SYNTHETIC DRILLING FLUIDS - A POLLUTION PREVENTION OPPORTUNITY FOR THE OIL AND GAS INDUSTRY

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ABSTRACT

Offshore oil and gas operators use specialized drilling fluids, referred to as "muds," to help maintain well control and to remove drill cuttings from the hole. Historically, either water-based muds (WBMs) or oil-based muds (OBMs) have been used for offshore wells. Recently, the drilling industry has developed several types of synthetic-based muds (SBMs) that combine the desirable operating qualities of OBMs with the lower toxicity and environmental impact qualities of WBMs. This report describes the operational, environmental, and economic features of all three types of muds and discusses potential EPA regulatory barriers to wider use of SBMs.

WBMs are widely used in shallow wells and often in shallower portions of deeper wells, but often are not effective in deeper wells and extended reach wells. Drilling with WBMs often takes much longer than with OBMs or SBMs, resulting in extra cost and air emissions from the drilling equipment. With WBMs both the muds and the drill cuttings are discharged onsite. Both OBMs and SBMs are recycled, with only the cuttings and a small amount of associated drilling fluids being disposed. The EPA's effluent limitations guidelines (ELGs) prohibit releases of free oil, as detected by the static sheen test, from drilling fluids and drill cuttings discharges. OBMs and cuttings cannot pass the static sheen test and must be transported to shore for disposal in a landfill, whereas some SBM cuttings can be discharged onsite. SBMs offer operational advantages over WBMs and pollution prevention potential over OBMs in many situations, but the widespread use of SBMs has been inhibited by concerns that the discharged drill cuttings would not meet the ELGs requirement for no free oil. Operators are reluctant to use SBMs because they may not be able to discharge cuttings onsite.

Key words: drilling fluids, synthetic-based muds, pollution prevention

INTRODUCTION

The term drilling fluids or drilling muds generally applies to fluids used to help maintain well control and remove drill cuttings (particles from underground geological formations) from holes drilled in the earth. Drilling muds are an essential part of the drilling operation. Geology, geography, and economics are major considerations in selecting the mud type used for any particular well. Additional factors considered include drilling performance, anticipated well conditions, worker safety, fluid cost, and waste disposal costs. While water-based muds (WBMs) are usually the mud of choice, some situations (e.g., deeper wells or extended reach wells) require use of other mud systems to provide acceptable drilling performance. Drilling fluids serve several important purposes:

- carrying cuttings to the surface for disposal,
- cooling and cleaning the drill bit,
- maintaining pressure balance between geological formations and the borehole,
- lubricating the bit and drill string,
- reducing friction in the borehole,
- sealing permeable formations, and

- stabilizing the borehole.

Drilling muds are formulated to minimize problems associated with geological formations, well chemistry, depth, and other factors. A major challenge facing mud engineers is to stabilize and control mud properties to optimize drilling performance as cost-effectively as possible.

A diverse array of mud additives is available to respond to most problems or significant changes in down-hole conditions. Some mud additives, however, may increase mud toxicity; substantial research has yielded less toxic alternatives. Additives to WBMs include agents to control viscosity, specific gravity, lubricity, temperature, corrosive influxes, and other properties.

The EPA's effluent limitations guidelines (ELGs) for the offshore discharge of drilling wastes affected the economic feasibility of industry operations by precluding the on-site discharge of drill cuttings associated with OBMs. The final ELGs for the offshore oil and gas industry, issued March 4, 1993 (58 FR 12454), established best available technology (BAT) limits for the discharge of muds and cuttings as follows:

- no discharges of free oil as detected by the static sheen test,
- a 30,000-ppm 96-hour LC50 toxicity limitation,
- limitations on cadmium and mercury content of barite used in muds,
- a ban on discharge of muds and cuttings that contain diesel oil, and
- a ban on discharge of drilling fluids and drill cuttings within three miles of shore.

Companies supplying mud systems and other related chemicals have responded to the ELGs by finding substitutes for WBMs and oil-based muds (OBMs). Since 1990, several low-toxicity, biodegradable synthetic-based muds (SBMs) with impressive performance and environmental characteristics have entered the market.

This paper examines operational, environmental, and economic properties of WBMs, OBMs, and SBMs. It describes SBM systems recently developed as substitutes for conventional drilling mud systems in certain circumstances.

METHODOLOGY

This paper is based on a study performed by Argonne National Laboratory for the U.S. Department of Energy (DOE), (Burke and Veil, 1995). The study was conducted through literature review and extensive communication with oil industry operators and drilling product supply companies. Much of the information on environmental impacts was previously published, but some of the key drilling performance and cost data was supplied directly by industry operators and was first published in Burke and Veil (1995).

RESULTS

WBMs

WBMs are by far the most commonly used muds, both onshore and offshore; EPA (1993a) estimates that nearly all shallow wells (less than 3,000 meters deep) and about 85% of wells deeper than 3,000 meters are drilled with the use of WBMs. EPA (1993a) reports that use of WBMs generates between 1,100 and 2,000 cubic meters (7,000 and 13,000 barrels) of waste per well, of which 220-450 cubic meters (1,400-2,800 barrels) consist of drill cuttings, depending upon the depth and diameter of the well. The National Research Council (1983) reports that the volume of drill cuttings with adhering WBMs continuously discharged during drilling totals about 500-1,000 cubic meters (3,000-6,000 barrels) per well and that intermittent bulk discharges of WBMs represent another 800-4,800 cubic meters (5,000-30,000 barrels) of WBM waste per well. In most cases, both the WBMs and the cuttings are discharged onsite to the ocean.

OBMs

The performance of WBMs is deficient for some applications, particularly when drilling high-angle, extended-reach wells, or in high temperatures or hydratable shales. OBMs have been developed and refined over the last 30 years to overcome these deficiencies. The type of OBM most commonly used in the Gulf of Mexico is an oil and brine emulsion containing various additives dispersed in oil. OBMs are used where WBMs are dangerous, technically impossible, or uneconomical to use and where high performance is required. OBMs are usually rented or sold and repurchased by the supplier.

Wells drilled with OBMs normally produce lower waste volumes than those drilled with WBMs because very little slumping or caving in of the walls of the hole occurs, and the mud is reconditioned and reused rather than discharged. Also, the muds are recycled and only the drill cuttings are disposed of. The average volume of OBM waste (drill cuttings with OBMs adhering to the cuttings) is estimated at 300-1,300 cubic meters (2,000-8,000 barrels) per well (Ayers 1994). However, OBM wastes cannot be discharged on-site under the EPA's ELGs because they contain oil. In U.S. offshore areas, most of this waste is hauled to shore for land disposal. Despite their unique and valuable properties, use of OBMs is limited because of the added cost of hauling and disposing of wastes onshore and the long-term liability concerns associated with onshore disposal sites.

SBMs

There are several SBM systems currently used, classified according to the molecular structure of their synthetic base fluids: esters, ethers, polyalphaolefins (PAOs), and olefin isomers. Other types of base compounds are likely to be developed in the future because use of SBMs is relatively new and the technology is still evolving. SBM systems do not need large dilution volumes to control solids, and the volume of spent mud and cuttings is reduced (Park et al. 1993). Like OBMs, SBMs are recycled and only the cuttings are discharged.

These various types of SBMs have a wide range of chemical properties and drilling performance. The environmental impacts from different types of SBMs differ as well. While much of this paper refers to SBMs as a general class of materials, it is important to recognize that SBMs are not a uniform product.

Uses and Advantages of SBMs

SBMs have drilling and operational properties similar to OBM systems and are used where OBMs are commonly used, such as in difficult drilling situations where the properties of WBMs would limit performance. In some instances, SBMs may provide better performance than OBMs. However, in spite of a few literature examples cited in Burke and Veil (1995), it cannot necessarily be concluded that all SBMs outperform all OBMs.

Although the purchase costs of SBMs generally are several times higher than the costs of OBMs, the cost disadvantage is overcome if cuttings from wells drilled with SBMs can be discharged on-site, saving transportation and disposal costs. SBMs are well-suited to the high-angle, directional, horizontal, and extended-reach wells that are common in the multiwell platform sites in the North Sea, the Gulf of Mexico, and elsewhere. The use of SBMs in the demanding conditions of the North Sea has been facilitated by British, Dutch, and Norwegian regulatory authorities, who have permitted the discharge of SBM cuttings in some instances.

The performance of SBMs and OBMs in drilling wells with large horizontal offsets, in some cases measuring several miles, has prompted significant changes in oil industry operations. The development of horizontal or extended-reach drilling techniques has permitted the use of one platform to drill an increased number of wells, hence reducing the overall number of platforms, operating costs, and associated environmental impacts.

SBMs have reduced well completion times compared with WBMs. Similar to OBMs, the SBMs have achieved significant cost savings over WBMs in problem wells because they improve performance (meters drilled per hour) and reduce downtime for common problems such as stuck drill pipes. Use of WBMs is more cost-effective in drilling many shallow wells, and WBMs will continue to be used in those instances. However, for more demanding drilling situations, SBMs or OBMs are often used because of their ability to drill more quickly. The cost savings can be substantial for some particularly difficult-to-drill wells. The quantifiable environmental benefits (compared with either WBMs or OBMs, as indicated) that result from use of SBMs include:

- Less waste is produced from a recyclable product (vs. WBMs);

- Elimination of diesel as a mud base lessens the pollution hazard, improves worker safety through lower toxicity and diminished irritant properties, and reduces consequent risk (vs. OBMs);

- Increased use of horizontal drilling reduces the areal extent and the environmental impacts of offshore oil and gas operations (vs. WBMs);

- Shortened drilling time results in reduced air emissions from drilling power sources (vs. WBMs); and

- Improved drilling performance decreases waste-generating incidents such as pipe stuck in the hole. Such incidents necessitate the use of diesel or other oil "pills" that add to the waste load from the mud (vs. WBMs).

SBMs resolve many of the environmental problems associated with most OBMs, while producing comparable drilling performance. For example, if the cuttings are discharged, use of SBMs eliminates the use of expensive onshore disposal facilities. Similar to WBMs, SBMs exhibit low toxicity, but unlike WBMs, SBMs are recycled, thus reducing the volume of waste discharged. The substantial environmental benefits demonstrated by this new technology appear to justify regulatory consideration.

Comparative Cost/Benefit Studies

The purchase price of SBMs is higher than that of OBMs and WBMs; however, compared with WBMs, the higher purchase price may be justified by the SBMs' improved performance in problem wells. Compared with OBMs, the higher purchase price of SBMs may be balanced by avoidance of hauling and onshore disposal costs and liability. Comparative field-cost data on different types of muds are scarce. This paper presents one set of preliminary field data that documents the substantial economic benefits that may result from the use of SBMs when drilling deep or complex wells. Burke and Veil (1995) provide additional data from other sites.

A major oil company provided detailed, verified platform cost and drilling data for a series of wells recently drilled in the Gulf of Mexico under similar conditions and to roughly equal depths (White 1994). Five of the wells used WBMs and three used PAO-type SBMs. No wells in this example were drilled with OBMs; therefore, it is not possible to compare the drilling effectiveness of OBMs to that of WBMs and SBMs with these data. Selected pertinent data are presented in Table 1 for the eight wells. The data demonstrate major benefits of SBMs over WBMs in several areas:

- As measured by drilled footage per day, SBMs perform with greater overall efficiency than WBMs. WBMs averaged 35 meters drilled per day, while SBMs averaged 102 meters per day.

- While significantly more costly on a per barrel basis, SBMs can reduce total mud costs and mud cost per drilled meter compared with WBMs. At most of the wells surveyed, the mud cost was lower for SBM wells than for WBM wells.

- The total costs for WBM wells were in the range of $9.6 - 14.7 million; the SBM wells cost in the range of $4.4 - 6.5 million. The total dry hole cost (includes the cost of drilling and casing the well but not installation of pumps and associated tubing) for each of the WBM wells was substantially higher than the most expensive SBM wells. SBMs reduce overall costs by reducing downtime and other non-productive activities.

- Improvements in efficiency yield significant increases in productivity. The WBM wells averaged 180 days to complete the dry hole and 197 days overall, while the SBM wells were completed on average in less than one third the time, 54 days to complete the dry hole and 61 days overall.

In this case, the average total dry hole cost of WBM wells was $11.4 million, compared with $5.4 million for SBM wells. This difference indicates a substantial economic benefit from use of SBMs as an alternative to WBMs. These costs do not include any onshore disposal costs for SBM cuttings. It is not known how conventional OBMs would have performed in these wells.

In some cases, such as the example shown above, the cost savings from use of SBMs or OBMs rather than WBMs are extremely large. Even for many shallower or less complicated wells, the cost savings are smaller but still significant. It is clear that the oil and gas industry will use OBMs and SBMs for many drilling applications. Some oil and gas producers have performed internal cost estimates and concluded that for their operations, SBMs are more cost-effective. For most such cost analyses, the factor that tips the balance toward using SBMs is the ability to discharge cuttings on-site and avoid the costs, logistic difficulties, and potential liabilities of transporting the cuttings to shore for disposal.

Water Column Impacts

Essentially all the field study results to date suggest that because of rapid settling and dilution, drilling fluid and drill cuttings discharges do not cause significant biological effects in the water column. The National Research Council (1983) reports that about 90% of the particles in discharged drilling fluids and almost all of the cuttings settle rapidly. Within an hour of release, the settling plumes are diluted by a factor of 10,000 or more.

Table 1 - Performance Comparison of WBM versus SBM (from White 1994)

Wells	Depth Drilled (m)	Depth per Day (m/day)	Total Mud Cost ($ million)	Mud Cost per Meter ($)	Total Dry Hole Cost ($ million)	Total Days (dry hole/ overall)
WBM Wells[a]						
C-1	5,300	65	–[b]	–	10.1	81/84
C-2	5,160	19	2.538	492	14.7	274/326
C-3	5,350	25	–	–	9.6	214/214
C-8	5,480	41	1.329	242	9.7	134/163
14[c]	5,220	27	1.550	296	12.7	197/197
SBM Wells						
C-5	5,130	92	0.806	157	5.2	56/60
C-6	5,520	84	1.707	308	6.5	66/82
C-7	5,260	131	0.776	147	4.4	40/42

a One additional well not reported here (C-4) was initially drilled with WBMs. After two stuck pipe incidents, the well was redrilled with SBMs and was successfully completed.

b A "–" indicates data not available.

c Well 14 does not follow the other wells in numerical sequence because it was drilled from the same location into an adjacent block with a different numbering scheme.

In terms of toxicity, most WBMs, SBMs, and mineral-oil-type OBMs are non-toxic. Friedheim and Pantermuehl (1993) report that PAO-type SBMs easily meet the toxicity protocols established by the United States, Great Britain, Norway, and the Netherlands. Peresich et al. (1991) present data to demonstrate that ester-type SBMs easily meet toxicity standards.

Another potential for concern lies in exposure to metals through bioaccumulation of the low concentrations of metals in drilling mud, principally cadmium and mercury, in the food chain. In drilling mud discharges, these metals are generally found in highly stable, insoluble forms. They have been shown not to bioaccumulate to harmful levels and are not biomagnified in the marine food webs (Neff 1988). More recent laboratory bioaccumulation tests found that fish exposed to SBM cuttings for 30 days had not taken up the SBM, while nearly all the tested fish exposed to OBM cuttings for 30 days showed accumulation of mineral oil in the guts, and about half of the tested fish showed accumulation in the tissues (Friedheim and Pantermuehl 1993).

Sea Floor Impacts

Discharge of OBM cuttings poses a greater environmental impact on the sea floor than does discharge of WBM cuttings. OBM cuttings can significantly increase oil content in sediment and decrease biological abundance and diversity of immobile bottom-dwelling organisms in the affected area. Major biological impacts are limited to a zone of about 500 meters around the drilling platform and are primarily due to physical burial and anoxia caused by the heavy organic loading and the barrier that the OBM cuttings present to oxygen transport to the sediment (Davies et al. 1988). Within this 500-meter zone, recovery is slow compared with recovery in an area of WBM discharges.

EPA (1993b) reviewed 23 studies of the field impact of discharges of drilling fluids and drill cuttings (presumably WBMs). The review suggests that localized sea-floor impacts may occur, depending upon the type of mud discharged and the energy level of the sea-floor environment, but regional-scale impacts have not been identified. Other literature not surveyed by EPA also suggests that environmental impacts of WBMs and SBMs and their drill cuttings discharges are not extreme or long-lived. The extent and duration of impacts from discharge of muds and cuttings are affected by the degree of natural mixing and dispersion of the sediments.

Gillmor et al. (1985) conducted a benthic evaluation at a deep (120 meters) low-energy site off the coast of New Jersey. Discharge of WBMs and cuttings caused a local decrease in the abundance of immobile, bottom-dwelling organisms because of physical burial and possibly inhibition of larval recruitment, but the discharges had little effect on diversity. Abundance levels of certain bottom-dwelling fish increased in the area of the drilling rig because of the additional bottom microrelief provided by the cuttings and the fallout of organic material from the community of organisms attached to the submerged portions of the platform (Gillmor et al. 1985; Neff 1987).

Neff et al. (1989) studied deep sites (80-140 meters) where WBMs and cuttings had been discharged in a high-energy environment at Georges Bank. In contrast to the results of Gillmor et al. (1985), Neff et al. (1989) observed only subtle changes in various benthic community parameters during and immediately after drilling. The degree of change observed was within the expected range of natural variation and appeared to have no effect on the benthic invertebrate and fish populations that support the rich commercial fishery of Georges Bank.

The amount of published data available on sea-floor impacts of SBMs is limited. Friedheim (1994) reports that seabed studies in the Gulf of Mexico indicated that a PAO-type SBM was either degrading or dispersing significantly during a six-month period.

Gjøs et al. (1991) reported on two sea-floor surveys conducted at a well in the Norwegian sector of the North Sea, a portion of which was drilled with an ester-type SBM. The SBM cuttings were discharged on-site. The surveys collected chemical and biological samples at two perpendicular transects. The first survey was conducted two days after drilling and discharge of the cuttings had ceased, and the second survey was conducted at the same stations one year later.

Table 2 compares the two years for sediment ester concentration and the abundance and diversity of benthic organisms. The 1990 (initial) concentrations were elevated within 200 meters of the discharge point, but the 1991 concentrations were nearly all diminished except for one station at 100 meters from the discharge point. These results indicate that the ester had degraded relatively quickly in the environment.

In the benthic analysis, the 1990 data indicate that the effects were only observed out to 100 meters from the well. One year later, those stations had returned to normal levels of abundance and diversity. In this case, the effects of the SBM were limited both spatially and temporally. Within one year, benthic populations were back to normal (Gjøs et al. 1991).

Candler et al. (1995) examined sea-floor impacts at a well in the Gulf of Mexico, 4,650 feet of which was drilled with a PAO-type SBM. The cuttings were discharged on-site in 39 meters of water. Three sets of chemical samples were taken over a two-year period, and one set of benthic organism samples was collected. Two years after the SBM discharges were completed, three sites within 50 meters of the well exhibited an adversely affected benthic community and elevated levels of total petroleum hydrocarbons (TPH, an indicator for PAO). The remaining 13 sites had much lower TPH levels after the two-year period and had benthic populations that were comparable to four reference stations in terms of species abundance and diversity (Table 3).

Candler et al. (1995) concluded that discharges of cuttings from wells drilled with PAO-type SBMs have a greater impact on benthic communities within a 50-meter zone around the discharge point than do discharges of WBMs and cuttings. However, compared with North Sea discharges of cuttings from wells drilled with OBMs, the rate of recovery for SBM-contaminated areas was greatly improved.

As stated earlier, SBMs are a diverse group of substances with widely different base fluids. The environmental impact from discharging SBM cuttings will vary depending on the base fluid and the energy of the environmental setting into which the cuttings are discharged. In general, SBMs have substantially lower environmental impacts than OBMs.

Non-Water Quality Environmental Impacts

Non-water-quality or indirect impacts of drilling muds are additional environmental and safety impacts associated with use and disposal of different types of drilling mud. Such impacts include air pollution from transportation; energy use during transportation; disposal site factors (use of scarce disposal sites, potential site contamination, threats to groundwater); and worker safety from use, loading, and unloading of the material.

Each mud type causes or mitigates a range of indirect environmental impacts associated with its use and disposal. Indirect impacts appear to be most severe with OBMs and seem to be favorably mitigated by SBMs. The indirect impacts of WBMs are neutral; while most WBMs are discharged on-site, significant volumes of WBM waste are still disposed of off-site.

As noted earlier, major indirect impacts of off-site waste disposal result from use of OBMs and, to a far lesser extent, WBMs. Disposal of diesel-based OBMs may place toxic hydrocarbons and priority pollutants in landfills, where they have the potential to leach into groundwater or otherwise leak out of containment. Another significant indirect impact from such disposal is the air pollution generated by the transportation of large volumes of OBM wastes to shore. The EPA (1993a) estimates that nationwide 298 tons per year of additional air pollutants will be released as a result of implementing its final ELGs for the offshore oil and gas industry. The major sources of these emissions are the supply boats used to transport mud and cuttings to shore. Other equipment items with significant air emissions contributions include cranes, trucks, tractors, and bulldozers used in the onshore handling and disposal of the mud and cuttings.

This level of air pollution is reduced by use of WBMs and the associated on-site disposal of WBM cuttings. Use of SBMs can also reduce indirect environmental impacts by virtue of shorter drilling times and the consequent reduced air emissions from drilling equipment. Indirect environmental impacts are further reduced for SBMs if on-site disposal of SBM cuttings is allowed.

Worker health and safety is another impact differing between mud types. A concern in this case is with diesel-based OBMs, which often contain hazardous substances and may cause irritation upon contact with the skin. Since oil field workers regularly come in contact with the mud they use, implementation of proper worker protection measures for diesel-based OBMs is necessary if this risk is to be minimized. Because of the potential hazards of diesel oil to workers, diesel-based OBMs are not frequently used offshore. WBMs occasionally may pose a similar problem for worker health and safety when a diesel oil pill or a toxic mud additive is used. SBMs can help minimize the worker health and safety risk caused by exposure since most synthetic base fluids exhibit low toxicity. Park et al. (1993) report that PAO-based SBMs have a much higher flash point than mineral oils, resulting in substantially fewer fumes being released. Friedheim (1994) corroborates this with evidence that far fewer vapors are given off by PAOs compared with mineral oil and diesel oil and that PAO base fluid is not a skin or eye irritant. Peresich et al. (1991) provide similar evidence for an ester-type SBM.

Avoidance of operational incidents, such as pipe stuck in the hole, also reduces pollution discharges. This widespread problem is often remedied in WBMs with use of an oil pill. An oil pill typically must be separately captured and disposed of in some manner other than overboard discharge. Some operators use a synthetic-based spotting fluid as a pill. This type of pill may meet EPA's discharge standards and avoid the need for separately capturing and disposing of the pill (Seraydarian 1988). The use of SBMs can aid in minimizing the incidence of stuck pipe in the first place, thus resulting in less downtime, reduced waste, and avoided pollution from this problem.

Table 2 - Comparison of Two Sea-Floor Studies at a Well Drilled with an Ester-Type SBM (from Gjøs et al. 1991)

Station Number	Location[a] (meters)	Mean Sediment Ester Concentration (mg/kg)		Number of Taxa		Number of Individuals		Diversity (Shannon-Weiner Index)	
		1990	1991	1990	1991	1990	1991	1990	1991
1	50 SW	85,300	0.21	4	51	16	379	1.5	4.3
2	100 SW	46,400	0.22	7	44	167	370	0.96	4.24
3	200 SW	208	1.34	52	38	290	212	4.52	4.31
4	500 SW	0.98	0.43	50	43	308	625	4.53	2.61
5	800 SW	0.42	0.18	57	49	284	365	4.72	4.36
6	1,200 SW	0.38	0.31	56	53	308	322	4.54	4.71
7	2,500 SW	0.26	0.39	51	45	316	230	4.64	4.54
8	5,000 SW	0.30	0.36	56	52	336	334	4.50	4.49
9	100 SE	360	11.68	35	52	234	408	3.39	4.41
10	200 SE	97	0.34	52	57	290	395	4.66	4.37
11	500 SE	2.44	5.28	51	52	255	367	4.75	3.98
12	1,200 SE	0.25	0.18	47	41	224	259	4.58	4.28
Reference Site A	–[b]	–	0.25	56	48	385	340	4.59	4.18
Reference Site B	–	–	–	53	58	368	329	4.33	4.73

[a] Location is given in distance and direction from the discharge point.

[b] A "–" indicates no data available.

Table 3 - Benthic Conditions after Two Years at a Well Partially Drilled with a PAO-Type SBM (from Candler et al. 1995)

Stations	Number of Taxa	Number of Individuals	Diversity (Shannon-Weiner Index)
3 Affected Stations[a]	8-22	17-141	1.69-2.25
13 Remaining Stations	26-38	162-280	2.32-3.15
4 Reference Stations[b]	27-32	152-219	2.49-2.86

[a] 25 meters south, 25 meters west, and 50 meters south of well.
[b] 2,000 meters north, south, east, and west of well.

Discussion

Technological developments in the drilling industry appear to have outgrown the regulatory categories in the offshore ELGs. The limitations of EPA's regulatory approach may result partially from past conventional wisdom that focused on two categories of mud, OBMs and WBMs. During the extended rule-making process, EPA emphasized current technologies in use, their environmental impacts, and the effects of proposed regulations.

The current availability of SBMs as a technical alternative to past and present practices may warrant regulatory consideration. Operators are concerned that some types of SBMs may not pass EPA's static sheen test for demonstrating that no free oil is present, and therefore the SBM cuttings would be prohibited from on-site discharge. If on-site discharge of SBM cuttings is not allowed, SBMs often are no longer economically attractive. Reevaluation of the current policy should include consideration of the limitations in the approach and clarification or amendment of the ELGs so that the use of SBMs is not unnecessarily precluded. The following are among the specific measures that need additional clarification:

- The term "synthetic base fluid" should be clearly and simply defined to include low-toxicity SBM products being developed.

- Application of the static sheen test should be evaluated. The test is intended to detect free crude oil, diesel oil, or mineral oil in drilling mud discharges. However, the continuous phase of some SBMs is lighter than water and could cause a detectable film in the static sheen test apparatus. While this film does not result from the type of free oil that EPA intended as an indicator of priority pollutants, it might be interpreted as a failure of the sheen test and thus preclude on-site discharge of the associated drill cuttings. The static sheen test procedure or interpretation of results should be clarified or amended to ensure that the original intent is accomplished, but that a wide range of pollution-preventing SBMs is not inadvertently subjected to unnecessary barriers.

Implicit in this revised approach is the recognition that EPA regulations must be flexible and responsive to the development of new technologies that reduce environmental impacts. Balancing environmental protection requirements with the need to encourage the development and use of new techniques and pollution prevention technologies should be an objective of a new approach to limitations on discharges.

CONCLUSIONS

EPA's ELGs have had desirable side effects with major ramifications for offshore operators. One prominent effect has been the development of innovative alternative SBM systems that can provide major benefits in terms of pollution prevention, operating costs, drilling efficiency, and performance. SBMs were developed to provide drilling fluids with performance properties similar to those of OBMs, but whose cuttings could be approved for discharge. Widespread application of this new technology in the United States is constrained by regulatory uncertainty over specific definitions and requirements in the ELGs and the resultant NPDES permits intended to curtail discharges of OBMs containing toxic pollutants into the marine environment. EPA regulations were not drafted with full consideration of the recent development of innovative mud technologies, including SBMs. EPA should consider revising or clarifying regulations to specifically address appropriate standards for SBMs.

EPA's offshore ELGs use a command-and-control, end-of-pipe approach that runs directly counter to the source reduction/pollution prevention approach that EPA has made an emerging policy priority. The offshore ELGs do not recognize the use of pollution prevention systems such as SBMs as a control technology for conventional pollutants (Burke 1994). Neither do the offshore ELGs consider the engineering aspects of the effectiveness of a drilling mud as a technology that could be used to reduce overall pollution levels.

Greater regulatory flexibility in encouraging innovation and new technology development can ease the introduction of alternative pollution prevention technology. The current regulatory wording of controls on offshore discharges suggests, however, that EPA may not be able to exercise the flexibility needed to resolve the present regulatory situation limiting the use of SBMs. To accomplish this goal, EPA should consider either (1) clarifying the present ELGs so that non-toxic and environmentally acceptable SBMs can comply or (2) establishing a new mud category for SBMs with appropriate controls for that category.

ACKNOWLEDGEMENTS

This research was sponsored by DOE's Office of Policy and Office of Fossil Energy under Contract W-31-109-Eng-38. The authors are grateful for the assistance of an industry work group in reviewing the draft report and providing helpful comments. We particularly thank Dan Caudle, Robert C. Ayers, Jr., and John Candler for assistance in collecting information and providing guidance.

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