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(72) **Inventeurs/Inventors:**
DIMITROFF, JEFF, CA;
CRAWFORD, GRAHAM, CA;
JACOBS, TREVOR, CA;
GHESNIER, IOAN, CA

(73) **Propriétaire/Owner:**
BLACKSTONE DRILLING FLUIDS LIMITED, CA

(74) **Agent:** DENTONS CANADA LLP

(54) **Titre :** LIQUIDE DE FORAGE POUR DES FORMATIONS DE CHARBON

(54) **Title:** DRILLING FLUID FOR COAL FORMATIONS

(57) **Abrégé/Abstract:**

Composition and method of strengthening a borehole in a coal formation, said method comprising applying to said coal formation a fluid composition comprising a brine component; a carbohydrate component and a strengthening component.

ABSTRACT

Composition and method of strengthening a borehole in a coal formation, said method comprising applying to said coal formation a fluid composition comprising a brine component; a carbohydrate component and a strengthening component.

DRILLING FLUID FOR COAL FORMATIONS

FIELD OF THE INVENTION

The present invention relates to drilling fluids and specifically aqueous brine drilling fluids that contain one or more fluid loss and wellbore strengthening additive in addition to common additives such as corrosion inhibitors, oxygen scavenger, defoamers, lubricants and other materials. The drilling fluid may be suitable for drilling through formations that contain coal, where strengthening the wellbore and preventing fluid loss to the formation while drilling is required.

BACKGROUND OF THE INVENTION

Brines have been commonly used as drilling fluids because they offer a wide density range without the need of suspended solids, also known as weighting materials. Brines are solutions of dissolved halides, nitrates or carboxylates of mono or divalent cations such as sodium, potassium, cesium, calcium and zinc.

Brine drilling has proven successful in increasing bit life and rate of penetration by 2-3 times because of the minimal amount of solids in the system. Plastic Viscosity is the restriction to flow due to the amount of solids in the system. Because of the reduced solids content, brines have inherently low Plastic Viscosity.

According to the American Association of Drilling Engineers paper #AADE-06-DF-HO-10 rate of penetration is linked to the Plastic Viscosity. In summary, the paper states that the lower the Plastic Viscosity the more effective weight that can be applied to the bit resulting in faster drilling.

Besides being cost effective and showing many performance benefits, well bore stability issues have been seen when drilling with brines through coal.

Canadian patent CA 2,451,952 suggests the use of cationic polymers to impart borehole stability in subterranean coal formations.

United States patent no. US 9,102,865 B2 and patent application no. US 2010/0210482 A1 teach a method comprising placing a wellbore servicing fluid comprising a cationic polymer into wellbore wherein the cationic polymer has a molecular weight of from about 300,000 Daltons to about 10,000,000 Daltons. A composition comprising a wellbore servicing fluid, a cationic polymer, and a brine.

United States patent no. US 6,124,244A teaches a drilling fluid comprising a blend of brine and additives for maintaining rheological properties in a neutral or slightly acidic brine and a method for using the drilling fluid to drill into a producing formation are disclosed. The drilling fluid comprises viscosifying polymer and fluid loss polymer that function in the brine without substantially adversely affecting their properties. The brine is substantially free of insoluble solids. The viscosifying polymer and/or the fluid loss control polymer can be acid soluble. Zinc salts in the form of zinc bromide alone or in a mixture of zinc bromide and calcium bromide are added to increase the density of the brine solution. The viscosifying polymer has pendant amide and sulfonic acid or sulfonate groups. Alternatively or additionally, the viscosifying polymer comprises a polysaccharide. The fluid loss control polymer can comprise a cross-linked, cationic or amphoteric starch. Soluble solids are dispersed in the brine.

United States patent no. US 5,635,458A teaches a water-based drilling fluid that reduces water adsorption and hydration of argillaceous rocks. The drilling fluid comprises a glycol with a molecular weight of less than about 200, an organic cationic material such as salts of choline or an organic salt of potassium, a filtration control agent, a viscosifier and water.

United States patent no. US 5,620,947A teaches a water-based well completion and workover fluid is disclosed which has improved rheological and filtration control properties at temperatures up to about 450° F. The composition comprises a saturated brine solution, a sized-salt that is insoluble in the saturated brine solution, and a water-soluble filtration additive comprising a polymer produced from at least two monomers selected from the group consisting of 2-acrylamido-2-methylpropanesulfonate, acrylamide, and 2-vinylpyrrolidone.

Patent Application WO 1995014066 A1 discloses that the swelling and migration of subterranean clay is inhibited during drilling for and stimulation of the production of hydrocarbon fluids, and preparation therefor, by treating said formations with a copolymer of about 5 % to about 50 % of an anionic monomer such as acrylic acid, methacrylic acid, or 2-acrylamido-2-

methyl propane sulfonic acid and the balance a cationic monomer selected from dimethyl diallyl ammonium chloride, or acryloxy or methacryloxy ethyl, propyl or 3-methyl butyl trimethyl ammonium chlorides or methosulfates. Permeability damage to the formation is reduced in the presence of the copolymer; it is particularly effective in spite of the presence of a foaming agent.

Despite the existence of the above-mentioned technologies, there still exists a need for a composition based on a brine drilling fluid that has minimal viscosity with an extremely low fluid loss that can stabilize coal and still give the performance enhancement of the brine drilling fluids.

SUMMARY OF THE INVENTION

According to a first aspect of the present invention, there is disclosed an aqueous brine drilling fluid composition that contains at least one fluid loss and wellbore strengthening additive. According to a preferred embodiment, the composition further comprises additives selected from the group consisting of: corrosion inhibitors, oxygen scavenger, defoamers, lubricants and combinations thereof.

According to another aspect of the present invention, the drilling fluid composition is suitable for drilling through formations that contain coal, where strengthening the wellbore and preventing fluid loss to the formation while drilling is required.

According to another preferred embodiment of the present invention, the at least one fluid loss and wellbore strengthening additives is selected from the group consisting of: sulphonated asphalt, wax, oxidized bitumen, resin, crosslinked carboxymethyl starch and low molecular weight carboxymethyl cellulose.

According to an aspect of the present invention, there is provided a brine-based drilling fluid for use in coal formations, said fluid comprising: a brine component; a carbohydrate component and a strengthening component. Preferably, the strengthening component is selected from the group consisting of: sulphonated asphalt, oxidized bitumen, resin, wax and a combination thereof. More preferably, the strengthening component is sulphonated asphalt.

According to a preferred embodiment, the carbohydrate component is selected from the group consisting of: derivatized starch, low molecular weight carboxymethyl cellulose and combinations thereof.

According to an aspect of the present invention, there is provided a use of a composition comprising a brine component; a carbohydrate component and a strengthening component to strengthen a borehole in a coal formation.

According to an aspect of the present invention, there is provided a method of strengthening a borehole in a coal formation, said method comprising applying to said coal formation a fluid composition comprising a brine component; a carbohydrate component and a strengthening component.

According to yet another aspect of the present invention, there is provided a fluid composition for use in drilling comprising:

- a brine-based fluid;
- a carbohydrate component in an amount ranging from 4 to 20 kg/m³; and
- a strengthening component in an amount ranging from 5 to 25 kg/m³.

Preferably, the carbohydrate component is present in an amount ranging from 8 to 15 kg/m³. Also preferably, the strengthening component is present in an amount ranging from 10 to 15 kg/m³.

According to a preferred embodiment, the brine is selected from the group consisting of: calcium chloride brine; potassium formate brine; calcium nitrate brine; and combinations thereof.

According to an aspect of the present invention, there is provided a fluid composition for use in drilling through a coal formation comprising:

- a calcium chloride brine having a specific gravity ranging from 1.100 to 1.355;
- a carbohydrate component in an amount ranging from 4 to 20 kg/m³; and
- a strengthening component in an amount ranging from 5 to 25 kg/m³.

According to yet another aspect of the present invention, there is provided a fluid composition for use in drilling through a coal formation comprising:

- a potassium formate brine having a specific gravity ranging from 1.300 to 1.500;
- a carbohydrate component in an amount ranging from 4 to 20 kg/m³; and
- a strengthening component in an amount ranging from 5 to 25 kg/m³.

According to yet another aspect of the present invention, there is provided a fluid composition for use in drilling through a coal formation comprising:

- a brine comprising calcium chloride and calcium nitrate having a specific gravity ranging from 1.355-1.600;
- a carbohydrate component in an amount ranging from 4 to 20 kg/m³; and
- a strengthening component in an amount ranging from 5 to 25 kg/m³.

According to yet another aspect of the present invention, there is provided a method of reducing borehole instability in a coal formation, said method comprising the steps of:

- providing fluid composition for use in drilling comprising:
 - a brine-based fluid;
 - a carbohydrate component in an amount ranging from 4 to 20 kg/m³; and
 - a strengthening component in an amount ranging from 5 to 25 kg/m³.
- injecting the fluid composition into the borehole; and
- allowing the fluid composition sufficient contact time onto a surface of the coal formation to permit deposition of at least one of the carbohydrate component and the strengthening component onto the surface of the coal formation.

According to yet another aspect of the present invention, there is provided a fluid composition for use in strengthening a borehole in a coal formation when drilling through said coal formation comprising:

- a brine comprising calcium chloride and calcium nitrate having a specific gravity ranging from 1.355-1.600;
- a carbohydrate component in an amount ranging from 4 to 20 kg/m³; and
- a strengthening component in an amount ranging from 5 to 25 kg/m³;

wherein, when is use, the PV is less than 15 mPa·s, the YP is less than 2 Pa and the HTHP @ 80°C is less than 6 mL.

BRIEF DESCRIPTION OF THE FIGURES

The invention may be more completely understood in consideration of the following description of various embodiments of the invention in connection with the accompanying figures, in which:

Figure 1a is a picture showing coal pieces broken off from the interior of a wellbore drilled through a coal formation and treated with a conventional coal wellbore treatment composition; and

Figure 1b is a picture showing coal pieces broken off from the interior of a wellbore drilled through a coal formation and treated with a coal wellbore treatment composition according to a preferred embodiment of the present invention.

DETAILED DESCRIPTION OF A PREFERRED EMBODIMENT

Unlike most reservoir rocks, coal has low integrity and is friable. Anthracite, which is one of the hardest forms of coal has a hardness of 2.2 on the Mohs hardness scale. This contributes to wellbore instability when drilling through coal. As described by T. Gentzis in his paper published in Energy Sources, Part A: Recovery, Utilization, and Environmental Effects, Volume 33, Issue 24, 2011, the formation of a filter cake or wall coating is crucial when drilling horizontally in weak coals at depth. By creating an effective filter cake, the drilling fluid maintains a constant positive pressure ($\Delta P = BHP - FP$; BHP = bottomhole pressure and FP = formation pressure) on the walls of the wellbore and prevent it from collapsing.

The inventors have surprisingly and unexpectedly found that a drilling fluid can be built on a brine backbone that has the typical performance benefits of brines while maintaining wellbore stability when drilling through coal. It has been hypothesized by the inventors that the carbohydrate component when injecting into the borehole and allowed time to make contact with the coal formation forms a coat on the coal surface such as a base layer. It is also thought that the strengthening component (such as sulphonated asphalt in one preferred embodiment) acts as a glue on the coal surface.

According to a preferred embodiment, the brine-based drilling fluid of the present invention may comprise one or more of the following: halides, nitrates or carboxylates of mono or divalent cations such as sodium, potassium, cesium, calcium and zinc, a fluid loss additive, a wellbore strengthening additive, corrosion inhibitors, oxygen scavenger, defoamers, lubricants and other materials. It is believed that the fluid loss additive (the carbohydrate component) and wellbore strengthening additive work synergistically to provide the desired wellbore stability in a coal formation throughout the drilling operation.

In yet another aspect, the fluid loss additive is selected from the group of crosslinked and non-crosslinked derivatized starch and low molecular weight carboxymethylcellulose. Wellbore strengthening additives are selected from the group consisting of: sulphonated asphalt, oxidized bitumen, resin or wax.

According to a preferred embodiment of the present invention, there is provided a use of the additives of the present invention as described herein in a drilling fluid.

According to a preferred embodiment of the present invention, there is provided a method of preparing a drilling fluid, by combining one or more fluid loss and wellbore strengthening additives of the present invention as described herein with a brine phase and optionally one or more additional drilling fluid components as described herein.

According to a preferred embodiment of the present invention, there is provided a method of drilling into a formation that contains coal, by circulating a drilling fluid in the well that contains the additive of the present invention as described herein and optionally one or more additional drilling fluid components as described herein. The drilling fluid may be circulated at any stage during drilling or post-drilling operations.

According to a preferred embodiment of the present invention, there is provided a drilling fluid composition that strengthens the wellbore and alleviates wellbore instability issues to an acceptable level when used in a drilling operation.

According to a preferred embodiment of the present invention, the additives of the present invention that strengthen the wellbore and/or prevent wellbore instability are selected from the group of derivatized starch, low molecular weight carboxymethyl cellulose, sulphonated asphalt, oxidized bitumen, resin and paraffin wax.

Oil soluble hydrocarbon resins considered within the scope of the present invention are selected from the group consisting of: synthetic aliphatic or aromatic homo or heteropolymers obtained by the polymerization of at least one of the following monomers: vinyl toluene, dicyclopentadiene, indene, methylstyrene, styrene, methylenedienes, pentadiene, 2-methyl-2-butene, cyclopentadiene, cyclopentene. The resulting polymer contains many double bonds that can be further hydrogenated to obtain fully or partially hydrogenated hydrocarbon resins.

Hydrogenation of the polymer generally increases the softening temperature of the hydrocarbon resin.

Paraffin wax is a natural product that consists mostly of straight chain and branched hydrocarbons that typically contain 20 to 50 carbon atoms.

According to a preferred embodiment of the present invention, the drilling fluid composition has a concentration of the fluid loss and wellbore strengthening additive sufficient to form a strong filter cake that stabilizes the wellbore. The concentration of the additive may be up to about 2% by weight of the drilling fluid. In one aspect, the additive is present at 0.04% to 2% w/w.

In the examples evaluating the various preferred embodiments of the present invention, brines of various densities were used as the base fluids to which was added from 8 to 15 kg/m³ of crosslinked carboxymethyl starch, 10 kg/m³ sulphonated asphalt, 5 L/m³ corrosion inhibitor and 5 L/m³ oxygen scavenger.

The drilling fluid may alternatively comprise essentially a water base and the one or more of the additives of the present invention without the addition of a viscosifier, fluid loss or anti-accretion additives.

In order to assess the effectiveness of the drilling fluid compositions of the present invention to form a strong filter cake that prevents loss of drilling fluid into the coal formation the following experiments were conducted.

Example 1: preparation of drilling fluid

Brines of various densities were used as the base fluids to which was added 8 to 15 kg/m³ crosslinked carboxymethyl starch, 10 kg/m³ sulphonated asphalt, 5 L/m³ corrosion inhibitor and 5 L/m³ oxygen scavenger. In addition, 15 kg/m³ coal dust was added to simulate drilled cuttings. The mixture was mixed on a Hamilton Beach mixer and aged for 16 h in order to allow the chemical additives to hydrate in brine. Rheology and fluid loss properties were measured at 50 and 80 °C, respectively in accordance with API 13I testing procedures. In the tables below, PV represents the slope of the shear stress/shear rate line above the yield point. YP indicates the

yield stress extrapolated to a shear rate of zero. HPHT is identified as a test to measure the static filtration behavior of water mud or oil mud at elevated temperature.

Table 1 reports the results of a series of tests carried out to assess the Properties of drilling fluid built with 1.3 S.G. CaCl_2 brine with no addition of starch, addition of 15kg/m^3 of starch and addition of 8kg/m^3 of starch. An indication of "no fluid retention" means that the fluid penetrates the coal formation rather than coating it at the surface. Preferably, a YP value of less than 2 is desirable. Preferably, a PV value of less than 15 is desirable. The lower the HTHP value obtained the better the composition rates. Ultimately, the best combination of the three values provides the most desirable choice of composition to be used.

Table 1: Properties of drilling fluid built with 1.3 S.G. CaCl_2 brine

Rheology @ 50 °C	Unit	CaCl_2 brine 1.3 S.G. (No Starch added)	15 kg/m^3 Starch	8 kg/m^3 Starch
600	Dial Reading	10.3	17.8	10.9
300	Dial Reading	5.4	9.7	5.9
200	Dial Reading	3.5	6.9	3.8
100	Dial Reading	1.8	3.9	2.1
6	Dial Reading	0.4	0.2	0.3
3	Dial Reading	0.3	0.1	0.3
PV	mPa·s	4.9	8.2	5.0
YP	Pa	0.25	0.9	0.45
Gel – 10 second	Dial Reading	0.3	0	0.3
Gel – 10 minute	Dial Reading	0	0	0.3
HTHP @ 80 °C	mL	No fluid retention	4.2	4.9

Table 2 the results of a series of tests carried out to assess the properties of drilling fluid built with 1.4 S.G. $\text{CaCl}_2/\text{Ca}(\text{NO}_3)_2$ brine with no addition of starch, addition of 15kg/m^3 of starch and addition of 8kg/m^3 of starch.

Table 2: Properties of drilling fluid built with 1.3 S.G. Potassium Formate brine

Rheology @ 50 °C	Unit	KOOCH brine 1.3 S.G. (No Starch added)	15 kg/m ³ Starch	8 kg/m ³ Starch
600	Dial Reading	3.2	9.0	5.1
300	Dial Reading	1.8	5.0	2.8
200	Dial Reading	1.6	3.3	2.3
100	Dial Reading	1.5	1.7	1.0
6	Dial Reading	0.3	0.2	0.4
3	Dial Reading	0.2	0.2	0.4
PV	mPa.s	1.3	4.0	2.1
YP	Pa	0.2	0.5	0.35
Gel – 10 second	Dial Reading	0.2	0.2	0.4
Gel – 10 minute	Dial Reading	0.3	0.1	0.2
HTHP @ 80 °C	mL	No fluid retention	8.0	8.6

Table 3 reports the results of a series of tests carried out to assess the properties of drilling fluid built with 1.4 S.G. $\text{CaCl}_2/\text{Ca}(\text{NO}_3)_2$ brine with no addition of starch, addition of 15kg/m^3 of starch and addition of 8kg/m^3 of starch.

Table 3: Properties of drilling fluid built with 1.4 S.G. $\text{CaCl}_2/\text{Ca}(\text{NO}_3)_2$ brine

Rheology @ 50 °C	Unit	$\text{CaCl}_2/\text{Ca}(\text{NO}_3)_2$ brine 1.4 S.G. (No Starch added)	15 kg/m ³ Starch	8 kg/m ³ Starch
600	Dial Reading	10.3	33.8	19.7
300	Dial Reading	5.4	18.2	10.5
200	Dial Reading	3.5	12.6	7.2
100	Dial Reading	1.8	6.8	3.8
6	Dial Reading	0.4	0.5	0.4
3	Dial Reading	0.3	0.4	0.3
PV	mPa.s	4.9	15.6	9.4
YP	Pa	0.25	1.15	0.45
Gel – 10 second	Dial Reading	0.3	0.2	0.3
Gel – 10 minute	Dial Reading	0	0.2	0.1
HTHP @ 80 °C	mL	No fluid retention	2.8	5.0

Table 4 reports the results of a series of tests carried out to assess the properties of drilling fluid built with 1.5 S.G. $\text{CaCl}_2/\text{Ca}(\text{NO}_3)_2$ brine with no addition of starch, addition of 15kg/m³ of starch and addition of 8kg/m³ of starch.

Table 4: Properties of drilling fluid built with 1.5 S.G. $\text{CaCl}_2/\text{Ca}(\text{NO}_3)_2$ brine

Rheology @ 50 °C	Unit	$\text{CaCl}_2/\text{Ca}(\text{NO}_3)_2$ brine 1.5 S.G. (No Starch added)	15 kg/m ³ Starch	8 kg/m ³ Starch
600	Dial Reading	19.7	62.9	36.0
300	Dial Reading	9.9	34.6	18.9
200	Dial Reading	6.4	24.2	12.7
100	Dial Reading	3.2	13.2	6.8

6	Dial Reading	0.4	1.0	0.5
3	Dial Reading	0.2	0.7	0.4
PV	mPa.s	9.4	28.7	17.1
YP	Pa	0.25	2.9	0.8
Gel – 10 second	Dial Reading	0.4	0.4	0.3
Gel – 10 minute	Dial Reading	0.2	0.5	0.2
HTHP @ 80 °C	mL	No fluid retention	3.6	4.0

Example 2: Field trial

The composition according to a preferred embodiment of the present invention was prepared and used in a wellbore drilled through a coal formation. The intent was to demonstrate that it provided additional wellbore strength thus maintaining wellbore integrity to allow for drilling and other operations to be successfully completed.

Numerous fluids were used during the drilling operation, these included:

JetCorr[®] at a concentration ranging between 8-10L/m³;

JetScav[®] at a concentration of 3L/m³ initially and then 1-2L/m³ monitored at wellsite;

JetSeal[®] at a concentration of 12kg/m³; and

CoalCure W[®] at a concentration ranging between 8-10kg/m³.

JetCorr[®] is a corrosion inhibiting composition comprising ethanol, 2,2'-oxybis-, a reaction product with ammonia). It is a filming amine as it lays a protective coating on pipe to prevent corrosion cell from forming. JetScav[®] is an oxygen scavenging composition comprising Diethylhydroxylamine. It is designed to react with dissolved oxygen in the fluid. JETSEAL[®] is a modified starch composition comprising carboxynethyl starch. It is hydrated in the brine and provides an increase in the viscosity of the fluid. COAL CURE W[®] is a composition comprising sulphonated asphalt, sodium sulphonated asphalt. It is a malleable composition whose function is mainly to seal and bond coal pleats. JETZAN[®] was also used in an amount ranging from 3-6

kg/m³. This composition comprises a xanthan gum and is a biopolymer for increasing the viscosity of the fluid.

During the trial, many chemicals were used for pH control, these included: Brine Buffer Amine (comprising an alkoxylated amine); MagOX (Magnesium Oxide); lime (Calcium Hydroxide); and caustic soda (Sodium Hydroxide).

Many operations were performed during the drilling of the wellbore through a coal formation, this ranged from tripping (pulling out the entire drillstring from the well bore) to reaming the interior of the wellbore after reaching a distance of 4000 m from the wellhead. The use of conventional compositions yielded a more brittle interior wellbore as exemplified in Figure 1a. After treatment with a composition according to a preferred embodiment of the present invention, the reaming along a similar distance yielded coal fragments (from the interior of the wellbore) as seen in Figure 1b. There is a clear difference between the conventional treatment and treatment with a composition according to the present invention. Treatment with a composition according to the present invention yielded a clearly stronger inner wellbore through a coal formation. This stronger inner wellbore provides wells with greater integrity facilitates performing successfully various operations when dealing with wellbores drilled through coal formations. Such results also leads to shortened durations for the need of a drill team where the savings on the need for a drilling crew can be upwards of 100,000\$ while the total savings reach well beyond 100,000\$ compared to the treatment with a conventional coal well treatment. Savings can come in various forms, from fewer tripping steps, to fewer equipment breakdowns, less downtime and increased rate of penetration.

The terms and descriptions used herein are set forth by way of illustration only and are not meant as limitations unless otherwise specifically indicated. Those skilled in the art will recognize that many variations are possible within the scope of the invention as defined in the following claims, and their equivalents, in which all terms are to be understood in their broadest possible sense unless otherwise specifically indicated. While the compositions shown and described in detail herein are fully capable of attaining the above-described aspects of the invention, the persons skilled in the art will understand that they are but a preferred embodiment of the present invention and the invention is not to be limited to those embodiments.

CLAIMS

1. A brine-based drilling fluid for use in coal formations, said fluid comprising:
 - a brine component;
 - a carbohydrate component; and
 - a strengthening component selected from the group consisting of: sulphonated asphalt, oxidized bitumen, resin, wax and a combination thereof.
2. The brine-based drilling fluid according to claim 1, wherein the strengthening component is sulphonated asphalt.
3. The brine-based drilling fluid according to any one of claims 1 to 2, wherein the carbohydrate component is selected from the group consisting of: derivatized starch, low molecular weight carboxymethyl cellulose and combinations thereof.
4. Use of a composition comprising a brine component; a carbohydrate component and a strengthening component selected from the group consisting of: sulphonated asphalt, oxidized bitumen, resin, wax and a combination thereof to strengthen a borehole in a coal formation.
5. Method of strengthening a borehole in a coal formation, said method comprising applying to said coal formation a fluid composition comprising a brine component; a carbohydrate component and a strengthening component selected from the group consisting of: sulphonated asphalt, oxidized bitumen, resin, wax and a combination thereof.
6. A fluid composition for use in drilling comprising:
 - a brine-based fluid;
 - a carbohydrate component in an amount ranging from 4 to 20 kg/m³; and
 - a strengthening component in an amount ranging from 5 to 25 kg/m³;wherein said strengthening component is selected from the group consisting of: sulphonated asphalt, oxidized bitumen, resin, wax and a combination thereof.
7. The fluid composition according to claim 6 wherein the carbohydrate component is present in an amount ranging from 8 to 15 kg/m³.

8. The fluid composition according to any one of claims 6 and 7, wherein the strengthening component is present in an amount ranging from 10 to 15 kg/m.

9. The fluid composition according to any one of claims 6 to 8, wherein the brine is selected from the group consisting of: calcium chloride brine; potassium formate brine; calcium nitrate brine; and combinations thereof.

10. A fluid composition for use in drilling through a coal formation comprising:
- a calcium chloride brine having a specific gravity ranging from 1.100 to 1.355;
 - a carbohydrate component in an amount ranging from 4 to 20 kg/m³; and
 - a strengthening component in an amount ranging from 5 to 25 kg/m³;

wherein said strengthening component is selected from the group consisting of: sulphonated asphalt, oxidized bitumen, resin, wax and a combination thereof.

11. A fluid composition for use in drilling through a coal formation comprising:
- a potassium formate brine having a specific gravity ranging from 1.300 to 1.500;
 - a carbohydrate component in an amount ranging from 4 to 20 kg/m³; and
 - a strengthening component in an amount ranging from 5 to 25 kg/m³;

wherein said strengthening component is selected from the group consisting of: sulphonated asphalt, oxidized bitumen, resin, wax and a combination thereof.

12. A fluid composition for use in drilling through a coal formation comprising:
- a brine comprising calcium chloride and calcium nitrate having a specific gravity ranging from 1.355-1.600;
 - a carbohydrate component in an amount ranging from 4 to 20 kg/m³; and
 - a strengthening component in an amount ranging from 5 to 25 kg/m³.

wherein said strengthening component is selected from the group consisting of: sulphonated asphalt, oxidized bitumen, resin, wax and a combination thereof.

13. A method of reducing borehole instability in a coal formation, said method comprising the steps of:
- providing fluid composition for use in drilling comprising:
 - a brine-based fluid;
 - a carbohydrate component in an amount ranging from 4 to 20 kg/m³; and

- a strengthening component in an amount ranging from 5 to 25 kg/m³; wherein said strengthening component is selected from the group consisting of: sulphonated asphalt, oxidized bitumen, resin, wax and a combination thereof;
- injecting the fluid composition into the borehole; and
- allowing the fluid composition sufficient contact time onto a surface of the coal formation to permit deposition of at least one of the carbohydrate component and the strengthening component onto the surface of the coal formation.

14. A fluid composition for use in strengthening a borehole in a coal formation when drilling through said coal formation comprising:

- a brine comprising calcium chloride and calcium nitrate having a specific gravity ranging from 1.355-1.600;
- a carbohydrate component in an amount ranging from 4 to 20 kg/m³; and
- a strengthening component in an amount ranging from 5 to 25 kg/m³, wherein said strengthening component is selected from the group consisting of: sulphonated asphalt, oxidized bitumen, resin, wax and a combination thereof;

wherein, when is use, the PV is less than 15 mPa.s, the YP is less than 2 Pa and the HTHP @ 80°C is less than 6 mL.

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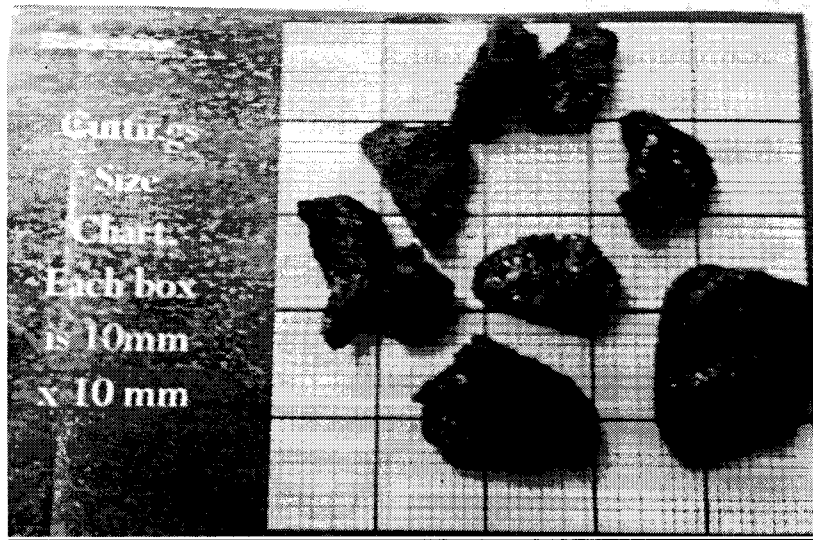


Figure 1a

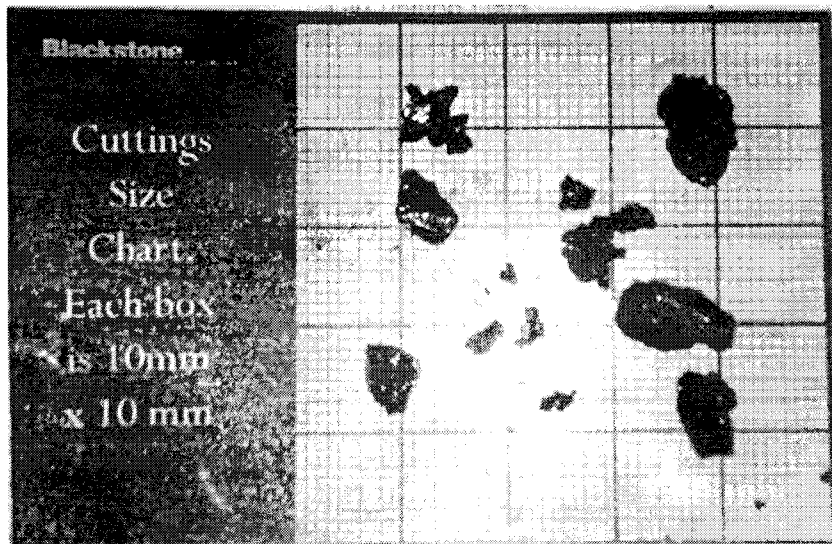


Figure 1b