FORMATION TESTERS AND WHAT THEY MAY ACCOMPLISH

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At the outset it will, perhaps, be well to differentiate the two principal methods of determining the content of any formation, suspected of bearing oil or gas in commercial quantities.

The method most familiar to operators, consists of analysis of content of a sample of the formation, secured from the well by the use of the modern core barrel.

The second method, and the one with which this paper is concerned, consists of securing an uncontaminated flow directly from the formation to be tested. This is accomplished by lowering the testing tool on the bottom of a dry string of drill pipe; seating the tapered fiber packer of the testing tool on the offset between the regular diameter hole and the "rat hole" for the purpose of excluding the rotary mud from the "rat hole" and by one of several patented devices opening the lower extension of the testing tool to receive the flow from the formation which the "rat hole" has penetrated.

It is not assumed that the formation testing tool should replace the core barrel. Certainly the core barrel is the proper tool for accurate well logging and stratigraphic correlation. But when that point is reached, in the process of drilling, where it is decided to set casing for a test, there are certain inherent weaknesses of the core barrel which make a place for the use of a more accurate testing device. The following are instances where the testing of a formation bu using the core barrel might lead to costly mistakes:

A survey of coring results, in the California fields, reveals the fact that not more than eighty per cent of the core was recovered on the average. Further, that in some instances the core was almost entirely washed away by the circulating fluid. In a hypothetical case we might recover a one foot core from a twenty foot sand, and although the oil sand recovered were rich in content of oil, it might be assumed that the sand encountered was only a thin break, and so pass up a commercially productive sand.

In other instances sands contain gumbo or shale breaks, and if the sand is loosely consolidated, the resulting core will consist mainly of gumbo or shale. Here again a productive sand might be passed up.

In still other instances, a promising appearing sand may be encountered, and although there are traces of salt water, the salt water may be attributed to contamination from rotary mud. In this case a string of casing is sacrificed, together with a resulting sacrifice in hole diameter, only to find that the formation produces salt water.

Perhaps an instance more deceptive than all others is that in which a core taken from a very high pressure sand would practically clean itself of oil in coming out.

The discovery well of the Oklahoma City field used the tester several times. The first test was made on a formation encountered at approxi-

mately 4,100 feet. A gas producing sand was disclosed. Within the next two hundred feet, two more promising sands were tested and proven dry. It was necessary to set casing at 4,900 feet to eliminate the dangers of drilling through so much open hole. At this depth, another huge gasser was disclosed. The gas was mudded off and the rotary was used to a depth of some 6,200 feet, where the present oil sand was discovered. Had a method of testing which required the setting of casing for each test been employed, the diameter of the hole would have been so greatly reduced that it would have been impossible to proceed farther after making the 4,900 foot test. It would have been necessary to drill another hole in order to test the formations below the 4,900 foot level, thereby greatly increasing the operating expense.

The Palacine Field, Stephens County, southern Oklahoma serves as another good example of the economic value of the formation tester in locating producing formations. In this area several test wells have been drilled at excessive costs due to the large number of sands encountered. In drilling the discovery well, formations were cored only a few feet and a temporary test made with a formation tester. By this method the operators have located two separate producing formations, one making oil and the other making gas. Due to the freakish character of the water producing horizons, temporary tests are made with the testing tool before casing is landed.

The South Texas, Arkansas, and Louisiana operators find it economical to make such tests on practically every well drilled. Oklahoma, having more definitely producing horizons, has been slower in adopting the practice. However, an increasing demand for testing service in the Oklahoma City and Seminole areas, indicates that the practice is being looked upon with favor wherever there is rotary drilling.

Examples of the above type are numerous and point clearly to the need for a tool which will secure an uncontaminated sample directly from the formation, and so eliminate the necessity for guessing, and to the writer it seems that the greatest practical value of the formation testing tool lies in the fact, that a reliable test may be made without the necessity of sacrificing the diameter of the hole.

The Halliburton Formation Tester is manufactured and sold by the Erle P. Halliburton Company of Duncan, Oklahoma. It is common practice when drilling with rotary tools, especially where there is likelihood of picking up a productive sand, to drill ahead a small diameter "rat hole." This gives the operator an opportunity to ream down to a place where the casing can be properly set when the producing horizon is encountered. After the large hole has been reamed down to a proper seat, the tester is then run in on drill pipe and a test made.

The sand tester consists essentially of a tapered packer below which is a perforated pipe extending into the "rat hole." This perforated pipe runs through the packer and opens inside an outer shell of five and five-eights inch hydraulic pipe. This shell is closed by a steel encased stopcock, which is geared to the packer, so that by turning the drill pipe a quarter of a turn to the left, the packer is opened, and by turning the drill

pipe a quarter turn to the right, the cock is closed. The inner shell rests on ball bearings and turns readily. There are two packing glands which prevent the packers from leaking. One is placed at the top of the outer shell and the other at the bottom. The gears of the stop cock are packed off from the rest of the tool to keep out sand or cuttings, which might interfere with the action of the gears.

The drill pipe is run with the stop cock closed, leaving the drill pipe dry. The same condition now exists as if the casing had been set and the hole bailed out. After the packer is seated, the stop cock is opened. This allows the fluid in the sand to enter the drill pipe, giving a sample of whatever is in the sand.

If gas is encountered it will blow through the drill pipe and if any fluid is in the sand it will flow into the drill pipe and can be taken out by closing the cock and removing the drill pipe. When oil or salt water are withdrawn with the drill pipe, especially after thirty or forty joints are removed, the gas causes the oil or salt water to flow by heads when stands of pipe are removed, giving positive evidence of the fluid in the sand.

The Sand Tester is allowed to remain seated from fifteen to forty-five minutes depending upon the condition of the sand. The complete test requires a round trip plus the fifteen to forty-five minutes that the tool is allowed to remain seated.

High pressure formations may be safely tested with this tool, provided a high pressure quick-acting blow-out preventer is used on the surface casing, during the running of the tester. A high-pressure drilling valve should also be used on the surface casing and the hole kept full of rotary mud to prevent a blow-out while the rotary pipe is out of the hole. These precautions should be observed as well in the use of other testing tools. Skepticism arises concerning the ability of the operator to determine definitely whether the stop-cock opens for the test. This is answered by Halliburton's operators, who say that when the cock is released, the tremendous pressure within the "rat hole" is released, and there is, consequently, a distinct settling of the drill pipe noticeable at the surface.

The Edwards Flow Tester is manufactured by the Houston Engineering Company of Houston, Texas. This tool differs from the Halliburton Tool chiefly in the manner of admitting the fluid. The portion entering the "rat hole" consists of a smaller perforated stem, bull plugged on the lower end. The bottom of the inner stem is threaded into a larger outer stem with left hand threads. After the packer is seated, rotating the drill pipe to the right unscrews the inner stem and permits it to drop some two feet into the "rat hole" exposing the perforated pipe to the fluid of the formation. After the test has been made, simply picking up the drill pipe closes the tester by drawing the smaller perforated stem into the larger outer stem. The advantages of this tool are that the opening and closing of valves is entirely eliminated, and the drill pipe may be rotated continuously during the period of testing, thereby eliminating much of the danger of frozen drill pipe. Also the perforated stem is protected,

while running in, from becoming plugged with mud, by being seated in the outer stem.

The Johnston Formation Testing Tool is manufactured by the Johnston Formation Testing Tool Company of Eldorado, Arkansas. This tool consists of the following: a packer superimposed on a length of five and three-sixteenths inch hydraulic pipe. Extending two and a half feet below the packer is a section of two and a half inch perforated pipe. This pipe opens inside the tool, directly on the primary valve. This valve is of the drop and seat type and is held closed by a heavy, spiral, box-car spring. It requires from two to four thousand pounds weight on the tool to compress this spring and open the valve. There is a by-pass through the primary valve, which is closed by an emergency valve. This emergency valve consists of a simple ball and seat, upside down, and held closed by an adjustable spiral spring. This emergency permits the pumping of rotary mud through the tool even while the primary valve is closed. At the top of the tool is the secondary valve. This is a trip valve, and can be opened by dropping a "go devil" on it. This valve is for the purpose of keeping the drill pipe free from mud, in the event the primary valve is opened by the too hanging up in a "tight" place.

When the operator is assured, by measurements, that the packer of the tool is seated, the stretch is taken out of the drill pipe, and the "go-devil" is dropped inside the drill pipe to open the secondary valve. The tool is now in condition to receive the sample from the formation, after the full weight of the drill pipe is permitted to rest on the heavy spring, opening the primary valve. After the test it is only necessary to pick up the drill pipe in order to close the primary valve and retain the sample within the drill pipe.

In conclusion, the following points seem to the writer to be of vital importance in the successful operation of any formation testing tool.

The tool should be carefully cleaned and oiled before each test, for the success of the test depends upon the positive action of the working parts of the tool.

The packer seat should be carefully prepared before the tool is run, for the object of this type of test is to eliminate contamination. It can be ascertained whether the mud is leaking past the seat by observing whether the mud in the annular space has a tendency to fall after the valve of the tool is opened.

Careful re-checking of depth is necessary in order that the operator may be certain that the packer is resting on the seat.

Where it is necessary to set the packer on a soft, incompetent seat, it seems that it would be wise to select a testing tool which does not require the turning of the drill pipe in order to open the valve, as a soft seat is apt to permits the turning of the packer, thus preventing the opening of the valve.

In high-pressure areas a quick-acting blow-out preventer and high-pressure drilling valve should be placed in the cellar on the surface pipe.

Perhaps the greatest objection to the use of these testing tools is the possibility that the drill pipe may freeze during the operation.