OFFSHORE PROCESSING & HANDLING OF DRILLED CUTTINGS & OTHER HYDROCARBON CONTAMINATED WASTES

The development of an environmentally sound alternative to onshore processing & disposal of non-aqueous base drilling fluids

Cuttings Processing

Introduction

The processing of non-aqueous based cuttings has, over the years, gone through many phases and generated any number of "solutions". None have been entirely successful and none are likely to provide a single solution to a problem with so many variables. The driver for innovation and development in the field has been, and to large a extent remains legislation. There are however nearly as many different laws or guidelines as there are countries. Apart from the legislative framework or lack of it operators themselves are becoming increasingly aware and concerned about the critical environmental issues relating to drilled cuttings disposal and are now often seen to be leading the way by putting in place their own policies and controls.

Legislative Framework

For the industry as a whole the substantial differences in cuttings disposal legislation and practice from one country to another does create difficulties. In the UK, for instance, the OSPAR decision 2000/3 established a 1% by weight limit on the quantity of non-aqueous based fluids (NABF), and this included synthetic fluids, that could be retained on the cuttings discharged to the marine environment. Elsewhere Nigeria has recently imposed a zero discharge limit. Similarly Kazakhstan has operated a zero discharge policy in the Caspian from the very first exploration well drilled in what is now the Kashagan field while in the US Gulf of Mexico a 6.9% (SBM) maximum of oil on cuttings is in place. These are just a few examples where legislators have imposed limits on the industry. There are many more where no restrictions exist. To a large extent legislators can only follow best available processing technology while at the same time taking note of developments in drilling fluid technology in general and the base oils used in particular. Because of this it is certain the industry will continue to see changes and developments in both the technology used and the legislative framework in which the industry must operate.

Options

Where there are strict restrictions in force on cuttings disposal the industry has broadly had to rely on a number of onshore disposal options. These have included thermal desorption, fixation and bio-remediation. Offshore the re-injection of cuttings has by and large been the only option. In others, where legislation is less restrictive, various methods of "mechanical" separation are being applied to meet discharge limits. The driers widely used in the GOM are one such example. The onshore options do however, of necessity, involve the transportation ("skip and ship") of large tonnages of invert emulsion contaminated cuttings from offshore installations to shore based processing facilities. This practice, widely used in the North Sea and increasingly elsewhere, carries with it considerable cost, logistics and HSE implications. There are for instance reports that for every tonne of drilled cuttings processed there is at least one mechanical movement involved. Whatever the number the impact on cost and HSE is significant and that is before the liability issues relating to the disposal of processed powder are taken into account.

Logistics & HSE

Clearly the movement of large tonnages of invert emulsion contaminated cuttings from offshore installations to shore based processing facilities is not the perfect solution to one of the industry's more important environmental problems. The ideal solution would, at the very least, require the

removal of “skip and ship” from the equation but to do that a technology for processing cuttings offshore would need to be found. Various types of thermal desorption have been used by the industry for a number of years to process cuttings onshore. The process which uses thermal energy to evaporate the fluid phases of the cuttings before recovering those phases separately as oil and water could in theory be developed to meet the more stringent demands of working in an offshore environment. However certain criteria have first to be met. Safety issues are clearly paramount and therefore how the thermal energy is generated is a vital component. Equally, operating offshore and effectively “online” with drilling operations, great emphasis needs to be placed on equipment reliability while at the same time ensuring that sufficient processing capacity is available to keep pace with the rate of cuttings generation. Others issues of importance are footprint, weight, mobility and, of course, cost. Meeting these and other criteria would be a challenge.

Technological Development

TWMA had been processing oily wastes and cuttings using a variety of technologies (including thermal desorption) since 1982, none however were considered entirely suitable for offshore application. In the mid 1990s the company, with the assistance of a major oil company, decided to look into the feasibility of developing a suitable thermal process for offshore use.The key elements addressed during this development programme included modularisation of the plant, reducing weight and footprint, meeting zoning specifications and getting processing throughput high enough to cope with cuttings generation rates. Individual module weights were to be kept to a minimum to meet crane lift restrictions and footprints reduced to fit within the limited space available on most offshore installations. The zoning specifications were designed to meet Zone 2 requirements. Some of the safety features included using enclosed containers with a CO_2 purge system, tying the equipment into the rigs emergency shutdown and computer controlling all operations. Processing rates were increased to keep pace with cuttings generation at typical rates of penetration not only in the 8½” but also the 12¼” hole sections.

The prototype RotoMill™ cuttings treatment plant specifically developed for offshore use operated on a continuous process basis governed by a computerised control system. Temperature (typically 260ºC) was generated to flash evaporate the fluid phase (water and oil). These evaporated fluids would then be condensed and recovered separately. Most importantly during the process there would be no emissions to the atmosphere and both the recovered water and oil would be suitable for recycling back into the drilling fluid. During initial onshore trials analysis of this recovered base oil showed that the process had little or no effect on the oil or its performance in the drilling fluid. The level of retained hydrocarbons in the recovered water was typically <20 ppm and the suspended solids between 5 and 15 mg/litre. The inert processed powder had a retained hydrocarbon content of less than 0.1%.

Field Trials

With the initial development programme complete field trials had to be carried out to prove the concept and the process. The company was fortunate that throughout this development phase an operator had been actively involved and an offshore installation was made available throughout the development stages.

- The first system, capable of operating in a Zone 2 area, on an offshore installation was commissioned in April 2001.
- The first offshore proving trial was initiated in June 2001 on board the rig Glomar Arctic III, operating on block 19/9 (Skene)
- A further two (2) trials were undertaken to allow the regulatory bodies such as the Dti and various environmental organisations the opportunity to audit of the efficiencies of the RotoMill™ technology, again on the Skene field

- Upon completion of the third (3) trial period the unit was accepted by the Dti as an alternative method for the processing and disposing of drill cuttings from an offshore installation.
- After acceptance from the Dti a further two (2) jobs have been completed as an integral part of their well programmes.
- The first RotoMill™ with a processing capacity of 6 metric tonnes per hour was mobilised to the Ocean Guardian in early August 2003 to operate for Shell (UK)

Recovered Products

One of the more critical elements in the development process was to confirm that the recovered products resulting from the process were suitable for recycling or disposal. Samples of the three products, water, oil and powder, were taken at regular intervals during the trial period and submitted to an independent laboratory for evaluation. The results are given below:

Water

The recovered water is suitable for discharge or reuse without further treatment and has the following properties

Component	Analysis
Mineral Oil	< 30 ppm
Suspended Solids	< 135 mg/L
Chemical Oxygen Demand	< 300 mg/L
pH	7 – 9

Solids

The recovered powder is suitable for discharge or reuse without further treatment and has the following properties

Component	Analysis
Mineral Oil	< 0.1% w/w
Chemical Oxygen Demand	< 300 mg/L
Particle Size Distribution	65% v/v < 45µ
Chlorides	Variable dependant upon the mud system

Note: A full Leachate analysis is available on request.

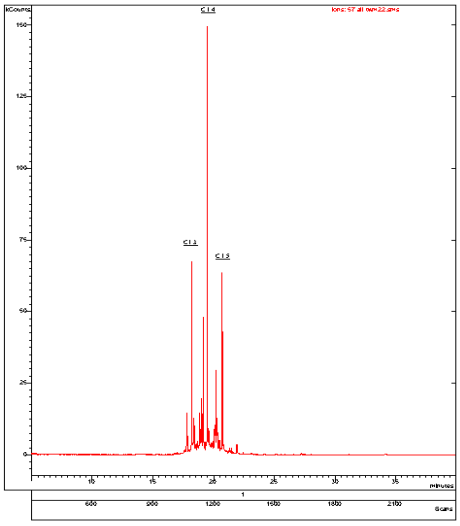
Oil

The recovered oil is suitable for reuse without further treatment and has the following properties.

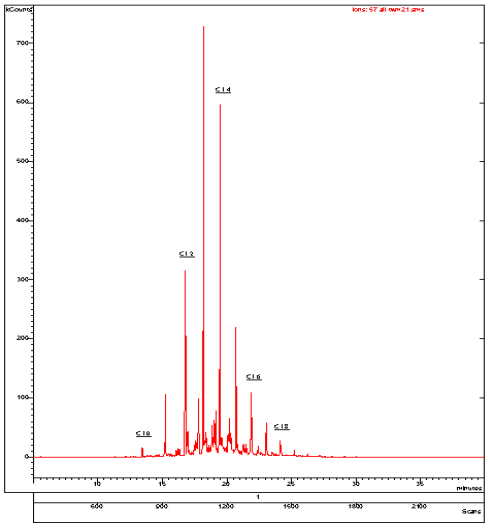
Carbon Chain Length	Base Oil	Recovered Base Oil
C_{10}		0.80%
C_{11}		4.90%
C_{12}	0.02%	14.70%
C_{13}	23.70%	33.10%
C_{14}	52.50%	27.30%
C_{15}	22.40%	9.90%
C_{16}	1.20%	4.90%
C_{17}		2.50%
C_{18}		1.20%
C_{19}		0.40%
C_{20}		0.20%
C_{21}		0.10%

Note: Additional carbon chains identified in the analysis are attributed to the collection of emulsifier products from the mud system

Base Oil (as received)



Recovered Base Oil



Cuttings Handling

The bulk movement and handling of drilled cuttings on an offshore installation is a critical part of the overall process of drilled cuttings recycling and disposal.

A cuttings handling system that meets the demands of the industry must be capable of safely, effectively and efficiently moving cuttings in bulk directly from the shakers to any of the following:

- Thermal processing units on the rig
- Bulk tanks on the support vessel for inter-field transfer
- Cuttings reinjection systems

Apart from these application offshore the CCDS system can also be used for the bulk shipment of cuttings to shore based processing facilities and for the filling of skips on the rig.

The key components to this integrated system are a CT Unit and a CST Unit. The CT (cuttings transfer) unit is designed to pump the cuttings either to processing systems on the rig, to bulk tanks on a boat or, if processing and disposal is being carried out onshore, to skips. A CST (cuttings storage & transfer) unit is designed to provide both buffer storage on the rig and bulk transport of cuttings on a support vessel. Both the CST and CT units use the same direct displacement pump. These pumps can move cuttings, without any need for slurrification, at rates of up to 100 tonnes per hour along a five inch line over distances upto 300'.

If skips are being used to transport cuttings to shore either the CST or CT unit can be used to fill these skips on the rig at a pre-determined location, without the need for individual crane lifts. The filled bins can then be batch loaded onto the offshore vessel. This minimises handling, simplifies logistics while freeing up the rig crane for other operations.

If cuttings are to be transported to shore or transferred inter-field in bulk the CST units can be located on the offshore vessel to store the cuttings. The CST unit can, with a total capacity of 70

metric tonnes and its own self contained pump, on arrival at the quay or offshore installation, simply pump the cuttings to the relevant storage facilities quickly and efficiently.

The CCDS System was originally developed by Total Waste Management Alliance plc to move cuttings at their Peterhead cuttings processing facility. It has now been successfully modified to meet the greater demands associated with offshore based operations.

The objective to simplify logistics, minimise environmental impact, improve safety and reduce costs has been met.

Conclusion

With the trial period complete full commercial development is now underway and Total Waste Management Alliance is now able to provide this integrated handling and processing technology to the industry wherever required for operational and environmental reasons. The transportation of large volumes of cuttings to onshore processing facilities for ultimate disposal is no longer a necessity and the problem can now be dealt with at source, using environmentally sound technology, offshore.