport capacity, while nevertheless being environmentally friendly.

BRIEF DESCRIPTION OF THE DRAWINGS

A detailed description of preferred embodiments of the present invention follows, with reference to the attached drawings, wherein:

Figures 1 and 2 illustrate drilling fluid in accordance with the present invention and conventional drilling fluid when contaminated with crude oil;

Figures 3 and 4 further illustrate drilling fluid in accordance with the present invention and conventional drilling fluid when contaminated with greater amounts of crude oil;

Figure 5 illustrates the relationship between crude oil quantity of contamination and foam stability in terms of half life time;

Figure 6 illustrates biodegradation of a drilling fluid in accordance with the present invention in aerobic conditions; and

Figure 7 illustrates biodegradation of a drilling fluid in accordance with the present invention in anaerobic conditions.

DETAILED DESCRIPTION

The invention relates to a foamable drilling fluid which contains a particular class of polymer that has been found in accordance with the present invention to provide the fluid with excellent stability when foamed even in the presence of crude oil and salt, which provides for good cuttings transport capability, desirable density values, and sufficient reutilization cycles, and which also results in an environmentally friendly fluid.

In accordance with the present invention, the fluid contains an aqueous solvent phase containing a surfactant, a polysaccharide preferably derived from a galactomannan gum, most preferably guar gum, and, preferably, a monovalent salt. The gas phase of the foamable drilling fluid, when foamed, may be any suitable gas and is preferably selected from the group consisting of nitrogen, air, natural gas, CO₂ and combinations thereof.

The aqueous solvent may be any suitable liquid into which the additives are soluble, such as water or the like.

The surfactant is preferably an ethoxylated alcohol sulfate, and sodium lauryl ether sulfate has been found to be particularly suitable for use in accordance with the present invention, particularly when having three moles of EO. Of course, other types of surfactants could be used, such as

ammonium lauryl ether sulfate, sodium lauryl sulfate, ammonium lauryl sulfate, triethanolamine lauryl sulfate, sodium alpha-olefin sulfonate and the like.

The class of polymer useful in accordance with the present invention as a polysaccharide source, specifically guar gum polymers, have been found to advantageously provide an additive to the drilling fluid of the present invention which provides for excellent stability and fluid characteristics while nevertheless providing an environmentally friendly and biodegradable drilling fluid.

Particularly desirable polysaccharides include polysaccharide polymers derived from galactomannan gum, such as hydroxypropyl guar, guar gum, and hydroxypropyl carboxymethyl guar. The most preferred polysaccharide derivative for use in this invention is a hydroxypropyl guar gum derivative, which provides the drilling fluid of the present invention with excellent characteristics at reasonably small amounts, for example between about 1.5 and about 3.0% w/v, and molecular weights between 1,500,000 and 4,000,000.

The salt serves to stabilize the foam by means of repulsive forces due to the presence of polar groups at the interface, and may suitably be a monovalent salt such as potassium chloride, sodium chloride, potassium acetate, acetate chloride and mixtures thereof.

The foamed drilling fluid, as set forth above, includes a gas phase, which may suitably be nitrogen, air, natural gas, CO₂ and the like. The foamed drilling fluid can be prepared using any known technique, and can be prepared at laboratory scale for example through mechanical mixing and gas injection.

The drilling fluid in accordance with the present invention is provided having different amounts of components so as to provide the desired resulting foamable fluid having stability, density, viscosity and other parameters as desired. For example, the foamed drilling fluid according to the invention may suitably have a density of between about 1.15 and about 5.0 ppg, and a volumetric gas fraction or quality of between about 45 and about 95% v/v. Viscosity at temperatures up to about 180°F for fluids having a quality of between about 80 and about 95% v/v is between about 25 and about 50cP.

In accordance with the present invention, it is particularly preferred to provide the liquid phase of the fluid containing polymer, surfactant and salt additives as set forth below in Table 1:

TABLE 1

Additive	Concentration range, ppm
Hydroxypropyl guar polymer	1.5 - 3.0
Surfactant selected from the group of ethoxylated alcohol sulfates (sodium lauryl ether sulfates with 3 moles EO)	0.3 - 1.0
Monovalent salt (KCl or NaCl)	0.1 - 0.5

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The foamable drilling fluid in accordance with the present invention is particularly useful for low-pressure applications, for example in depleted or partially depleted reservoir areas where lower density drilling fluids are needed. In such environments, a foamed drilling fluid in accordance with the present invention is particularly advantageous in that formation damage due to drilling fluid filtrate into the formation can be substantially reduced, while nevertheless maintaining the cutting carrying capacity of the drilling fluid and while maintaining normal penetration rates.

A further advantage of the drilling fluid of the present invention is that the fluid stability helps maintain cuttings in the fluid for periods of time while drilling is ceased, such that cuttings do not return downhole.

Another advantageous feature of the fluid of the present invention is that the stability is not impacted at high

temperatures which are frequently encountered in subterranean formations.

Still further, the drilling fluid of the present invention maintains stability when exposed to substantial amounts of crude oils, and/or salts, which of course are frequently encountered contaminants when drilling through subterranean formations. Depending upon the physico-chemical composition of the crude oil, large amounts of contamination can significantly increase foam stability, and the foam stability reactants at contamination levels up to at least about 50% w/v of crude oil.

The fluid of the present invention is stable at temperatures up to at least 180°F, and has a foam half lifetime of at least about 17 minutes.

Finally, the foamed drilling fluids in accordance with the present invention can be collapsed, or broken down for example at the surface, if desired, by adding low molecular weight alcohol, defoamers and/or pH adjusting additives. These breakdown mechanisms do not cancel the effect of the surfactant and permit regeneration of the foam by using the same foaming solution with a minimal amount of additional additives. This may be desirable in order to decrease the cost of the drilling fluid and provide good surface control.

The following examples further demonstrate the excellent characteristics of the drilling fluid of the present invention.

EXAMPLE 1

In this example, a drilling fluid in accordance with the present invention is compared to a commercial Transfoam O fluid.

The drilling fluid in accordance with the present invention (Foamdrill) was prepared utilizing water as an aqueous solvent, wherein the aqueous solvent contained sodium lauryl ether sulfate having three moles of EO, hydroxypropyl guar polymer and potassium chloride in amounts set forth in Table 2 below.

The foam was formed using air, in a mechanical mixing method. The foam was prepared and mixed with 10% w/v of crude oil in order to determine static foam stability.

A commercially available fluid (Transfoam O) was prepared containing an anionic Transfoam O surfactant, non-ionic Dionic 900 polymer, and KCl as salt in the amount set forth in Table 2 below, also using air as the gas phase and a mechanical mixing method. The foam was prepared and mixed containing crude oil in an amount of 10% w/v so as to determine the static foam stability.

TABLE 2

	FOAMDRILL	TRANSFOAM 0
Concentration (%w/v)		
Surfactant	0.5	1.0
Polymer	0.2	0.4
Salt	0.5	0.5
Foam Level (ml)	400	540
Half life time (min)	26.7	5.8

As shown in Table 2, the drilling fluid of the present invention (Foamdrill) reached a foam level of 400 ml, and maintained this foam level for a half life time of 26.7 minutes. The half life time is defined as the time during which the column reduces in height to half of the beginning level.

By contrast, the Transfoam 0 fluid reached a foam level of 540 ml, but also reached the half lifetime in only 5.8 mins. Clearly, the foam of the present invention is more stable in the presence of crude oil than the conventional Transfoam 0 fluid, and is therefore beneficial for use as a drilling fluid in accordance with the present invention.

EXAMPLE 2

This example demonstrates the advantageous characteristics of the foam of the present invention when exposed to 10% w/v oil contamination, and when prepared using an air expansion method. Both foam formulations were prepared using concentrations as

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shown in Table 2. As shown in Figures 1 and 2, the drilling fluid of the present invention (Figure 1) exhibits higher stability in the presence of crude oil contamination than the commercial formulation (Figure 2). Further, the foam of the present invention, as shown, is homogeneous and uniform, while in contrast, the conventional foam has bubbles with different sizes, and is not uniform, and the foam is substantially broken.

EXAMPLE 3

In this example, a drilling fluid was prepared in accordance with the present invention as described in Example 1, and mixed with a 50% w/v amount of crude oil. A commercial drilling fluid (Transfoam O) was also prepared and mixed with crude oil in an amount of 50% w/v.

While the drilling fluid of the present invention maintained a foam structure when allowed to rest (Figure 3), the commercial fluid immediately separated to well below the half life level (Figure 4). This occurred using both mechanical mixing methods and air expansion foam forming methods.

Figure 5 shows the influence of crude oil concentration on stability of the foam of the present invention. As shown, as the crude oil contamination increases, foam stability also significantly increases. Further, the increase in foam stability is more substantial with certain types of crude oil. Highly acidic crude oils do tend to reduce the foam stability to

50

some extent, although greater stability still occurs at higher oil concentrations. This demonstrates that the foam can be broken down in the presence of acidic crude oils, and on the other hand, that crude oils with similar chemical compositions exhibit similar foam stability.

EXAMPLE 4

In this example, a drilling fluid in accordance with the present invention and as described in Example 1 above was prepared and mixed with different amounts of crude oils. Once thoroughly mixed, the foam was then allowed to stand and the half life time was measured. The physical-chemical properties of crude oils investigated in this example are shown in Table 3.

TABLE 3

Crude Oil	Water by Distill %	Dehydration %	Salt by conduct PPM	API Gravity @ 60°F	Ac. Num. mg KOH/g crude oil	Saturated % w/v	Aromatic % w/v	Resins % w/v Asphalt % w/v	Asphalt % w/v
1	0	-	5.2	24.7	0.38	41.1	42.3	12.2	4.4
2	0	-	6.6	25.9	0.41	40.9	43.9	11.2	4.0
3	0	-	3.1	30.7	0.23	49.3	41.4	8.5	0.8
4	6.95	6.18	37.8(D)	28.6(D)	0.16(D)	44.4	43.4	8.8	3.3
5	3.99	7.37	35.3(D)	25.4(D)	0.29(D)	43.0	42.0	11.4	3.6
6	0	-	4.4	29.2	0.30	45.4	40.6	11.1	2.9
7	0	-	3.4	28.5	0.25	46.9	44.7	7.2	1.2
8	0	-	6.0	23.8	0.32	39.8	40.8	14.0	5.4
9	4	-	23.8(D)	11.4	4.98	16.5	51.4	22.5	9.6
10	2	-	282.8	10.4	1.82	28.6	44.0	23.2	4.2
11	<0.1	-	-	22.5	-	29.8	44.3	17.9	7.9
12	1.2	-	-	34	-	-	-	-	-

Even with a 10% contamination of crude oil, the foam maintained a half life of approximately 1020 seconds.

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EXAMPLE 5

In this example, the toxicology of the drilling fluid additives of the present invention, as well as biodegradability, was evaluated.

In this example, toxicity (CL_{50} - 96h) of the additives of the drilling fluid of the present invention was evaluated. In this type of testing, the higher the CL_{50} number, the lower the actual toxicity of the component. The surfactant of the present invention was found to have a toxicity of 300 mg/l, while the polymer component was found to have toxicity of greater than about 500 mg/l. As compared to commercial surfactant, these toxicities are substantial improvements. For example, a number of commercial surfactants were evaluated which have toxicities in the range of about 25 up to about 250 mg/l, all of which are substantially lower than, and therefore more toxic than, the ingredients of the present invention.

Biodegradation of the components of the fluids of the present invention was also measured over time under aerobic and anaerobic conditions, as compared to basic glucose.

Figures 6 and 7 illustrate the results obtained, wherein the fluid of the present invention is illustrated as "Foamdrill". As shown in Figure 6, under aerobic conditions, the "Foamdrill" fluid reaches a 60% biodegradation level quite rapidly and has a biodegradation profile comparable to glucose.

In Figure 7, for the anaerobic biodegradation of the Foamdrill fluid is nearly identical to glucose.

Thus, the drilling fluid of the present invention exhibits excellent biodegradability and is therefore extremely environmentally friendly.

EXAMPLE 6

In this Example, the cleaning capacity of the Foamdrilling fluid in accordance with the present invention is demonstrated. A pilot test was carried out in well P-203, of the La Paz field, in Venezuela. A 12 $\frac{1}{4}$ " hole was drilled in the aforementioned well using 30-50 gallons per minute (gpm) of foam solution and 600-1000 scfm of nitrogen. Drilling was carried out using minimum annular velocities of 45ft/min. During the course of drilling, increments of injection pressures were not observed, drilling cuttings in the shakers were as expected according to the drilling rate, problems due to physical obstruction of cuttings or cutting deposition in the well was not observed, and the foam maintained a high stability at the well outlet before the breakdown process. All of these characteristics demonstrate an excellent cleaning capacity of the foam drilling fluid in accordance with the present invention.

EXAMPLE 7

In the same pilot test as carried out in Example 6, an effective fluid reutilization cycle was also conducted. The

93

foam was formed and, upon exiting the well, was broken using alcohol and defoamer. The foaming solution with drilling cutting were separated and sent to shakers in order to separate the solids and regain the solution to be used again. With minimal addition of new components, the foam was regenerated approximately 76 times. This shows excellent re-usability of the fluid in accordance with the present invention.

It should be readily apparent that the drilling fluid in accordance with the present invention is stable, and useful in carrying cuttings to the surface during drilling operations, while nevertheless presenting a low density which is useful in low pressure applications so as to avoid formation damage and fluid loss, while also reducing cost.

Further, the drilling fluid is environmentally friendly.

It is to be understood that the invention is not limited to the illustrations described and shown herein, which are deemed to be merely illustrative of the best modes of carrying out the invention, and which are susceptible of modification of form, size, arrangement of parts and details of operation. The invention rather is intended to encompass all such modifications which are within its spirit and scope as defined by the claims.

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WHAT IS CLAIMED IS:

1. A foamable drilling fluid, comprising:
an aqueous solvent;
a surfactant; and
a polysaccharide.
2. The fluid of claim 1, wherein said polysaccharide is derived from a galactomannan gum.
3. The fluid of claim 2, wherein said galactomannan gum is selected from the group consisting of hydroxypropyl guar, guar gum, hydroxypropyl carboxymethyl guar and mixtures thereof.
4. The fluid of claim 2, wherein said galactomannan gum is hydroxypropyl guar.
5. The fluid of claim 1, wherein said surfactant is an ethoxylated alcohol sulfate.
6. The fluid of claim 5, wherein said ethoxylated alcohol sulfate is selected from the group consisting of ammonium lauryl ether sulfate, sodium lauryl sulfate, ammonium lauryl sulfate, triethanolamine lauryl sulfate, sodium alpha-olefin sulfonate, and mixtures thereof.

108280-80514660

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7. The fluid of claim 1, wherein said polymer is present in an amount between about 1.5 and about 3.0% w/v.

8. The fluid of claim 1, further comprising a salt.

9. The fluid of claim 8, wherein said salt is a monovalent salt.

10. The fluid of claim 8, wherein said salt is selected from the group consisting of potassium chloride, sodium chloride, potassium acetate, acetate chloride and mixtures thereof.

11. The fluid of claim 8, wherein said salt is potassium chloride.

12. The fluid of claim 6, wherein said fluid contains said polymer in an amount between about 1.5 and about 3.0% w/v, said surfactant in an amount between about 0.3 and about 1.0 % w/v, and said salt in an amount between about 0.1% and about 0.5% w/v.

13. The fluid of claim 1, wherein the fluid is a foamed fluid containing a gas.

09941508-082801

56

14. The fluid of claim 13, wherein said gas is selected from the group, consisting of nitrogen, air, natural gas, CO₂ and mixtures thereof.

15. The fluid of claim 13, wherein the foamed fluid has a viscosity of between about 1.15 and about 5.0 ppg.

16. The fluid of claim 13, wherein the foamed fluid has a viscosity of between about 25 and about 50 cP for qualities between about 80 and about 95%, at temperatures up to about 180°F.

17. The fluid of claim 13, wherein the foamed fluid is stable when exposed to oil and salt contaminants.

18. The fluid of claim 13, wherein the foamed fluid is stable when mixed with crude oil up to at least about 50% w/v of crude oil.

19. The fluid of claim 13, wherein the foamed fluid has a half life time of at least about 17 min.

20. The fluid of claim 13, wherein the foamed fluid is stable at temperatures up to at least about 180°F.

108280-80514660

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21. A foam drilling fluid, comprising:

a liquid phase comprising an aqueous solvent, a polysaccharide and a surfactant; and

a gas phase selected from the group consisting of air, nitrogen, natural gas, CO₂ and combinations thereof.

108280-8 514660

58

ABSTRACT

A foamable drilling fluid is provided which includes an aqueous solvent; a surfactant; and a polysaccharide preferably derived from a galactomannan gum. The foamed drilling fluid includes a liquid phase consisting of the aqueous solvent, polysaccharide and surfactant, and a gas phase of air, nitrogen, natural gas, CO₂ and mixtures thereof. The drilling fluid is stable in the presence of crude oil and salt and environmentally friendly.

09941508-082801

59

Practitioner's Docket No. 00-30

PATENT

COMBINED DECLARATION AND POWER OF ATTORNEY

(ORIGINAL, DESIGN, NATIONAL STAGE OF PCT, SUPPLEMENTAL, DIVISIONAL, CONTINUATION, OR C-I-P)

As a below named inventor, I hereby declare that:

TYPE OF DECLARATION

This declaration is of the following type:

(check one applicable item below)

☒ original.

☐ design.

NOTE: With the exception of a supplemental oath or declaration submitted in a rehearing, a supplemental oath or declaration is not treated as an amendment under 37 C.F.R. 1.512 (Amendments after allowance), M.P.E.P. § 714.16, 7th Edition.

☐ supplemental.

NOTE: If the declaration is for an International Application being filed as a divisional, continuation or continuation-in-part application, do not check any item; check appropriate one of last three items.

☐ national stage of PCT.

NOTE: If one of the following 3 items apply, then complete and also attach ADDED PAGES FOR DIVISIONAL, CONTINUATION OR C-I-P.

NOTE: See 37 C.F.R. § 1.53(b) (continued prosecution application) for use of a prior nonprovisional application declaration in the continuation or divisional application being filed on behalf of the same or fewer of the inventors named in the prior application.

☐ divisional.

☐ continuation.

NOTE: Where an application discloses and claims subject matter not disclosed in the prior application, or a continuation or divisional application names an inventor not named in the prior application, a continuation-in-part application must be filed under 37 C.F.R. § 1.53(b) (application filing requirements — nonprovisional application).

☐ continuation-in-part (C-I-P).

INVENTORSHIP IDENTIFICATION

WARNING: If the inventors are each not the inventors of all the claims, an explanation of the facts, including the ownership of all the claims at the time the last claimed invention was made, should be submitted.

My residence, post office address and citizenship are as stated below, next to my name. I believe that I am the original, first and sole inventor (if only one name is listed below) or an original, first and joint inventor (if plural names are listed below) of the subject matter that is claimed, and for which a patent is sought on the invention entitled:

TITLE OF INVENTION

POLYMER-ENHANCED FOAMABLE DRILLING FLUID

108280-80514660

SPECIFICATION IDENTIFICATION

the specification of which:

(complete (a), (b), or (c))

(a) ☒ is attached hereto.

NOTE: The following combinations of information supplied in an oath or declaration filed on the application filing date with a specification are acceptable as minimums for identifying a specification and compliance with any one of the items below will be accepted as complying with the identification requirement of 37 CFR 1.52:

"(1) name of inventor(s), and reference to an attached specification which is both attached to the oath or declaration at the time of execution and submitted with the oath or declaration on filing;

"(2) name of inventor(s), and attorney docket number which was on the specification as filed; or

"(3) name of inventor(s), and title which was on the specification as filed."

Notice of July 13, 1995 (1177 O.G. 60).

(b) ☐ was filed on _____, as ☐ Serial No. 0 / _____
or ☐ _____
and was amended on _____ (if applicable).

NOTE: Amendments filed after the original papers are deposited with the PTO that contain new matter are not accorded a filing date by being referred to in the declaration. Accordingly, the amendments involved are those filed with the application papers or, in the case of a supplemental declaration, are those amendments claiming matter not encompassed in the original statement of invention or claims. See 37 C.F.R. § 1.67.

NOTE: The following combinations of information supplied in an oath or declaration filed after the filing date are acceptable as minimums for identifying a specification and compliance with any one of the items below will be accepted as complying with the identification requirement of 37 CFR 1.52:

"(4) application number (consisting of the series code and the serial number, e.g., 08/123,456);

"(5) serial number and filing date;

"(6) attorney docket number which was on the specification as filed;

"(7) title which was on the specification as filed and reference to an attached specification which is both attached to the oath or declaration at the time of execution and submitted with the oath or declaration; or

"(8) title which was on the specification as filed and accompanied by a cover letter accurately identifying the application for which it was intended by either the application number (consisting of the series code and the serial number, e.g., 08/123,456), or serial number and filing date. Absent any statement to the contrary, it will be presumed that the application filed in the PTO is the application which the inventor(s) executed by signing the oath or declaration."

M.P.E.P. § 801.01(a), 7th Ed.

(c) ☐ was described and claimed in PCT International Application No. _____, filed on _____ and as amended under PCT Article 19 on _____ (if any).

(Declaration and Power of Attorney [1-1]—page 2 of 7)

108280-80514660

60

SUPPLEMENTAL DECLARATION (37 C.F.R. § 1.87(b))

(complete the following where a supplemental declaration is being submitted)

- ☐ I hereby declare that the subject matter of the
- ☐ attached amendment
- ☐ amendment filed on _____

was part of my/our invention and was invented before the filing date of the original application, above-identified, for such invention.

ACKNOWLEDGEMENT OF REVIEW OF PAPERS AND DUTY OF CANDOR

I hereby state that I have reviewed and understand the contents of the above-identified specification, including the claims, as amended by any amendment referred to above.

I acknowledge the duty to disclose information, which is material to patentability as defined in 37, Code of Federal Regulations, § 1.56.

(also check the following items, if desired)

- ☒ and which is material to the examination of this application, namely, information where there is a substantial likelihood that a reasonable Examiner would consider it important in deciding whether to allow the application to issue as a patent, and
- ☒ in compliance with this duty, there is attached an information disclosure statement, in accordance with 37 C.F.R. § 1.96.

PRIORITY CLAIM (35 U.S.C. §§ 119(a)-(d))

NOTE: "The claim to priority need be in no special form and may be made by the attorney or agent if the foreign application is referred to in the oath or declaration as required by § 1.62. The claim to priority and the certified copy of the foreign application specified in 35 U.S.C. 119(a) must be filed in the case of an interference (§ 1.93), when necessary to overcome the date of a reference relied upon by the examiner, when specifically required by the examiner, and in all other situations, before the patent is granted. If the claim to priority or the certified copy of the foreign application is filed after the date the issue fee is paid, it must be accompanied by a petition requesting entry and by the fee set forth in § 1.179. If the certified copy is not in the English language, a translation must not be filed except in the case of interference; or when necessary to overcome the date of a reference relied upon by the examiner; or when specifically required by the examiner; in which event an English language translation must be filed together with a statement that the translation of the certified copy is accurate." 37 C.F.R. § 1.55(a).

I hereby claim foreign priority benefits under Title 35, United States Code, §§ 119(a)-(d) of any foreign application(s) for patent or inventor's certificate or of any PCT international application(s) designating at least one country other than the United States of America listed below and have also identified below any foreign application(s) for patent or inventor's certificate or any POT international application(s) designating at least one country other than the United States of America filed by me on the same subject matter having a filing date before that of the application(s) of which priority is claimed.

(complete (c) or (d))

- (c) ☒ no such applications have been filed.
- (d) ☐ such applications have been filed as follows.

NOTE: Where item (c) is entered above and the international Application which designated the U.S. itself claimed priority check item (d), enter the details below and make the priority claim.

(Declaration and Power of Attorney [1-1]—page 3 of 7)

62

**PRIOR FOREIGN/PCT APPLICATION(S) FILED WITHIN 12 MONTHS
(6 MONTHS FOR DESIGN) PRIOR TO THIS APPLICATION
AND ANY PRIORITY CLAIMS UNDER 35 U.S.C. § 119(a)-(4)**

COUNTRY (OR INDICATE IF PCT)	APPLICATION NUMBER	DATE OF FILING (day, month, year)	PRIORITY CLAIMED UNDER 37 USC 119
			☐ YES ☐ NO
			☐ YES ☐ NO
			☐ YES ☐ NO
			☐ YES ☐ NO
			☐ YES ☐ NO

**CLAIM FOR BENEFIT OF PRIOR U.S. PROVISIONAL APPLICATION(S)
(34 U.S.C. § 119(e))**

I hereby claim the benefit under Title 35, United States Code, § 119(e) of any United States provisional application(s) listed below:

PROVISIONAL APPLICATION NUMBER

FILING DATE

**CLAIM FOR BENEFIT OF EARLIER USPCT APPLICATION(S)
UNDER 35 U.S.C. § 120**

- ☐ The claim for the benefit of any such applications are set forth in the attached ADDED PAGES TO COMBINED DECLARATION AND POWER OF ATTORNEY FOR DIVISIONAL, CONTINUATION OR CONTINUATION-IN-PART (C-I-P) APPLICATION.

(Declaration and Power of Attorney (1-1)—page 4 of 7)

63

**ALL FOREIGN APPLICATION(S), IF ANY, FILED MORE THAN 12 MONTHS
(6 MONTHS FOR DESIGN) PRIOR TO THIS U.S. APPLICATION**

NOTE: If the application filed more than 12 months from the filing date of this application is a PCT filing forwarding the basis for this application entering the United States as (1) the national stage, or (2) a continuation, divisional, or continuation-in-part, then also complete **ADDED PAGES TO COMBINED DECLARATION AND POWER OF ATTORNEY FOR DIVISIONAL, CONTINUATION OR C-I-P APPLICATION** for benefit of the prior U.S. or PCT application(s) under 35 U.S.C. § 120.

POWER OF ATTORNEY

I hereby appoint the following practitioner(s) to prosecute this application and transact all business in the Patent and Trademark Office connected therewith.

(list name and registration number)

Robert H. Bachman, (19,374); Gregory P. LaPointe, (28,395);
Barry L. Kelmachter (29,999); and George A. Coury, (34,309)

(check the following item, if applicable)

- ☐ I hereby appoint the practitioner(s) associated with the Customer Number provided below to prosecute this application and to transact all business in the Patent and Trademark Office connected therewith.
- ☐ Attached, as part of this declaration and power of attorney, is the authorization of the above-named practitioner(s) to accept and follow instructions from my representative(s).

NOTE: Special care should be taken in continuation or divisional applications to ensure that any change of correspondence address in a prior application is reflected in the continuation or divisional application. For example, where a copy of the oath or declaration from the prior application is submitted for a continuation or divisional application filed under 37 CFR 1.53(b) and the copy of the oath or declaration from the prior application designates an old correspondence address, the Office may not recognize, in the continuation or divisional application, the change of correspondence address made during the prosecution of the prior application. Applicant is required to identify the change of correspondence address in the continuation or divisional application to ensure that communications from the Office are mailed to the current correspondence address. 37 CFR 1.53(a)(4), § 601.02, M.P.E.P., 7th Edition.

SEND CORRESPONDENCE TO

DIRECT TELEPHONE CALLS TO:
(Name and telephone number)

☒ Address
BACHMAN & LAPOINTE, P.C.
900 Chapel Street, Suite 1201
New Haven, CT 06510-2802

Gregory P. LaPointe
(203) 777-6628, Ext. 111

☐ Customer Number _____

(complete the following if applicable)

Since this filing is a ☐ continuation ☐ divisional there is attached hereto a Change of Correspondence Address so that there will be no question as to where the PTO should direct all correspondence.

(Declaration and Power of Attorney [1-1]—page 6 of 7)

108280-80514660

DECLARATION

I hereby declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code, and that such willful false statements may jeopardize the validity of the application or any patent issued thereon.

SIGNATURE(S)

NOTE: Carefully indicate the family (or last) name, as it should appear on the filing receipt and all other documents.

NOTE: Each inventor must be identified by full name, including the family name, and at least one given name without abbreviation together with any other given name or initial, and by his/her residence, post office address and country of citizenship. 37 CFR § 1.62(b)(2).

NOTE: Inventors may execute separate declarations/statements provided each declaration/statement sets forth all the inventors. Section 1.62(b)(3) requires that a declaration/statement, inter alia, identify each inventor and prohibits the execution of separate declarations/statements which each sets forth only the name of the executing inventor. 62 Fed. Reg. 63,131, 63,142, October 12, 1997.

Full name of sole or first inventor

Yenny

Virginia

Rojas

(GIVEN NAME)

(FAMILY INITIAL OR NAME)

(FAMILY (OR LAST) NAME)

Inventor's signature

Date 16/08/2001

Country of Citizenship

Venezuela

Residence San Antonio de los Altos Edo. Miranda, Venezuela.

Post Office Address Urb. Sta. Rosa, Sector El Tambor, PDVSA, Edif. Sur 1, PB-43 Los Teques, Edo. Miranda, Venezuela.

Full name of second joint inventor, if any

Alida

del Carmen

Aponte

(GIVEN NAME)

(FAMILY INITIAL OR NAME)

(FAMILY (OR LAST) NAME)

Inventor's signature

Date 16/08/2001

Country of Citizenship

Venezuela

Residence San Antonio de los Altos Edo. Miranda, Venezuela

Post Office Address Urb. Sta. Rosa, Sector El Tambor, PDVSA, Edif. Norte 1, 5to. piso, Oficina 123 Los Teques, Edo. Miranda, Venezuela.

Full name of third joint inventor, if any

(GIVEN NAME)

(FAMILY INITIAL OR NAME)

(FAMILY (OR LAST) NAME)

Inventor's signature

Date

Country of Citizenship

Residence

Post Office Address

(Declaration and Power of Attorney [1-1]—page 6 of 7)

65

(check proper box(es) for any of the following added page(s)
that form a part of this declaration)

☐ Signature for fourth and subsequent joint inventors. Number of pages added _____

...

☐ Signature by administrator(s), executor(s) or legal representative for deceased or incapacitated inventor. Number of pages added _____

...

☐ Signature for inventor who refuses to sign or cannot be reached by person authorized under 37 CFR 1.47. Number of pages added _____

...

☐ Added page for signature by one joint inventor on behalf of deceased inventor(s) where legal representative cannot be appointed in time. (37 CFR 1.47)

...

☐ Added pages to combined declaration and power of attorney for divisional, continuation, or continuation-in-part (C-I-P) application.

☐ Number of pages added _____

...

☐ Authorization of practitioner(s) to accept and follow instructions from representative.

...

(If no further pages form a part of this Declaration,
then end this Declaration with this page and check the following item)

☒ This declaration ends with this page.

0941508-082801

66



FIG. 1



FIG. 2

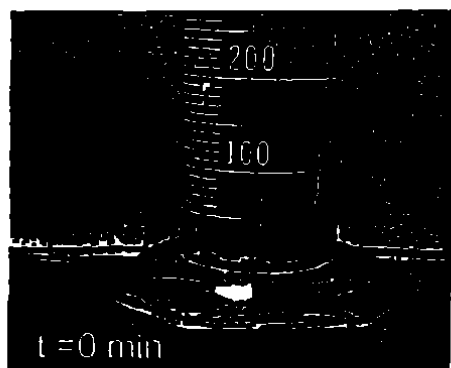


FIG. 3

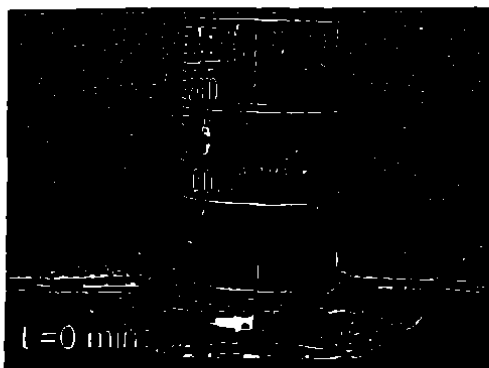


FIG. 4

09941508.082801

62

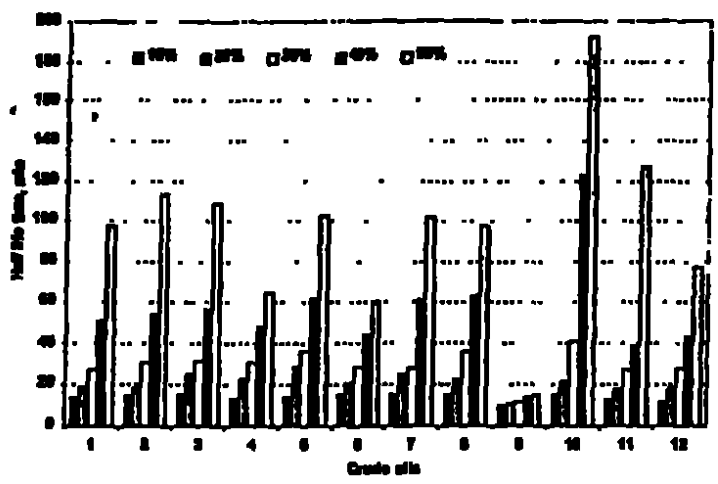


FIG. 5

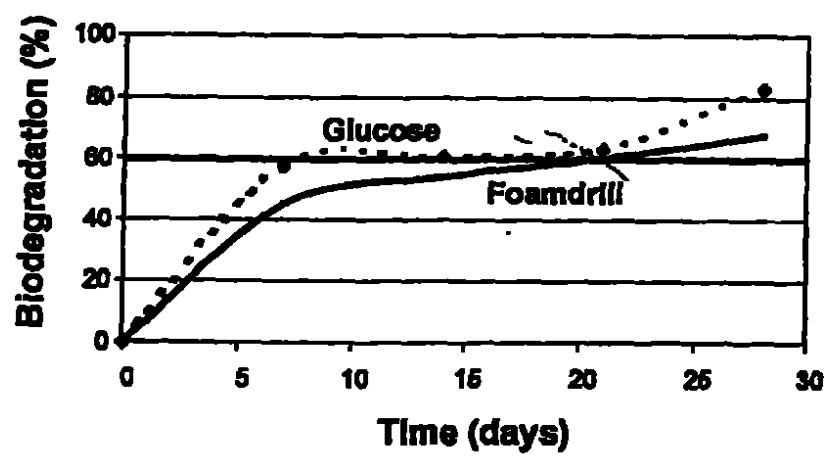


FIG. 6

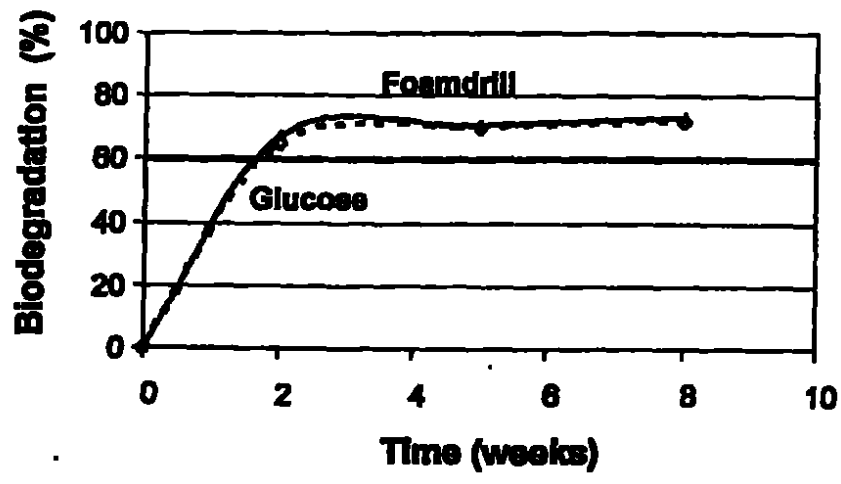


FIG. 7

108280-80574660

68

United States Patent & Trademark Office

Office of Initial Patent Examination

Application papers not suitable for publication

SN 09/941508 Mail Date 8/28/01

- ☐ Non-English Specification
- ☐ Specification contains drawing(s) on page(s) _____ or table(s) _____
- ☐ Landscape orientation of text ☐ Specification ☐ Claims ☐ Abstract
- ☐ Handwritten ☐ Specification ☐ Claims ☐ Abstract
- ☐ More than one column ☐ Specification ☐ Claims ☐ Abstract
- ☐ Improper line spacing ☐ Specification ☐ Claims ☐ Abstract
- ☐ Claims not on separate page(s)
- ☐ Abstract not on separate page(s)
- ☒ Improper paper size - Must be either A4 (21 cm x 29.7 cm) or 8-1/2"x 11"
 - ☐ Specification page(s) _____ ☐ Abstract
 - ☒ Drawing page(s) _____ ☐ Claim(s)
- ☐ Improper margins
 - ☐ Specification page(s) _____ ☐ Abstract
 - ☐ Drawing page(s) _____ ☐ Claim(s)
- ☐ Not reproducible

<u>Reason</u>	<u>Section</u>
☐ Paper too thin	☐ Specification page(s) _____
☐ Glossy pages	☐ Drawing page(s) _____
☐ Non-white background	☐ Abstract
	☐ Claim(s)
- ☐ Drawing objection(s)
 - ☐ Missing lead lines, drawing(s) _____
 - ☐ Line quality is too light, drawing(s) _____
 - ☐ More than 1 drawing and not numbered correctly
 - ☐ Non-English text, drawing(s) _____
 - ☐ Excessive text, drawing(s) _____
 - ☐ Photographs capable of illustration, drawing(s) _____

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7069

**TRADUCCIÓN DEL INGLÉS AL CASTELLANO de la Solicitud de
Patente de los Estados Unidos No.09/941,508 relacionada con:**

**FLUIDO DE PERFORACIÓN ESPUMABLE MEJORADO DE
POLÍMERO**

**ANEXOS. La Solicitud de Patente de los Estados Unidos Serie No.09/
941,508 arriba mencionada, Declaración y Poder, Solicitud de Patente,
Certificación del Comisionado de Patentes y Marcas de los Estados
Unidos de América.**

LOS ESTADOS UNIDOS DE AMÉRICA

**DEPARTAMENTO DE COMERCIO DE LOS ESTADOS UNIDOS DE
AMÉRICA**

Oficina de Patentes y Marcas de los Estados Unidos

Septiembre 09, 2002

**ESTE PARA CERTIFICAR QUE ANEXO AL PRESENTE SE
ENCUENTRA UNA FIEL COPIA TOMADA DE LOS REGISTROS
DE LA OFICINA DE PATENTES Y MARCAS DE LOS ESTADOS
UNIDOS DE AQUELLOS DOCUMENTOS DE LA SOLICITUD DE
PATENTE IDENTIFICADA ABAJO LA CUAL CUMPLE LOS
REQUISITOS PARA CONCEDERLE UNA FECHA DE
PRESENTACIÓN BAJO LA NORMA 35USC 111.**

**NUMERO DE SOLICITUD: 09/941,508
FECHA DE PRESENTACION: Agosto 28, 2001**

**Por autorización del
COMISIONADO DE PATENTES Y MARCAS**

**N. Woodson (Firmado)
N. WOODSON
Funcionario de Certificaciones**

SELLO ADHERIDO

**FLUIDO DE PERFORACIÓN ESPUMABLE MEJORADO DE
POLÍMERO**

ANTECEDENTES DE LA INVENCION

La invención se relaciona con un fluido de perforación y, más particularmente, con un fluido de perforación espumable, estable y seguro ambientalmente.

Durante el curso de la perforación de un pozo subterráneo, los fluidos de perforación son necesarios con el fin de lubricar el barreno de perforación y llevar los cortes de formación a la superficie. Adicionalmente, el fluido de perforación es necesario con el fin de balancear las altas presiones encontradas en la formación subterránea.

Los fluidos de perforación espumados se conocen y usan en situaciones donde se desea reducida densidad, por ejemplo en formaciones de baja presión, donde las otras funciones de un fluido de perforación aún se necesitan. En las formaciones de baja presión, el uso de fluidos que tienen mayor densidad puede dar como resultado una pérdida parcial o total de fluido dentro de la formación, lo cual puede dar como resultado un costo de perforación incrementado, la fractura de la formación y/o el daño, e incluso la pérdida del pozo.

En dichas instancias, la perforación de bajo balance se realiza típicamente con el fin de evitar dichas ocurrencias deseables y, si es necesario, permitir un corto influjo de la formación.

Un número de problemas se experimentan con fluidos de perforación espumables conocidos. Estos incluyen cortos periodos de estabilidad en presencia de contaminantes de la formación, pobre capacidad de transporte, cortos ciclos de reutilización y demandas ambientales.

Es claro que permanece la necesidad de un fluido espumable de perforación, el cual es estable en presencia de contaminantes de la formación tales como petróleo crudo y/o sal, el cual tiene efectiva capacidad de transporte de corte, el cual exhibe buenos ciclos de reutilización a través de la re-generación de espuma en la superficie, y el cual es amistoso ambientalmente.

Es consecuentemente el objetivo primordial de la presente invención proporcionar un fluido de perforación espumable que tiene estas propiedades.

Otros objetivos y ventajas de la presente invención aparecerán enseguida.

RESUMEN DE LA INVENCION

De acuerdo con la presente invención, los anteriores objetivos y ventajas se han obtenido rápidamente.

De acuerdo con la invención, un fluido de perforación espumable se proporciona el cual comprende un solvente acuoso, un tensioactivo, y un polisacárido guar derivado preferiblemente de una goma de galactomannan, y más preferiblemente goma guar.

De acuerdo con un aspecto adicional de la presente invención, un fluido de perforación espumado se proporciona, el cual comprende una fase líquida que comprende un solvente acuoso, un polisacárido derivado preferiblemente de una goma galactomannan y un tensioactivo; y una fase de gas seleccionada a partir del grupo que consiste de nitrógeno, aire, gas natural, CO₂ y sus combinaciones.

Se ha encontrado que el aditivo de polisacárido de la presente invención proporciona ventajosamente excelente estabilidad y capacidad de transporte de corte, siendo sin embargo amistoso ambientalmente.

BREVE DESCRIPCIÓN DE LOS DIBUJOS

Una descripción detallada de modalidades preferidas de la presente invención sigue, con referencia a los dibujos que se anexan, donde:

las Figuras 1 y 2 ilustran un fluido de perforación de acuerdo con la presente invención y un fluido de perforación convencional cuando está contaminado con petróleo crudo;

las Figuras 3 y 4 ilustran adicionalmente el fluido de perforación de acuerdo con la presente invención y el fluido de perforación convencional cuando está contaminado con mayores cantidades de petróleo crudo;

la Figura 5 ilustra la relación entre la cantidad de contaminación del petróleo crudo y la estabilidad de la espuma en términos del tiempo de vida medio;

la Figura 6 ilustra la biodegradación de un fluido de perforación de acuerdo con la presente invención en condiciones aeróbicas; y

la Figura 7 ilustra la biodegradación de un fluido de perforación de acuerdo con la presente invención en condiciones anaeróbicas.

DESCRIPCIÓN DETALLADA

La invención se relaciona con un fluido de perforación espumable que contiene una clase particular de polímero que se ha encontrado de acuerdo con la presente invención para proporcionar el fluido con excelente estabilidad cuando está espumado aún en presencia de petróleo crudo y sal, el cual proporciona buena capacidad de transporte de cortes, deseables valores de densidad, y suficientes ciclos de reutilización, y el cual además da como resultado un fluido ambientalmente amigable.

De acuerdo con la presente invención, el fluido contiene una fase de solvente acuoso que contiene un tensioactivo, un polisacárido preferiblemente derivado de una goma de galactomannan, más preferiblemente goma guar, y, preferiblemente, una sal monovalente. La fase de gas del fluido de perforación espumable, cuando se espuma, puede ser cualquier gas adecuado y se selecciona preferiblemente a partir del grupo que consiste de nitrógeno, aire, gas natural, CO₂ y sus combinaciones.

El solvente acuoso puede ser cualquier líquido adecuado dentro del cual los aditivos son solubles, tal como agua o similar.

El tensioactivo es preferiblemente un sulfato de alcohol etoxilado, y un sulfato de éter lauril de sodio se ha encontrado particularmente adecuado para uso de acuerdo con la presente invención, particularmente tiene tres moles de EO. Por supuesto, otros tipos de tensioactivos pueden usarse, tales como sulfato de éter lauril de amonio, sulfato lauril de sodio, sulfato lauril de amonio, sulfato lauril de trietanolamina, sulfonato de alfaolefina de sodio y similares.

La clase de polímero útil de acuerdo con la presente invención como fuente de polisacárido, específicamente se ha encontrado que los polímeros de goma guar proporcionan ventajosamente un aditivo para el fluido de perforación de la presente invención el cual proporciona excelente estabilidad y características de fluido mientras proporciona, sin embargo, un fluido de perforación ambientalmente amigable y biodegradable.

Los polisacáridos particularmente deseables incluyen polímeros de polisacárido derivados a partir de goma galactomannan, tal como guar de hidroxipropil, goma guar, y guar carboximetil hidroxipropil. El derivado de polisacárido más preferido para uso en esta invención es un derivado de goma guar hidroxipropil, que proporciona el fluido de perforación de la presente invención con excelentes características en cantidades razonablemente pequeñas, por ejemplo entre alrededor de 1,5 y alrededor de 3,0% p/p, y pesos moleculares entre 1 500 000 y 4 000 000.

La sal sirve para estabilizar la espuma mediante fuerzas de repulsión debido a la presencia de grupos polares en la interfaz, y puede adecuadamente ser una sal monovalente tal como cloruro de potasio, cloruro de sodio, acetato de potasio, acetato de sodio y sus mezclas.

El fluido de perforación espumado, como se establece arriba, incluye una fase de gas que puede adecuadamente ser nitrógeno, aire, gas natural, CO₂ y similar. El fluido de perforación espumado puede prepararse usando cualquier técnica conocida, y puede prepararse a escala de laboratorio, por ejemplo a través de mezclado mecánico e inyección de gas.

El fluido de perforación de acuerdo con la presente invención se proporciona con diferentes cantidades de componentes en forma tal de proporcionar el deseado fluido espumable resultante que tiene estabilidad, densidad, viscosidad y otros parámetros como se desee. Por ejemplo, el fluido de perforación espumado de acuerdo con la invención puede tener adecuadamente una densidad de entre alrededor de 1,15 y alrededor de 5,0 ppg, y una fracción de gas volumétrica o calidad de entre alrededor de 45 y alrededor de 95% v/v. La viscosidad a temperaturas de hasta alrededor de 82°C para fluidos que tienen una calidad de entre alrededor de 80 y alrededor de 95% v/v está entre alrededor de 25 y alrededor de 50 cP.

De acuerdo con la presente invención, se prefiere particularmente proporcionar la fase líquida del fluido que contiene los aditivos de polímero, tensioactivo y sal como se establece abajo en la Tabla 1:

TABLA 1

Aditivo	Rango de concentración, ppm
Polímero guar hidroxipropil	1,5 – 3,0
Tensioactivo seleccionado a partir del grupo de sulfatos de alcohol etoxilado (sulfatos de éter lauril de sodio con 3 moles EO)	0,3 – 1,0
Sal monovalente (KCl o NaCl)	0,1 – 0,5

El fluido de perforación de acuerdo espumable con la presente invención es particularmente útil para aplicaciones de baja presión, por ejemplo en áreas de reservorio agotadas o parcialmente agotadas donde se necesitan fluidos de perforación de menor densidad. En dichos ambientes, un fluido de perforación espumado de acuerdo con la presente

invención es particularmente ventajoso en cuanto a que el daño de la formación debido al filtrado del fluido de perforación dentro de la formación puede reducirse sustancialmente mientras se mantiene sin embargo la capacidad de llevar el corte del fluido de perforación y mientras se mantienen las velocidades normales de penetración.

Una ventaja adicional del fluido de perforación de la presente invención es que la estabilidad del fluido ayuda a mantener los cortes en el fluido durante periodos de tiempo aunque haya cesado la perforación, en forma tal que los cortes no retornan a la perforación.

Otra característica ventajosa del fluido de la presente invención es que la estabilidad no se ve impactada a altas temperaturas que se encuentran frecuentemente en las formaciones subterráneas.

Aún adicionalmente, el fluido de perforación de la presente invención mantiene la estabilidad cuando se expone a cantidades sustanciales de petróleos crudos, y/o sales, las cuales por supuesto encuentran frecuentemente contaminantes cuando se perfora a través de formaciones subterráneas. Dependiendo de la composición fisico-química del petróleo crudo, grandes cantidades de contaminación pueden incrementar significativamente la estabilidad de la espuma, y la estabilidad de la espuma en reactivos a niveles de contaminación de hasta por lo menos alrededor de 50% p/v de petróleo crudo.

El fluido de la presente invención es estable a temperaturas de hasta por lo menos 82°C, y tiene un tiempo de vida medio de por lo menos alrededor de 17 minutos.

Finalmente, los fluidos de perforación espumados de acuerdo con la presente invención pueden colapsarse, o romperse por ejemplo en la superficie, si se desea, agregando alcohol de bajo peso molecular, desespumantes y/o aditivos de ajuste del pH. Estos mecanismos de rotura no cancelan el efecto del tensioactivo y permiten la regeneración de la espuma usando la misma solución de formación de espuma con una cantidad mínima de aditivos adicionales. Lo anterior puede ser deseable con el fin de disminuir el costo del fluido de perforación y proporcionar buen control de la superficie.

Los siguientes ejemplos demuestran adicionalmente las excelentes características del fluido de perforación de la presente invención.

EJEMPLO 1

En este ejemplo, un fluido de perforación de acuerdo con la presente invención se compara con un fluido comercial Transfoam O.

El fluido de perforación de acuerdo con la presente invención (Foamdrill) se preparó utilizando agua como un solvente acuoso, donde el solvente acuoso contenía sulfato de éter lauril de sodio que tiene tres moles de EO, el polímero guar hidroxipropil y cloruro de potasio en las cantidades establecidas en la Tabla 2 de abajo.

La espuma se formó usando aire, en un método de mezclado mecánico. La espuma se preparó y mezcló con 10% p/v de petróleo crudo con el fin de determinar la estabilidad estática de la espuma.

Un fluido comercialmente disponible (Transfoam O) se preparó que contiene un tensioactivo aniónico de Transfoam O, polímero no iónico Dionic 900, y KCl como sal en la cantidad establecida en la Tabla 2 de abajo, usando también aire como la fase de gas y un método de mezclado mecánico. Se preparó y mezcló espuma que contenía petróleo crudo en una cantidad de 10% p/v en forma tal de determinar la estabilidad estática de la espuma.

TABLA 2

Concentración (% p/v)	FOAMDRILL	TRANSFOAM O
Tensioactivo	0,5	1,0
Polímero	0,2	0,4
Sal	0,5	0,5
Nivel de Espuma (ml)	<u>400</u>	<u>540</u>
Tiempo de vida medio (minuto)	26,7	5,8

Tal como se muestra en la Tabla 2, el fluido de perforación de la presente invención (Foamdrill) alcanzó un nivel de espuma de 400 ml, y mantuvo este nivel de espuma durante un tiempo de vida medio de 26,7 minutos. El tiempo de vida medio se define como el tiempo durante el cual la columna reduce en altura la mitad del nivel de inicio.

En contraste, el fluido Transfoam O alcanzó un nivel de espuma de 540 ml, pero además alcanzó un tiempo de vida medio en únicamente 5,8 minutos. Claramente, la espuma de la presente invención es más estable en presencia de petróleo crudo que el fluido convencional Transfoam O, y es consecuentemente benéfico para uso como un fluido de perforación de acuerdo con la presente invención.

EJEMPLO 2

Este ejemplo demuestra las características ventajosas de la espuma de la presente invención cuando se expone a 10% /v de contaminación de petróleo, y cuando se preparó usando un método de expansión de aire. Ambas formulaciones de espuma se prepararon usando concentraciones como se muestra en la Tabla 2. Como se muestra en las Figuras 1 y 2, el fluido de perforación de la presente invención (Figura 1) exhibe mayor estabilidad en presencia de contaminación del petróleo crudo que la formulación comercial (Figura 2). Adicionalmente, la espuma de la presente invención, como se muestra, es homogénea y uniforme, mientras que en contraste, la espuma convencional tiene burbujas con tamaños diferentes, y no es uniforme, y la espuma está sustancialmente rota.

EJEMPLO 3

En este ejemplo, un fluido de perforación se preparó de acuerdo con la presente invención como se describe en el Ejemplo 1, y se mezcló con una cantidad 50% p/v de petróleo crudo. Un fluido de perforación comercial (Transfoam O) se preparó y mezcló también con petróleo crudo en una cantidad de 50% p/v.

Aunque el fluido de perforación de la presente invención mantuvo una estructura de espuma cuando se dejó descansar (Figura 3), el fluido comercial se separó inmediatamente bien debajo del nivel de vida media (Figura 4). Lo anterior ocurrió usando tanto los métodos de mezclado mecánico como los métodos de formación de espuma de expansión de aire.

La Figura 5 muestra la influencia de la concentración del petróleo crudo en la estabilidad de la espuma de la presente invención. Como se muestra, a medida que la contaminación del petróleo crudo incrementa, la estabilidad de la espuma también incrementa significativamente. Adicionalmente, el incremento en la estabilidad de la espuma es más sustancial con ciertos tipos de petróleo crudo. Los petróleos crudos más ácidos tienden a reducir la estabilidad de la espuma en alguna extensión, aunque mayor estabilidad ocurre aún a mayores concentraciones de petróleo. Lo anterior demuestra que la espuma puede romperse en presencia de petróleos crudos ácidos, y por otro lado, que los petróleos crudos con similares composiciones químicas exhiben estabilidad de la espuma similar.

EJEMPLO 4

En este ejemplo, un fluido de perforación de acuerdo con la presente invención y como se describe en el Ejemplo 1 de arriba se preparó y mezcló con diferentes cantidades de petróleos crudos. Una vez mezclados completamente, la espuma se dejó entonces permanecer y se midió el tiempo de vida medio. Las propiedades fisico-químicas de los petróleos crudos investigadas en este ejemplo se muestran en la Tabla 3.

TABLA 3

Petróleo crudo	Agua en % destilado	Des- hidratación %	Sal por conducto FTB	Gravedad API 15 °C	Ac. Num. Mg KOH/g petróleo crudo	Saturado % p/p	Aromático % p/p	Resina p/p Asfalto % p/p	Asfalto % p/p
1	D	-	5,2	24,7	0,38	41,1	42,3	12,2	4,4
2	D	-	6,6	25,9	0,41	40,9	43,9	11,2	4,0
3	D	-	3,1	30,7	0,23	49,3	41,4	8,5	0,8
4	6,93	6,18	37,5 (D)	25,6 (D)	0,16 (D)	44,6	43,4	8,8	3,3
5	3,99	7,37	35,3 (D)	25,4 (D)	0,29 (D)	43,0	42,0	11,4	3,6
6	D	-	4,4	28,2	0,30	45,4	40,6	11,1	2,9
7	D	-	3,4	28,5	0,25	46,9	44,7	7,2	1,2
8	D	-	6,0	25,5	0,32	39,8	40,8	14,0	5,4
9	4	-	23,8 (D)	11,4	4,98	16,5	51,4	22,5	9,6
10	2	-	282,8	10,4	1,82	28,6	44,0	23,2	4,2
11	<0,1	-	-	22,5	-	29,9	44,3	17,9	7,9
12	1,2	-	-	34	-	-	-	-	-

Aún con un 10% de contaminación de petróleo crudo, la espuma mantuvo una vida media de aproximadamente 1 020 segundos.

EJEMPLO 5

En este ejemplo, la toxicología de los aditivos del fluido de perforación de la presente invención, así como la biodegradabilidad, se evaluó.

En este ejemplo, la toxicidad (CL₅₀ - 96h) de los aditivos del fluido de perforación de la presente invención se evaluó. En este tipo de prueba, a mayor número CL₅₀, menor la toxicidad actual del componente. Se encontró que el tensioactivo de la presente invención tiene una toxicidad de 300 mg/l, mientras que se encontró que el componente de polímero tiene una toxicidad mayor de alrededor de 500 mg/l. Comparado con el tensioactivo comercial, estas toxicidades son mejoras sustanciales. Por ejemplo, un número de tensioactivos comerciales se evaluaron los cuales tienen toxicidades en el rango de alrededor de 25 hasta alrededor de 250 mg/l, todas las cuales son sustancialmente menores de ...

Las Figuras 6 y 7 ilustran los resultados obtenidos, donde el fluido de la presente invención se ilustra como "Foamdrill". Como se muestra en la Figura 6, bajo condiciones aeróbicas, el fluido "Foamdrill" alcanza un 60% de nivel de biodegradación bastante rápidamente y tiene un perfil de biodegradación comparable a glucosa.

En la Figura 7, para la biodegradación anaeróbica del fluido Foamdrill el fluido es cercanamente idéntico a la glucosa.

Consecuentemente, el fluido de perforación de la presente invención exhibe excelente biodegradabilidad y es consecuentemente extremadamente amistoso ambientalmente.

EJEMPLO 6

En este Ejemplo, se demuestra la capacidad de limpieza del fluido de espuma de perforación de acuerdo con la presente invención. Una prueba piloto se llevó a cabo en un orificio P-203, de La Paz, en Venezuela. Un orificio de 31,12 cm se perforó en el pozo antes mencionado usando 30 a 50 galones por minuto de solución de espuma y 600 a 1 000 scfm de nitrógeno. La perforación se llevó a cabo usando velocidades anulares mínimas de 45pies/minuto. Durante el curso de la perforación, no se observaron incrementos de las presiones de inyección, los cortes de perforación en los agitadores fueron como se esperó de acuerdo con la velocidad de perforación, no se observaron problemas debido a la obstrucción física de los cortes o deposición de corte en el pozo, y la espuma mantuvo una alta estabilidad del puerto de salida del pozo antes del proceso de rotura. Todas estas características demostraron una excelente capacidad de limpieza del fluido de perforación de espuma de acuerdo con la presente invención.

EJEMPLO 7

En la misma prueba piloto llevada a cabo en el Ejemplo 6, también se condujo un ciclo efectivo de fluido reutilización. La espuma se formó y, ante la salida del pozo, se fracturó usando alcohol y desespumante. La solución espumante con el corte de perforación se separó y envió a agitadores con el fin de separar los sólidos y recuperar la solución a ser usada nuevamente. Con adición mínima de nuevos componentes, la espuma se regeneró aproximadamente 76 veces. Esto permite excelente re-utilización del fluido de acuerdo con la presente invención.

Será fácilmente evidente que el fluido de perforación de acuerdo con la presente invención es estable, y útil en llevar a cabo cortes en la superficie durante las operaciones de perforación, mientras, sin embargo,

se presenta una baja densidad la cual es útil en aplicaciones de baja presión en forma tal de evitar el daño de la formación y pérdida de fluido, reduciendo también el costo.

Adicionalmente, el fluido de perforación es amigable ambientalmente.

Se debe entender que la invención no está limitada a las ilustraciones aquí descritas y mostradas, las cuales se consideran meramente ilustrativas de las mejores formas de llevar a cabo la invención, y las cuales son susceptibles de modificación de forma, tamaño, arreglo de partes y detalles de operación. La invención pretende más bien incluir todas estas modificaciones las cuales se encuentran dentro de su espíritu y alcance tal como se define mediante las reivindicaciones.

REIVINDICACIONES

LO QUE SE REIVINDICA ES:

1. Un fluido de perforación espumable, que comprende:
un solvente acuoso;
un tensioactivo; y
un polisacárido.
2. El fluido de la reivindicación 1, donde dicho polisacárido se deriva de una goma galactomannan.
3. El fluido de la reivindicación 2, donde dicha goma galactomannan se selecciona a partir del grupo que consiste de guar hidroxipropil, goma guar, guar hidroxipropil carboximetil y sus mezclas.
4. El fluido de la reivindicación 2, donde dicha goma galactomannan es guar hidroxipropil.
5. El fluido de la reivindicación 1, donde dicho tensioactivo es sulfato de alcohol etoxilatado.
6. El fluido de la reivindicación 5, donde dicho sulfato de alcohol etoxilatado se selecciona a partir del grupo que consiste de sulfato de éter lauril de amonio, sulfato lauril de sodio, sulfato lauril de amonio, sulfato lauril de trietanolamina, sulfato alfaolefina de sodio, y sus mezclas.

7. El fluido de la reivindicación 1, donde dicho polímero está presente en una cantidad entre alrededor de 1,5 y alrededor de 3,0% p/v.

8. El fluido de la reivindicación 1, que comprende adicionalmente una sal.

9. El fluido de la reivindicación 8, donde dicha sal es una sal monovalente.

10. El fluido de la reivindicación 8, donde dicha sal se selecciona a partir del grupo que consiste de cloruro de potasio, cloruro de sodio, acetato de potasio, acetato de sodio y sus mezclas.

11. El fluido de la reivindicación 8, donde dicha sal es cloruro de potasio.

12. El fluido de la reivindicación 6, donde dicho fluido contiene dicho polímero en una cantidad entre alrededor de 1,5 y alrededor de 3,0% p/v, dicho tensioactivo en una cantidad entre alrededor de 0,3 y alrededor de 1,0 % p/v, y dicha sal en una cantidad entre alrededor de 0,1% y alrededor de 0,5% p/v.

13. El fluido de la reivindicación 1, donde el fluido es un fluido espumado que contiene un gas.

14. El fluido de la reivindicación 13, donde dicho gas se selecciona a partir del grupo que consiste de nitrógeno, aire, gas natural, CO₂ y sus mezclas.

15. El fluido de la reivindicación 13, donde el fluido espumado tiene una viscosidad de entre alrededor de 1,15 y alrededor de 5,0 ppg.

16. El fluido de la reivindicación 13, donde el fluido espumado tiene una viscosidad de entre alrededor de 25 y alrededor de 50 cP para calidades entre alrededor de 80 y alrededor de 95%, a temperaturas de hasta alrededor de 82°C.

17. El fluido de la reivindicación 13, donde el fluido espumado es estable cuando se expone a contaminantes de petróleo y sal.

18. El fluido de la reivindicación 13, donde el fluido espumado es estable cuando se mezcla con petróleo crudo hasta por lo menos alrededor de 50% p/v de petróleo crudo.

19. El fluido de la reivindicación 13, donde el fluido espumado tiene un tiempo de vida medio de por lo menos alrededor de 17 minutos.

20. El fluido de la reivindicación 13, donde el fluido espumado es estable a temperaturas de hasta por lo menos alrededor de 82°C.

21. Un fluido de perforación de espuma, que comprende:
una fase líquida que comprende un solvente acuoso, un polisacárido y un tensioactivo; y
una fase de gas seleccionada a partir del grupo que consiste de aire, nitrógeno, gas natural, CO₂ y sus combinaciones.

EXTRACTO

Un fluido espumable de perforación se proporciona el cual incluye un solvente acuoso; un tensioactivo; y un polisacárido preferiblemente derivado de una goma galactomannan. El fluido de perforación espumado incluye una fase líquida que consiste del solvente acuoso, polisacárido y tensioactivo, y una fase de gas de aire, nitrógeno, gas natural, CO₂ y sus mezclas. El fluido de perforación es estable en presencia de petróleo crudo y sal y ambientalmente amigable.

ES TRADUCCIÓN FIEL Y COMPLETA DEL DOCUMENTO ANEXO
TERMINADA ESTE 11 DE NOVIEMBRE DE 2002.



2do. EXAMEN DE FORMA PATENTE DE INVENCION

Folio 83

Radicación no 02-76282

Concepto Técnico no 46

Clasificación Internacional de Patentes: C09K 7/2

Practicado el examen de acuerdo a lo establecido en el Art. 38 de la Decisión 486 se determinó que esta solicitud de Patente de Invención:

- SI ☒ NO ☐ Contiene un resumen de la invención (Art.26-e).
- SI ☒ NO ☐ Contiene el título o nombre de la invención (Art.27-d).
- SI ☒ NO ☐ Contiene la descripción de la invención (Art.26-b).
- SI ☒ NO ☐ NO ES APLICABLE ☐ Contiene los dibujos necesarios para comprender la invención (Art.26-d)
- SI ☒ NO ☐ Contiene una o más reivindicaciones. (Art.26-c).
- SI ☐ NO ☐ NO ES APLICABLE ☒ Han sido desarrollados los productos y/o procedimientos a partir de recursos genéticos o de sus productos derivados de los que cualquiera de los Países Miembros es país de origen. (Art. 26- h).
- SI ☐ NO ☐ NO ES APLICABLE ☒ Los productos y/o procedimientos han sido obtenidos o desarrollados a partir de los conocimientos tradicionales de las comunidades indígenas, afro americanas, o locales de los países miembros, de acuerdo a lo establecido en la Decisión 391 y sus modificaciones y reglamentaciones vigentes.(Art.26-i).
- SI ☐ NO ☒ La invención se refiere a un producto relativo a un material biológico. (Art.26-j).
- SI ☒ NO ☐ NO ES APLICABLE ☐ La prioridad coincide con la materia reivindicada.
- SI ☒ NO ☐ CUMPLE LOS REQUISITOS TÉCNICOS

OBSERVACIONES Y OTROS: SI ☐ NO ☒ ver hoja(s) anexa(s)

EXAMINADOR TÉCNICO
202056

Bogotá D. C., enero 22 de 2004.



2020
Bogotá DC

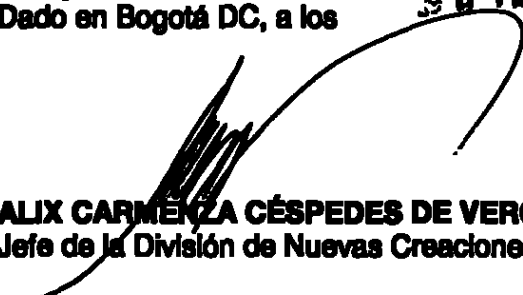
Folio 84

Doctor
RAMIRO CASTRO DUQUE
Apoderado
INTEVEP S.A.

REFERENCIA:	Radicación No.	02-76282
	Trámite	002
	Evento	001
	Actuación	416
	Oficio No.	51
	Folios	001

Teniendo en cuenta que la solicitud de privilegio de patente que se tramita bajo el expediente indicado en la referencia, reúne los requisitos de forma establecidos en los artículos 26 y 27 de la Decisión 486 de la Comisión de la Comunidad Andina, y en las demás disposiciones vigentes sobre la materia, se envía el extracto de la solicitud a la Oficina de Comunicaciones para efecto de su publicación en la Gaceta de Propiedad Industrial, conforme lo establece el artículo 40 de la misma Decisión.

Cúmplase
Dado en Bogotá DC, a los 03 FEB. 2004


ALIX CARMEN CÉSPEDES DE VERGEL
Jefe de la División de Nuevas Creaciones

202056