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# Treatment of Drilling Wastes Using Thermal Desorption

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**ABSTRACT:** Drilling activities is associated with a lot of waste disposal especially drill cuttings. These cuttings and other wastes have detrimental effect on the environment and the ecosystem if disposed without treatment. There are specifications by regulatory bodies on discharge limit before disposal which most of the multinational rarely adhere to. This work will examine the feasibility of low-temperature thermal desorption processes for the treatment of drilling waste. A field drilling activity in the Niger Delta was obtained for samples of drilling waste. After the operation was carried out in the heat-desorption unit, reverse analyzes on the cuttings were conducted to assess the proportion of the oil content at 350 ° C and the oil percentages at 350 ° C were 0.2, 0.4, 0.8, 0.2 and 0.4 percent respectively for the five different samples used. The outcome achieved satisfies the statutory criteria of less than 1 percent by weight for oil cuttings (OOC) and reduces potential environmental liabilities. This research shows the productivity in the treatment of drilling wastes in thermal desorption minimizes and reduces its environmental effects.

**KEYWORDS:** Drill waste, Treated cuttings, Thermal desorption, Oil content, Oil percentage.

## I. INTRODUCTION

Exploring and processing of oil and gas is a big global operation, hence the environmental consequences (impact on the atmosphere, aquatic and terrestrial environment) must be reckoned with else we will continue to face even more problems than we have today.

In the past, the oil industry takes several measures to preserve the impacts on limits set by the regulatory authorities, but it is quite evident, particularly in a developing world like Nigeria, that something needs to be done.

Disposal of waste from the operations of these energy sectors includes numerous approaches including soil planting, pit disposal, drainage of slurry, waste landfilling, heat treatment, burning and evaporation, Ety (2011).

Onshore and offshore activities use a range of waste disposal approaches in accordance with environmental standards and guidance. The choices for discharge, underwater injection and shore transportation are restricted in the offshore sector.

Onshore alternatives to waste disposal include land processing, field irrigation, evaporation and burial site methods, and corresponding surface drilling, incinerations, replenishment, declines, recycling, etc.

Effective waste management was originally little oriented and generally the approach chosen was one that would be cheapest without taking care of the environment. But it's not in the early years now. Currently the environmental laws to regulate the excesses that operators may deal with have been set in effect.

Oil companies operating in Nigeria's Niger Delta are, in certain cases, necessary, as recommended and authorized by Petroleum Resources (DPR), Nigeria's regulatory agency for petroleum industries, to enforce good oil field disposal practices, UNDP 2006.

The treatment of drilling wastes involves using thermal desorption method among others. Thermal desorption is the separation and recovery process resulting in three stream: water, oil and solid. Thermal desorption method is safe, reliable and economical, Onwukwe (2014).

## II. RELATED WORK

Drilling waste is the mud and cuttings generated while drilling a well. Drilling waste is defined as any solid or liquid generated by the drilling process. It can range from dry solid to pure liquid. However, drilling wastes are usually a combination of solids and liquids and this makes their transportation a challenge

Drilling activities is a major operation in the upstream petroleum industry which impacts negatively on the environment as it generates significant amount of wastes. Environmentally, responsible actions requires an understanding, improved operations that minimize or eliminate any adverse environmental impact can be developed, Reis (1996).

The waste generated during any drilling operation includes drill cuttings, drill fluids, chemical additives, heavy metals as well as air pollutant.

The finding and production of petroleum involves the generation of drilling waste which forms a major source of pollution in oil producing environment. Almost every process in the finding and production of petroleum generates wastes which impacts the environment negatively.

Exploration and Production (E&P) wastes are introduced into the environment through accidental spills, leaks, blowouts and drilling operations, Sharif *et al* (2017). These wastes toxic chemicals pose significant risks to the environment, human health as well as wildlife. The potential for accidental or routine release of drilling wastes into the environment is alarming and thus threaten to sustain the industry operations. Many of the toxic chemicals associated with oil and gas drilling are known to accumulate and magnify in the food chain posing a risk to aquatic organisms higher in the food chain, such as fish and birds. From past safety records and statistics, the researcher identified that harmful environmental incidences will continue to take place, but the effects of these pollutants on human health and the environment can be minimized through proper environmental monitoring and mitigation measures; including the use of modern technological advances, Enty (2011).

Drilling waste and its treatment is an increasingly important part of any oil drilling operation, whether it is on land or off shore. These wastes, which typically include drill fluid cuttings and well bore clean-up fluid are hazardous and must be treated before disposal.

The adverse effects of the discharge from the petroleum (oil) prospecting are of great concern because of the effect or impact of drill cuttings (oil based, water based, and synthetic based mud) on the immediate environment.

Many of the materials and wastes associated with drilling activities have the potential to impact on the environment negatively. The potential impact depends primarily on the material, its concentration after release of the biotic community that is exposed. Some environmental risks may be significant while others are very low, Sharif *et al* (2017). The major impacts of great concerns are pollution of water bodies, pollution of land, as well as air pollution. Improper disposal of contaminated drill cuttings into the water bodies (ocean) exposes marine life to danger. Excessive release of air pollutants from internal combustion engines makes the air unsafe for both humans and animals and animals and some of their effects includes respirations, soil acidification. Release of hydrogen sulphide, of course, can be fatal to those exposed, Enty (2011).

Because the discharges of drilling waste impart primarily on the locals, rather than ecosystem wide, it can be anticipated that the bulk of adverse human health effects would take place in those areas nearest to the site of discharge. Localized impacts of drillings could led to the contamination of drinking water for human consumption or sport fish sources by a host of toxic chemicals. Furthermore accumulation of the chemicals within local food chains would occur with continuous discharge or occasional accidental release of toxic drilling muds. The chemicals of concern would accumulate in the food chain organisms and increase in concentration as they move up the food chain, essentially growing in toxicity. Exposure via drinking water or fish consumption would adversely impact population, even with low pollution levels in the exposure medium, Rana(2008).

Ingestion of contaminated food or water remain the primary threats to the general population. This could happen through accidental release; intentional release, either permitted or not permitted into the water body; or seepage from onshore storage areas into ground water, Enty(2011).

The effects on human health include changes in the levels of certain blood enzymes, effects on children's neurobehavioral development, negative impacts on central nervous system, brain and eyes and skin irritation. These include both non-carcinogenic and carcinogenic effects based on exposure to a particular chemical and direction and intensity of exposure, Rana (2008).

### III. METHODOLOGY

#### Materials

The following were the materials and equipment used;

Specimen (Drillingwaste), Sample cup, Condenser, Heating element,

Thermostat, Liquid receiver, Fine steel wool, Grease, Pipe cleaners, Spatula, Calculator, Record sheet, Metal cylinder, Scale, Timer, Retort machine.

### Procedure

The drill cuttings were placed in the treatment unit and heated. The drill cuttings were heated through a diesel-fire boiler in the treatment unit. A close loop mechanism regulates the flow rate and temperature of the hot fluid to avoid fluid breaking down. The hydrocarbon and water in the drill cuttings are evaporated from 80 to 280°C and are transferred from the inlet end to the processor outlet. The vapors emitted from the raw materials are then pulled by a vapor scrubber condensing the steam and mostly hydrocarbon. The condensed steam and hydrocarbon are then passed to the separator where the oil (base oil) and water are separated to their various tanks/reservoirs, (ref. Figure 1). The heated materials (now treated cuttings) moved from the heating unit to the thermal plant outlet where they are collected for retort analysis to ascertain the percentage of oil in the cuttings.

The principal aim of thermal desorption process is to heat the waste material to a specific temperature (or sequence of temperatures) in order to change the physical state of the volatile contaminants (i.e from liquid or solid to gas); vaporizing them from the material in order to facilitate their removal and subsequent recovery, while preventing their destruction.

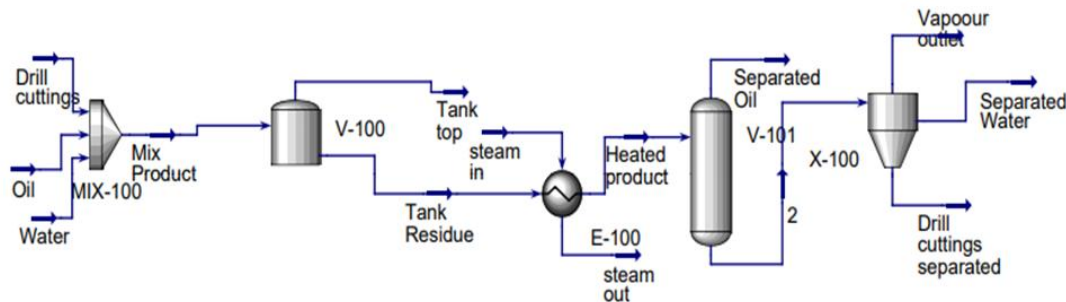


Figure 1. Process Flow Diagram of Drill Wastes Treatment Simulation.

## IV. EXPERIMENTAL RESULTS

Following the treatment process, samples were taken and a retort test study was conducted on the drill waste samples. Table 1. displayed findings in order to assess the final proportion of the oil in the treated cuttings for the retort analyses of the samples handled.

Following the testing of the retort, the amount of oil (%) in the samples were 0.2%, 0.4%, 0.8%, 0.2% and 0.4% for samples, A, B, C, D and E, respectively, values which are below the DPR criterion of < 1 which is not dangerous if disposed of to the environment.

This is aimed at minimizing any environmental risks.

Table 1. Results of Retort on Treated Cutting Samples

| S/N | Properties                 | Treated Drill Cuttings Samples |          |          |          |          |
|-----|----------------------------|--------------------------------|----------|----------|----------|----------|
|     |                            | Sample A                       | Sample B | Sample C | Sample D | Sample E |
| 1   | Full Retort                | 323.3g                         | 321.6g   | 361.8g   | 325.4g   | 325.7g   |
| 2   | Empty Retort               | 273.3g                         | 271.6g   | 311.8g   | 275.4g   | 275.7g   |
| 3   | Weight of material         | 50.0g                          | 50.0g    | 50.0g    | 50.0g    | 50.0g    |
| 4   | Weight of full Glass       | 24.8g                          | 29.2g    | 21.7g    | 20.3g    | 25.9g    |
| 5   | Weight of Empty Glass      | 19.9g                          | 19.2g    | 16.8g    | 16.2g    | 17.3g    |
| 6   | Weight of Oil + Water      | 4.9g                           | 10.0g    | 4.9g     | 4.1g     | 8.6g     |
| 7   | Weight of Water (ml x 1.0) | 4.8g                           | 9.8g     | 4.5g     | 4.0g     | 8.4g     |
| 8   | Weight of oil (6-7)        | 0.1g                           | 0.2g     | 0.4g     | 0.1g     | 0.2g     |
| 9   | Oil (8/3) x 100            | 0.2%                           | 0.4%     | 0.8%     | 0.2%     | 0.4%     |



|    |                     |      |       |      |      |       |
|----|---------------------|------|-------|------|------|-------|
| 10 | Water % (7/3) x 100 | 9.8% | 19.6% | 9.0% | 8.0% | 16.8% |
|----|---------------------|------|-------|------|------|-------|

Table 2. gives a description of the oil volume (percent) of all the various treatments.

**Table 2. Volume of Oil (%) in the Different Treated Cutting Samples**

| S/No | Samples | Vol. of Oil in Dry Ash sample (%) |
|------|---------|-----------------------------------|
| 1.   | A       | 0.2                               |
| 2.   | B       | 0.4                               |
| 3.   | C       | 0.8                               |
| 4.   | D       | 0.2                               |
| 5.   | E       | 0.4                               |

The oil (percent) in the treated cuttings samples after the retort test was carried out revealed that 0.2%, 0.4%, 0.8%, 0.2% and 0.4% for samples, A, B, C, D and E, respectively were obtained, and this achieves the aim to minimize any environmental risks in drilling waste disposals.

Treatment of the cuttings was carried out by means of a thermal desorption method that minimizes potential environmental risk, decreases land demand and lowers waste and recycles.

The process has contributed to the regeneration of base oil appropriate for reuse in the manufacture of fresh drilling fluid. In the samples processed, the oil content were below the 1% DPR criterion.

There are some potential uses for the extracted oil:

- Fluid basis for the formulation of a fresh fluid for heating, which decreases the expense of heating fluid about 35%.
- TDU burners petrol or other on-site processes
- Refined hydrocarbon goods feedstock
- The better content of the extracted oil is beneficial compared with its initial situation and thus retains its initial economic worth.

The treated cuttings are used in numerous applications, including:

- Landfill
- Mix with concrete or combined for construction
- As a shield for a wellness deposit

The water is reused to moisturize the clean solids processed in dry form to stop a dusting impact in the close-loop phase of washing skips.

## V. CONCLUSION

Treatment of drill waste is very significant because of the possible environmental and human health danger that they pose by extension. There have been different established forms of drill waste that have a harmful effect on the ecosystem,

these wastes include toxic compounds that must be sufficiently handled before disposing according to the DPR guidelines. Due to the hazardous nature of these wastes, thermal desorption process was used in the treatment of the drilling wastes. Thermal desorption is the application of heat to the drilling wastes materials to a specific temperature in order to change the physical state of the volatile contaminants thereby separating the various components of the drilling wastes (oil, water and solids residue).

The recovered water is used in moistening and cooling down the solids at the outlet end of the treatment unit to prevent dust effect.

The recovered oil (base oil) is taken to rig site or designated drilling fluid contractor for the makeup of new drilling fluid thereby reducing the cost of drilling fluid by about 35%. Also, the base oil is used as fuel for thermal desorption burners or other processes on site.

The solid residue (treated cuttings) are disposed off, mixed with concrete for construction or for re-filling of damage section of roads.

A test on the treated cuttings performed is to evaluate the percentage of oil in the cuttings. At the conclusion of the test, 0.2%, 0.4%, 0.8%, 0.2% and 0.4% for samples, A, B, C, D and E, respectively were obtained. This was less than the



DPR criterion of  $< 1\%$  which will not be environmentally damaging if the sample were disposed of and the goal of the treated cuttings is met.

This study demonstrates that thermal desorption method is the most efficient and environmentally suitable and the recovery and further recycling of the different elements, which prevent economic loss.

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