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BUREAU OF MINERAL RESOURCES, GEOLOGY AND GEOPHYSICS

Record 1965/169

THE ROLE OF AIR DRILLING IN PETROLEUM EXPLORATION WITH PARTICULAR REGARD TO AUSTRALIA

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History

The advantages of air drilling in areas where surface formations are extremely hard has long been recognized in Australia as well as overseas. The majority of seismic drills presently in use in this country are equipped with a compressor and pneumatic drills in addition to the conventional mud pumps. More recently, the air drilling technique has been used in conjunction with large rotary rigs in Australia.

In 1963/64 W.L. Sides & Son Pty Ltd drilled three stratigraphic wells for the Bureau and used air drilling for the upper part of each well. Because only primary compressors (output to 125 p.s.i.) were available, water influx soon caused the back pressure to exceed the pressure rating of the compressors and the deepest penetration achieved by this method was 970 feet in B.M.R. No.12.

In 1964 Exoil (N.T.) Pty Ltd air and mist drilled East Mereenie No.2, and by using primary and booster compressors were able to drill the upper 4122 feet of the well before mudding. This section of the well was drilled in 20 days compared with the 74 days which were required to drill the equivalent section in East Mereenie No.1 using mud as a circulating medium.

Transoil (N.T.) Pty Ltd drilled the upper 1500 feet of of 12¼" hole for Mount Charlotte No.1 in 80 hours using air while the equivalent section in Alice No.1 required 150 hours on bottom using mud. In both East Mereenie No.2 and Mount Charlotte No.1 the average footage per bit was more than doubled by using air. Magellan Petroleum Company, Alliance Oil Development N.L. and Farmout Drillers N.L. are other operators that have used air drilling to advantage.

Gas Drilling

Gas drilling requires essentially the same wellhead equipment as air drilling. A pressure sealed rotating head, an air pressure by-pass assembly and return or "blooie" line are required for both techniques. A substantial saving is realized by dispensing with the compressors but a high pressure, high volume gas producing well must exist within several miles. Gas drilling has been attempted at Gilmore in Queensland, has been successfully used at Mereenie in the Northern Territory, and will be used for a second well at Palm Valley also in the Northern Territory.

Advantages

There are several situations where the advantages of air or gas drilling are pronounced:

(a) Drilling severe lost circulation zones. The usual cause of lost circulation is fracturing of formations by the hydrostatic pressure of the mud column. The next most frequent cause is the occurrence of underground caverns generally associated with limestone, dolomite or volcanic lithology. In both these cases, the reduced hydrostatic head greatly alleviates the problem and, because the cuttings are frequently in the form of a fine powder, a portion of them is invariably returned to the surface.

(b) Productive formations that are sensitive to water, mud or cement. In some areas, the hole is drilled by conventional means to a point just above the productive reservoir. Casing is cemented at this depth and then drilling continued using air or gas. In this way, the reservoir is never damaged by water-bearing fluids.

(c) Deviation problems. When a hole deviates, reducing the weight on the bit reduces the tendency of the hole to deviate further. In these circumstances a pneumatic or "hammer drill" will usually help to drill a straight hole. A hammer drill is a device that uses air pressure to impart a series of blows to the drilling bit in the same manner as a jackhammer. A percussion type bit (one faced with tungsten carbide or other material of a similar hardness) must be used to withstand the intense pounding action. The device is fitted just above the bit so that the jarring effect is not dampened by intervening components of the drill string. When working at maximum capacity, the hammer drill reduces the pressure in the string by about 250 p.s.i. As it becomes possible to increase the weight on the bit its effectiveness diminishes and the available air pressure is better utilized by deleting the hammer drill and thereby increasing the volume of air in circulation.

(d) Slow drilling. For hard and medium hard formations, when drilling progress is reduced to a few feet an hour, removal of cuttings is not a problem and air drilling almost invariably results in greater penetration rates. The reasons are not clear but the increase may possibly be explained by the fact that the bit is always in contact with the formation (no mud cushion) and because the formation may chip and break more easily in the absence of a large hydrostatic head.

<u>Limitations</u>

Before embarking on an air drilling programme, the economics must be carefully considered as compressor hire will normally increase rig rentals by about 50%. In the Moonie-Roma area the sediments are relatively soft and drill very rapidly regardless of which circulating fluid is chosen. Mud is generally the most effective in keeping the hole clean (free of cuttings). Consequently air drilling is inadvisable in this area.

Other limitations of air drilling are:

(a) Unconsolidated formations.
In soft shales, excessive caving will occur in the absence of a mud column. The hole diameter soon increases to such an extent that practical volumes

of air are no longer effective in removing cuttings. A mud column tends to prevent caving by exerting a back pressure on the formation and by "plastering" the walls of the hole. In the United States and Canada, patents for a two fluid system of drilling which would solve this problem have been granted but this method is little used at present.

(b) Inadequate formation water or excessive water influx. When formations are extremely dry, the moisture content of the air tends to make the cuttings floccuate and stick to the drillpipe. Chemical additives that inhibit water absorption by the cuttings will generally prevent the drillpipe becoming stuck on this account. On the other hand, as the amount of formation water increases, it becomes more difficult to blow the hole clean. Drilling with mist and aerated water commences as the water inflow increases. Ultimately, if water inflow at rates exceeding 500 barrels per hour are encountered at depth, the pressure capabilities of the specialized oilfield compressors (even though some are rated to 1000 p.s.i.) are exceeded and air drilling must be abandoned.

(c) Sour gas.
If natural gas containing hydrogen sulphide is encountered, and allowed to flow, rapid corrosion of the wellhead equipment results. For safety reasons, the drilling fluid must be converted to mud as soon as hydrogen sulphide is detected.

(d) Downhole fires.
These occasionally occur in coal formations but are fortunately very rare in formations containing inflammable natural gas. The proportion of air to natural gas under which burning or an explosion will occur is critical over a very limited range (about 8 to 10% gas in air). Normally the only evidence of downhole fires are scorched drill stems and detection of carbon monoxide or dioxide in the return line.

(e) Corrosion.
As aerated fluids under pressure will corrode steel, special corrosion inhibitors are normally added to the fluid. In rare instances, drillpipe lined with plastic or other inert material is used.

<u>Other Considerations</u>

Some alterations to the normal logging and coring programmes may be necessary for air drilling. In general, the cutting of extremely long cores is prohibited because of the absence of mud to support and lubricate the inner core barrel. Cores to 20 foot lengths should be obtained without difficulty. Wireline coring is feasible. Some operators recommend that an adequate annulus around the core barrel be assured by using a slightly larger that usual coring bit for a specific size of core barrel. Care must be taken to ensure that circulation is accomplished before rotating the corehead. The compressibility of air can lead to erroneous conclusions in this regard.

The Formation Density log, Gamma Ray log, Neutron Log, Induction Log and Temperature Log may be run in empty hole. Sonic and electrical surveys may be made by filling the hole with water after cessation of drilling. Micrologging is not effective in the absence of a filter cake.

Conclusions

It has been abundantly proven that air drilling will increase penetration rates in hard formations especially if these formations occur near the surface. So far this method has been used for deep wells only in the Amadeus and Georgina Basins. Plans to introduce it in the Great Artesian Basin of South Australia and the Canning Basin of Western Australia have been announced. As the number of high pressure oilfield compressors available in this country increases, it is certain that the proportion of air drilled holes will increase.