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MATERIAL FOR TREATING OIL WELL DRILLING FLUIDS

William G. Van Beckum, Longview, Wash., assignor to Weyerhaeuser Timber Company, Tacoma, Wash., a corporation of Washington

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This invention relates to a product for use in oil well drilling muds for bridging cracks, crevices, fissures and other porous or faulty formations encountered by the drill bit, and so arresting the loss of well drilling fluids from the bore to the formation through which the well is being drilled.

Loss of the well drilling fluid to the formation is known to the trade as "loss of circulation," and the use of fibrous or bulky materials to prevent loss of circulation in oil well drilling operations is well known to the art. Hay, straw, sawdust, chopped bagasse, flax fiber and like materials have long been used for this purpose. The mechanics of their use has been to mix the additives with the mud in the pit and "gun" the mixture to some semblance of uniform consistency. When the fortified mud reaches the place in the well where it is lost to the formation, the bulky or fibrous material mats, crowds and otherwise seals off the openings and arrests the flow of mud from the well.

Generally, the material is not added to the oil well drilling fluid until needed, at which time it is important that the material be capable of fast addition to and incorporation in the mud; that it be of such nature that it will not clog pumps or the drill bit, and that it be capable of use with any of the three fundamental types of drilling fluids, e. g., oil, oil emulsions, or water base muds.

It is well known to the art that substances which are effective circulation loss preventatives in some formations are not useful in others. The effectiveness of the product is related, at least partially, to the particle size of the additives and the size of the openings in the faulty formation. Applicant has conceived of a product having a broad particle size range consisting of feltable fibers to cover large openings in the formation with a felted mat having small or tortuous openings, and a non-fibrous or non-feltable material capable of plugging small openings in the formation itself or filling the interstices in the fiber belt. This product is effective to seal a wider range of formation porosities than either constituent alone, and is more effective in closing off large openings than when either ingredient is used by itself. The product is especially useful as a fibrous-type circulation loss preventative which may be shipped in bales or bags at an economical density, and which is made easily and readily applicable to the mud by incorporating in the fiber a non-fibrous material to prevent felting of the fiber in the package. The product possesses the important attribute of cleanliness, it lacks any offensive odor, it is not subject to bacterial decomposition, and is available in constant supply in quantities sufficient to supply large demands therefor. A preferred product is of such nature that it is subject to controlled manufacture and composition.

One of the components of the lost circulation preventative is a fibrous material. Practical types of fibrous materials are wood fiber, bagasse, cellophane strips, and flax fiber. The instant invention is described herein with reference to wood fiber, and reference is made to U. S. Asplund Patents No. 2,008,092 and No. 2,145,851, relating to the manufacture of wood fiber. In the Asplund process, wood chips are introduced into an atmosphere of steam at high pressure, providing a temperature above 212° F., at which the lignin content of the particular wood is softened to permit ready defibration by mechanical means. The chips quickly soften and are fed directly to a rotary defibering disc mechanism housed in said environment which mechanically rubs the softened chips to ultimate fibers or a predominance of such fibers. The resulting defibered wood is then discharged to the atmosphere. There is no intention to limit the invention, where the fibrous material is of wood, to the use of Asplund defibrator fiber, since mechanically produced fibers, such as McMillan fiber, are satisfactory for use in the manufacture of lost circulation preventatives.

Wood fibers may be treated with materials inert to the well drilling fluid as, for example, with asphalt to collect and hold the fines created by the grinding operations, with borax, or with caustic solutions preparatory to the removal of lignins, polysaccharides and other soluble organic substances.

A second component of the lost circulation preventative material is a non-fibrous or non-feltable material incorporated with the packaged fiber to facilitate rapid fluffing of the baled or bagged material at the time it is to be added to the well drilling fluid. It will be understood that the compressed material, to be added to the well drilling fluid, must be broken apart and substantially disintegrated in order to be readily and completely dispersed in the drilling fluid.

One purpose of the non-fibrous or non-feltable material is to prevent the fibrous material from felting so tightly upon dense packaging thereof as to be difficult to break apart. Practical types of non-fibrous materials useful for this purpose are sawdust, seed hulls such as cottonseed hulls, nut shells such as peanut shells, flax shives, and the substantially non-feltable portions of the bark of trees and especially the cork and bast fiber fractions of the bark.

A second function of the non-fibrous material is to plug small openings in the formation through which the well hole is drilled, and to fill and seal the interstices in the fiber felt which forms over larger openings in the formation. The meritorious performance of the mixture for this purpose is due to the wide range of particle size and shape, regardless of the exact nature of the materials used. It is important, however, and believed critical to the successful performance of materials embodying the invention, that one of the components of the lost circulation preventative provide a fibrous felt in which to incorporate the non-fibrous material.

It is an object of the invention to provide a material having a wide range of particle size and shape for bridging or sealing cracks, crevices, fissures and other porous or faulty earth formations encountered by the drill in well drilling operations to form a barrier for preventing further loss of the well drilling fluid to the formation.

It is a further object of the invention to provide a material for treating well drilling fluids comprising a mixture of a fibrous material capable of forming a felt over cracks, crevices, fissures and other porous or faulty formations through which the well is drilled, and a non-fibrous material for enhancing breaking and fluffing bales or other dense packages of the fibrous material at the time of treating the well drilling fluid.

It is a further object of the invention to provide a material for treating well drilling fluids comprising a mixture of fibrous and non-fibrous materials derived from trees.

It is a further object of the invention to provide a material for treating well drilling fluids comprising a mate-

rial capable of forming a felt over cracks, crevices, fissures and other porous or faulty formations encountered by the drill, and a material for plugging and sealing openings in the felt.

It is a further object of the invention to provide a material for treating well drilling fluids comprising a mixture of feltable fibers and the non-feltable constituents of the bark of trees.

It is a further object of the invention to provide a material for treating well drilling fluids comprising a mixture of wood fiber and the cork component of the bark of trees.

It is a further object of the invention to provide a method of treating well drilling fluids to provide a barrier for plugging or sealing cracks, crevices, fissures and other porous or faulty formations encountered by the drill to prevent further loss of well drilling fluids.

Various other and ancillary objects and advantages of the invention will become apparent from the following description of an illustrative embodiment of the invention and explanation of the manner of its use.

Wood fibers such as those produced by the Asplund defibrator disclosed and described in U. S. Letters Patent No. 2,008,092 and No. 2,145,851 are ideally suited to be added to well drilling fluids for the purpose of forming a densely felted mat over cracks, crevices, fissures and other porous or faulty formations which are encountered by the drill in oil well drilling operations. These fibers are made from wood which is chipped and defibered and fluffed to assure proper bridging characteristics. When added to the well drilling fluid, the fibers form a fibrous mat over gravelly, fractured and fissured formations and quickly become imbedded with mud to speedily form a tough seal to stop the flow of well drilling fluids from the bore. The fibers readily mix with the mud and stay in suspension until deposited to stop the loss of drilling fluid. It is preferred that wood fibers be treated with asphalt to collect and hold dust created by the defibering process so that the viscosity of the fluid is not disturbed by the addition of dust with the fiber.

Notwithstanding these properties of wood fiber and the obvious advantages attending its use, acceptance by the trade has been limited because of the difficulty of breaking up packages of compressed fiber fast enough when a problem of lost circulation called for immediate action. When packaged at a density economical for shipping, the fibers were so felted together that addition to the mud was difficult and slow. Various attempts were made to improve handleability, one of which was to limit the packaged fiber to 10–12 pounds per cubic foot density. Merchandising in bags was proposed. Notwithstanding these provisions, the low density material still presented disadvantages with respect to handleability, and similar trouble was encountered in pouring from the bags at the well.

Applicant has discovered that physical incorporation of quantities of a non-fibrous or non-feltable material in intimate mixture with the fiber prevents felting of the fiber package and so enables it to be quickly broken up and the fibers fluffed for addition to the well drilling fluid, and, at the same time, make the product more effective for preventing lost circulation of oil well drilling fluids by broadening the particle size range and providing a greater variation of particle shapes.

Examples of non-fibrous materials which may be added to fiber to prevent felting of the compressed product are sawdust, seed hulls such as cottonseed hulls, nut shells such as peanut shells, flax shives, and the substantially non-feltable components of the bark of trees and especially the cork and bast fiber components of the bark. A product constituting from about 1/3 to 2/3 non-fibrous material, and from about 2/3 to 1/3 fibrous material, by weight, is particularly useful as a product for insuring pourability of the packaged material. As a practical matter, however, the composition is limited only by the amount of non-feltable material needed to insure pourability of the material from the package. It will be appreciated that the density to which the package is compressed is the controlling factor which determines the proportions of non-feltable material to fiber. The proportions given hereinabove are for densities of from 10 pounds to about 30 pounds per cubic foot.

A product constituting approximately 60–70% cork and 30–40% bast fiber or sclerenchyma tissue is particularly useful, both to prevent felting together of the fibers when the product is baled or bagged, and as a material for filling the interstices of the mat or felt created by deposition of the fibers over gravelly, fractured or fissured formations in the well bore. The cork provides flake or plate-like particles of a size which are retained on 14 mesh and 28 mesh screens, and a more granulated product of plus-65 mesh screen size. The fiber content of the bark is made up of elongated fibers having a diameter such as will enable them to pass through a 65 mesh screen, and having a length of, roughly, ten diameters. These fibers are relatively stiff and differ sufficiently from wood fibers in structure and performance to provide an almost wholly dissimilar material. These bark fibers form a mat over porous portions of the wall of the bore and so augment the sealing properties of the wood fibers. The cork, for example, being neither fibrous in structure nor capable of being felted under conditions attending baling or bagging of the fiber, prevents the fibers from felting together and obviates the expenditure of time and effort to break up the bales and fluff the fiber at the time of adding the material to the drilling fluid. On the other hand, the mixture of fibrous and non-fibrous materials herein described may be poured from the bag into the pit adjacent the well and quickly dispersed in the mud. Other advantages attending the use of this material are that it is substantially inert insofar as the well drilling fluid is concerned; the material is not subject to bacterial decomposition and will not rot, deteriorate or sour, either during storage or in the hole; the material does not rope, nor does it break down through circulation, and stays in suspension in the mud until the presence of a crack, crevice, fissure, or other porous formation in the wall of the hole causes the material to be deposited in place to perform its intended function.

A mixture of fiber and cork and/or comminuted whole bark contains particles of various sizes and shapes which coact to seal a larger range of openings in the wall of the bore than does fiber alone. Fiber, as the name implies, is relatively long compared to its thickness or diameter whereas the cork particles are somewhat flat and thin, with the larger sizes being more or less plate-like and the smaller sizes somewhat granular. Comminuted whole bark particles are of varying shapes and sizes. The bark particles serve as fillers for the interstices in the fiber mat and enable the mat to more effectively seal the wall of the bore against the loss of circulation therefrom. A mixture of wood fiber, cork and comminuted whole bark provides a large range of particle sizes and a great diversity of particle shapes. Utility of such a product is judged by the character of the formation wherein loss of drilling fluid occurs. Cork is a satisfactory plugging material for a porous formation, whereas fiber is more effective for sealing cracks. For large fissures the combined material is better than either one alone, the fibers forming a felt over the fissure and the cork and other particles plugging interstices in the felt.

On the other hand, by reason of the fact that either cork or wood fiber is by itself a satisfactory material for treating well drilling fluids to stop the loss of the mud to formations encountered by the drill, and that for specific types of formations one or the other of these products will function as well or better than a mixture of the two, the proportions of these materials in a loss of circulation

preventative may be said to be in the range of from zero to 100 parts non-fibrous material to 100 to zero parts fiber. In most instances, a mixture of the two materials is a superior bridging material and, in addition, possesses the advantage of being easily and quickly added to the drilling fluid.

Other bark and wood products may be used to replace approximately half of the cork in the wood-fiber cork mixture. These materials are Silvacon 412, a mixture of approximately 40% cork and 60% bast fiber from the bark of the Douglas fir; ground whole bark; and wood sawdust. These materials differ sufficiently from wood fiber in their physical aspects to come within the description of nonfeltable materials in the loss of circulation mixture. For test purposes, whole bark used to replace approximately half of the cork content of the wood-fiber cork mixture was ground through a ¼ inch screen to produce "coarse material." For other test purposes, whole bark was ground through a ⅛ inch screen to produce "fine material." The physical properties of the batches of ground whole bark are compared with plus-65 mesh screen cork in the following table:

TABLE I

Physical properties of ground whole bark

	Screen Analysis		
	Coarse Ground Whole Bark	Fine Ground Whole Bark	Cork
Plus-28 mesh.....percent..	69	40	77
Plus-65 mesh.....do....	25	47	22
Plus-100 mesh.....do....	4	8.5	1
Bulk density (1 lb./cu. ft.).....	9.6	13.4	15.5

Tests were made to determine the effectiveness of the various experimental mixtures as lost circulation material. For this purpose, samples of Aquagel mud were treated with 15 pounds per barrel of the following lost circulation materials:

(1) Regular D–164: 40% wood fiber, 60% cork
(2) 40% wood fiber, 30% coarse-ground whole bark, 30% cork
(3) 40% wood fiber, 30% fine-ground whole bark, 30% cork

Table II indicates that the mixture of wood fiber, cork and ground whole bark is an efficient lost circulation material. The data indicate that the particle size of the additive has a profound influence on the extent of loss of circulation. It will be appreciated, however, that varying conditions in formations encountered by the drill call for materials having a wide range of particle sizes and shapes, and that the following test data are not indicative of the optimum particle sizes for all types of formations.

TABLE II

Fluid loss through Nevada No. 100 sand bed at 100 p. s. i.

	None	Control 40% fiber, 60% cork	40% fiber, 30% cork, 30% Coarse Ground Whole Bark	40% fiber, 30% cork, 30% Fine Ground Whole Bark
0 Time (cc.).....	5	12	11	20
30 sec. (cc.).....	176	70	54	30
1 min. (cc.).....	186	71.5	56	31
5 min. (cc.).....	197	74	60	33.5
15 min. (cc.).....	206	83.5	65.5	39
30 min. (cc.).....	215.5	96.5	70.2	44

As has been stated, one of the functions of the non-fibrous or non-feltable content of the herein described material is to insure a loosely packed, easy to handle package. Wood fiber alone is easily felted, and too much time is consumed, either in breaking apart highly compressed bales or in empting tightly packed bags, particularly when time is at a premium. Tightly compressed fibers are not easily separated, and expensive and cumbersome machines are required to fluff the material. Table III shows the comparative resistance to compression of lost circulation fibers, and is a determination of the looseness of the bales. The procedure was to compress the fibers to the same volume or density and to measure the force required. The greater the force, the more tightly the material would be packed in a bag. Two separate series of tests were run; one to a 30 pounds per cubic foot density, and the other to a 10 pounds per cubic foot density. It will be noted that when finely ground whole bark is used to replace 50% of the cork content of the bale, approximately the same degree of "looseness" is achieved as when cork alone is used as the non-fibrous material.

TABLE III

Comparative resistance to compression of lost circulation fibers

	Force to Compress to 30 lb./cu. ft. (lb.)	Force to Compress to 10 lb./cu. ft. (lb.)	Appearance of Compressed Fibers 10 lb./cu. (ft.)
Wood Fiber.....	over 10,000	251	semi-tight.
40% Fiber, 60% Cork.....	4,850	68	very loose.
40% Wood Fiber, 60% Coarse Ground Whole Bark.	7,900	89	semi-loose.
40% Wood Fiber, 60% Finely Ground Whole Bark.	8,600	104	semi-tight.
40% Wood Fiber, 30% Cork, 30% Coarse Ground Whole Bark.	6,800	62	loose.
40% Wood Fiber, 30% Cork, 30% Finely Ground Whole Bark.	6,800	68	Do.

From the data in Table III, it is apparent that wood fiber was by far the most tightly packed material, and that a mixture of wood fiber and cork packs the least. All other values lie much closer to the wood fiber and cork values than they do to the wood fiber values. The conclusion is made that substitution of cork by other materials such as ground whole bark will tend to increase the tightness of a bag, the increase being directly proportional to the reduction in amount and lack of range of particle size and variability in shape of the material substituted. It is apparent, however, that ground whole bark can be used to replace cork to the extent of 50% of the cork normally used in the wood-fiber cork mixture. For example, a lost circulation material having the composition of 65% cork and 35% fibrous material may be modified to have a maximum of approximately 30% ground whole bark, 30% cork, and 40% wood fiber.

Having now described my invention and in what manner the same may be used, what I claim as new and desire to protect by Letters Patent is:

1. A product for treating oil well drilling fluids comprising a mixture of wood fiber and the comminuted cork component of the bark of trees, said cork being of plus 65-mesh size, the product being capable of forming a barrier for preventing loss of well drilling fluid to cracks, crevices, fissures and the like encountered by the drill, the product being compressed to a density of from 10 pounds to about 30 pounds per cubic foot, the cork component being present in an amount sufficient to substantially reduce felting of the compressed fiber and to enhance the dispersion of the fiber in the mud.

2. A product for treating oil well drilling fluids comprising a mixture of wood fiber and a non-fibrous, non-feltable constituent of the bark of trees, the product being capable of forming a barrier for preventing loss of well drilling fluid to cracks, crevices, fissures and the like encountered by the drill, the product being compressed to

a density of from 10 pounds to about 30 pounds per cubic foot, the non-fibrous, non-feltable material being present in an amount sufficient to substantially reduce felting of the compressed fiber and to enhance the dispersion of the fiber in the mud.

3. A product to be added to oil well drilling fluids to form a barrier for preventing loss of well drilling fluid to cracks, crevices, fissures and the like, comprising a mixture of from 30–40% wood fiber and from 60–70% of the cork component of the bark of trees, said cork being of plus-65 mesh size, the product being compressed to a density of from 10 pounds to about 30 pounds per

cubic foot, the cork component being present in amount sufficient to prevent felting of the compressed fiber.

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