Cuttings re-injection can solve disposal problems

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DRILLING IN THE NEW ERA has focused efforts on environmental issues and operators are under pressure to make major decisions about drilled cuttings disposal.

Due to the harsh North Sea environmental conditions, drilled cuttings containment using conventional cuttings boxes inflates the cost of zero discharge operations. Serious health and safety concerns are also associated with offloading these cuttings boxes during harsh North Sea weather.

Cuttings re-injection (CRI) and bulk shipment are two zero discharge solutions currently used to allow for the continued use of oil based mud. Cuttings re-injection is the most cost effective and is not as weather dependent as containment methods. CRI permanently disposes of the waste in the host formation with no future liabilities or cost.

Since 1995, **Apollo Services** has had five cuttings re-injection projects ongoing in the North Sea alone, including Shell Brent Bravo, BP Andrew, BP Wytch Farm, Total North Alwyn, Total Dunbar, and Talisman Clyde.

CRI BENEFITS

Tightening of the allowable discharge limits, revocation of many once-accepted disposal methods and other changes make it necessary for operators to establish long range plans for drilling waste. Cuttings re-injection is a preferred approach because it:

- Is the only permanent on-site disposal method available that can fully comply with zero discharge to the surface environment;
- Does not rely on land farming, treatment, solidification, encapsulation or moving cuttings to another location where the operator might face future environmental concerns;
- Returns cuttings to their native environment and does not discharge hydrocarbon waste into the air as thermal operations do;
- Is an inexpensive process relative to many environmental solutions that are not permanent.

Apollo's North Sea history includes over 12 years of successful CRI operations and downhole designs that enhance the use of CRI technology.

INJECTION THEORY

Modeling techniques used to establish fracturing parameters for increased production differ significantly from models that simulate cuttings injection. The characteristics of cuttings slurries are opposite those considered when modeling for well stimulation.

Cuttings slurry particles are small in size, soft and ductile, pumped at low rates for long periods of time, purposely designed to keep the fluid horsepower low, and are generally high in fluid loss. The goal with slurry injection is to minimize the impact on the formation.

Quality control and site-specific rheological and physical property adjustments are crucial for maintaining zonal isolation. Most formations change after cuttings have been placed into the formation.

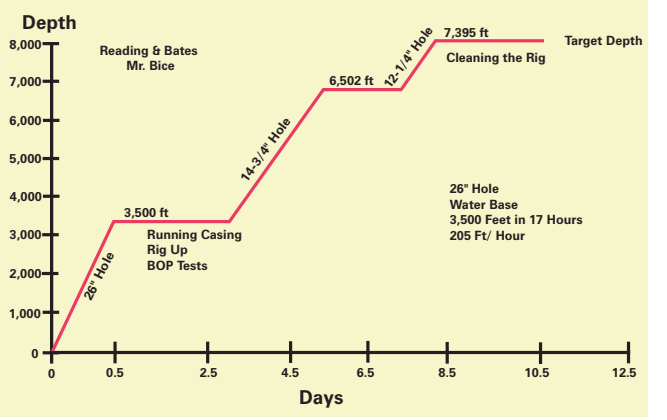
INJECTION PROCESS

Cuttings are removed from the drilling fluid using conventional solids control equipment, and then transported to the cuttings slurrification system using slides, vacuums or screw conveyors. When the cuttings reach the CRI system, they are transformed into pumpable slurry by mixing the cuttings with seawater and chemicals.

Grind size is critical to success. Large particles, 200-300 micron in size, typically fill up the near-wellbore area because they cannot be forced into the formation. Then formations require higher pressures to inject, creating a potential risk to cement shoe integrity. Also, the finer the grind, the less chemical needed and the smaller quantities of slurries required.

After a homogeneous slurry is prepared and conditioned it is injected into the exposed formation through the annular space between two strings of casing. Our cuttings slurries are typically pumped at rates no higher than 2 to 3 bbl/minute.

Vacuum system performance



CUTTINGS TRANSFER SYSTEMS

Our cuttings transfer systems being used now in the North Sea consist of continuous discharge vacuum pod and solids transfer pumps. The continuous discharge vacuum pods push the cuttings out of the bottom of the pod and continue to maintain a vacuum in the pod. This allows the second continuous discharge pod to provide 100% backup.

Cuttings solids transfer pumps provide an even more elegant solution where they are applicable because of the low horsepower required to drive the cuttings to the re-injection unit.

OPERATING CONSIDERATIONS

Some of the considerations in the planning stage include:

- Identify suitable cuttings disposal/sealing formations;

- Select surface equipment and design the casing program;
- Design the injection program and contingency planning;
- Prevent plugging in the annulus and the formation;
- Prevent cuttings slurries from breaching to the surface or to drinking water formations;
- Consider the impact on producing wells or future wells;
- Provide quality control and monitor injection procedures;
- Abandon waste disposed of to permanently entomb the waste;
- Obtain regulatory approval and address environmental and safety concerns.

Characteristics of the subsurface environment, sealing formations, injection zone, slurry properties, drilling plans, subsurface slurry disposal dimensions and other elements directly impact each of these operational considerations.

LITHOLOGY CONCERNS

The targeted formation should not contain natural fractures or faults that might communicate slurry to the surface or to formations containing potable water.

Additionally, the disposal formation must be associated with some type of seal mechanism that will adequately restrict the slurry to the specified formation interval. This sealing mechanism can be reinforced by slurry design.

Review of mechanical property logs, cores, leak off tests, pore pressures, mud logs and other data from offset wells can be used as a tool when addressing these issues. Fractures modeling has proven useful in estimating the size and shape of the disposal plumes.

Seismic data can be utilized for identification of natural vertical fracturing that could make the project fail and can be utilized to define the formation properties such as fracture rock strengths, pore pressures, and other elements crucial to CRI.

SURFACE EQUIPMENT REQUIREMENTS

The properties of the drill cuttings dictate the type of grinding equipment required. Modified centrifugal pumps designed to reduce the size of cuttings using high shear rates are most effective when processing cuttings from soft, hydratable shale formations.

When a sizable quantity of hard cuttings will be processed, a mechanical grinder should be used to produce a maximum particle size of 100 microns.

Proper system design is important. In zero discharge operations, the rig cannot drill if the CRI surface equipment is not able to stay ahead of the drill rate/surge conditions.

CASING PROGRAM

The casing program is developed after the injection zone and sealing formations have been identified. The cement integrity of the surface casing defines the upper sealing boundary of the injection zone and the top of cement for the intermediate casing string provides the lower boundary.

The injection plume will likely be initiated at the casing shoe and could grow vertically upward and outward from that point, depending on a variety of conditions.

For this reason, the casing shoe needs to be set at an adequate depth below the top of the injection zone.

MONITORING

For successful results, dedicated supervisors should monitor all phases of the operation, the condition of equipment, and the experience level of personnel.

NEW TECHNIQUES

Cuttings dryers are being tested and are very promising. Our patent pending system utilizes the cuttings dryer to cut the disposal volume to approximately 50% of typical disposal volumes.

And where synthetics are dischargeable, we are taking all of the free synthetic off of the cuttings.

We have used our new parasite string to provide an injection point after drilling surface hole without the need to drill an intermediate hole prior to injection.

This allows the operator to use oil base fluids directly out from under surface casing and provides for a disposal point on the first well of a platform. ■