AUTOMATIC MUD SAMPLER AND PACKAGER

FIG. 5

FIG. 6

FIG. 7

FIG. 8

FIG. 9

FIG. 10

FIG. 11

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ABSTRACT OF THE DISCLOSURE

A packaging material for a drilling mud sampler. The packaging material is tubular in form and made of a flexible, heat-sealable, gas-retentive material with a relatively high tensile strength.

Cross-reference to related applications

This is a division of S.N. 361,515, filed Apr. 21, 1964, now U.S. Patent 3,333,391, issued Aug. 1, 1967.

This invention relates to the packaging of fluid mixtures which contain large amounts of suspended or entrained particulate solids. In a particular aspect, the invention relates to apparatus for the packaging of drilling fluid samples obtained in the rotary drilling of boreholes in the earth, especially in the drilling of oil and gas wells.

In a preferred embodiment, a packaging material is produced which preserves the original gas content of the sample for quantitative analysis.

The incentive for analyzing periodic samples of drilling mud for the presence of hydrocarbon gases has been recognized for many years. Such analysis of the drilling mud, when correlated with the drilling depth, gives a more immediate and reliable indication of the presence of valuable petroleum deposits than any other method of well logging. However, extensive routine use of quantitative hydrocarbon mud-gas logging has been slow to develop, due in part to the difficulty of obtaining reliable, representative samples of the mud stream. Moreover, once representative samples are obtained, it is difficult to preserve the mud samples in such a way as to prevent the escape of hydrocarbon gases.

In a great many drilling operations it is conventional practice to collect mud samples manually. That is, from time to time field personnel at the drilling site simply scoop a bucket of fluids from the mud riser box, or from some other exposed mud surface, and label the sample to indicate drilling depth or time, or both. This method of sample collection is unsatisfactory for several reasons. Perhaps most important is the fact that the mud has been exposed to the atmosphere prior to collection, thus enabling a major proportion of the light gases, especially methane and ethane, to escape if they were initially present. Moreover, human fallibility introduces various errors, both in the composition of samples and in the correlation of sampling time with drilling depth.

Accordingly, it is an object of the present invention to provide an apparatus for obtaining uniform, representative samples of drilling mud from the return flowline at accurately timed intervals. It is a further object to package the samples in a manner which will preserve their original composition, especially with respect to hydrocarbon gas content.

The apparatus of the present invention receives a continuous sample stream of drilling mud from the return flowline, or from the surface conductor casing, for the purpose of packaging periodic samples for analysis. While the apparatus is on a standby basis, the sample stream is simply diverted to the mud pits. At timed intervals the sample stream is passed through a delivery tube which directs the mud to a scaling system where a sample of the mud is encased in a plastic pouch. The operation is repeated at selected intervals until a large number of samples are collected in a fixed sequence and correlated with drilling depth.

The sampling and packaging device of the present invention is composed of four principal sub-systems or sub-combinations. Following the sequence in which the systems operate, the first is a flow control system, or valve assembly, which is itself sub-divided into two parts: A first valve places the mud sample stream alternately on standby basis, and then switches to a sampling cycle at periodic intervals. A second valve functions to supply a stream of water at periodic intervals, timed to coincide with the standby position of the mud control valve.

The second major sub-combination includes a conduit for periodic delivery of the sample stream to the packaging system, and means for disposal of excess mud supplied to the packaging system. In a preferred embodiment, the mud disposal means also provides temporary storage for the flexible packaging material in which the mud samples are to be encased or sealed.

The sealing means, located near the outlet end of the delivery tube, consists essentially of a pair of clamping jaws and a pair of heat seal jaws. The packaging material is fed from temporary storage through the space between the two pairs of jaws. A continuous flow of the sample stream passes from the delivery tube into that portion of the packaging film located between the jaws, and thence through the mud disposal line. At a time designated for the sealing of each successive sample, the clamping jaws are activated first whereby a pouch of mud is held separate from the flowing stream. At this time the flow of mud is interrupted and a stream of water is passed through the delivery tube and disposal line in the same manner as was the mud. During the flow of water, the clamping jaws remain firmly engaged against opposite sides of the plastic tube, to prevent passage of fluids between the jaws. Once the flow of water has cleaned the inner surface of the plastic tube immediately adjacent the area held by the clamping jaws, the heat seal jaws are activated, while the clamping jaws remain firmly engaged. The flow of water is then interrupted and electric current is passed through the heating element of the sealing jaws to complete the formation of a gas-tight seal, thereby preserving the true composition of the packaged sample.

Both the clamping jaws and the sealing jaws are then retracted to permit the advance of the sample storage wheel, in order to place a fresh portion of the packaging material in position for the formation of the next successive sample pouch.

FIGURE 1 is an isometric view of an embodiment of the packaging apparatus of the invention.

FIGURES 2 and 3 are cross-sectional views of the flow control system of the apparatus of FIGURE 1.

FIGURE 4 is a cross-sectional view of the upper blades of the clamping and heat seal jaws of the apparatus of FIGURE 1.

FIGURES 5 through 11 are diagrammatic sectional views of the clamping and sealing jaws, illustrating the sequence of steps involved in the operation of the apparatus.

Referring to FIGURE 1, the apparatus is seen to consist of four major sections: a flow control system, a delivery section, a packaging section, and a collection and storage assembly. The flow control system includes valves 11 and 12, the first of which functions to direct a sample stream of mud from line 13 through port 14 and discharge line 15, and alternately through port 16 into the
livery tube 17. Valve 12 functions to direct a stream of water through line 18, port 19 and delivery tube 17 for the purpose of periodically flushing the system, as more fully explained in connection with the packaging section as discussed below.

The elongated central area of the illustrated embodiment includes delivery tube 17 and outer flow tube 20, substantially concentric therewith. Tubular film 21, stored along the outer surface of tube 20, is composed of a highly flexible, heat-sealable, gas-retentive sheath having a relatively high tensile strength.

The packaging section is composed of clamping jaws 22 and heat seal jaws 23 which function, respectively, to form each successive pouch or cell and hold it separate from a flowing stream of water which removes excess mud and particulate solids from the area to be sealed; and then to form a permanent heat seal, thus completing the formation of each successive pouch.

The collection and storage section consists essentially of a large diameter wheel 24 to which one end of tubular film 21 is fastened at point 25. Periodic rotation of the wheel, in a clockwise direction from the side viewed, through an arc corresponding to the space occupied by a single pouch at the perimeter of the wheel, advances each successive film of the packaging section from its position on tube 20 to a location between jaws 22 and 23, in readiness for the formation of the next successive sample pouch.

In valve 11, the position of plunger 26 is controlled by double-acting pneumatic piston 27. For example, in the position shown, plunger 26 is seated against port 14 thereby forcing the flow of mud through port 16 into delivery tube 17. In the alternate position, plunger 26 seats against port 16 thereby directing the flow of mud through port 14 and discharge line 15. The flow of air to pneumatic piston 27 is controlled by a solenoid-actuated valve, which in turn is actuated by time sequence controller 29.

In valve 12, the position of plunger 30 is controlled by double-acting pneumatic piston 31. For example, in the position shown, plunger 30 is seated against port 19 thereby excluding the flow of water and permitting the passage of mud through port 16 into delivery tube 17. In the opposite position, plunger 30 is lifted at a time when plunger 26 is seated against port 16, thereby permitting the inflow of water to delivery tube 17 while mud flow is excluded. The flow of air to pneumatic piston 31 is also controlled by a solenoid-actuated valve, which in turn is activated by a signal from time sequence controller 29.

The specific description of valves 11 and 12, including the description of the actuation means associated therewith, is for the purpose of illustration only. It is within the scope of the invention, in its broadest form, to substitute other flow control means for producing an equivalent manipulation of stream flow.

The end of delivery tube 17 is flared outward to form an elongated rectangular outlet 35. The primary function of the flared portion is to shape the packaging material just prior to the clamping and sealing stage of the operation, in order to prevent the formation of wrinkles between the clamping and sealing jaws, thus providing a smooth seal. Moreover, the flared outlet improves the cleaning efficiency of the flushing operation just prior to the sealing step, ensuring a clean inner packaging surface between the heat-seal jaws. An additional shaping action may readily be obtained, if desired, by equipping the flared outlet with a longitudinal rib or finlike extension along the outer surface of the major transverse axis. Such an extension also aids the flow of mud into discharge line 20.

The upper blade of clamping jaws 22 is driven by double-acting pneumatic piston 41. The lower blade is simultaneously driven upward by the same force, transmitted through endless chain pair 42. Similarly, the upper half of heat seal jaws 23 is driven by piston 43, and the lower half is forced upward by endless chain pair 44.

Wheel 24 is periodically advanced by ratchet and pawl mechanism 39, actuated by piston 38, which is in turn operated by a solenoid valve, and controller 29.

In FIGURE 4 the detailed construction of the upper blades of jaws 22 and 23 is shown. The gripping edge of blade 22 is provided with an elastomeric pad 53 bonded within a groove or depression along the metallic blade. Electrical heating element 54 consists essentially of Nichrome ribbon, and is separated from blade 23 by means of insulating layer 55. The lower blades of jaws 22 and 23 are mirror-image duplicates of the upper blades. As a specific example of the operation of the device, a continuous stream of mud is supplied through line 13 at the rate of 3 gallons per minute. Referring to FIGURE 1, the initial stage of the operation is begun with the illustrated positions of plungers 26 and 30 of valves 11 and 12, respectively. The mud stream is thereby directed through tube 17 into the packaging area, where it emerges from rectangular outlet 35. The direction of mud flow is reversed by the packaging film and is then discharged along the annulus between lines 17 and 20, and through clamp line 34. The clamping and sealing jaws are open, as shown in FIGURE 5. During this period of circulation the tubular packaging material is held stationary by expandable pneumatic clamp 36, which also serves to prevent the leakage of mud through the narrow annular space surrounding the outer surface of tube 20. The leakage of mud through this annular space would represent no serious loss in terms of mud volume; however, due to its abrasive nature and the presence of some large cuttings, the leakage of mud into this annular space is considered very undesirable inasmuch as it may lead to the development of leaks in the packaging material through a cutting or tearing action during its periodic advance along the surface of tube 20.

The preferred example of flexible tubular packaging material consists essentially of inner and outer laminations of plastic resin film. The outer lamination is polyethylene terephthalate resin film, known by the trade name "Mylar," having a thickness of .0005 inch. The inner lamination is polyethylene resin film having a thickness of .002 inch. It is a preferred feature of this particular film, as well as of any suitable equivalents, that the material must possess a high degree of hydrocarbon gas retentiveness. In the preferred example, such retentiveness is characteristic of the Mylar lamination.

The packaging material must also be readily amenable to the formation of a permanent, gas-tight heat seal. In the preferred embodiment this characteristic is supplied by the polyethylene lamination. Studies have shown that the inner lamination of polyethylene should not exceed .002 inch in thickness because of its propensity to absorb significant quantities of hydrocarbon gas from the mud sample.

Other flexible, heat-sealable packaging materials may be used, including metal foils, for example. A foil may be used alone, or as a combination with a synthetic resin film. Pressure alone is capable of forming a metal-to-metal seal, without the need for heat.

With a continued flow of mud stream through the confined space near outlet 35, the clamping jaws 22 are activated and engaged against opposite sides of tube 21 to form a mud sample pocket 61 as illustrated in FIGURE 6. With clamping jaws 22 remaining engaged, a signal is received from the detector 20 and the detector 20 activates pneumatic piston 31 and lifts plunger 30, thereby admitting a stream of water through line 18 and port 19. This position of plungers 26 and 30 is illustrated in FIGURE 3, and the position of the clamping and sealing jaws is shown in FIGURE 7. The circulation of water within the space confined by packaging film 21 at the end of delivery tube 17 functions primarily to remove
the retained hydrocarbon gases associated with the mud samples; and
(c) means within the sheath for sealing the cells in a gas-tight manner and for retaining the mud samples and gas within the cells to preserve the original composition of the mud samples.

2. A package as defined by claim 1 wherein the sheath comprises a laminated synthetic resin film, one lamination being polyethylene terphthalate resin film and one lamination being polyethylene resin film.

3. A package as defined in claim 2 wherein the sealing means is a permanent, gas-tight seal of polyethylene formed by heat-pressure bonding of the polyethylene on opposite sides of the sheath.

4. A package as defined in claim 1 wherein the sequence of the cells is arranged to reflect the drilling depth at the time each sample was obtained.

5. A gas-retentive package containing a sequence of fluid samples and associated gases comprising:
(a) an elongated flexible sheath comprising a lamination of polyethylene and polyethylene terephthalate;
(b) a sequence of cells within the sheath containing a plurality of fluid samples and the retained gases associated with the samples; and
(c) means within the sheath for sealing the sheath in a gas-tight manner at intervals to separate the cells and to preserve the original composition of the samples disposed within the cells.

6. A package as defined by claim 5 wherein the sealing means comprises a permanent, gas-tight seal of polyethylene formed by heat-pressure bonding of the polyethylene on opposite sides of the sheath.

7. A package as defined by claim 5 wherein the cells are arranged in a sequence to reflect the time at which the sample was obtained.

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