Experimental Investigation Of Down-Hole Directional Drilling

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Directional drilling involves improved drilling techniques that deviate wellbores to the targeted trajectory to reach the targeted reservoirs. Currently, directional drilling has many applications because of its numerous advantages over conventional vertical wells. Gas, as well as oil reservoirs, contain lateral length shapes rather than vertical length shapes. Directional drilling plays an important role in retrieving resources that contain shapes that are not vertical, as well as gas or oil that cannot flow to a larger reservoir or the gas or oil trapped. Similarly, directional drilling is important in accessing multiple reservoirs having one rig as well as adjusting the gas pressure in mines using a process called degasification. Although directional drilling ideology has it is begging during the 19th century, it never received widespread application until currently (Thijs Vromen et al., 2017, p. 237). Advancements in technology have aided directional drilling to gain various traction, and correctly, digital technologies have increased their application. As a result, oil and gas operators have developed better mechanisms of drilling to the reservoirs and have incorporated computer control use in operating drills more accurately.

The History

Directional drilling started as a marriage of road boring and oil wells directional drilling. It was first applied in 1920 when it was used in oil well drilling as a way of producing more oil. These early directional drilling applications had a small extension possibility and built rates. For example, the slant drilling method needed 610m (2000 feet) for the completion of a well transitional curve starting from straight up to horizontal. Current technology has aided directional drilling completion at a turn of 90 degrees at about 31m (100 feet). The ancient method used in the production of gas and oil was vertical hole drilling, starting from the ground surface to the area of the gas or oil reserve. Craving in was then prevented by a steel casing inserted into the hole. The steel casing holes were punctured by a gun that was perforated. This steel casing was at the level of the gas and oil reserves. The main disadvantage of this drilling method is that a limited penetration was experienced to the gas or oil bearing-rock. As a result, a limited amount of oil or gas flowed out into the steel casing. Directional drilling currently has increased gas or oil production to more than 18 times that which was produced by y the vertical drilling. Later, in 1990, directional drilling was adapted for utility installation usage (Jiang et al., 2018, p. 760).

The Directional Drilling Process

The directional drilling process starts with a trailer or track-mounted directional drilling machine. This machine pushes the head linked to the hollow pipe at a various angle toward the ground. When every drill joint is pushed toward the ground, a different other one is positioned behind it. In a predetermined path, across obstacles, pilot holes are drilled horizontally. The drill is then monitored by the drilling string electronic beacons behind a cutting head. The beacon relays information that the driller at the surface depends on to steer a bore within the specified path (Zhou et al., 2018, p. 456).

Numerous directional drilling machines also use a slurry or drilling fluid known as mud. Other directional drilling machines use air or foam, all of them. The drilling mud or fluid is made of water with performance-enhancing additives as well as bentonite clay. The high-pressure fluid jets are used in cutting through the soil in the soft ground. This cutting then suspends the used fluid. Pumping of more fluid results in more suspension of the cuttings are either removed mechanically or heaped in the pit (Crichton et al., 2017, p. 89).

The angled bit is used to drill horizontal wells and holes in the soil that are soft. The pipe, as well as an angled bit, are rotated for the straight bore achievement. Rotation ceases to steer a bit toward a specific location or direction. The forward thrust application follows the alignment of the angle of the bit. A forward thrust and the drilling fluid jet cut through the soil in the new path.

In areas of hard rock, mostly the mud motor is used. A mud motor is developed to change the boring or drilling fluid hydraulic pressure using mechanical rotations. The mechanical rotation rotates a drill bit without rotating a drip pipe. Therefore, the drip pipe remains stationary as the drill bit rotates. Mud motor angle alignment results in steering the drip pipe (Liu et al., 2018, p. 456).

However, an unstable or soft ground a steering case or wash pipe is used in preventing curving in of this ground by pushing it down to the well (Spencer et al., 2017, p. 100). The bit detachment is done upon the arrival of the pipe at an exit portal. The hole is then enlarged by attaching the drill pipe endpoint to the reamer. Pulling the back of the reamer when rotating a drill bit allows the borehole enlargement. The addition of a drill pipe behind a reamer ensures the availability of a pipe in the well (Spencer et al., 2017, p. 367).

The pipe is attached to the reamer in situations where the hole is larger than it. This reamer with a pipe is then attached to the swivel then connected with a product pipe. The drilling fluid poured down the well is used as a lubricant to allow smooth entry of the pipe into the well. Rotation of the reamer, as well as the drilling pipe, allows pulling down the pipe into the borehole. Rotation of the pipe in the hole is prevented by the used swivel (Crichton et al., 2017, p. 234).

Currently, the new global positioning and drilling sensors technology has brought great improvement in directional drilling. Real-time technology use has greatly improved the bit angles controlling ways. Other instruments utilized in directional drilling are bottom hole assembly configuration, whipstocks,

mud motors, 3D measuring devices as well as the specialized drill bit (Kuttel et al., 2017, p. 45).

Oil Well Drilling Dynamics

Rotary drilling is used in the production of gas and oils. Different components or elements make the rotary system. The rock-cutting tool, known as a bit, is used in creating the boreholes. This bit is a component of the rotary system. A roller cone bit is the oldest rotary type that was made of three rollers that had steel covering teeth that crushed rocks. Polycrystalline Diamond Compact (PDC) is an alternative bit that has a steel body with tungsten carbides or artificial diamond inserts (Zhou et al., 2018, p. 123). Mechanical transmission containers or boxes in a motor generate the energy driving the bit. The motor transmission drives a rotary table: huge discs that store kinetic energy. The drill string forms the medium that transports the energy out of the surface to a bit. This drilling string is made of drilling pipes: narrow tubes of about 9m long connected with threaded links with an out diameter of about 127mm as well as a thickness of about 9mm. However, larger or smaller pipes can be used (Zhou et al., 2018, p. 345).

The drilling string's lowest part of BHA is made of thick tubular walls referred to as drill collars. According to the borehole diameter, the collars have a range of diameters (4.75-9.5 in), which is about 120mm- 240 mm. The height of BHA can be many meters long, as well as has dedicated down-bore instruments or tools. Many stabilizers put drill collars in positions that are short with a diameter nearly the same as the bit (Feng et al., 2017, p. 234).

The drilling process needs a very compressive force of 104 to 106 N of the bit. The dynamic force applied on the bit is referred to as the Weight Bit (WOB); however, Force-on the bit is a fair name. A hosting system suspends the entire drill string. This hosting system is made of the winch, drilling line as well as the travelling block that has the hooks. Hook load force pulls up the drill string that rests on the well bottom side (T. Vromen et al., 2017). The hook lord prevents buckling of the drill pipe by ensuring the pipe tension is consistent. When these drill pipes are running in tension, then the BHA has partial compression. The BHA buckling can result from torsional and axial direction BHA loading Stabilizers placement, and the drill collar's large thickness of the walls prevents this buckling. A real stabilizer will give the lateral movement drill string hinge boundary. Stabilizer additional supports cause increases of a critical buckling load (Singh et al., 2017).

Torque transmission occurs from a rotary table towards the drilling string. This torque needs the ratio of the bit referred to as Torque On Bit, that is, TOB (Singh et al., 2017).

A fluid referred to as mud is used. This fluid is pushed down through bit jets or the drilling string then comes back to a surface using the annulus that exists in between a borehole wall and the drilling string. The used mud lubricate compensates for rock pressure as well as removes all rock cuttings from the well (Monteiro and Trindade, 2017).

Hook load steers the process of drilling; a rotary table increases speed while at the surface as well as

the mud flow rate (Buerger et al., 2017). The drilling string's downward speeds provide the correct measure of penetration rate. The pressure of he stands pipe (flow line pressure in the top of a drilling string) shows the total pressure decrease in the annulus and the drilling string. The standpipe pressure and the penetration rate show the drilling process and progress, which the drilling engineer interprets and uses in adjusting various steering parameters (Nikoofard et al., 2018).

During the drilling process, a drill string undergoes several vibration types (Dong and Chen, 2018).

Longitudinal (Axial) Vibrations

These vibrations result from the interaction of the well bottom with the drilling bit. However, in extreme form, bit bounce vibrations are produced. The bit bounces vibration results from the bit losing bottom well contact (Feng et al., 2017).

Lateral Or Bending Vibrations

These vibrations result from the eccentricity of the pipe that causes centripetal forces, called drill string whirl.

Forward Whirl

Deflated drill collar rotation sections at the axis of the borehole in a similar direction as the drill collar moves around the axis (Kuttel et al., 2017).

Backward Whirl

The stabilizer and drill collar roll motion in a different direction over the walls of the wells as they move around the axis.

Rotational Or Tensional Vibration

These are vibrations resulting from nonlinear interactions between the drilling string or the rock and the bit with a wall of the borehole. This is called a stick-slip vibration,

Stick-Slip Vibrations

This is the drill string tensional vibrations having alternation stops as well as BHA great angular speed or velocity (Lv et al., 2017, p. 45).

Hydraulic Vibrations

These are vibrations from a circulation system, moving from a pump pulsations.

In conclusion, the directional drilling process has a long history dating from the 1920s. This process has improved over time with the equipment used. Drilling involves a rotary system. A drilling string is a column pipe that transmits the torque and the drilling fluid. This drilling string undergoes several vibration types, including lateral, longitudinal, hydraulic as well as tensional vibrations (Dong and Chen, 2018).

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