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Cost-Effective Environmental Compliance in the Gulf of Mexico

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One of the bright spots in U.S. exploration and production is the Gulf of Mexico, where improved techniques for drilling in ever-deeper waters have yielded some of the largest discoveries in recent years.

The trend toward deep water (i.e. water depth greater than 1,000 ft.) is clearly increasing. In 1995, 84 deep-water wells were drilled, which comprised 8.6 percent of the drilling activity in the Gulf of Mexico that year. Today, there are 189 rigs operating in the Gulf of Mexico, with 40 rigs drilling in deep-water, which makes up 21 percent of the total. This trend will probably continue to increase, as newer technologies become available to make operation in even deeper water feasible.

Environmental regulations just on the horizon promise to create a new level of costs in an already expensive undertaking. (Source: *Federal Register*, Vol. 66, No. 14, January 22, 2001, p. 6855.)

At issue is the disposal of cuttings generated from offshore drilling operations. Currently, cuttings drilled with water-based or synthetic oil-based muds are discharged to the ocean. However, in October, unlimited, unregulated dumping will end. The U.S. Environmental Protection Agency will put new regulations in place (40 CFR, Parts 9 and 435 – Effluent Limitation Guidelines and New Source Performance Standards for the Oil and Gas Extraction Point Source Category) which will limit dumping of cuttings as follows:

a. No dumping of cuttings will be permitted if drilled with diesel or mineral oil-based muds.
b. Dumping permitted of cuttings drilled in ester-based synthetic oil-based muds that retain a maximum of 9.4 percent oil on cuttings by weight.
c. Dumping permitted of cuttings drilled in non-ester-based synthetic oil-based muds that retain a maximum of 6.9 percent oil on cuttings by weight.

Even with these new effluent limitations in place, many observers believe it is only a matter of time before the regulations will be tightened to the point that all dumping of drilled cuttings will be eliminated. Such is already the case in the UK Sector of the North Sea. In the near future, it is likely that we will see heightened awareness of environmental issues overall, as debate over such issues as global warming and opening ANWR to petroleum exploration moves forward. For this reason, many believe a no-dumping posture on the part of the EPA is inevitable. Some companies, such as BP, intend to proactively commit to zero discharge of all cuttings regardless of worldwide environmental regulations.

The Deepwater Pathfinder is a dynamically positioned drillship capable of operating in 10,000 ft. of water and offers a state-of-the-art solids control equipment system that maximizes solids removal efficiency and minimizes environmental impact.

The History

In the 60s and 70s, before there was any concern over dumping cuttings into the Gulf, diesel oil-based mud was the dominant choice for most drillers. However, when pollution from these cuttings became an issue, the industry largely switched to Lo-Tox Mineral Oil muds. The mineral oil was basically diesel with most of the polynuclear aromatic hydrocarbons removed. As pollution concerns regarding the mineral oil started to rise, some areas put limits on the discharge of these cuttings.

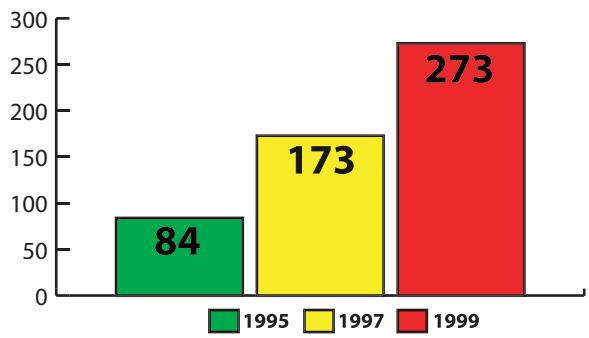
When initiated, the limit was typically 10 percent oil on cuttings by weight that could be discharged. Cuttings with oil content greater than this level had to be contained and eventually disposed of in some approved manner, including disposal at an approved site, injected,

land farmed or treated with some sort of bio-remediation process. In the late 80s and early 90s, synthetic oil-based muds (SBMs) were developed to replace oil-based muds (OBMs) and mineral oil-based muds. SBMs use synthetic organic chemicals as base fluids. They contain no polynuclear aromatic hydrocarbons, exhibit lower toxicity and bioaccumulation potential and biodegrade faster than OBMs. It was thought that synthetic oil-based muds were far less troublesome to oceanic life. The cost of synthetic oil-based muds ($160-300/bbl) is much higher than oil-based muds ($70-90/bbl), but the added expense of containing, shipping and treating the OBM cuttings makes the use of SBMs desirable.

Saving Money with Solids Control

Bottom line, sub-oceanic drilling today requires careful management of solids to minimize drilling costs. A key strategy is to avoid sacrificing good solids control in order to meet the new regulations for retention on cuttings (ROC). It is easy to get low ROC values if only large cuttings are removed from the mud. With large cuttings, there is relatively little surface area per unit volume. This result is possible by running coarse mesh screens that only remove the large particles. When removing very small particles, the surface area per unit volume increases dramatically, therefore the ROC will increase accordingly.

It is important to remove as many drilled particles as possible, regardless of size, to minimize drilling costs. Without effective solids control, the sand content of the mud (API defines sand as particles larger than 74 microns) will create a thick filter cake, which is the number one cause of stuck pipe. Thick filter cake and poor rheology caused by a high concentration of low-gravity solids also cause high torque and drag, high surge and swab pressures, poor cement bonds, formation damage, reduced rate of penetration, shorter bit life and many other problems. All of these problems can cause drilling delays and will typically result in increased drilling costs.



GOM deep water wells drilled by year

If good solids control practices are not employed, the only alternative solution is dilution. Excess dilution, however, will also greatly increase costs. Take, for example, a typical Gulf Coast region well with a typical casing program. Assume that approximately 2,300 bbls of solids are generated. Not all of this will be drilled with oil-based or synthetic oil-based muds. Assuming conservatively that only 1,000 bbls of cuttings are drilled with SBMs, and assuming the solids removal system is 80 percent efficient, 200 bbls of cuttings will remain in the mud system that will need to be diluted. If 4 percent is the maximum desired solids content, which is a typical target for the Gulf Coast, the required dilution volume will be 5,000 bbls. At $300 per barrel, the dilution cost will be $1,500,000.

If the solids removal efficiency is increased to 85 percent, 150 bbls of solids will need to be diluted and the dilution cost will then be $1,125,000, for a savings of $375,000. Additionally, if the rig does not have space to accommodate the dilution volume, some or all of the contaminated mud will have to be off-loaded to a boat and sent to shore for storage and reconditioning, which will add considerable cost. An ideal solids removal system will provide sufficient solids removal efficiency such that maintaining the mud tank volume level will offer enough dilution to keep the drilled solids within the desired range.

These dilution costs may seem high, and they certainly are, but the drilling delays caused by poor solids removal may cost much more. Some of the deepwater drilling rigs rent for as much as $200,000 per day. A general rule of thumb in the Gulf of Mexico as to the total daily drilling cost (all costs – rig, boats, personnel, helicopters, equipment, etc.) is two times the day rate. In this situation, the daily drilling cost would be $400,000 so any delay in getting to the drilling target will result in a significant increase in cost. Additionally, every day not drilling delays the production of oil or gas and the associated revenue.

Available Solids Management Technology

Today, it is possible to meet the upcoming environmental regulations and at the same time do a good job of solids control. High performance solids removal equipment is required and must be properly maintained and operated. Drilling fluid also must be maintained properly and good drilling practices employed. Methods available today to handle cuttings drilled with SBM include the following:

Overboard Discharge of Cuttings. By establishing the higher discharge level of 9.4 percent ROC allowed for ester-based SBM, the EPA has encouraged the use of this type of drilling fluid. The EPA suggests that compliance with ester-based fluids discharge regulations can be

achieved with drying technologies available for cuttings including High-G linear shakers and horizontal and vertical screen bowl centrifuges. The 9.4 percent limit can often be achieved with High-G linear shakers alone or with High-G linear shakers and High-G cuttings dryers. Such a solution utilizes fine screening surfaces and ensures effective solids control. If other SBMs are used (olefins), the allowable discharge is reduced to 6.9 percent. In order to achieve this level, screen bowl centrifuges must be used. But, these centrifuges only offer a cut comparable to 100 mesh or coarser screens. As a result, downstream decanting centrifuges must be run to maintain effective solids management, as the effluent from the screen bowl centrifuge is laden with detrimental solids.

Cuttings Injection. Cuttings injection is another disposal option that is available if the geological formation will accept the injected cuttings. The cuttings discharged by the solids control equipment are processed through a grinding system and slurrified. The slurry is then pumped into a disposal zone that must be able to accept the slurry fast enough to keep up with the drilled cuttings produced. This injection may be done in a separate well or behind the casing. The risk associated with cutting injection is that if the zone ever plugs, either drilling must stop, or collection and shipping of the cuttings becomes necessary. The benefit is that since there is no discharge to the environment, no compromises have to be made between discharge compliance and good solids control. Additionally, less expensive diesel or mineral oil-based muds can be used, although an operator may still choose to use SBMs as they are more environmentally friendly should a mishap arise.

Ship to Shore. When shipping all cuttings to shore for treatment/disposal, there is no reason to compromise solids control so one should remove the maximum amount of drilled solids that is economically practical. As in the case of cuttings injection, diesel or mineral oil based-muds may be used in an effort to reduce costs.

Interrelated Factors In Drilling

Overall, there are three very important interrelated factors that, together, create a cycle that can minimize drilling costs and make compliance cost effective. These factors are:

a. Good drilling practices
b. Good solids control practices
c. Properly maintained drilling fluids

Maximum penetration rates may be attained by choosing the proper bit for the formation drilled, optimizing hydraulics, selecting the proper weight on bit and proper rotation rate. If this is done, larger cuttings will often result and fine drilling particles will be minimized. Larger drilled cuttings are easier to remove than fine particles, therefore the efficiency of the solids removal system will be maximized. If the solids removal efficiency is high, there will be less detrimental drilled solids remaining in the mud system, which will minimize drilling fluid maintenance and dilution costs. Mud with proper fluid properties will offer improved hydraulics, and mud with a low concentration of drilled solids will allow higher rates of penetration. This, in turn, will generate the larger cuttings which facilitate effective solids control management.

The Marine 700, a semi-submersible capable of operating in 5,000 ft. of water, offers one of the most environmentally-sensitive solids control systems available.

Conclusion

For many reasons, today's offshore operator has to do a better job of managing solids. Not only because of the tremendous financial savings that can be recognized, but because it is becoming imperative in the area of environmental responsibility. Saving money is accomplished by having high solids removal efficiencies. High removal efficiencies provide a thin, compressible filter cake, which is the key to minimizing wellbore problems, dilution requirements and overall mud maintenance cost. Best practices coupled with highly efficient equipment will minimize drilling costs and total environmental impact. ■

Mitchell J. Derrick was named president of Derrick Equipment Company in 1999. Previously, he had served the company in various research and development and sales and marketing capacities. He was also a software consultant for various Fortune 100 companies. He received a BSE from Princeton University in civil engineering and operations research in 1993.

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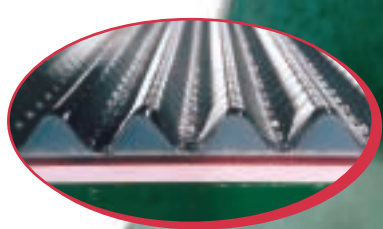
Derrick will continue to invest significantly in research and development in an effort to save you money through reduced dilution requirements, minimized environmental exposure and minimized downtime which can be attributed to insufficient solids control.



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