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WELL DRILLING

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This invention relates to well drilling and more particularly to a method and composition for preventing lost circulation of drilling fluid through opening in well hole walls.

In the drilling of wells by the modern rotary-drilling method it is the practice to introduce a drilling fluid into the well through the drill stem and the bit. This drilling fluid has a number of functions among which are cooling and lubrication of the rotating stem and bit, softening and washing away the formation, removing the cuttings from around the bit and coating the interior of the bore hole. In order that these functions may be properly carried out it is necessary to circulate the fluid into and out of the well hole. This is usually done by pumping the drilling fluid into the well through the drill stem under pressure.

It frequently happens that circulation of drilling fluid into and out of the well hole is interrupted or seriously curtailed in the well by the loss of fluid to the formation through which the bore hole is passing. Such "lost circulation," as it is commonly termed, may develop through loss of fluid to porous sand formations, fissured or cracked formations, cavernous formations or lifting of the overburden through the use of high fluid pressures. However, regardless of the reason for the loss of circulation, it is always a serious problem and is often difficult to solve. Its seriousness will be more apparent when it is realized that loss of circulation may result in the "freezing" of the drill stem or bit in the bore hole through the accumulation of cuttings about them and the lack of lubrication. Loss of circulation may also result in the entire loss of a porous producing formation through the infiltration of drilling fluid and consequent sealing of the formation.

Many methods and materials have been proposed to prevent "lost circulation" but none of these methods or materials has proved to be entirely satisfactory. Most of the methods heretofore proposed have depended upon the addition of fibrous bulk agents, usually of an organic nature such as cotton seed hulls, sugar cane fibres, redwood fibres, cotton, feathers, peat moss, etc., to the drilling fluid to form a matted or wadded seal over the formation into which circulation is being lost.

Experience has shown that these materials frequently form only a thin layer or seal over the formation which is subsequently removed by further drilling or by the insertion of casing. Furthermore, such organic materials are subject

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to fermentation and other process of deterioration which may not only be destructive of the seal but harmful to the drilling fluid. Tests have shown, moreover, that such fibrous materials vary greatly in compressibility at different pressures or well depths and that under high pressures they decrease in volume to such an extent that their final volume under pressure is only a small percent of their surface volume.

I have found a method and material which have proven to be far superior to any presently known method or material for the prevention of lost circulation. Tests have shown that the compressibility of the material under high pressures is low, that it does not deleteriously affect the composition of the drilling fluid, that it may be readily retained in the drilling fluid and that it is unaffected by high well temperatures.

I have discovered that certain volcanic rocks which can be expanded by heating may be used under certain conditions, to be later described, in well drilling fluids to form light weight drilling fluids and to prevent lost circulation through opening in the well hole walls. These materials are light in weight, may be readily graded as to size and weight and are readily pumpable in all fluid media ordinarily used as drilling fluids.

I have found that, particularly in the case of lost circulation, the conditions of use are important. I have found that in the case of lost circulation due to causes other than lifting of the overburden due to high pressure fluids most successful results are obtained when the expanded particles of volcanic rock are incorporated into the fluid in successive portions of successively smaller size particles each being of sufficient size to bridge the openings formed by the preceding particles. In general, if the particle sizes are equal to about one-half of the smallest average dimension of the opening which they are intended to bridge, the most rapid and effective bridging will take place. It appears that the mechanism of my invention in such cases is one of progressively bridging the openings through which circulation is lost with large size particles and subsequently with particles of decreasing size.

In the case of lost circulation due to the use of high pressure fluids, the practice which appears to be most satisfactory is that of adding the expanded volcanic rock to the drilling fluid to reduce its weight. I have found that such expanded volcanic rock will successfully reduce the weight of any of the mixtures commonly used as drilling fluids, e. g., oil or water base muds containing added chemicals, salt solutions, or-

ganic mixtures such as starch and glutenous mixtures, or lost circulation mixtures containing bulky fibrous materials. These expanded volcanic rocks will stay in suspension in viscous fluids or plastic solid suspensions such as bentonite or other clay mixtures, asphalt emulsion mixtures or other viscous oil mixtures and yet will not appreciably reduce the viscosity of the fluid.

The expanded volcanic rock

While I may employ in my composition and method any volcanic rock which may be expanded by heating, I prefer to use expanded perlite. Expanded perlite is obtained by expanding the volcanic rock of the same name by the Mulheisen or similar process. In such processes the expansion takes place upon heating during which time the molecular water is driven off leaving a light weight, uniform textured, inert mineral substance. The expanded material appears to be composed of small cells containing gas and is generally accepted as having the composition of an amorphous aluminum silicate where the radical components vary greatly. The perlites that have proven most satisfactory are those which have a composition similar to that of the better grades of bentonite clay. The conditions of expansion may be controlled so as to give expanded particles of perlite of controlled size and weight. Although the limiting factors in the use of the various sizes of perlite appear to be the size of the pump orifices and crushing strength of the expanded particles, I have found that sizes up to about 1/4 inch are generally satisfactory. Larger sizes of perlite may, of course, be used depending upon the condition of the well and the handling equipment. Preferably the perlite should not compress more than 25% of its bulk volume on applications of fluid column pressures of 10,000 pounds per square inch.

The drilling fluid

Perlite and the other volcanic rocks which may be expanded by heating such as pumicite and pumice may be added to any mixtures commonly used in drilling wells. The drilling fluid may be any of the water-clay muds, starch and gum muds, oil base muds, silicate muds, asphalt emulsion, etc. It may also be added to any of the commonly used lost circulation mixtures. In each case the addition of perlite will reduce the weight of the mud. Due to the light weight of the material it may be safely pumped into the well in water alone, without the use of expensive mud, to seal the formation through which circulation is being lost and without the possibility of the material settling around drill pipe and bit with a resulting costly fishing job.

The highest concentrations of pulpy materials that can ordinarily be pumped in the fluid media generally used in oil wells is about 30 pounds per barrel of fluid. Expanded perlite on the other hand has been pumped in concentrations as high as 100 pounds per barrel of fluid. The difference in the amount of material which may be pumped apparently results from the fact that additions of perlite only slightly affect the viscosity of the fluid whereas all the materials ordinarily used for lost circulation increase the viscosity markedly. The importance of this difference becomes apparent in the decreased cost of mud necessary to get a "fill-up" in very porous or fractured zones.

The exceptional results which may be had by

the use of the material and method of my invention will be more apparent from a consideration of the following examples.

Example I

Continued lost circulation occurred while drilling below 8800 feet on a 9000 foot contract. All known methods were resorted to, including cementing. Nine cement plugs were set while drilling 100 feet. The amount of cement in each varied from 50 to 100 sacks. Considerable difficulty was encountered in getting the plugs to remain stationary. The operation of drilling the last 200 feet consumed three weeks at a cost of \$800.00 per day for the rig plus the cost of materials and cementing services. After the last plug was set without results a total of 1244 cubic ft. of perlite was used and the well completed in three days' time.

Example II

In drilling a well at 9000 feet returns were lost. All known methods and materials were used over several weeks without results. The hole was cemented several times without results. At this point 1024 cubic ft. of perlite was used, returns were completely restored and the well was cored and casing set. The well was then deepened 900 feet without further difficulty.

Example III

While drilling at 3740 feet returns were lost completely. All known materials were used without results and the lost circulation which continued over a period of days resulted in caving the hole where the cavings came in on the drill pipe causing a costly fishing job which took three weeks to complete. Then 320 cubic ft. of perlite in 100 barrels of bentonite mud were pumped to the bottom. Returns were obtained immediately and all of the mud in the hole which contained other lost circulation materials was discarded. The well was then drilled 130 feet deeper where another porous zone was found. An additional 140 cubic ft. of perlite restored returns immediately.

Example IV

Circulation was lost in a well at a total depth of 7500 feet. The suspected depths of trouble were at approximately 5400 feet and at the bottom of the well (7500 ft.). Usual methods including cementing failed to gain returns. A total of 1800 cubic ft. of perlite spotted in the well restored full returns.

While I believe that my theory of the bridging action of perlite and related expanded volcanic rocks is correct and this theory is consistent with the observed facts, I do not bind myself to this theory. Accordingly, it will be understood that while I have illustrated and described a present preferred application of my invention, it may be otherwise embodied or practiced within the scope of the following claims.

I claim:

1. A well-drilling fluid for use in oil or gas well holes, comprising a fluid medium, a base material suspendible in said fluid medium and a quantity of volcanic rock particles which have been expanded into a cellular form by heating, all in proportions to form a pumpable mixture.
2. A composition for use in preventing lost circulation in well holes comprising water, a water suspendible clay and a quantity of volcanic rock particles which have been expanded into cellular form by heating, all in proportions to form a pumpable mixture.

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3. A composition for use in preventing lost circulation in well holes comprising a mixture of water, a water suspensible clay and expanded perlite in proportions to form a pumpable mixture.

4. A composition for use in preventing lost circulation in well holes comprising water, bentonite and expanded perlite in proportions to form a pumpable mixture.

5. A composition for use in preventing lost circulation through openings in well hole walls comprising a fluid medium, a clay suspensible in said fluid medium and a quantity of volcanic rock particles which have been expanded into cellular form by heating, said particles being of sufficient size to bridge the openings through which circulation is lost, all in proportions to form a pumpable mixture.

6. A composition for preventing lost circulation of drilling fluid through openings in well hole walls comprising a mixture of drilling fluid and expanded perlite particles of sufficient particle size to bridge the openings through which circulation is lost, all in proportion to form a pumpable mixture.

7. The method of preventing lost circulation of drilling fluid through openings in well hole walls which comprises incorporating into the drilling fluid expanded perlite particles of sufficient size to bridge the openings through which circulation is lost and pumping the resulting composition into the well hole.

8. The method of preventing lost circulation of drilling fluid in well holes which comprises incorporating into the drilling fluid expanded perlite particles and pumping the resulting composition into the well hole.

9. The method of preventing lost circulation of drilling fluid through openings in well hole walls which comprises incorporating into the drilling fluid expanded particles of volcanic rock having a cellular structure and a size sufficient to bridge the openings through which circulation is lost and pumping the resulting composition into the well hole.

10. The method of preventing lost circulation of drilling fluid in well holes which comprises

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successively incorporating into the drilling fluid expanded particles of volcanic rock having successively smaller particle sizes, pumping the successive resulting compositions into the well hole to bridge an opening through which circulation is lost.

11. The method of preventing lost circulation of drilling fluid through openings in well hole walls which comprises incorporating into the drilling fluid expanded particles of volcanic rock of graded sizes having a range of particle size up to about one-half of the smallest average dimension of the opening and pumping the resulting mixture into the well hole.

12. The method of preventing lost circulation of drilling fluid containing suspended clay particles through openings in well hole walls which comprises successively pumping portions of the drilling fluid into the well hole into each portion of which expanded particles of volcanic rock have been incorporated, the particles in each portion being successively smaller in size, thereby bridging the openings with successively smaller particles and finally sealing the bridge with a layer of clay particles.

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