NEW TECHNOLOGIES TO MEET NEW REGULATIONS

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Introduction

Environmental issues and standards have been developing globally for the last several years. This is especially true of regulations on the disposal of drill cuttings. Now new regulations all over the world sharply limit the disposal of these wastes. Old technologies cannot always meet modern environmental limits. Many times the approach to finding new treatment technologies for waste focus trying to adapt or improve old approaches rather than look for new solutions. This puts the focus on the technology and not the problem.

We at OIEnvironmental believe that one should start the treatment requirements and work back to a process that will provide the needed result. This approach has lead to the development of our new process for treating oily cuttings for separation of oil from them.

Cuttings Characteristics and Treatment Goals

Oily cuttings are a mixture of bits of earthen materials covered by an oil based mud. An oil based mud is an oil external emulsion in which the dispersed water phase contains dispersed solids. The oil phase itself might also contain dispersed solids. To dispose of this mixture into the sea or in a land disposal site the oil must be removed. The separation of the oil from the water and solids in the cuttings is then the goal of the cuttings treatment process.

Since the oil based mud is an emulsion it stabilized by strong surface active chemicals and physical forces designed to keep it from separating. Much of the oil present may also be adsorbed to solids. This means that the problem is not just one of separating the mixture but first of destroying the emulsion. The emulsion acts to both stabilize the emulsion but also to isolate the oil in the mud so that it is hard to get reactants to the oil in the first place and to collect the oil for removal in the second.

The characteristics of the cuttings then require that two functions are needed in order to achieve clean oil and clean solids and clean water. First the emulsion must be destabilized and the then the phases separated. Another important factor is that these two functions be done rapidly.

How the Process Works

Solutions to the problems identified above were considered and several individual processes were combined to do the job. These steps include:

- Using a strong surface active agent, pH control and heat to break the emulsion,
- Using a combination of chemical reaction and volatilization to either destroy the oil or vaporize it,
- Optimizing the reaction rate using an especially designed reactor to effect mixing and movement of cuttings through the process system,
- A chemical injection scheme that spreads the reactions and heat generation over the whole process,
- Recovery of oil and water by condensation, and
- Scrubbing of the non condensable vapors to remove reactants and other pollutants.

The equipment used in the process includes:

- Two reactors,
- Solids injection equipment for cuttings and solid reactant addition,
- Liquid injection equipment for addition of liquid reactants and water,
- Two heat exchangers for preheating air and condensing oil and water,
- A counter-current gas-liquid extractor for scrubbing waste gases from the vapor vent,
- A control system, and
- Various pumps and tanks.

Three chemicals and water are used in the actual separation process. Water is an essential ingredient in the reaction mixture. Since cuttings contain some water, the amount of water added is the difference between the ideal amount and the water content of the cuttings. The chemicals added are:

- Water
- OIN – 1 A strong surface acting agent (usually added into the water stream injected into the reactor),
- OIN – 7 A reagent used to adjust the pH and generate heat,
- OIN – 12 A reagent added to condition the clays in the cuttings, generate heat and neutralize OIN –7.

The first three are injected into Reactor 1 and the last one is injected Reactor 2.

The cuttings are metered into the first reactor along with water, OIN –1 and OIN –7. The reactor mixing system ensures thorough mixing and movement of the cuttings through the reactor. In this reactor a combination of surface active chemical, pH adjustment and heat break the emulsion into separate phases so that all phases are exposed to air. Oil and water are vaporized. The reaction mix passes from Reactor 1 into Reactor 2. Immediately the OIN –12 reactant is injected and mixed with the reaction mix. In reactor 2 more heat is generated and OIN –12 reacts with OIN –7 to produce a product that is a natural constituent of soils and sediments. Oil and water are also vaporized in this reactor.

The vapors produced in the reactors are not due to simple thermal desorption and work on an entirely different principle. While the reactions are going on a stream of air is drawn through the reactors sweeping the vapors from them. These vapors are passed through an air to vapor heat exchanger to preheat the air entering the reactors and to begin the oil and water recovery process. From the first exchanger the vapors pass into a water to vapor exchanger where cold water rapidly cools the vapors and completes the recovery of oil and water. The water recovered from the exchangers is re-cycled to the process and the oil is recovered for re-use or for sale.

The vapors pass from the exchangers pass into a counter-current scrubber where they are extracted with a water solution to absorb reactant vapors and carbon dioxide. The exhaust vapors are essentially air.

Process Controls

The process uses simple, practical observations for control. The injection rates for water and the chemicals determine the quality of the product cuttings. Initially the injection rates are set by determining the cuttings characteristics including:

- pH,
- Water content,
- Oil content, and
- Stability of the cuttings.

Using this information and chemical equivalents the initial injection rates are determined. Once in operation the appearance of the cuttings is a good indicator that the process is functioning properly and monitoring temperatures and making injection rate adjustments are used to control the process.

Process Advantages

The process has several advantages. It is vary fast with a total residence time in both reactors of about 80 seconds. Oily cuttings are injected into the reactors and 80 seconds later dry powdery inorganic materials come our of the Reactor 2 exit. This means that a fairly small unit can process a very large amount of cuttings per day.

The treated cuttings are composed of the earthen materials drilled up and some reaction products from the process that are common constituents of soils and sediments. The oil content of the treated cuttings is consistently below one percent. The oil is a usable product. For synthetic mud bases it may be possible to recycle it into the mud system on the drilling rig. Some oils undergo chemical reactions but oil formulations used to make muds could be modified to prevent this. The condensed water is essentially fresh water with a small amount of reactant vapor dissolved in it. It could be recycled to the treatment process which would reduce the net water requires for the process. The scrubber solution is a water solution of simple inorganic compounds and its volume for a tonne of cuttings treated is very small. There is negligible air pollution.

Unlike thermal desorption processes the processes does not contain a source of ignition.

Comparison to Other Cuttings Cleaning Processes

Compared to thermal desorption the OI process is much faster. With a residence time in the process of 80 seconds it is easily several factors faster than thermal desorption units. It also has a much higher capacity. The original concept unit could process 30 tonnes per hour. The pilot unit currently used for development work can process 2 tonnes per hour. A 10 tonne per hour unit is being engineered for use on North Sea rigs that is much smaller than the process equipment needed for cuttings re-injection. The OI process operates at much lower temperatures than thermal desorption units which means that there is less chance to oxidize the oil.

Compared to solvent extraction units it produces much less waste. Solvent wash units can end up with large volumes of liquid waste to dispose of. Washing with water containing detergents creates water emulsions that are very difficult to treat or dispose of. Solvent extractions can make a larger volume of liquid waste than you started with. Once the cuttings are clean then the solvent has to be removed.

Unique Features of the Process

There are three features of the process that work together to make it function effectively:

- Breaking the emulsion with chemicals, heat and pH control,
- Generation of heat chemically,
- The mechanical design of the reactors.

Breaking the emulsion allows access of the chemicals to all the phases of the emulsion. The chemicals now have ready access to the components of the cuttings. Generating heat chemically has two advantages:

- the heat is nearly instantaneous, and
- it is generated where it is needed and there is no wait on heat transfer.

The mechanical action of the reactors ensures that the contact between the reactants in maximized to speed up chemical reactions and phase changes.

Conclusions

The OI process meets the treatment criteria discussed above. The process is fast, efficient and returns products that can be safely used or disposed of.