AADE-03-NTCE-08

Meeting the Challenges of the New SBF Regulations at the Rig Site

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This paper was prepared for presentation at the AADE 2003 National Technology Conference "Practical Solutions for Drilling Challenges", held at the Radisson Astrodome Houston, Texas, April 1 - 3, 2003 in Houston, Texas. This conference was hosted by the Houston Chapter of the American Association of Drilling Engineers. The information presented in this paper does not reflect any position, claim or endorsement made or implied by the American Association of Drilling Engineers, their officers or members. Questions concerning the content of this paper should be directed to the individuals listed as author/s of this work.

Abstract

With the introduction of synthetic-based drilling fluid (SBF) in the early 1990's, it became apparent that the existing regulations for water-based drilling fluids were not appropriate for SBF. As part of an accelerated regulatory process, the US Environmental Protection Agency (EPA) and industry worked together to produce the data necessary for developing new Effluent Limitation Guidelines (ELG) specifically designed for SBF. The Presumptive Rulemaking Process allowed the fast-track development of the ELG. EPA Region VI then used these guidelines to write permit modifications to the General Permit to include SBF.

The new permit called for additional testing to be performed on the rig with a quality assurance/quality control program that is more strenuous than what is typical for this industry. The requirements include a modified retort test to measure the retention of base fluid on cuttings, which has to be performed at least once a day while drilling, and a reverse phase extraction test, which is to be performed at least once per week, to determine drilling fluid contamination of formation oil.

This paper will review the permitting process and the effects that the new permit is having on the rig. It will look at the steps that should be taken on the rig when SBF are to be used.

Introduction

On February 16, 2002, the US Environmental Protection Agency (EPA) introduced a modified permit for offshore oil and gas exploration that included regulation for synthetic-based drilling fluids (SBF). These regulations are the culmination of five years of cooperative research between EPA and industry.

The benefit of these new requirements is the clear authorization of SBF cuttings discharges that is an important tool for deepwater drilling. Controlling discharge was the EPA's justification for continued discharge of SBF cuttings. In order to control the discharge of SBF cuttings, the EPA required the use of cuttings dryers and highest performance SBF base fluids.

While industry members clearly saw the operational benefits for use of SBF before the new regulations were instituted, there were deep concerns throughout the regulatory process that if the new regulatory requirements were too costly, or operationally difficult, it would make SBF technology too expensive to use. In order to be able to afford the continued use of SBF offshore, industry advocated for reasonable regulatory limits and test procedures.

The end result of the regulatory process was intended by both the Agency and industry representatives that worked on the regulations to achieve the pollution-control requirements of the Agency without being either too expensive or too difficult operationally. For the most part, the regulations involve transitioning the typical SBF operating practices into regulatory requirements. This transition to the new regulations involves additional testing both onshore (before the mud is sent out to the rig) and on the rig itself. Meeting the new challenges of this transition is discussed below.

During the regulatory process, several operators began using cuttings dryers to recover mud and reduce discharges. The new regulations required the use of cuttings dryers on most rigs using SBF. The cost and operational challenges involving new equipment are also discussed below.

Regulatory Overview

When SBF were introduced, industry immediately started efforts to incorporate SBF into the offshore discharge regulations and set about working through regulatory departments. Cooperation of the Minerals Management Service (MMS) was required for interpretation and monitoring activities with the current General Permit. Secondly, industry began working with EPA Region VI, which encompasses areas offshore Louisiana and Texas, to update the General Permit. Finally, efforts began with the EPA in Washington to write appropriate guidelines for SBF.

In 1998, the EPA in Washington acknowledged that it would write specific guidelines for SBF using a new process call the Presumptive Rulemaking Process. As an alternative to the traditional rulemaking process that can take longer than seven years, the EPA was going to try the new rulemaking process that was designed to produce results in two years. The new rulemaking process consists of three steps. The first step was to gather as much information as possible on SBF. In the second step, the EPA issued what it thought was the appropriate limitations for this technology. In the third step of the process, the Agency, industry, and other interested stakeholders worked together to confirm with additional data and testing that the initial presumptions were correct. If additional data indicates that changes to the presumptive rules need to be changed, then the necessary changes are made before the guidelines are finalized.

EPA issued its first draft proposal of the guidelines in February 1999 using the Presumptive Rule Making Process. After the EPA made its presumptive ruling, work continued from February 1999 to April 2000 in trying to evaluate the proposed test methods. Industry workgroups revised the tests and guidelines, improved them, and tried to determine their feasibility. The EPA then published its Notice of Data Availability (NODA) in April 2000. Between April and October of 2000, the EPA reviewed additional information received as a result of the NODA. In November the final EPA decisions were announced and in December 2000 the final Effluent Limitation Guidelines (ELG) was signed.[1]

The Industry then continued the process by working with regional offices of the EPA to write the new guidelines into the General Permit used to regulate offshore discharges. The permit for discharges of SBF and other non-aqueous drilling fluids (NAF) was effective in February 2002.[2] The requirements of the new permit are listed in Table 1 with the ones that do not apply to the rig site highlighted in green. This paper discusses the various new tests and impacts on offshore operations.

Crude Oil Contamination

Traditionally, all offshore operations attempt to minimize any crude oil contamination in drilling fluids. In traditional water-based drilling fluids (WBM), crude oil contamination can lead to failure of the static sheen test and require the rig to stop discharges. The introduction of SBF in the early 1990s brought concerns that the environmental benefits of SBF would be eliminated if they became contaminated with crude oil. Consequently, the typical contracts for SBF use include non-buy-back policies if the mud becomes contaminated with crude. Routine monitoring over several years of SBF use indicate that crude oil contamination incidents of SBF were rare.

In the WBM regulations, the test for determining the contamination of formation oil is the Static Sheen Test. As noted in Table 1, this requirement is still applicable to SBF. However, an industry study showed that this test was not very effective in detecting formation oil contamination. The new test that was developed for SBF was the Reverse Phase Extraction (RPE) test. If the RPE test fails, the operator does have the option of sending the sample to a shore-based analytical laboratory to have a confirming gas chromatography/ mass spectrometry (GC/MS) test performed. The GC/ MS test results supercedes the RPE test results as it is a more definitive test.

The RPE test has proven to be an acceptable test for testing for crude contamination at the rig site. With proper training and following of protocols, there can be a minimum of false positives.[3] The weekly test is run with the same frequency as a Static Sheen Test and since the test is designed for field usage, most rigs have not experienced significant difficulty implementing the new test.

While the occurrence of crude oil contamination incidents has been low, the impact on operations of the rare incidents has increased dramatically with the implementation of the RPE test. Prior to implementation of the RPE test, concerns with crude oil contamination centered around the financial considerations when the mud was returned at the end of the well. Most low concentrations of crude oil contamination would pass the Static Sheen Test.

With the implementation of the RPE test limitation, contamination of a mud system with minor levels of crude contamination could push SBF cuttings discharges into noncompliance and require the discharge to stop until the contamination was removed. During a kick event, salt water and crude oil can sometimes flow into the wellbore. One technique that may be effective in preventing the contamination of the whole mud system is to isolate slugs of crude contamination associated with kicks when they are first circulated out of the wellbore. The issue of mud contamination with crude oil is not exclusive to SBF. The industry has been able to operationally prevent and resolve WBM contamination with crude oil for many years. While crude oil contamination incidents have not stopped the use of SBF, it is an issue that deserves attention within SBF operations so that it can be addressed in a manner that is least disruptive to the offshore operation.

ROC Requirements

The most significant impact of the new SBF regulations was the new retention of base fluid on cuttings (ROC) limitation. As seen in Table 1, ROC is ≤6.9% for fluids that meet the C1618 IO quality limitation. This number was based on what the EPA saw as the Best Available

Technology (BAT) – cuttings dryers. The EPA developed their ROC limits using "technology-based" principles. During the two-year process they used the methodology:

- define BAT
- collect data on BAT
- statistically apply a 95% confidence factor to arrive at a regulatory limit.

While the new limitation represents the most significant new regulatory burden for SBF, it also represents an estimated 50% reduction in SBF discharged into the environment. Commitment on the part of industry to use this new technology resulted in the ability of the Agency to justify the continued discharge of SBF cuttings. In order to reduce the regulatory burden of applying the new requirement, the Agency offered several options for monitoring the equipment used to achieve the regulatory requirement.

As part of the permit, an ROC value must be determined from each of the discharge points of cuttings, *i.e.*, cuttings dryer and centrifuge. It should be noted that there is a zero discharge limit on SBF except that which adheres to the cuttings discharge and small volume discharges. The permit gives examples of what the EPA considers small volume discharges.[2] These include *de minimis* discharges, displaced interfaces, accumulated solids in sand traps, pit clean-out, and centrifuge discharges made while changing mud weight. The inclusion of small volume discharges was intended to make the ROC limit more reasonable operationally.

In order to monitor the performance of cuttings dryers, numerous retort tests are required. The flexibility written into the guidelines and permit by the ROC limitation has also added complexity to the monitoring process. In many cases, operators have been driven to add personnel offshore for the specific tasks of running and monitoring the cuttings-dryer equipment.

Although the requirement of a demonstration of capability for conducting the retort test used in the ROC limit is not specified in the method, it should be part of the rigsite control measures to insure that the permit-required data is generated by a qualified individual. There should also be a written Standard Operating Procedure (SOP). This will insure that each person performing this measurement is performing it in a consistent manner.

The dedication of the industry to implement the new cuttings-dryer technology has resulted in a high level of compliance with the new requirements. A review of 19 post-permit wells consisting of 350 sampling intervals using various solids-control equipment was performed.[4] Figs. 1 and 2 shows the results of the cuttings dryer and fines units, respectively. The results of the two units combined are presented in Fig. 3.

Equipment requirements

One of the difficulties in using the new technology of cuttings dryers is finding a place to put the equipment in the limited space of an offshore rig. Some rigs may have to employ cuttings-handling equipment (an auger or vacuum system) to get the cuttings from the shale shaker to the cuttings-dryer equipment or modify the rig so that the dryer can be located next to the shale shakers.

It should be noted that the technology of cuttings dryers was obtained from other industries and adapted to the oilfield. For this reason the equipment used may not be designed for sampling of the cuttings in a safe and representative manner. The access point for one type of cuttings dryer is a flap that opens up to the inside of the unit. Initially the sampling was performed by opening the flap and inserting a sample cup by hand into the unit. This was noted as not being a safe technique for sampling and some type of sampling device had to be designed. No matter the model of cuttings dryer, the sampling device should be designed to allow safe access to the cuttings and removable for easy cleaning. It should also be simple to construct on the rig if needed.

Documentation Requirements

The implementation of the new ROC and RPE tests has resulted in new documentation requirements that greatly eclipse those previously required by the permit. The need for proper documentation has moved the industry from simply sampling the mud system and performing a test to having a dedicated person to document every step of the analyses. One approach to ensuring compliance is to have a Quality Assurance Program (QAP) in place for all aspects of compliance data gathering for discharge testing. This can include a Quality Assurance Manual that outlines the general quality program and Standard Operating Procedures (SOPs) to ensure consistence in data gathering. Some of the additional requirements for the collection and analysis of SBF could include calibration logs for the triple-beam balance used and the refrigerator in which the samples are stored (4^oC) using a calibrated thermometer.

Other measures such as continued demonstration of capability should be included in ROC analyses. One example of this is every 20 samples, a duplicate test should be conducted and come within 10 percent of the original analysis. This type of attention to quality insures accurate reporting for the new limitations.

When the SBF arrives at the rig site, the SBF should be accompanied with a certificate of compliance for base stock compliance and formation oil contamination as well as the barite certificate of compliance for mercury and cadmium levels. These certifications will not be discussed in this paper as they do not involve the rig site, but these documents insure that the base fluid used in the mud is in compliance with the permit and that the SBF is free of formation oil contamination.

In Section 2.C.2 of the modified permit, it states that "samples and measurements taken for the purpose of monitoring shall be representative of the monitored activity". One way to insure that samples are consistently representative is to have a Sampling Plan. This type of plan further promotes quality assurance as each plan would be rig specific and include information such as timing of sampling events, the sampling locations of various equipment, sampling techniques, and documentation. This type of sampling plan should be presented to the company representative for approval.

Once a well is completed in which SBF was used, all of the documentation associated with complying with the permit should be transferred to the operator. Below is a list of analytical reports that should be provided to the operator. All of these are requirements of the permit and must be retained for a period of three years.

- Certification of compliance – Base Stock Limitations (toxicity, biodegradation, and PAH)
- Certification of Compliance – Barite Stock Limitations (mercury and cadmium)
- Certification of non-contamination of mud system by GC/MS
- Drilling fluid inventory
- Copies of chain-of-custody documents for samples taken for evaluation off site
- Static sheen test results
- RPE test results (including quality control sample results
- ROC test results

The addition of these quality-control measures have been achieved using the same personnel that monitor the ROC limitation. The improvements in the defensibility of the data seem to outweigh the additional burden of time and documentation efforts.

Personal and Work Space Requirements

Because of the increase in work load that the new regulations impose, some companies designate a specific person such as compliance personnel (CP) to perform the additional tests and maintain the documentation. This person should have documentation showing demonstration of capability for a quality system and the appropriate SOP.

Some of the tasks that this CP may perform are evaluation of the ROC, performing the RPE test, labeling and storing chain-of-custody documents, storing samples for toxicity and formation oil, and record keeping. Below is a list of equipment that should be provided for the CP:

- three 50-mL retorts
- three extra retort cells
- triple-beam balance
- electronic balance
- calibration weights
- isopropyl alcohol
- RPE apparatus
- miscellaneous glassware
- waste container
- computer, printer, and related office supplies
- procedure manuals including SOPs.

One service company performed an HSE audit to evaluate and recommend a safe working environment for the CP. The results of this evaluation indicated the following recommended work environment:

- Space – It is recommended that 100 ft^2 be allotted for this facility with 48 ft^2 (6 ft x 8 ft) considered as a minimum.
- Ventilation – The HVAC system should be adequate to provide a minimum of 6 air changes per hour and maintain temperature between 60-80°F.
- Lighting – Florescent lighting should be provided and adequate to provide 100-150 foot-candles at the work surface.
- Electrical – Electrical supply and installation should be safe and adequate to operate the environmental controls and all equipment.
- Furnishings – The facility should be equipped with a minimum of 6 linear feet of stainless steel counter, a stainless steel sink with running water and drain provided.
- Noise and vibration –The facility should be positioned and constructed in such a way as to minimize vibration transmitted to the interior of the facility. Noise levels should be below 70 dBA.
- Communications – Voice communications equipment should be provided. Communications with other critical areas of the rig by phone or intercom is necessary to communicate work instructions and emergency situations.

These conditions have been achievable at most rigs with minor additions and alterations.

Conclusions

The impact of the first year of regulations has not caused a noticeable decrease in the use of SBF, which indicates that industry has not been unduly burdened by the regulations. Industry has responded to the new regulatory limits and testing procedures with additional personnel and operational-control measures. The goals of both EPA and industry have been met by providing pollution-prevention control without being too expensive or operationally difficult. As SBF use and discharge continues to evolve, it is likely that additional experience with the new regulations will lower operational difficulties and reduce non-compliance events.

Acknowledgments
The authors thank the Mary Dimataris for her help with the manuscript.

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Table 1 - Permit requirement for Offshore Oil and Gas Exploration and Production		
Requirement	Frequency	Permit Limit
Stock limitation – 10-day sediment test	1/year on representative sample	Ratio of 10-day LC50 Ratio ≤1.0
Stock limitation – biodegradation	1/year on representative sample	Ratio of % theoretical degradation Ratio ≤1.0
Stock limitation – PAH	1/year on representative sample	≤10 ppm
Sheen Test	1/week	No sheen
NAF Discharge rate of cuttings	1/hour	1,000 bbl/hr maximum
Mercury/cadmium	Once prior to drilling	1.0 mg/kg mercury 3.0 mg/kg cadmium
Drilling fluids chemical inventory	Ongoing	Record of chemical additives must be kept – total volume or mass
SPP toxicity test with Mysid	Monthly and EOW	96-hr LC50 ≥30,000 ppm
Sediment Toxicity (Leptocheirus Test)	IO: Monthly and/or EOW Ester: EOW	Ratio of 96-hour LC_{50} Ratio ≤1.0
Formation Oil	Once prior to drilling (GC/MS Certification)	No Discharge
	Weekly (RPE Test) – Wellsite testing	No Discharge
Retention of base fluid on cuttings	Once per day/ every 500 ft with max. 3 per day	≤6.9 % for IO ≤9.4 % for ester
Deck drainage	Once per day	No free oil using visual sheen

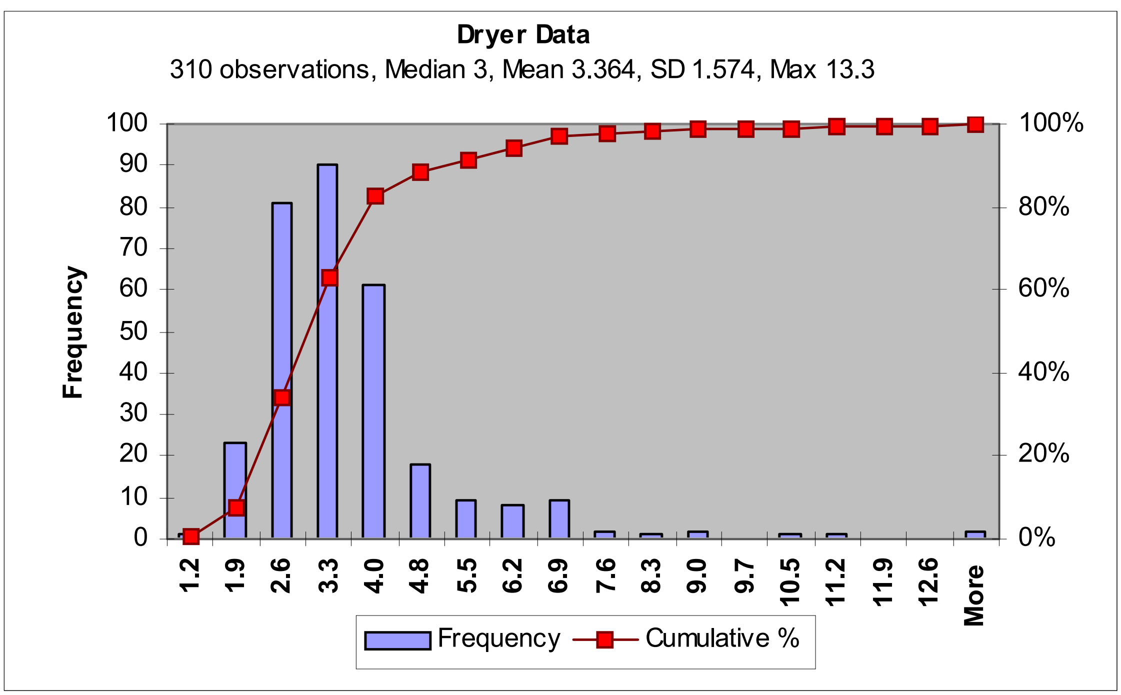

Fig. 1 - ROC Data from Cuttings Dryer Units.

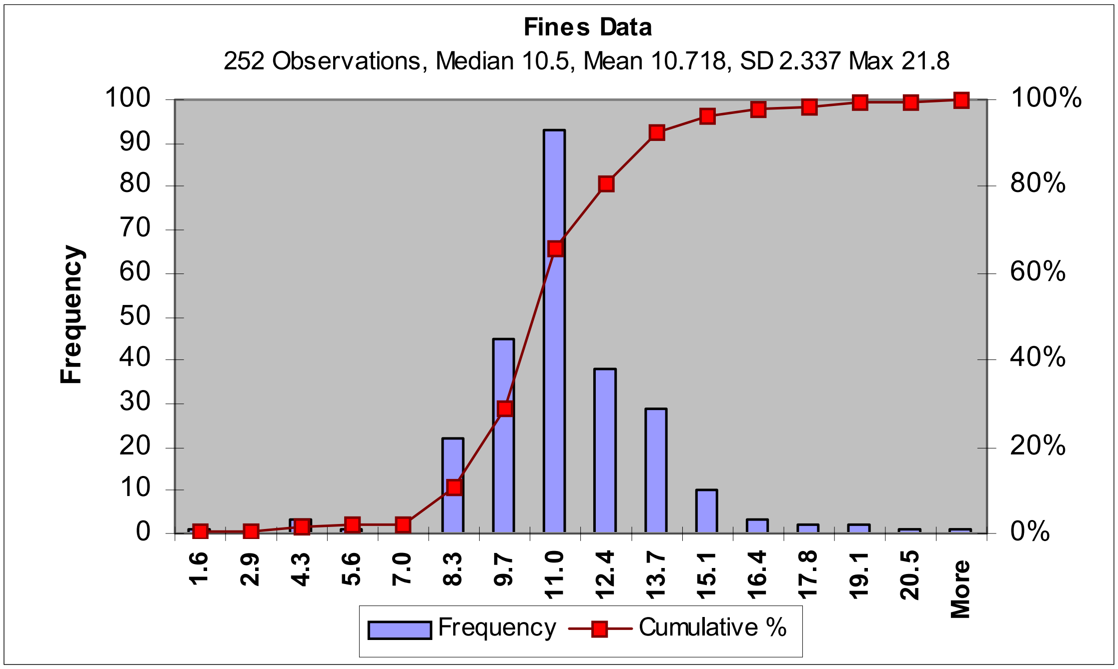

Fig 2 - ROC Data from Fines Units.

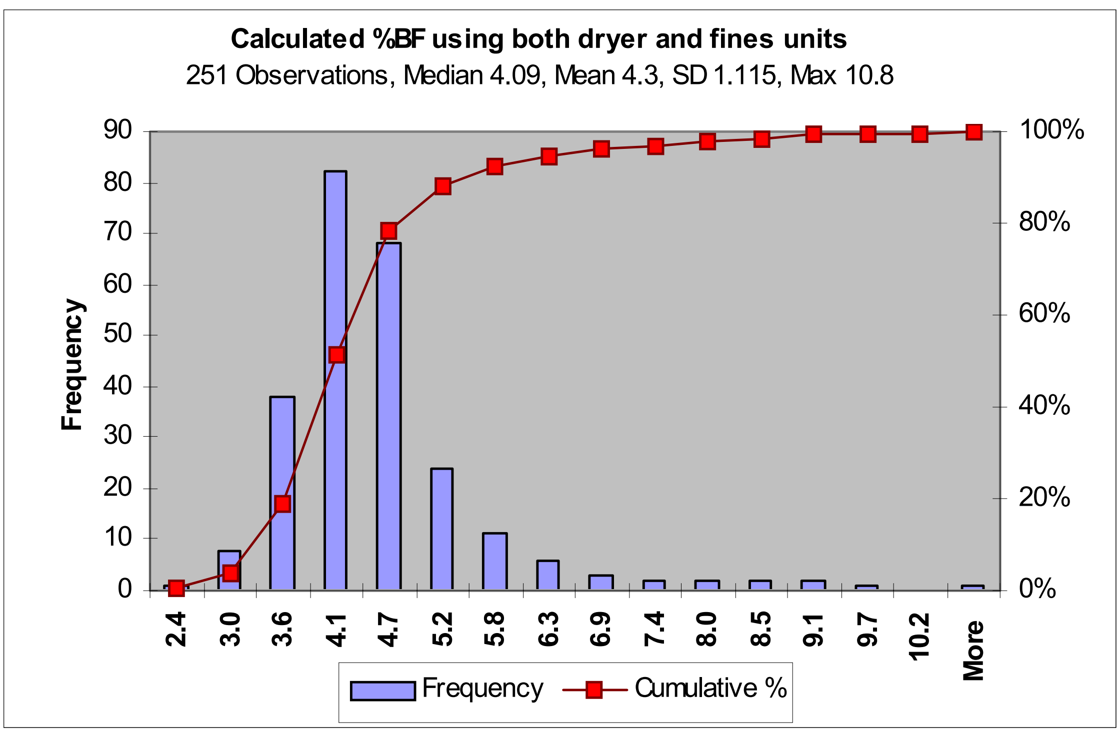

Fig. 3 - Combined ROC Data from Cuttings Dryers and Fines Units.