VENEWS

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VENTURE CHEMICALS, INC.

MAY 2001

HOLE CLEANING IN HORIZONTAL WELLS

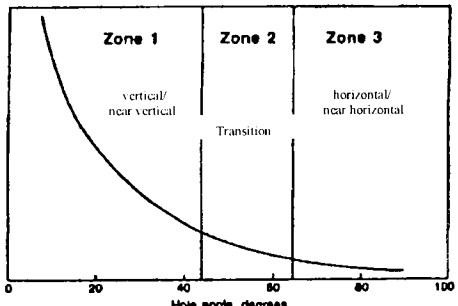
The drilling of horizontal wells has become a widely used technique. Three or four extended-reach multilateral wells can replace up to 20 vertical wells that will drain small offshore reservoirs. A key problem associated with this technique is the efficient removal of cuttings from the vertical (0 to 45 degree from vertical), transition (45-50 degree from vertical) and horizontal (45-90 degree) sections of the hole. (See Fig. 1.)

Removal of cuttings from the borehole during drilling operations is a prime function of the drilling fluid. In vertical holes, cuttings can be transported to the surface if the slip velocity (downward movement of the cuttings due to gravity) is overcome by sufficient annular velocity of the largest cuttings, then all the cuttings should eventually be lifted to the surface. It is generally thought that fluids exhibiting laminar flow combined with higher yield values are satisfactory for removing cuttings in the vertical section of the hole.

Horizontal drilling has raised a number of controversies concerning optimum properties for cuttings transport. This is because the influence of gravity on cuttings in these wells deals with a few inches in the horizontal section rather than several thousand feet in a typical vertical well. Cuttings only have a few inches to fall before they are laying on the side (bottom) of the hole in horizontal wells. As with any controversial topic there are countless opinions as to the best way to solve the problem. The primer located in this issue deals with the basics of hole cleaning and some of the options in dealing with the problem.

For further information, read our hole cleaning primer in this issue or call U.S.1-800-523-1933 or (337) 232-1977 for information on Venture products.

Figure 1. Cleaning High-Angle Holes



Ref.: Adapted from O&G Journal, Nov. 26, 1990, p. 64.

PROOF, n. Evidence having a shade more of plausibility than of unlikelihood. The testimony of two credible witnesses as opposed to that of only one.

Ambrose Bierce (1842 - 1914), The Devil's Dictionary

FACTS ABOUT THE OIL INDUSTRY

- The U.S. Energy Information Administration projects that **U.S. demand for refined petroleum products will grow by over 35%** in the next two decades, increasing from 18 million barrels a day in 1996 to 24.6 million barrels a day by 2020.
- The U.S. oil and gas industry **employs 14 million people** and generates about 4% of U.S. economic activity.
- It is **larger** than the domestic auto industry and larger than education and social services, the computer industry and the steel industry combined.
- The exploration and production sector alone **employed nearly 326,000 people** in 1998.

- U.S. Department of Energy

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Bit, Stabilizer and Collar Balling: Add 0.5 to 2% by volume for initial treatment and follow with 0.5 to 2 drums per 24 hours maintenance treatment. Slug treatments wiped around in a concentrated slurry will improve the effectiveness of the treatment.

Differential Sticking: The standard initial treatment recommended in the preceding examples will suffice for most problems.

Stuck Drill Pipe: Can be spotted in its concentrated form if density is not a safety consideration across the zone where the drill pipe is stuck. Sufficient soaking time should be allowed while tension and torque is being applied to the pipe.

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"This young lady has delusions of adequacy."

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"If you see two people talking and one looks bored, he's the other one."

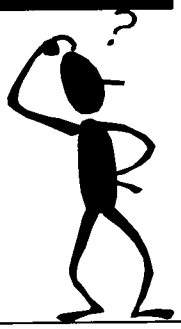
"This employee is depriving a village somewhere of an idiot."

"He doesn't have ulcers, but he's a carrier."

"The gates are down, the lights are flashing, but the train isn't coming."

"The wheel is turning, but the hamster is dead."

THOUGHT TICKLERS



"Nearly all men can stand adversity, but if you want to test a man's character, give him power."

- Abraham Lincoln

"In the name of God, stop a moment, cease your work, look around you."

- Leo Tolstoy

"The task of the leader is to get his people from where they are to where they have not been."

- Henry Kissinger

"Discovery consists in seeing what everyone else has seen and thinking what no one else has thought."

- Albert Szent-Gyorgi

"Nothing is a waste of time if you use the experience wisely."

- Auguste Rodin

"Labor to keep alive in your breast that little spark of celestial fire called conscience."

- George Washington

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VENTURE CHEMICALS, INC.
HOLE CLEANING PRIMER

Hole cleaning is one of the basic functions of any drilling fluid. Cuttings generated by the bit, plus any caving and/or sloughing, must be carried to the surface by the mud.

Failure to achieve effective hole cleaning can lead to serious problems including:

- stuck pipe
- excessive torque and drag
- annular pack-off
- lost circulation
- high mud costs
- slow drilling rates

OVERCOMING SLIP VELOCITY

The circulation of fluid carries cuttings from the bit, back to the surface. These cuttings have a tendency to fall back down through the ascending fluid. This is known as **slip velocity.**

The slip velocity will depend upon two things: viscosity and density. The thicker and higher density of the fluid, the lower the slip velocity. For prime removal of cuttings, the fluid velocity must overcome the slip velocity. In effect, fluid velocity can be lowered in a highly viscous or very dense fluid and cuttings still be removed from the well bore.

ADJUSTING DRILLING FLUID

The density of a fluid is determined by other factors and is not usually considered a factor in hole cleaning. Adjustment of hole cleaning properties are limited to the adjustments to viscosity and velocity of the drilling fluid.

The **viscosity** desired will depend upon the desired hydraulics and the size of the cuttings. The velocity will depend on: the pump (capacity, speed, efficiency), the drill pipe size and the size of the well bore.

The **velocity** of a fluid will determine its flow characteristics, or flow profile. There are five stages, or different profiles, for a drilling fluid:

- no flow
- plug flow
- transition
- laminar
- turbulent

The proper combination of velocity and viscosity is a must for the right hydraulics and efficient hole cleaning.

The ideal velocity is one that will achieve **laminar** (or streamline) flow because it provides the maximum cuttings removal without eroding the well bore.

Cuttings will have a tendency to collect at points of low fluid velocity in the well bore annulus. These areas are found in washouts and where drill pipe rests against the wall of the well bore. That being said, it's a good practice to rotate and work (raise and lower) the drill string while just circulating to clean the hole. This will keep cuttings in the main flow of the fluid and not allow them to gather next to the wall or pipe.

There are times when rotation of pipe is not possible. This can be offset with different mud types and changing certain mud properties. Properties of particular interest to hole cleaning include **mud weight**, **viscosity** and **gel strength**.

Mud weight helps buoy cuttings and slow their settling rate, but it isn't really used to improve hole cleaning. Mud weights should be adjusted based only on pore pressure, fracture gradient and well-bore stability requirements.

Mud viscosities help determine carrying capacity. Historically, yield points were thought to be the key parameter effecting hole cleaning. More recently, evidence concludes that Fann 6 and 3 rpm values are better indicators of carrying capacity.

Source: www.workover.co.uk

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HOLE CLEANING PRIMER

These values are more representative of LSRV which effects hole cleaning in marginal situations. One common rule of thumb is to maintain the 3 rpm value so that it is greater than the hole size (in inches) in high angle wells.

Gel strengths provide suspension under both static and low shear rate conditions. The ideal situation is for the fluid to have high, fragile gels that develop quickly and are easily broken. Higher gels should be avoided because of the high transient pressure they produce leading to a number of serious drilling problems.

SUSPENSION OF CUTTINGS

Gel strength is an integral factor in halting slip velocity. When circulation is interrupted, the gel strength must be such that the cuttings won't fall, but be suspended until drilling is resumed and they are subsequently carried to the surface. This ability is called the **thixotropic property** of a drilling fluid.

The ability of thickening at low velocities and thinning at high velocities is called the **shear-thinning property** of a drilling fluid. The magnitude of gel strengths and shear-thinning capability of a drilling fluid will depend upon the concentration and quality of clay solids in the fluid system.

Drilling fluids must suspend drill cuttings under a wide range of conditions. Drill cuttings that settle during static conditions can cause bridges, fill or develop cutting beds in horizontal bores. This in turn can cause stuck pipe or lost circulation.

Cuttings transport in horizontal bores is more difficult than in vertical bores. The transport velocity as defined for vertical bores is not relevant for deviated holes since the cuttings settle to the low side of the hole across the fluids flow path and not in the direction opposite to the flow of drilling fluid.

In horizontal bores, cuttings accumulate along the bottom side of the borehole forming cuttings beds. These beds restrict flow, increase torque and are difficult to remove. In HDD, the critical factor during the pilot bore is hole cleaning.

One approach to use for difficult hole cleaning situations found in horizontal bores is the use of shear-thinning, thixotropic fluids with high LSRV and laminar flow conditions.

Examples of these fluid types are biopolymer systems and flocculated bentonite slurries.

Such drilling fluid systems provide a high viscosity with a relatively flat annular velocity profile, cleaning a larger portion of the bore cross section. This approach tends to suspend cuttings in the mud flow path and prevent cuttings form settling to the low side of the bore.

PRACTICAL HOLE CLEANING GUIDLEINES

- Use hole cleaning techniques to minimize cuttings-bed formation and subsequent slumping which can occur in 30-60 degree hole sections.
- Utilize elevated viscosity fluids from the start because cuttings beds are easy to deposit, but difficult to remove.
- Maintain LSRV between 1.0 and 1.2 times the hole diameter when in laminar flow.
- Treat mud to obtain elevated, flat gels for suspension during static and low flow rate periods.
- Schedule periodic wiper trips and pipe rotation intervals for situations where sliding operations are extensive.
- Rotate pipe at speeds above approximately 50 rpm if possible to prevent bed formations and to help remove pre-existing beds.

Source: www.workover.co.uk

VEN-BRIEFS

Antarctica contains about 7.2 million cubic miles of ice, about 84% of all the glacial ice on Earth, according to the USGS. Melting all the Antarctica ice would cause a global sea level rise of about 240 feet. Such a rise would flood virtually all the world's coastal areas and drown many islands."

- USAToday, February 1, 2001

Fortunately, even the most drastic scientific scenarios for global warming don't envision Antarctica warming enough to directly melt all of this ice for at least hundreds of years, if ever.

In fact, one of the first effects of a warmer climate could be more snow for Antarctica, which would more than make up for melting ice. This would happen because warm air carries more water vapor to turn into snow.

Still, we can't be sure all of Antarctica's ice is going to stay frozen as the world's climate warms, whether naturally or because of gasses humans are adding to the atmosphere.

While straightforward melting isn't going to send water from Antarctica's ice washing through the streets of New York City and London, nature may have other ways of putting water from some of the ice into the world's oceans.

The weak spot could be the West Antarctic Ice Sheet. But even under the worst scenario, ocean-front property owners won't have to worry about water from Antarctica any time soon.

- USAToday.com, Jan. 19, 1999

Selected References on Hole Cleaning in Horizontal Wells

VENTURE CHEMICALS, INC.

Many articles have been written concerning the problem of hole cleaning in horizontal wells. This selection of papers and presentations represent some of the key references. Clip and save for future reference.

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