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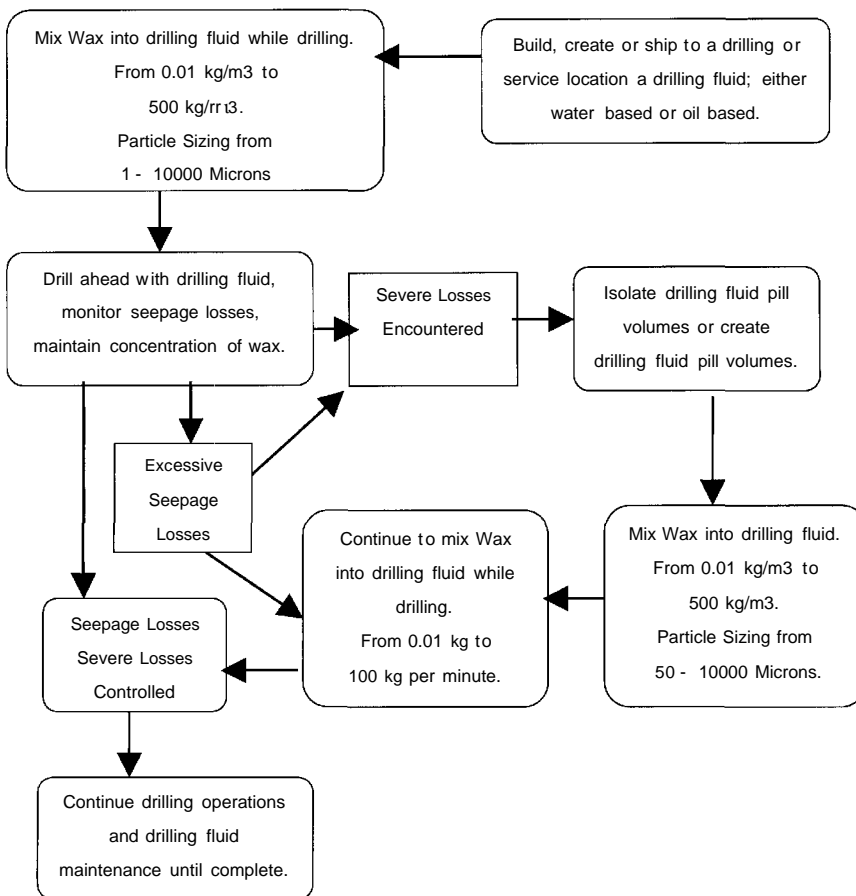
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[Continued on next page]

(54) **Title:** DRILLING FLUID AND METHOD FOR REDUCING LOST CIRCULATION



(57) **Abstract:** Lost circulation of drilling fluid is one of the most serious and expensive problems facing the drilling industry. The present invention relates to an improved drilling fluid for reducing or preventing lost circulation to an underground formation surrounding a well bore in the process of drilling a well. The drilling fluid comprises a base fluid and wax or waxy substance as a primary seepage loss agent. The invention also provides a method of reducing or preventing lost circulation to an underground formation surrounding a well bore in the process of drilling a well using the drilling fluid of the invention, wherein the primary seepage loss agent is added to the drilling fluid, either before or during drilling, and the drilling fluid is pumped down hole during drilling.

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FR, GB, GR, HU, IE, IS, IT, LT, LU, LV, MC, MT, NL, PL,
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- with amended claims and statement

For two-letter codes and other abbreviations, refer to the "Guidance Notes on Codes and Abbreviations" appearing at the beginning of each regular issue of the PCT Gazette.

AMENDED CLAIMS**received by the International Bureau on 13 September 2007 (13.09.2007)**

CLAIMS:

1. A drilling fluid for reducing or controlling lost circulation to an underground formation surrounding a well bore in a process of drilling a well, comprising:
5 a base fluid; and
 a seepage loss agent comprising wax or waxy substance and having a particle size of greater than 50 microns, the wax or waxy substance being substantially insoluble in hydrocarbons at temperatures below melt point.
- 10 2. The drilling fluid of claim 1, wherein the particles remain substantially solid during the entire drilling procedure.
3. The drilling fluid of claim 1 or 2, wherein the base fluid is a hydrocarbon based fluid.
- 15 4. The drilling fluid of claim 1 or 2, wherein the base fluid is an emulsion or a well kill fluid.
5. The drilling fluid of claim 1 or 2, wherein the base fluid is an aqueous based fluid.
- 20 6. The drilling fluid of any one of claims 1 to 5, wherein the seepage loss agent comprises a natural wax or a synthetic wax.
7. The drilling fluid of claim 6, wherein the seepage loss agent comprises a natural
25 wax which is a paraffin wax, a petrolatum wax, a microcrystalline wax, a semi-microcrystalline wax, an intermediate wax, an ozocerite wax, a ceresine wax or a montan wax.
8. The drilling fluid of any one of claims 1 to 7, wherein the primary seepage loss
30 agent comprises a paraffin wax.

9. The drilling fluid of any one of claims 1 to 7, wherein the primary seepage loss agent comprises a microcrystalline wax.
- 5 10. The drilling fluid of any one of claims 1 to 9, wherein the primary seepage loss agent comprises a mixture of a paraffin wax and a microcrystalline wax.
11. The drilling fluid of any one of claims 1 to 10, wherein the wax or waxy substance is refined.
- 10 12. The drilling fluid of claim 11, wherein the seepage loss agent comprises a synthetic wax which is a polypropylene wax, a wax polyethylene, a high density polyethylene wax, a polytetrafluoroethylene wax, a Fischer-Tropsch wax, a fatty acid amine wax, a chlorinated hydrocarbon wax, a chemically modified hydrocarbon wax, or a polyamide wax.
- 15 13. The drilling fluid of any one of claims 1 to 12, wherein the seepage loss agent is in a concentration of about 0.01 kg/m^3 to about 500 kg/m^3 in the drilling fluid.
- 20 14. The drilling fluid of claim 13, wherein the seepage loss agent is in a concentration of about 1 kg/m^3 to about 100 kg/m^3 in the drilling fluid.
15. The drilling fluid of claim 14, wherein the seepage loss agent is in a concentration of about 5 kg/m^3 to about 20 kg/m^3 in the drilling fluid.
- 25 16. The drilling fluid of claim 15, wherein the seepage loss agent has a particle size of 50 microns to about 10000 microns.
17. The drilling fluid of claim 16, wherein the seepage loss agent has a particle size of about 100 microns to about 6000 microns.
- 30 18. The drilling fluid of any one of claims 1 to 17, wherein the seepage loss agent has a melt point of greater than about 20°C .

19. The drilling fluid of claim 18, wherein the seepage loss agent has a melt point between about 25⁰C and about 200⁰C
- 5 20. The drilling fluid of claim 19, wherein the seepage loss agent has a melt point between about 40⁰C and about 140⁰C
21. The drilling fluid of claim 20, wherein the seepage loss agent has a melt point between about 65⁰C and about 85⁰C.
- 10 22. The drilling fluid of any one of claims 1 to 21, further comprising a lost circulation material.
23. The drilling fluid of claim 22, wherein the lost circulation material is selected from
15 organic fibers, sawdust, Gilsonite®, asphalt, cellophane, plastic, calcium carbonate, sulfonated asphalt, sulfonated Gilsonite® and combinations thereof.
24. A method of reducing or preventing lost circulation of drilling fluid to a subterranean formation during the process of drilling a well, comprising:
20 adding to a drilling fluid a seepage loss agent as defined in any one of claims 1 to 23; and
pumping the drilling fluid downhole during drilling.
25. The method of claim 24, wherein the seepage loss agent is added to the drilling
25 fluid before or during drilling.
26. The method of claim 24, wherein the seepage loss agent is added into the drilling fluid while circulating the well or is added to holding tanks to be circulated into the drilling fluid and pumped into the well.
- 30 27. The method of any one of claims 24 to 26, wherein the seepage loss agent forms a semi-permeable layer of wax in or on the underground formation.

28. A seepage loss agent for reducing or controlling seepage losses to a permeable underground formation during a process of drilling a well in an oil or gas recovery operation, the seepage loss agent comprising:
- 5 particles of wax or a mixture thereof, all or a majority of the particles having a particle size greater than 50 microns and being substantially insoluble in hydrocarbons at temperatures below the melt point of the particles, wherein the particles remain substantially solid during the drilling process.
- 10 29. A seepage loss agent for reducing or controlling seepage losses to a permeable underground formation during a process of drilling a well in an oil or gas recovery operation, the seepage loss agent consisting essentially of:
- particles of wax or a mixture thereof having a particle size greater than 50 microns and being substantially insoluble hydrocarbons at temperatures below the melt point of the particles,
- 15 wherein the particles remain substantially solid during the entire drilling process.
- 20 30. The seepage loss agent of claim 28 or 29, wherein the particles comprise a natural wax or a synthetic wax.
31. The seepage loss agent of any one of claims 28 to 30, wherein the particles are particles of natural wax or a mixture of particles of two or more natural waxes.
- 25 32. The seepage loss agent of claim 31, wherein the natural wax is a vegetable wax or a mineral wax.
33. The seepage loss agent of claim 32, wherein the natural wax is a mineral wax.
- 30 34. The seepage loss agent of claim 33, wherein the mineral wax is a refined mineral wax.

35. The seepage loss agent of claim 34, wherein the refined mineral wax is a paraffin wax, a petrolatum wax, a microcrystalline wax, a semi-microcrystalline wax, an intermediate wax, a ozocerite wax, a ceresine wax, a montan wax or a mixture thereof.
- 5
36. The seepage loss agent of claim 35, wherein the particles are particles of a refined paraffin wax, particles of a refined microcrystalline wax or a mixture thereof.
37. The seepage loss agent of claim 36, wherein the particles are particles of a refined
- 10 microcrystalline wax.
38. The seepage loss agent of claim 36, wherein the particles are particles of a refined paraffin wax.
- 15
39. The seepage loss agent of claim 38, wherein the refined paraffin wax is a refined C₂₀-C₃₅ paraffin wax.
40. The seepage loss agent of claim 36, wherein the particles are a mixture of particles of a refined paraffin wax and particles of a refined microcrystalline wax, wherein
- 20 the microcrystalline particles are larger than the paraffin particles.
41. The seepage loss agent of any one of claims 28 to 30, wherein the particles comprise a synthetic wax.
- 25
42. The seepage loss agent of claim 41, wherein the synthetic wax is a polypropylene wax, a polyethylene wax, a high density polyethylene wax, a polytetrafluoroethylene wax, a Fischer-Tropsch wax, a fatty acid amine, a chemically modified hydrocarbon wax, a polyamide wax or a mixture thereof.
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43. The seepage loss agent of claim 42, wherein the synthetic wax is a Fischer-Tropsch wax.

44. The seepage loss agent of any one of claims 28 to 43, wherein the seepage loss agent comprises a mixture of particles of two or more different waxes.
- 5 45. The seepage loss agent of any one of claims 28 to 44, wherein the seepage loss agent comprises a mixture of particles of two or more different particle sizes.
46. The seepage loss agent of any one of claims 28 to 45, wherein the particles are in the range of 50 microns to about 20000 microns.
- 10 47. The seepage loss agent of claim 46, wherein the particles are in the range of 100 microns to about 10000 microns.
48. The seepage loss agent of claim 47, wherein the particles are in the range of 100 microns to about 5000 microns.
- 15 49. The seepage loss agent of claim 48, wherein the particles are in the range of 500 microns to about 4000 microns.
- 20 50. The seepage loss agent of any one of claims 45 to 49, wherein the seepage loss agent comprises a mixture of particles sized in the ranges of a) 300 - 500 microns, b) 800 - 1200 microns and c) 3000-4000 microns.
- 25 51. The seepage loss agent of claim 50, wherein the particles of a), b) and c) are in a ratio of about 1:1:1 in the mixture.
52. The seepage loss agent of any one of claims 28 to 51, wherein the melt point of the particles is above operational temperatures.
- 30 53. The seepage loss agent of claim 52, wherein the melt point of the particles is at least about 10°C above the highest operational temperature.

54. The seepage loss agent of any one of claims 28 to 53, wherein the particles have a melt point above bottom hole temperature.
55. The seepage loss agent of any one of claims 28 to 54, wherein the particles have a melt point below a temperature in the underground formation.
56. The seepage loss agent of any one of claims 28 to 55, wherein the particles have a melt point above 40⁰C.
57. The seepage loss agent of claim 56, wherein the particles have a melt point above 65⁰C,
58. The seepage loss agent of any one of claims 28 to 56, wherein the particles have a melt point in the range of 40⁰C to 140⁰C.
59. The seepage loss agent of claim 58, wherein the particles have a melt point in the range of 65⁰C to 85⁰C.
- 60- A seepage loss agent for reducing or controlling seepage losses to a permeable underground formation during a process of drilling a well in an oil or gas recovery operation, the seepage loss agent consisting essentially of:
particles of refined mineral wax having a particle size between about 100 microns and about 10000 microns, the particles being substantially insoluble in hydrocarbon based drilling fluids at temperatures below the melt point of the particles, the melt point of the particles being above operational temperatures and above bottom hole temperature such that the particles remain substantially solid during the drilling process.
61. The seepage loss agent of claim 60, wherein the particles have a melt point below a temperature in the underground formation such that all or a portion of the particles will melt at the formation temperature.

62. The seepage loss agent of any one of claims 28 to 61, wherein the seepage loss agent is dispersable in a viscosified drilling fluid without the use of surface active agents, stabilizers or emulsifiers.

5 63. The seepage loss agent of claim 62, which is dispersed in a viscosified drilling fluid without the use of surface active agents, stabilizers or emulsifiers.

64. A seepage loss agent for reducing or controlling seepage losses to a permeable underground formation during a process of drilling a well in an oil or gas recovery operation, the seepage loss agent comprising:

10 particles of one or more natural or synthetic waxes, all or a majority of the particles having a particle size greater than 50 microns and being substantially insoluble in hydrocarbons at temperatures below the melt point of the particles such that the particles remain substantially solid during the drilling process.

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65. A seepage loss agent for reducing or controlling seepage losses to a permeable underground formation in an oil or gas recovery operation, comprising:

20 particles of wax or a mixture thereof, all or a majority of the particles having a particle size greater than 50 microns and being substantially insoluble in hydrocarbons at temperatures below the melt point of the particles.

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66. A drilling fluid for reducing or controlling seepage losses to a permeable underground formation in a process of drilling a well in an oil or gas recovery operation, the drilling fluid comprising:

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a base fluid; and

a seepage loss agent as defined in any one of claims 28 to 65,

67. The drilling fluid of claim 66, wherein the base fluid is a hydrocarbon based fluid or an invert emulsion.

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68. The drilling fluid of claim 66, wherein the base fluid is an aqueous based fluid or an aqueous emulsion.

69. The drilling fluid of any one of claims 66 to 68, wherein the drilling fluid is viscosified.
- 5 70. The drilling fluid of any one of claims 66 to 69, wherein the drilling fluid is free of surface active agents, stabilizers and emulsifiers.
71. The drilling fluid of any one of claims 66 to 70, wherein the seepage loss agent is in a concentration of about 0.01 kg/m^3 to about 500 kg/m^3 in the drilling fluid.
- 10 72. The drilling fluid of claim 71, wherein the seepage loss agent is in a concentration of about 1 kg/m^3 to about 100 kg/m^3 in the drilling fluid.
73. The drilling fluid of claim 72, wherein the primary seepage loss agent is in a concentration of about 5 kg/m^3 to about 20 kg/m^3 in the drilling fluid.
- 15 74. The drilling fluid of any one of claims 66 to 73, additionally comprising a lost circulation material.
- 20 75. The drilling fluid of claim 74, wherein the lost circulation material is selected from the group consisting of organic fibers, sawdust, Gilsonite®, asphalt, cellophane, plastic, calcium carbonate, sulfonated asphalt, sulfonated Gilsonite® and combinations thereof.
- 25 76. The drilling fluid of claim 70, which is a viscosified aqueous based drilling fluid that is free of surface active agents, stabilizers and emulsifiers, wherein the drilling fluid is fully disposable upon completion of the drilling process.
- 30 77. A method of reducing or controlling seepage losses to a permeable underground formation in a process of drilling a well in an oil or gas recovery operation, comprising;
providing a drilling fluid as defined in any one of claims 66 to 76; and

pumping the drilling fluid downhole during the drilling process.

78. A method of reducing or controlling seepage losses to a permeable underground formation in a process of drilling a well in an oil or gas recovery operation, comprising:

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- providing a drilling fluid comprising a base fluid;
- providing a seepage loss agent as defined in any one of claims 28 to 65;
- adding the seepage loss agent to the base fluid or the drilling fluid prior to or during drilling; and

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pumping the drilling fluid downhole during the drilling process.

79. A method of reducing or controlling seepage losses to a permeable underground formation in a process of drilling a well in an oil or gas recovery operation, comprising:

15

- providing a hydrocarbon based drilling fluid;
- providing a seepage loss agent, the seepage loss agent consisting essentially of wax particles having a particle size greater than 50 microns and being substantially insoluble in the drilling fluid and in formation hydrocarbons at temperatures below the melt point of the wax particles such that the wax particles remain substantially solid during the drilling process;

20

- adding the seepage loss agent to the drilling fluid prior to or during drilling;
- and

pumping the drilling fluid downhole during the drilling process.

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80. The method of any one of claims 77 to 79, wherein the seepage loss agent is added directly to the drilling fluid while circulating the well, is added to holding tanks or premix tanks to be circulated into the drilling fluid and pumped downhole, or a combination of the above.

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81. The method of any one of claims 77 to 79, wherein the seepage loss agent is added to the drilling fluid prior to drilling, during drilling, or a combination of the above.

82. The method of any one of claims 77 to 79, wherein the seepage loss agent is added to the drilling fluid in a single addition prior to drilling.
- 5 83. The method of any one of claims 77 to 79, wherein the seepage loss agent is mixed directly into the drilling fluid while circulating at a rate of about 0.01 kg per minute to about 100 kg per minute while drilling ahead.
- 10 84. The method of any one of claims 77 to 79, wherein the seepage loss agent is mixed into a holding tank or a premix tank containing the drilling fluid at a concentration of about 0.01 kg/m³ to about 500 kg/m³.
- 15 85. The method of any one of claims 77 to 79, wherein the amount of the seepage loss agent added to the drilling fluid is adjusted during the drilling process to account for anticipated or real time changes in lost circulation.
- 20 86. Use of solid wax particles of greater than 50 microns in size for reducing or controlling seepage losses to a permeable underground formation in a process of drilling a well in an oil or gas recovery operation, the particles being substantially insoluble in hydrocarbons at temperatures below the melt point of the particles and remaining substantially solid during the drilling process.
- 25 87. Use of a seepage loss agent for reducing or controlling seepage losses to a permeable underground formation in a process of drilling a well in an oil or gas recovery operation, the seepage loss agent comprising wax particles of greater than 50 microns, which particles are substantially insoluble in hydrocarbons at temperatures below the melt point of the particles and which remaining substantially solid during the drilling process.
- 30 88. Use of a drilling fluid comprising a base fluid and a seepage loss agent for reducing or controlling seepage losses to a permeable underground formation in a process of drilling a well in an oil or gas recovery operation, the seepage loss agent comprising wax particles of greater than 50 microns and being substantially

insoluble in hydrocarbons at temperatures below the melt point of the particles, the particles remaining substantially solid during the drilling process.

Statement under Article 19m PCT

Substitute claims 1 to 27 are based on original claims 1 to 26. Claim 1 has been amended to more accurately define the invention as contemplated. Other minor amendments have been made for improved clarity and to correct typographical errors. Certain claims were re-ordered for a more logical progression and dependencies have been amended accordingly. Claims 2 and 9 are new and former claim 26 has been deleted. New claim 2 finds support throughout the description, for example, at page 11, line 25, to page 12, line 23, and in Example 2. New claim 9 is supported by instant claim 7. Instant claim 7 corresponds to former claim 6 except that its scope has been restricted.

Claims 28 to 88 have been introduced and these serve to further define embodiments of the invention as contemplated. The subject matters of the new claims are supported by the specification, including the original claims.

For convenience, the general relationship between the former claims and the replacement claims is provided below:

Substitute Claims	Former Claims
1	1
2	new
3-7	2-6
8	8
9	new
10	21
11	9
12	7
13-15	10-12
16-23	13-20
24-27	22-25
cancelled	26
28-88	new

STATEMENT UNDER ARTICLE 19 (1)

Support for the new claims can be found at least at the following locations in the specification and in the preceding substitute claims:

New Claim	Support
28	claim 1 and 2; page 10, lines 20-21 ; page 11, line 25, to page 12, line 25
29	based on new claim 28 with narrower scope
30	claim 6
31	page 10, lines 22-25
33-38	claims 7-12
39	page 10, lines 20-22
40	page 10, lines 24-25
41-43	claims 6 and 12
44	page 10, lines 22-25
45	page 9, lines 28-30
46-49	claims 15-17; page 10, lines 1-6
50-51	Example 3
52-55	page 12, line 16, to page 13, line 5
56-59	claims 20-21 ; page 12, lines 26 -29
60	claims 1, 34, 47, 52, 54; page 30, line 31, to page 31, line 9
61	page 12, lines 20-23
62-63	page 7, line 9-16
64	claims 1, 2, 28, 29, 60
66-75	claims 1 to 23 and 28-65
76	Example 4; page 7, lines 10-14
77-85	method claims based on preceding claims; pages 16-17
86-88	use claims based on preceding claims

STATEMENT UNDER ARTICLE 19 (1)