METHOD AND APPARATUS FOR CONTROLLING DUST IN A ROTARY DRILLING OPERATION

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This invention relates to an improved method and apparatus for controlling dust in a rotary drilling operation.

When a rotary drill is used in a rock formation, it produces large volumes of dust which must be controlled to protect personnel and equipment. When air alone is injected into a drill hole to blow out cuttings, dust can be controlled only with mechanical collecting means outside the hole. Dust can be suppressed by injecting water at the drilling face, but water is destructive to the bearings of cone-type drill bits. When water reaches the bearings, the bit life may be shortened as much as 60 percent compared with a bit which runs in air.

An object of the present invention is to provide an improved method and apparatus for controlling dust in a drilling operation in which water is injected into the drill hole but kept away from the critical parts of the drill bit likely to be damaged.

Another object is to provide an improved dust control method and apparatus in which both air and water streams are conducted separately through a drill rod and the water discharges out of contact with the bearings of the bit, while a portion of the air stream alone is directed on the bearings to flush away foreign particles.

In accomplishing these and other objects of the invention, I have provided improved details of structure, preferred forms of which are shown in the accompanying drawings, in which:

FIGURE 1a is a vertical sectional view, partly in elevation and partly diagrammatic, of the upper portion of a rotary drill string equipped with dust control apparatus in accordance with my invention;

FIGURE 1b is a continuation of FIGURE 1a showing the lower portion of the drill string;

FIGURE 2 is a vertical sectional view of a portion of a drill rod which has a modified means for conducting the water stream; and

FIGURE 3 is a vertical sectional view, partly in elevation, of the lower portion of a drill string and bit which have a modified means for discharging water into the drill hole.

FIGURES 1a and 1b together show a tubular drill string which includes a rotatable drive spindle 16, a drive coupling 12 attached to the lower end of the spindle, a drill rod 13 threadededly engaged with the coupling and formed of individual sections 13a, a stabilizer 14 threadededly engaged with the lowermost of these sections, and a cone-type drill bit 15 threadededly engaged with the stabilizer. The spindle is connected with a suitable drive mechanism (not shown). The drill string operates within a drill hole H which has a drilling face F at the bottom. A stationary housing 16 fits within the upper end of the drive spindle 10. An elbow 17 is fixed to the top of the housing. An air inlet pipe 18 is connected to the elbow and leads to a source of compressed air. Thus an air stream is blown downwardly through the bore of the drill string. The foregoing parts are conventional, except where I have adapted them to accommodate my dust control apparatus, as hereinafter explained.

The drill bit 15 includes a plurality of cones 19 which are rotatably mounted on the usual antifriction bearings 20 and have the usual cutting teeth 21. The bit body has a bore 22 which forms a continuation of the bore through the drill string. As also known in the art, the bit body has a plurality of main and auxiliary air passages 23 and 24 leading from its bore. The main air passages 23 conduct the major portion of the air stream to the drilling face F where it discharges as jets to blow away cuttings. The auxiliary air passages 24 conduct the remainder of the air stream to the respective bearings 20 to flush away foreign particles. The returning air stream carries the cuttings from the drill hole. In a typical bit the major portion of the air stream constitutes 80 to 85 percent, but this range may vary. Bits are known in which the major portion is only about 70 percent of the air stream. My invention operates with the same effectiveness no matter what percentages are used in the breakdown of the total air.

In accordance with my invention, I mount a stationary water line 25 inside the drive spindle 10. The upper end of the water line extends through a seal housing 26 at the bend of elbow 17 and is connected to a water source. The lower end of the water line is connected to a swivel 27 mounted in the drive coupling 12 on the axis thereof. The mounting includes a bore 28 and a pipe 29 which are welded at opposite ends to the coupling wall and to the swivel. The coupling wall has radially and longitudinally passages 30 and 31 which communicate with pipe 29. Each drill rod section 13a is cut away at the base of its externally threaded portion to form an annular passage 32. The upper portion of the wall of each section 13a has an inwardly sloping passage 33 extending from passage 32 to the bore. The lower portion of the wall of each section has an outwardly sloping passage 34 extending from the bore and an inwardly sloping passage 35 in communication therewith extending to the bottom of its internally threaded portion. FIGURE 3 shows a closure 36 to the outside of each section at the end of passage 34. A small diameter tube 37 extends through the bore and connects passages 33 and 34. This same arrangement of passages and tubes is present in each section 13a and in the stabilizer 14 to provide a continuous channel for conducting a water stream from the water line 25 to the drill bit 15.

The drill bit 15 has an annular passage 38 at the base of its externally threaded portion and inwardly sloping passages 39 leading from passage 38 to the respective main air passages 23. Passage 38 communicates with the annular passage 36, whereby the water stream discharges through the annular passage and passages 39 into passages 23. The auxiliary air passages 24 communicate with the bore 22 above the points where the main air passages 23 communicate therewith. Hence the water stream cannot reach the auxiliary air passages nor the cone bearings 20. Instead the entire water stream goes to the main air passages where the air stream atomizes the water, enabling it to wet the cuttings effectively and suppress dust.

FIGURE 2 shows drill rod sections 13b which have modified means for conducting the water stream. Each drill rod section has a longitudinal groove 40 cut in the outside face of its wall. I replace the water tube 37 with a tube 41 inserted in groove 40, and I apply a weld 42 to fill the outer portion of the groove. The drill rod sections 13b have annular passages 43 similar to those of the first embodiment, and passages 44 and 45 which afford communication between the annular passages and the upper and lower ends of tube 41. Normally I use this modification in drill rods which have thick walls not unduly weakened by cutting a groove therein; otherwise I use the first embodiment. It should also be noted that the two embodiments of drill rod section can be used in the same drill string as long as the threads fit, and the modified water-conducting means also can be used in the stabilizer 14.

FIGURE 3 shows a stabilizer 14a and bit 15a which
have modified means for discharging the water stream. I replace passages 39 in the bit with radial passages 46 in the stabilizer. Passages 46 discharge water from the annular passage 36 directly into the drill hole H above the working parts of the bit. Air pressure prevents the water from reaching the bit cones, but instead carries the water out of the drill hole with the cuttings. Thus there is no possibility of the water causing damage to the bit.

In operation, I introduce an air stream through the bore of the drill string in the usual manner to blow cuttings away from the drilling face F and also away from the cone bearings 29. I separately introduce a water stream through the water conducting means formed by tubes 37 or 41 and the connecting passages. The water discharges into the main air passages 23 or directly into the drill hole H, where it effectively wets the cuttings and suppresses dust, but never reaches the bearings. Subsequently air pressure forces the water out the drill hole along with cuttings and dust. I have obtained satisfactory results with air volumes of about 600 to 1500 cubic feet per minute and pressures of about 70 to 75 p.s.i.g. Nevertheless these limits are not critical. The air volume can vary from small amounts up to about 2500 cubic feet per minute or even higher. The pressure likewise can vary from small amounts up to about 150 p.s.i.g. or higher. I adjust the water volume so that the cuttings and water discharge from the hole as wetted dust, not mud.

From the foregoing description it is seen that my invention affords a simple method and apparatus for controlling and suppressing dust in a rotary drilling operation. Water is introduced to the drill hole at a location where it effectively wets the dust, yet it remains out of contact with parts of the drill bit likely to be damaged. Thus the water does not affect the life of the bit. While I have shown and described certain preferred embodiments of my invention, it is apparent that other modifications may arise. Therefore, I do not wish to be limited to the disclosure set forth but only by the scope of the appended claims.

1. In a rock-drilling operation wherein a tubular drill string, which includes a bit of the type having cones and bearings rotatably mounting the cones, rotates within a drill hole while the cones engage a drilling face at the bottom of the hole and produce cuttings which include dust, a method of controlling the dust comprising injecting an air stream through the drill string, discharging a major portion of the air through the bit into the drill hole to blow cuttings from the drilling face and out the hole, discharging a minor portion of the air into the bearings to flush away foreign particles, conducting a water stream through the drill string, maintaining the water stream separate from the air stream from the upper end of the drill string to the bit, and discharging the water into the drill hole separately from the minor portion of the air where the water wets the cuttings without contacting the bearings.

2. A method as defined in claim 1 in which the water stream discharges into the major portion of the air within the bit.

3. A method as defined in claim 1 in which the water stream discharges directly into the drill hole separately from both portions of the air.

4. A method as defined in claim 1 in which the water volume is adjusted to discharge the cuttings as wetted dust, and the air volume can vary from small amounts up to about 2500 cubic feet per minute and the air pressure can vary from small amounts up to about 150 p.s.i.g.

5. A method as defined in claim 1 in which the major portion of the air constitutes at least about 70 percent thereof and the minor portion the remainder.

6. In a rock-drilling apparatus which includes a rotatable tubular drill string and a cutting bit attached to one end thereof, said cutting bit having cones and bearings rotatably mounting said cones and bearings being adapted to engage a drilling face within a drill hole and produce cuttings which include dust, the combination therewith of an apparatus for controlling dust in the cuttings, said last-named apparatus comprising means for injecting an air stream through said drill string to said bit, said bit having main air passages for discharging a major portion of the air into the drill hole to blow cuttings from the drilling face and out the hole and auxiliary air passages for discharging a minor portion of the air into the bearings to flush away foreign particles, and means for separately conducting a water stream through said drill string to said bit, said bit having passages for discharging the water into the drill hole separately from the minor portion of the air, whereby the water wets the cuttings without contacting the bearings.

7. An apparatus as defined in claim 6 in which the water passages discharge into the main air passages within the bit.

8. An apparatus as defined in claim 6 in which the water passages discharge directly into the drill hole separately from the main air passages.

9. An apparatus as defined in claim 6 in which the drill string includes a drill rod formed of threadedly connected sections, and said water-conducting means includes tubes extending inside said sections and passages in the walls of said sections around the threaded connections affording communication between the tubes of the sections at either side of the connection.

10. An apparatus as defined in claim 6 in which the drill string includes a drill rod formed of threadedly connected sections each having a longitudinal groove in the outside of its wall, and said water-conducting means includes tubes extending within said grooves and passages in the walls of said sections around the threaded connections affording communication between the tubes of the sections at either side of the connection.

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