Title: SYSTEM AND METHOD FOR REMOVING PARTICLES FROM A WELL BORE

Abstract: A system and method for removing particles from a well bore penetrating a possible hydrocarbon producing formation, according to which drilling fluid is mixed with a weighted material, and the mixture is introduced into a well bore so that the mixture scours any particles accumulated in the well bore. A well-completion fluid is introduced into the well bore that dissolves the weighted material.
SYSTEM AND METHOD FOR REMOVING PARTICLES FROM A WELL BORE

Background

This invention relates to a system and method for using a weighted sweep material for removing particles from a well bore penetrating a possible hydrocarbon producing formation.

A problem often encountered in well-drilling operations is the accumulation of drilling cuttings, especially on the low side of deviated, or horizontal, well bores. As these cuttings accumulate within the well bore, it is necessary to occasionally pump a volume of drilling fluid that has been weighted to a density higher than the active drilling fluid system in order to clean, or sweep, the well of the drilling cuttings. This “weighted sweep” material, which is often in the form of barite, or the like, is introduced into the well bore with the drilling fluid and scours the low side of the well bore to clean the well bore of cuttings. The weighted sweep material also provides extra buoyancy to mobilize and remove the cuttings from the well bore, and the cuttings are then separated from the weighted sweep material by shaker screens, or the like.

Upon completion of the weighted sweep, the weighted sweep material must be removed from the drilling fluid and taken out of the well bore. However, it is virtually impossible to remove all of the weighted sweep material from the well bore. Thus, some of the material will remain in the well bore and become part of the well formation, which may cause several problems. For example, the presence of the non-removable, weighted sweep material could reduce the permeability of the rock being drilled and cause a distortion of the particle size distribution of the bridging materials in the drilling fluid. Also, the presence of the weighted sweep material makes it difficult, if not impossible, to eliminate some plugging of the permeable zones in the formation. Thus, the rock in the drilled pay zone could be damaged, and thus possibly impede the withdrawal of oil and gas.

Therefore, what is needed is a system and method for removing the cuttings from the well bore without encountering the above problems.

Brief Description of the Drawing

The drawing is a diagrammatic view depicting the system of an embodiment of the present invention.
Detailed Description

According to an embodiment of the invention, and with reference to the drawing, a deviated well bore 10 is formed below ground G and adjacent to an oil or gas reservoir 12. A drill pipe 14 is disposed in the well bore 10 with the outer diameter of the drill pipe being less than the inner diameter of the well bore, or casing, to form an annulus 16.

It will be assumed that, as a result of the well-drilling operation, there is an accumulation of drilling cuttings 18 in the annulus 16, especially on the lower side thereof as shown, which need to be removed for the reasons described above. To this end, a source 20 of drilling fluid, or mud, is pumped into the well bore via a conduit 22 and by a pump 24. A source 26 of a weighted material, to be described in detail, is introduced, via a conduit 28, into the conduit 22 for mixing with the drilling fluid upstream of the well bore 10.

The mixture of fluid and weighted material forms a “weighted sweep” material which is introduced into the annulus 16 at the inlet end of the well bore 10. As the weighted sweep material passes through the annulus 16, it scour the lower side of the well bore 10 to remove the drilling cuttings 18. The mixture of the weighted sweep material and the cuttings is circulated back to the surface for separation and further conventional treatment. However, some of the weighted material remains in the annulus and must be removed for the reasons described above.

One or more well-completion fluids are then introduced into, and flow through, the annulus for various well-completion procedures. These well-completion fluids are conventional and may include mineral acids, organic acids, chelating agents, and ammonium salt solutions.

According to an embodiment of the invention, the weighted material is of a type that will be dissolved by each of the above well-completion fluids, which, after use, are circulated out of the well bore 10. The weighted material preferably is a metal salt. More preferably, the weighted material is an oxide, hydroxide, carbonate, sulfate, phosphate, tungstate, fluoride, pyrophosphate or orthosilicate salt of an alkaline earth metal, a transition metal, especially a transition metal from Period 4 of the Periodic Table of Elements, a metal selected from Groups 13, 14 and 15 of the Periodic Table of Elements or a Lanthanide series rare earth metal. Specific examples of metal salts that are absorbable by the well completion fluids and thus are suitable for use as the weighted material include magnesium oxide, barium pyrophosphate, aluminum hydroxide, calcium fluoride, calcium tungstate, magnesium
orthosilicate, iron oxide, iron tungstate, manganese oxide, manganese carbonate, manganese tungstate, manganese hydroxide, iron hydroxide, zinc oxide, zinc carbonate, zinc phosphate, zinc sulfate, lanthanum hydroxide, cerium hydroxide, lanthanum oxide, bismuth oxide, hydroxylapatite (hydrated calcium phosphate), anhydrite (calcium sulfate), dolomite (calcium magnesium carbonate), copper oxide, tin oxide, strontium carbonate, and strontium phosphate

**Example**

A weighted material, having a specific gravity of greater than 2.6, is passed from the source 26 into the conduit 22 where it mixes with drilling fluid from the source 20, which drilling fluid can be in a mud-like form. This forms a weighted sweep material with a fluid weight of approximately 2 to 4 pounds per gallon greater than the drilling fluid in the annulus. The weighted sweep material is pumped into the annulus 16 by the pump 24, and scours the lower side of the well bore 10 to remove the drilling cuttings 18. The mixture of the weighted sweep material and the cuttings is then circulated back to the ground surface for separation, and/or further treatment and some of the weighted sweep material accumulates in the annulus 16. Well-completion fluids are then circulated through the annulus 16 in connection with various conventional well-completion operations well known to those skilled in the art.

Since the weighted sweep material is soluble in the well completion fluids mentioned above, when the latter fluids are circulated through the annulus 16 as described above, the weighted sweep material is dissolved and removed by the fluids. Thus, the annulus is void of the weighted material and the permeability of the rock drilled through during the drilling operation is not reduced, while plugging of the permeable zones in the formation is eliminated, thus eliminating the problems discussed above.

**Variations**

It is understood that the above embodiment is not limited to the particular well bore described and shown herein, but is equally applicable to horizontal bores and vertical bores. Also, the embodiment is not limited to the use of one weighted material described above, but rather two or more weighted materials of the above type can be mixed before being introduced into the conduit 22. Further, the expression "drilling fluid" is meant to cover fluids and muds. Moreover, the fluid that dissolves the weighted material does not have to be a "well-completion" fluid but can be any fluid that dissolves the weighted material. Still further, although the expression "well bore" has been used herein, it is understood that it is
meant to cover casings, pipe, strings, conduits, or any other type of device capable of transferring fluids.

Although only a few exemplary embodiments of this invention have been described in detail above, those skilled in the art will readily appreciate that many other modifications are possible in the exemplary embodiments without materially departing from the novel teachings and advantages of this invention. Accordingly, all such modifications are intended to be included within the scope of this invention as defined in the following claims. In the claims, means-plus-function clauses are intended to cover the structures described herein as performing the recited function and not only structural equivalents, but also equivalent structures.
What is claimed is:

1. A method for removing particles from a well bore, comprising mixing drilling fluid with a weighted material, introducing the mixture into a well bore so that the mixture scourcs any particles accumulated in the well bore, and introducing a second fluid into the well bore that dissolves the weighted material.

2. The method of claim 1 wherein the weighted material is a metal salt.

3. The method of claim 1 wherein the weighted material is an oxide, hydroxide, carbonate, sulfate, phosphate, tungstate, fluoride, pyrophosphate or orthosilicate salt of a metal selected from the group consisting of alkaline earth metals, transition metals, Group 13, 14 and 15 metals and Lanthanide series rare earth metals.

4. The method of claim 1 wherein the weighted material is a metal salt selected from the group consisting of magnesium oxide, barium pyrophosphate, aluminum hydroxide, calcium fluoride, calcium tungstate, magnesium orthosilicate, iron oxide, iron tungstate, manganese oxide, manganese carbonate, manganese tungstate, manganese hydroxide, iron hydroxide, zinc oxide, zinc carbonate, zinc phosphate, zinc sulfate, lanthanum hydroxide, cerium hydroxide, lanthanum oxide, bismuth oxide, hydrated calcium phosphate, calcium sulfate, calcium magnesium carbonate, copper oxide, tin oxide, strontium carbonate, and strontium phosphate.

5. The method of claim 1 wherein the second fluid is a well-completion fluid.

6. The method of claim 1 wherein the second fluid is selected from the group consisting of mineral acids, organic acids, chelating agents, and ammonium salt solutions.

7. The method of claim 1 further comprising passing the second fluid, with the dissolved weighted material, out of the well bore.

8. The method of claim 1 wherein the weighted material has a specific gravity greater than 2.6.

9. A system for removing particles from a well bore, comprising a source of drilling fluid, means for mixing the drilling fluid with a weighted material, means for introducing the mixture into a well bore so that the mixture scourcs any particles accumulated in the well bore, and a source of a second fluid that, when introduced into the well bore, dissolves the weighted material.

10. The system of claim 9 wherein the weighted material is a metal salt.

11. The system of claim 9 wherein the weighted material is an oxide, hydroxide,
carbonate, sulfate, phosphate, tungstate, fluoride, pyrophosphate or orthosilicate salt of a metal selected from the group consisting of alkaline earth metals, transition metals, Group 13, 14 and 15 metals and Lanthanide series rare earth metals.

12. The system of claim 9 wherein the weighted material is selected from the group consisting of magnesium oxide, barium pyrophosphate, aluminum hydroxide, calcium fluoride, calcium tungstate, magnesium orthosilicate, iron oxide, iron tungstate, manganese oxide, manganese carbonate, manganese tungstate, manganese hydroxide, iron hydroxide, zinc oxide, zinc carbonate, zinc phosphate, zinc sulfate, lanthanum hydroxide, cerium hydroxide, lanthanum oxide, bismuth oxide, hydroxyapatite, anhydrite, dolomite, copper oxide, tin oxide, strontium carbonate, and strontium phosphate.

13. The system of claim 9 wherein the second fluid is a well-completion fluid.

14. The system of claim 9 wherein the second fluid is selected from the group consisting of mineral acids, organic acids, chelating agents, and ammonium salt solutions.

15. The system of claim 9 wherein the second fluid, with the dissolved weighted material, is passed out of the well bore.

16. The system of claim 9 wherein the weighted material has a specific gravity greater than 2.6.
INTERNATIONAL SEARCH REPORT

A. CLASSIFICATION OF SUBJECT MATTER
IPC 7 C09K7/02 E21B37/06 E21B21/00

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

B. FIELDS SEARCHED
Minimum documentation searched (classification system followed by classification symbols)
IPC 7 C09K E21B

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 practical, search terms used)
EPO-Internal

C. DOCUMENTS CONSIDERED TO BE RELEVANT

<table>
<thead>
<tr>
<th>Category</th>
<th>Citation of document, with indication, where appropriate, of the relevant passages</th>
<th>Relevant to claim No.</th>
</tr>
</thead>
<tbody>
<tr>
<td>X</td>
<td>US 2 245 886 A (WEIR JAMES W ET AL) 17 June 1941 (1941-06-17)</td>
<td>1, 2, 9, 10</td>
</tr>
<tr>
<td>Y</td>
<td>WO 95 03140 A (MOBIL OIL CORP) 2 February 1995 (1995-02-02) page 1, line 4 - line 37</td>
<td>1-7, 9-15</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>A</td>
<td>US 2 605 221 A (HOEPPEL RAYMOND W) 29 July 1952 (1952-07-29) column 1, line 23 - column 2, line 9</td>
<td>1-4</td>
</tr>
<tr>
<td>A</td>
<td>US 2 234 790 A (ZACHER VERNON B) 11 March 1941 (1941-03-11) page 1, left-hand column, line 22 - right-hand column, line 39</td>
<td>6, 7, 14, 15</td>
</tr>
</tbody>
</table>

Further documents are listed in the continuation of box C.

Patent family members are listed in annex.

* Special categories of cited documents:
  *A* document defining the general state of the art which is not considered to be of particular relevance
  *E* earlier document but published on or after the international filing date
  *L* document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)
  *C* 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

** Special categories of cited documents:
  **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
  **S** document member of the same patent family

Date of the actual completion of the international search
14 November 2003

Date of mailing of the international search report
26/11/2003

Name and mailing address of the ISA
European Patent Office, P.B. 5816 Patentlaan 2 NL-2280 HV Rijswijk Tel. (+31-70) 340-2040, Tx 31 651 epos nl Fax (+31-70) 340-3016

Authorized officer
Boulon, A
<table>
<thead>
<tr>
<th>Patent document cited in search report</th>
<th>Publication date</th>
<th>Patent family member(s)</th>
<th>Publication date</th>
</tr>
</thead>
<tbody>
<tr>
<td>US 2245886 A</td>
<td>17-06-1941</td>
<td>NONE</td>
<td></td>
</tr>
<tr>
<td>WO 9503140 A</td>
<td>02-02-1995</td>
<td>WO 9503140 A1</td>
<td>02-02-1995</td>
</tr>
<tr>
<td></td>
<td></td>
<td>US 5415696 A</td>
<td>16-05-1995</td>
</tr>
<tr>
<td>US 2605221 A</td>
<td>29-07-1952</td>
<td>NONE</td>
<td></td>
</tr>
<tr>
<td>US 2234790 A</td>
<td>11-03-1941</td>
<td>NONE</td>
<td></td>
</tr>
</tbody>
</table>