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Remediating Fracking Drill Cuttings

Drill cuttings contain valuable liquid materials that can and should be recovered.

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Abstract

Drill cuttings are an ever increasing waste stream generated by the oil and gas industry. In an attempt to limit the adverse environmental impact caused by drilling fluids present in the drill cuttings, efforts are made worldwide to convert the drill cuttings to a non-hazardous material, which significantly eases the disposal process. At the same time, drilling requires large volumes of expensive drilling fluids. In light of the above, econ industries decided to test its well-proven indirect heated thermal desorption unit for recovering drilling fluids from drill cuttings. The process has been successfully used for the treatment of a variety of oil based wastes for many years. In the following study, laboratory and field tests applying the batchwise indirect heated vacuum thermal desorption process have been conducted. The TPH concentrations of the treated drill cuttings have been reduced from 12,000 ppm to below 250 ppm in the lab tests and from 300,000 ppm to 640 ppm in the field tests. It was also discovered that the recovered oil is comparable with the original drilling oil; hence, it can be reused for drilling activities. With an average energy consumption of 170 to 230 kWh/t, the system is around five times more energy efficient when compared with other thermal desorption systems. This combination of low energy consumption together with the recovery of the valuable drilling fluids

makes the process a first class and inexpensive alternative to existing treatment methods.

Introduction

A number of drill cutting treatment technologies are already in use. However, none of these provide completely satisfactory results.

1.) Rotary kiln

Rotary kilns have been used for many years for treating oil wastes and drill cuttings. However, in recent years their application has been viewed with increasing skepticism.

Rotary kilns operate with very low energy efficiency and require vast amounts of thermal energy, leading to high operational costs. Inevitably, rotary kiln units discharge high emissions. Environmental authorities worldwide no longer permit the use of this type of equipment. A further restriction is that rotary kilns can deal with only a maximum TPH content of around 3 percent. Therefore, input material with higher TPH contents often have to be mixed with inert material to reduce the caloric load. Again, such methods increase the energy consumption per ton of treated material. Especially when talking about wastes with varying consistencies, an exact adjustment of the caloric value of the input material is required but difficult to achieve. In the past, incorrect adjustment of caloric values as well as unsafe handling by the operating staff has resulted in serious fire outbreaks and damage.

2.) Hammer mills

Hammer mills are often used for the treatment of drill cuttings. However their applicability is restricted by the limited temperature of around 250°C since the desorption temperature is only achieved through friction within the mill. Here again, it must be considered that desorption of the contaminants takes place under atmospheric pressure. Due to the low temperature and the absence of any form of vacuum, this technology is not suitable for drill cuttings containing heavier oil fractions, as the resultant TPH contents present following the treatment are often too high. On the other hand, the wear of the hammers is significant and the related maintenance times, as well as wear part costs, are high.

3.) Bioremediation

A lot of research has been carried out looking at bioremediation as a treatment alternative for drill cuttings. Where only light fuel oils up to diesel fractions are present, this technology can work under favorable ambient conditions. However, due to the long time required for treatment, vast space requirements, and the very specific demands on the input material and climate conditions required, this methodology is seen as impracticable. In addition, the treatment targets are often not met.

4.) Liquid solid extraction

In the liquid solid extraction process, contaminants are extracted by process fluids from the solid matrix. Usually, detergents containing water are used as process fluid. For drill cuttings with high oil content, being bound firmly to the soil matrix, this technology faces many problems. One of the major disadvantages of this system is the large amount of expensive detergents required. As the detergents are usually hazardous to water they have to be separated, and a sophisticated waste water treatment system has to be employed. Besides this, the quality of the final treat material is often insufficient, especially for fine material containing heavy oil fractions.

Methods

1.) Indirect heated vacuum thermal desorption

For this study, tests have been conducted, using indirect heated vacuum thermal desorption technology. In this process heat and controlled vacuum are applied to evaporate substances having a boiling point of up to 450°C (under atmospheric pressure). Due to the vacuum, the boiling point for substances is considerably lower compared with atmospheric pressure. Due to the fact that the systems runs in a batch-wise process, each process can be fine tuned and is extremely flexible. This flexibility allows an adjustment and optimization of the batch process to suit the characteristics of each input material.

To heat the evaporator, temperature resistant synthetic oil is circulated inside the evaporator´s heating jacket and central shaft. The rotating shaft inside the still-standing cylindrical evaporator vessel ensures intensive mixing during the process, allowing a highly efficient heat transfer to the product and short, energy-saving batch times. Following the vaporization of water and hydrocarbons, the exhaust stream is led through a highly effective vapor filter unit to prevent dust from merging with the vapors. Specially designed heat exchangers separate the vaporized substances from the main vapor stream by condensation, using indirect cooling. For the individual recovery of valuable substances, gradual heating assures their defined separate evaporation and condensation.

2.) Laboratory tests

July 2006, laboratory tests were conducted using two types of North Sea drill cuttings. 100 l samples have been treated batch-wise at product temperatures up to 300°C and a pressure inside the vacuum desorber of down to 50 mbar (abs). The required retention time to achieve the result required by our client was 350 minutes.

3.) Field tests

A test with 100 tons of drill cuttings from German gas fields was successfully completed in August 2013. The plant used was a VacuDry 12,000 x 2 plant. This plant was originally designed for the treatment of grinding swarfs from the metal industry. Due to the extremely high level of torque from the auger, this plant is especially suitable for the treatment of pasty and sticky material, such as drill cuttings. Batches of 16 tons of drill cuttings have been treated in one 12,000 liter evaporator at product temperatures up to 250°C and a pressure below 50 mbar(abs).

Results

1.) Laboratory tests

During the test's two distinct main process phases, water evaporation and oil evaporation were observed as shown in Table 3. The following results achieved are shown in Table 4.

Both samples were processed for 350 minutes within the laboratory plant. However, the point when only negligible amounts of liquids were evaporated occurred much earlier: After 248 minutes for sample A and after 269 minutes for sample B. Therefore, shorter batch times are possible.

Field tests

Table 5 has the evaporation phases during the lab testing. The total petroleum hydrocarbons (TPH)-value (C10-C40) of the output material (DIN ISO 16703) was 640 mg/kg as a dry substance.

Discussion and Conclusion

The laboratory and the field tests demonstrated clearly that the vacuum process performed extremely well. Drill cuttings, with different oil and water content, can be treated in batch times of less than 5 hours, making the technology very economical. A final TPH content from the lab test below 250 ppm was well within the given limits. The 640 ppm is also satisfactory. The recovered oil is of high quality and can be reused for drilling applications.

However, there is still potential for additional improvements. During the lab analysis and the field test, the heating temperature was limited to 330°C and 270°C respectively. During the lab test, the heating temperature was limited due to technical reasons. In the field tests, the operators, unfamiliar with the new material, operated the plant far below its technical capabilities of 400°C heating temperature.

Therefore, by increasing the heating temperature to 400°C, the TPH-value of the output material will be significantly lowered, and the batch time will be considerably reduced.

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