The drilling fluid additive (10) may also include acid soluble granules (14).
Published:

— with international search report (Art. 21(3))
DRILLING FLUID ADDITIVE

Field of the Invention

The present invention relates generally to drilling fluid additives and, in particular, to drilling fluid additives for use in sealing pores and/or fractures in drilled formations to prevent or at least limit lost circulation of drilling fluid. In particular, the present invention relates to drilling fluid additives for use in sealing highly porous/fractured drilled formations.

Although the present invention will be described with particular reference to sealing pores and fractures inside boreholes for oil, gas, and geothermal wells, it will be appreciated that it may be used to seal pores and fractures in other types of wells.

Background Art

Wells such as oil, gas, and geothermal wells are typically drilled to depths of thousands of metres below the Earth's surface. Such wells are drilled using a drill bit that is positioned at the bottom of the well borehole, and that is connected to a drill pipe that extends up to the surface. A drilling fluid such as drilling mud is pumped down the drill pipe to the drill bit, and is then circulated back up an annulus between the borehole and the drill pipe so that drill cuttings produced by the cutting action of the drill bit on the drilled formation are carried up to the surface by the drilling fluid. At the surface, the drill cuttings are usually removed from the drilling fluid so that the fluid can be recirculated through the borehole.

Various problems can occur while drilling such wells. The problem of "lost circulation" occurs when drilling fluid escapes from the borehole through pores and fractures in the drilled formation instead of returning up the annulus between the borehole and the drill pipe. An undesirable increase in the amount of torque which is required to rotate the drill pipe can sometimes be experienced while the drill pipe is being rotated. Also, sometimes the drill pipe can be subjected to excessive drag while it is being moved up or down in the borehole. Other problems that are associated with unstable boreholes are sloughing of formation which can occur when drilling through formations such as coal and
shale formations, and differential sticking where the drill pipe becomes stuck while drilling.

All of these problems are a common occurrence when drilling oil, gas, and geothermal wells. The occurrence of any of these problems can add millions of dollars to the cost of drilling a well. Furthermore, if there is a well blowout as a result of any of the aforementioned problems occurring, the blowout can be fatal to people who are located near the site of the blowout at the time that it occurs.

In the past, a common practice to combat these problems was to add ground coconut shell, ground-up Formica or other inorganic fibres to the drilling fluid to create a "pill" which is then pumped downhole. However, the use of these additives/supplements has been found to be unable to inherently solve the various drilling problems, especially the problem of lost circulation, and they can actually cause further damage if they are used in the producing zone of the drilled formation and if they plug the pores of the producing zone irreversibly. In particular, the addition to the drilling fluid of non-biodegradable particles/solids that can penetrate the formation may permanently obstruct the producing zone thus making the well non-productive.

Organic drilling fluid additive products that are biodegradable have been developed from rice husks, peanut shells, and softwood in an attempt to overcome the problem of permanent producing zone obstruction which is associated with non-biodegradable additives. However, these organic products have been found to have some disadvantages in their application as drilling fluid additives due to their natural properties.

A particular organic drilling fluid additive that has been found to be effective at sealing pores and fractures in formations and that is therefore able to prevent or limit lost circulation when drilling such formations is FRACSEAL™ (Coarse) drilling fluid additive. The additive, which includes a blend of long teakwood fibres and short cotton fibres, is disclosed in published Australian Patent Application No. 200172159, the contents of which are incorporated herein by reference.

It has been found that FRACSEAL™ (Coarse) drilling fluid additive is only effective in sealing pores and fractures in formations that have a permeability in the range of 2000 - 5000 mD (milli Darcy). This is unfortunate, as it is known that severe lost circulation that occurs when drilling highly
porous/fractured formations having permeability that is greater than 5000 mD costs oil companies US$2-3 billion per annum.

It would therefore be desirable to have a drilling fluid additive that combines the advantages of FRACSEAL™ (Coarse) drilling fluid additive and that is able to seal formations having a permeability that is greater than 5000 mD.

It is against this background that the present invention has been developed.

Summary of the Invention

It is an object of the present invention to overcome, or at least ameliorate, one or more of the deficiencies of the prior art mentioned above, or to provide the consumer with a useful or commercial choice.

Other objects and advantages of the present invention will become apparent from the following description, taken in connection with the accompanying drawing, wherein, by way of illustration and example, a preferred embodiment of the present invention is disclosed.

According to a first broad aspect of the present invention, there is provided a drilling fluid additive comprising fibres, and flakes.

Preferably, the fibres include organic fibres.
Preferably, the fibres include biodegradable fibres.
Preferably, the fibres include cellulose fibres.
Preferably, the fibres include ground fibres.
Preferably, the fibres include sized fibres.

Preferably, the fibres range in size from 1 to 2000 microns. It is particularly preferred that the fibres range in size from 5 to 800 microns.

Preferably, the fibres include long fibres. It is preferred that the long fibres include wood fibres. It is particularly preferred that the long fibres include hardwood fibres. In a particular preferred form, the long fibres include teak (tectora/tectona) wood fibres. For example, the long fibres may include tectoraAectona grandis (Common Teak) wood fibres. The wood fibres may include ground and sized saw dust.

Preferably, the fibres include short fibres. It is preferred that the short fibres include cotton (gossypium/gossipium) fibres.
Preferably, the fibres include a mixture of long fibres and short fibres. It is preferred that the ratio of long fibres to short fibres ranges between 30% long fibres and 70% short fibres, to 40% long fibres and 60% short fibres.

Preferably, the flakes include organic flakes.

Preferably, the flakes include biodegradable flakes.

Preferably, the flakes include cellulose flakes.

Preferably, the flakes include ground flakes.

Preferably, the flakes include sized flakes.

Preferably, the flakes range in size from 100 to 25,000 microns. In a preferred form, the flakes range in size from 500 to 25,000 microns. In another preferred form, the flakes range in size from 100 to 6000 microns.

Preferably, the flakes include nut shell flakes. In a particular preferred form, the flakes include peanut shell flakes.

Preferably, the fibres and flakes are mixed together. It is particularly preferred that the fibres and flakes are blended together.

Preferably, the drilling fluid additive further comprises soluble granules. It is preferred that the soluble granules include acid soluble granules. It is particularly preferred that the acid soluble granules include calcium carbonate (CaC0₃) granules.

Preferably, the soluble granules range in size from 150 micron to 375 micron.

Preferably, the concentration of the soluble granules in the drilling fluid additive ranges from 10% to 15%. For example, in a 25 lbs bag of the drilling fluid additive, the weight of the soluble granules may range from 2.5 lbs to 3.75 lbs.

According to a second broad aspect of the present invention, there is provided a pill comprising a drilling fluid, and a drilling fluid additive according to the first broad aspect of the present invention.

Preferably, the drilling fluid is a liquid drilling fluid. For example, the drilling fluid may be a water-based drilling fluid, an oil-based drilling fluid, or a synthetic-based drilling fluid.

Preferably, the ratio of drilling fluid to drilling fluid additive is such that there is approximately 50 lbs of drilling fluid additive in each barrel of the pill.
According to a third broad aspect of the present invention, there is provided a method of sealing pores or fractures inside a borehole, the method comprising the steps of:

- providing a pill according to the second broad aspect of the present invention; and
- circulating the pill through the borehole so that a substantially impermeable wall or filter cake that includes a matrix of the fibres and flakes of the drilling fluid additive of the pill forms on a wall surface of the borehole.

According to a fourth broad aspect of the present invention, there is provided a borehole through which a pill according to the second broad aspect of the present invention has been circulated, the borehole including a substantially impermeable wall or filter cake on a wall surface of the borehole, the cake including a matrix of the fibres and flakes of the drilling fluid additive of the pill.

**Brief Description of the Drawings**

In order that the invention may be more fully understood and put into practice, a preferred embodiment thereof will now be described with reference to the accompanying drawing, in which:

- Figure 1 depicts a matrix of long fibres, short fibres, and flakes in a preferred embodiment of a drilling fluid additive.

**Best Mode(s) for Carrying out the Invention**

Referring to figure 1, a drilling fluid additive 10 according to a preferred embodiment of the present invention includes a blend of graded, organic and biodegradable flakes 11, long fibres 12, and short fibres 13.

Flakes 11 are obtained by grinding and sizing peanut shells. The peanut shells are ground and sized so that the flakes 13 have a size ranging from 100 to 6000 microns.

Long fibres 12 are ground and sized cotton (gossypium/gossipium) fibres.

Short fibres 13 are ground and sized teak (tectora/tectona grandis) wood fibres. In particular, short fibres 13 are obtained by grinding and sizing teakwood sawdust.

The long fibres 12 and the short fibres 13 are ground and sized so that
they range in size from 5 to 800 microns.

The flakes 11 as well as the long fibres 12 and the short fibres 13 may all
be produced using the same grinding and/or sizing equipment. For example,
they may all be produced using the equipment and/or methods disclosed in
published Australian Patent Application No. 200172159 whose contents have, as
mentioned above, been incorporated herein by reference.

The ratio of flakes 11, long fibres 12, and short fibres 13 in the drilling
fluid additive 10 is such that the ratio of long fibres 12 to short fibres 13 is in the
range of 30% long fibres to 70% short fibres, to 40% long fibres to 60% short
fibres, and the ratio of flakes 11 to the fibres 12, 13 is in the range of 20% flakes
to 80% fibres, to 30% flakes to 70% fibres.

The drilling fluid additive 10 is added to a drilling fluid such as, for
example, a water or oil-based drilling mud to form a lost circulation pill. The ratio
of the drilling fluid additive 10 to the drilling fluid in the lost circulation pill is
preferably such that there is approximately 50 lbs of drilling fluid additive 10 in
each barrel of the pill.

In use, the drilling fluid to which the drilling fluid additive 10 has been
added, and which is called a lost circulation pill, is pumped down a well borehole.
In particular, the drilling fluid is pumped down the drill pipe to the drill bit, and is
then circulated back up an annulus between the wall of the borehole and the drill
pipe.

In addition to the additive 10, the drilling fluid which is circulated back up
the annulus also includes cuttings and other fine solid particles. The
overbalance pressure (i.e. the extent to which the hydrostatic pressure of the
drilling fluid in the borehole exceeds the pressure of the formation through which
the borehole is being drilled) of the drilling fluid results in the flakes 11, long
fibres 12, and the short fibres 13 of the additive 10 combining with the cuttings
and other fine solid particles in the drilling fluid to form a thin wall/filter cake that
lines the wall surface of the borehole.

The long fibres 12 and the short fibres 13 form a matrix in the wall cake.
The flakes 11 combine with the long and short fibre matrix to reduce the spaces
between the long fibres 12 and the short fibres 13 in the matrix, and to create or
form an enhanced matrix 14 in the wall cake. The cuttings and other fine solid
colloidal particles in the drilling fluid further enhance the matrix 14 by filling the
spaces between the flakes 11, long fibres 12, and short fibres 13 and making the wall cake impermeable. The impermeable wall cake is able to substantially plug or seal a highly porous/fractured formation having a permeability that is greater than 5000 mD, and is thereby able to substantially stop drilling fluid from entering the formation from the borehole and being lost.

In other preferred embodiments of the drilling fluid additive according to the present invention, the graded organic flakes may range in size from 500 to 25,000 microns.

In some preferred embodiments the drilling fluid additive 10 can also include particles/granules 14 of ground calcium carbonate (CaCO₃). The calcium carbonate granules 14 enable the additive 10 to be used to seal producing well formations without causing damage to the formations.

The calcium carbonate granules 14 are ground to a size ranging from Mesh 40 (375 Micron) to Mesh 100 (150 Micron). The concentration of the calcium carbonate granules 14 in the drilling fluid additive 10 typically ranges from 10% to 15%, or 2.5 lbs to 3.75 lbs for a 25 lbs bag of drilling fluid additive 10.

The inclusion of the grounded and sized calcium carbonate granules 14 makes the drilling fluid additive 10 particularly suitable for sealing a producing formation such that severe lost circulation in the formation is eliminated or at least reduced.

The seal/plug formed by the additive 10 can be removed/released without damaging the sealed formation zone by acidizing/adding acid to the additive 10 so that the acid dissolves the calcium carbonate granules 14. After the seal/plug has been removed/released in this way, the formation zone is able to produce an amount of oil or gas which is the same as or more than that which was originally intended.

Laboratory tests of the drilling fluid additive according to the present invention have been conducted using a modified API Filter Press Test with aggregates having sizes of 2-5 cm as filter media. These tests have demonstrated the very effective sealing ability of the drilling fluid additive. In particular, they have demonstrated that the combined matrix of fibres and flakes is able to form a substantially impermeable filter cake or barrier that fills or blocks the gaps between the aggregates.
Whereas other lost circulation materials (LCM) such as FRACSEAL™ (Coarse) are only able to effectively seal highly fractured formations with a success rate of less than 10%, it is anticipated that the drilling fluid additive according to the present invention will be able to effectively seal such formations with a success rate of over 90%.

The inclusion of calcium carbonate granules in the drilling fluid additive results in an acid soluble drilling fluid additive that can be used to eliminate or at least reduce lost circulation in a producing formation. Importantly, modifying the drilling fluid additive in this manner enables the additive to eliminate or at least reduce lost circulation without damaging the formation. This is in contrast to other acid soluble lost circulation materials that are available and that are prone to damaging producing formations so that the amount of oil or gas that the formations are able to reduce is consequently reduced.

It will be appreciated by those skilled in the art that variations and modifications to the invention described herein will be apparent without departing from the spirit and scope thereof. The variations and modifications as would be apparent to persons skilled in the art are deemed to fall within the broad scope and ambit of the invention as herein set forth.

Throughout the specification and claims, unless the context requires otherwise, the word "comprise" or variations such as "comprises" or "comprising", will be understood to imply the inclusion of a stated integer or group of integers but not the exclusion of any other integer or group of integers.

Throughout the specification and claims, unless the context requires otherwise, the term "substantially" or "about" will be understood to not be limited to the value for the range qualified by the terms.

It will be clearly understood that, if a prior art publication is referred to herein, that reference does not constitute an admission that the publication forms part of the common general knowledge in the art in Australia or in any other country.
CLAIMS:
1. A drilling fluid additive comprising fibres, and flakes.
2. The drilling fluid additive of claim 1, wherein the fibres include organic fibres.
3. The drilling fluid additive of any one of the preceding claims, wherein the fibres include biodegradable fibres.
4. The drilling fluid additive of any one of the preceding claims, wherein the fibres include cellulose fibres.
5. The drilling fluid additive of any one of the preceding claims, wherein the fibres include ground fibres.
6. The drilling fluid additive of any one of the preceding claims, wherein the fibres include sized fibres.
7. The drilling fluid additive of any one of the preceding claims, wherein the fibres range in size from 1 to 2000 microns.
8. The drilling fluid additive of claim 7, wherein the fibres range in size from 5 to 800 microns.
9. The drilling fluid additive of any one of the preceding claims, wherein the fibres include long fibres.
10. The drilling fluid additive of claim 9, wherein the long fibres include wood fibres.
11. The drilling fluid additive of claim 10, wherein the long fibres include hardwood fibres.
12. The drilling fluid additive of claim 11, wherein the long fibres include teak (tectora/tectona) wood fibres.
13. The drilling fluid additive of claim 12, wherein the long fibres include Common Teak (tectora/tectona grandis) wood fibres.
14. The drilling fluid additive of any one of claims 10 to 13, wherein the wood fibres include ground and sized saw dust.
15. The drilling fluid additive of any one of the preceding claims, wherein the fibres include short fibres.
16. The drilling fluid additive of claim 15, wherein the short fibres include cotton (gossypium/gossipium) fibres.
17. The drilling fluid additive of any one of claims 15 to 16, wherein the fibres include a mixture of long fibres and short fibres.
18. The drilling fluid additive of claim 17, wherein the ratio of long fibres to short fibres ranges between 30% long fibres and 70% short fibres, to 40% long fibres and 60% short fibres.

19. The drilling fluid additive of any one of the preceding claims, wherein the flakes include organic flakes.

20. The drilling fluid additive of any one of the preceding claims, wherein the flakes include biodegradable flakes.

21. The drilling fluid additive of any one of the preceding claims, wherein the flakes include cellulose flakes.

22. The drilling fluid additive of any one of the preceding claims, wherein the flakes include ground flakes.

23. The drilling fluid additive of any one of the preceding claims, wherein the flakes include sized flakes.

24. The drilling fluid additive of any one of the preceding claims, wherein the flakes range in size from 100 to 25,000 microns.

25. The drilling fluid additive of claim 24, wherein the flakes range in size from 500 to 25,000 microns.

26. The drilling fluid additive of claim 24, wherein the flakes range in size from 100 to 6000 microns.

27. The drilling fluid additive of any one of the preceding claims, wherein the flakes include nut shell flakes.

28. The drilling fluid additive of claim 27, wherein the flakes include peanut shell flakes.

29. The drilling fluid additive of any one of the preceding claims, wherein the fibres and flakes are mixed together.

30. The drilling fluid additive of claim 29, wherein the fibres and flakes are blended together.

31. The drilling fluid additive of any one of the preceding claims, wherein the additive further comprises soluble granules.

32. The drilling fluid additive of claim 31, wherein the soluble granules include acid soluble granules.

33. The drilling fluid additive of claim 32, wherein the acid soluble granules include calcium carbonate (CaCC\(_{3}\)) granules.
34. The drilling fluid additive of any one of claims 31 to 33, wherein the soluble granules range in size from 150 micron to 375 micron.
35. The drilling fluid additive of any one of claims 31 to 34, wherein the concentration of the soluble granules in the drilling fluid additive ranges from 10% to 15%.
36. A pill comprising a drilling fluid, and a drilling fluid additive according to any one of the preceding claims.
37. The pill of claim 35, wherein the drilling fluid is a liquid drilling fluid.
38. The pill of any one of claims 35 to 37, wherein the ratio of drilling fluid to drilling fluid additive is such that there is approximately 50 lbs of drilling fluid additive in each barrel of the pill.
39. A method of sealing pores or fractures inside a borehole, the method comprising the steps of:
   providing a pill according to any one of claims 35 to 38; and
   circulating the pill through the borehole so that a substantially impermeable wall or filter cake that includes a matrix of the fibres and flakes of the drilling fluid additive of the pill forms on a wall surface of the borehole.
40. A borehole through which a pill according to any one of claims 35 to 38 has been circulated, the borehole including a substantially impermeable wall or filter cake on a wall surface of the borehole, the cake including a matrix of the fibres and flakes of the drilling fluid additive of the pill.
41. A drilling fluid additive substantially as hereinbefore described with reference to figure 1.
42. A pill substantially as hereinbefore described with reference to figure 1.
43. A method of sealing pores or fractures inside a borehole, the method being substantially as hereinbefore described with reference to figure 1.
44. A borehole substantially as hereinbefore described with reference to figure 1.
INTERNATIONAL SEARCH REPORT

International application No. PCT/AU20 11/001209

A. CLASSIFICATION OF SUBJECT MATTER

Int. Cl.

C09K 8/10 (2006.01) C09K 8/506 (2006.01) C09K 8/32 (2006.01)

According to International Patent Classification (IPC) or to both national classification and IPC.

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

EPDOC & WPI & CAPLUS with keywords (FIBRE+, FLAKE+, FLECK+, DUST etc) covering full scope of the claims...

C. DOCUMENTS CONSIDERED TO BE RELEVANT

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<th>Citation of document, with indication, where appropriate, of the relevant passages</th>
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<td>US 2,214,366A (FREELAND J.W. ET AL) 10 September 1940. See Table 1, Page 2; Line 20, Column 1, Page 2; Claims 1 &amp; 2, Page 3.</td>
<td>1, 5, 6, 9, 15, 17, 22-26, 29, 30, 35B, 36, 37, 39 &amp; 40.</td>
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<td>WO 2004/013448 A2 (MALCOLM M. ET AL) 12 February 2004. See Abstract; Lines 10-25, Page 12; Fig 1; Page 10, Lines 21-31.</td>
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<td>-See Lines 10-25, Page 12; Page 10, Lines 21-31.</td>
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<td>WO 2009/046980 A1 (SERVICES PETROLIERS SCHLUMBERGER ET AL) 16 April 2009. See Abstract; Claim 1, Page 16; Para 1, Page 2; Para 2, Page 6.</td>
<td>1, 2, 9, 15, 17, 22-26, 29-34, 35B, 36, 37, 39 &amp; 40.</td>
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Further documents are listed in the continuation of Box C

* Special categories of cited documents:
  "A" document defining the general state of the art which is not considered to be of particular relevance
  "E" earlier application or patent but published on or after the international filing date
  "L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another publication or other special reason (as specified)
  "O" document referring to an oral disclosure, use, exhibition or other means
  "P" document published prior to the international filing date but later than the priority date claimed
  "T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
  "X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
  "Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art
  "K" document member of the same patent family

Date of the actual completion of the international search: 25 October 2011

Date of mailing of the international search report: 31 October 2011

Name and mailing address of the ISA/AU

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Form PCT/ISA/210 (second sheet) (July 2009)
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<td>US 2006/0019834 Al(MELBOUCI M. ET AL) 26 January 2006. See Abstract; Examples, Pages 6 &amp; 7.</td>
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### Box No. II  Observations where certain claims were found unsearchable (Continuation of item 2 of first sheet)

This international search report has not been established in respect of certain claims under Article 17(2)(a) for the following reasons:

1. [ ] Claims Nos.:

because they relate to subject matter not required to be searched by this Authority, namely:

2. [ ] Claims Nos. 41-44

because they relate to parts of the international application that do not comply with the prescribed requirements to such an extent that no meaningful international search can be carried out, specifically:

The claims do not comply with Rule 6.2(a) because they rely on references to the description and/or drawings.

3. [ ] Claims Nos.:

because they are dependent claims and are not drafted in accordance with the second and third sentences of Rule 6.4(a)

### Box No. III  Observations where unity of invention is lacking (Continuation of item 3 of first sheet)

This International Searching Authority found multiple inventions in this international application, as follows:

1. [ ] As all required additional search fees were timely paid by the applicant, this international search report covers all searchable claims.

2. [ ] As all searchable claims could be searched without effort justifying additional fees, this Authority did not invite payment of additional fees.

3. [ ] As only some of the required additional search fees were timely paid by the applicant, this international search report covers only those claims for which fees were paid, specifically claims Nos.:

4. [ ] No required additional search fees were timely paid by the applicant. Consequently, this international search report is restricted to the invention first mentioned in the claims; it is covered by claims Nos.:

### Remark on Protest

- [ ] The additional search fees were accompanied by the applicant's protest and, where applicable, the payment of a protest fee.
- [ ] The additional search fees were accompanied by the applicant's protest but the applicable protest fee was not paid within the time limit specified in the invitation.
- [ ] No protest accompanied the payment of additional search fees.
**Supplemental Box**
(To be used when the space in any of Boxes I to IV is not sufficient)

**Continuation of Box No: 1 (Basis of the report)**

There are two Claims numbered 35 on Page 11. For the purpose of this report, said Claims are construed as 35A & 35B.
This Annex lists the known "A" publication level patent family members relating to the patent documents cited in the above-mentioned international search report. The Australian Patent Office is in no way liable for these particulars which are merely given for the purpose of information.

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Due to data integration issues this family listing may not include 10 digit Australian applications filed since May 2001.

END OF ANNEX