# Thermal Desorption Technique Applied In Treatment of Oil Drill Cutting

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## Abstract

This study investigated the effectiveness of treating drill cuttings using thermal desorption method. Components of drill cuttings and their proportions were determined before and after the treatment. The flow rate and its variation with temperature of the mill were monitored for five days to find out the efficiency of thermal desorption unit. The weight and relative percentage of each component and other laboratory tests such as Retort Analysis, Petroleum Hydrocarbon, pH, Temperature and Suspended Solid were carried out on each component (oil, water and solid). The results obtained show that the temperature decreased with increase in flow rate of drill cutting. The flow rate and temperature stabilized between the ranges of 20-40$m^3$/hr and 232-274$^oC$ respectively. Petroleum hydrocarbons, pH, temperature and suspended solids range from 0.10-0.35mg/l, 6.5-7.0, 30-40$^oC$ and 15-35mg/l in that order. These values were below World Health Organization (WHO) limit except for temperature which was slightly above the limit. The implication of this result is that most of the liquid content (base oil and water) were conserved and reused.

**KEYWORDS**- Oil treatment, drill cuttings, thermal desorption.

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## I. Introduction

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.

Drill cuttings may be contaminated in either water based mud (WBM) or oil based mud (OBM), and while it has become an accepted practice to treat the OBM cuttings, the treatment of WBM cuttings is becoming common in more sensitive environments. Well bore clean-up fluids are typically hydrocarbon contaminated and will also require the filtering of contaminants prior to disposal or reuse.

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. Crude oil operation requires the use of specific formulated fluid system often referred to as drilling mud. This fluid is used to lubricate the drilling bit and stem, transport formulated cuttings to the surface and seal off porous geologic formulations.

The management of drill cuttings involves using thermal desorption method among others. Thermal desorption is the separation and recovery process resulting in three stream; water, oil and solid. The heating volatilizes liquid and the vapour is cooled and separated into water-oil phases. The liquid phase can be recovered and made into a new drilling-fluid system or used as a fuel source, while the solids could be disposed of or reused. It is safe, reliable and economical.

A case study of thermal desorption procedure using a TCC-Rotomill cutting plant was undertaken in this study in Port Harcourt, Nigeria.

## II. Materials and Method

Samples of drill cuttings were collected from total waste management company. The drill cuttings samples were collected from two different mixing tank using auger and cups. In the pre-treatment stage, the weight and relative percentage of each component of oil, water and solids in the given material was determined. The treatment was done according to the procedure described by TWMMA (Total waste management alliance, 2008). In the process of treatment of drill cuttings, three distinct components were produced. Oil, water and solid (dry power).

### Laboratory Analysis

The following parameters were used to analyze the requirement for each component.

a) Recovered Oil: This was determined using retort analysis.
b) Recovered Solid (Dust or Soil): pH and PAHs (Polyaromatic Hydrocarbons) were determined using multi-probe meter.
c) Recovered Water: Temperature, pH, suspended solid and PAHs were determined also with a multi-probe meter.

| Raw Material Retort | Oil Retort |
|---|---|
| Oil (24%) | Oil (90%) |
| Water (33%) | Water (0%) |
| Solid (43%) | Solid (10%) |
| SG (1.81g) | |

Table 4: Mean value for the raw material retort and oil retort for day five

## III. Results and Discussion

### Results

Table 1 shows the drill cuttings retort (raw material) and its relative percentage

| Raw Material | Wt(g) | Oil (%) | Water (%) | Solid (%) | Total (%) |
|---|---|---|---|---|---|
| Sample A | 1.88 | 30 | 23 | 47 | 100 |
| Sample B | 1.98 | 27 | 24 | 49 | 100 |

Table 1: Drill Cutting Retort (Raw Material) and its Relative Percentage

Tables 2, 3 and 4 are mean values for the raw material retort and oil retort for 5 days while table 5 is the variation of mill temperature with flow rate.

| Day 1 | | Day 2 | |
|---|---|---|---|
| Raw Material Retort | Oil Retort | Raw Material Retort | Oil Retort |
| Oil (24%) | Oil (92%) | Oil (30%) | Oil (94%) |
| Water (25%) | Water (0%) | Water (24%) | Water (0%) |
| Solid (51%) | Solid (8%) | Solid (46%) | Solid (6%) |
| SG (1.82g) | | SG (1.88g) | |

Table 2: Mean values for the raw material retort and oil retort for days 1 and 2

| Day 3 | | Day 4 | |
|---|---|---|---|
| Raw Material Retort | Oil Retort | Raw Material Retort | Oil Retort |
| Oil (26%) | Oil (93%) | Oil (25%) | Oil (94%) |
| Water (24%) | | Water (20%) | Water (0%) |
| Solid (50%) | Water (0%) | Solid (55%) | Solid (6%) |
| SG (1.86g) | | SG (1.94g) | |

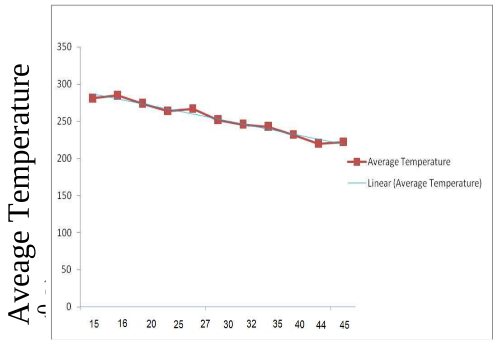
Table 3: Mean values for the raw material retort and oil retort for days 3 and 4

| **Day 5** | |
|---|---|
| Raw Material Retort | Oil Retort |
| Oil (24%) | Oil (90%) |
| Water (33%) | Water (0%) |
| Solid (43%) | Solid (10%) |
| SG (1.81g) | |

Table 4: Mean value for the raw material retort and oil retort for day five.

| Rate ($m^3/_{hr}$) | Frequency | Average Temperature($^oC$) |
|---|---|---|
| 15 | 2 | 281 |
| 16 | 1 | 285 |
| 20 | 6 | 274 |
| 25 | 8 | 264 |
| 27 | 5 | 267 |
| 30 | 7 | 252 |
| 32 | 1 | 246 |
| 35 | 6 | 243 |
| 40 | 6 | 232 |
| 44 | 1 | 220 |
| 45 | 2 | 222 |

Table 5: Variation of Mill Temperature with Flow Rate




Flow Rate ($m^3$/hr)

Fig. 1: Variation of Average Mill Temperature with Flow Rate.

| Recovered Oil | Oil | Water | Solid | Total |
|---|---|---|---|---|
| Sample | (%) | (%) | (%) | (%) |
| Sample A | 93 | 0 | 7 | 100 |
| Sample B | 95 | 0 | 5 | 100 |

Table 6: Recovered Oil Result

| Parameter | WHO Standard | Sample A | Sampl e B |
|---|---|---|---|
| pH | 6.5 – 8.5 | 6.9 | 6.7 |
| PAHs(mg) | 0.5 | 0.1 | 0.15 |

Table 7: Recovered Solid Result

| Parameter | WHO Standard | Sample A | Sample B |
|---|---|---|---|
| Temperature ($^oC$) | 20-30 | 33 | 39 |
| pH | 6.5-8.5 | 6.7 | 6.8 |
| Suspended Solid (Mg/L) | 50 | 17 | 23 |
| PAHs(mg) | 0.5 | 0.35 | 0.25 |

Table 8: Recovered Water Result

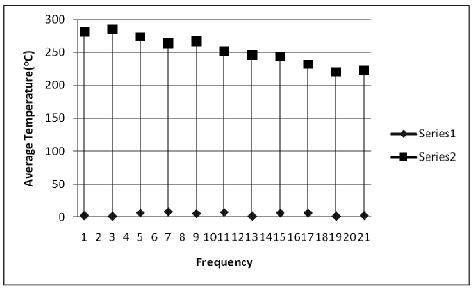



Fig. 2: Variation of Average Mill Temperature with Frequency.

## Discussion

### Drill Cuttings Retort Result Analysis

From the analysis of the two samples of drill cuttings used as raw material, the results (table 1) show that the drill cuttings were heavy and good for treatment in the thermal desorption unit plant and the cuttings would regulate the mill temperature, and also conserve the oil and water produced from being destroyed by excessive heat.

### Variation of Mill Temperature with Flow Rate

The variation of mill temperature with flow rate was monitored for five days, and the findings used for correlation test which resulted as minus one (-1). Thus there is a perfect negative correlation indicating that temperature decreases with increase in the volume of the drill cutting. This was demonstrated in fig. 1 which shows negative linear correlation. The clustering of the points around the straight line in fig. 1 indicates that there is a strong linear correlation which means that the dependent variable (temperature) decreases as the independent variable (volume) increases which is good for drill cuttings treatment. It was deduced from table 6 that temperature stabilized with the flow rate between the ranges 20-40$m^3$/hr thereby conserving more of the liquid content of drill cuttings.

### Recovered Oil

The result (table 6) shows that there is no water content in the recovered oil. The suspended solid and hydrocarbon level were minute and are below discharge limits. The oil recovered by the process is unaffected by the thermal desorption because of relatively low temperature used in the process, and are free from any odour and can be recycled back into the drilling mud system or used as fuel for thermal desorption engine or resold for other purposes. The superior quality of the recovered oil compares favourably to its original state and therefore holds its original economic value.

### Recovered Solid (Dust)

The pH and PAH content determined from the produced solids (dust) (table 7) shows that the values of these parameters were small and below the WHO discharge limit. So the inert solid phase can be used in industry as filler or bulking agent and can be used for concrete work.

### Recovered Water

The result of recovered water analysis (table 8) indicate that the pH, PAHs and suspended solids are minute and below WHO standard. The temperature is slightly above the standard but still appropriate and could be discharged and re-used.

## IV. Conclusion

Treatment of drill cuttings is very important because of the potential threat it poses to the environment and human health by extension. This waste contains some hazardous substances which if not properly treated and disposed of will cause serious harm in the environment.

There are many methods of treating drill cuttings, but thermal desorption method has shown comparative advantage over others. This is demonstrated in its ability to conserve base liquid contents especially the base oil which has high economic value.

This research further shows that the method is most effective, economical and environmentally friendly. The recovery of the products and subsequent recycling and selling help reduce stress on the environment and avoidable economic loss.

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