Global Scientific JOURNALS

GSJ: Volume 6, Issue 12, December 2018, Online: ISSN 2320-9186
www.globalscientificjournal.com

# CHARACTERIZATION OF DEAD CRUDE OIL FROM NGAMIA REGION TURKANA COUNTY, KENYA

Otieno Judith Peres [1*], Daniel Oyoo Okanga'[2]and Robert Bichanga'[1]

[1]Department of Chemistry, Kenyatta University- Kenya

[2]Department of Petroleum Engineering, Kenyatta University- Kenya

[*] Correspondence: E mail judeeperezz@gmail.com

ABSTRACT

Petroleum is the major source of energy exploited worldwide. It is literarily known as 'black Gold' because of its scarcity on earth and the economic importance attached to oil and gas exploitation. Crude oil is evaluated by the physicochemical analysis of its constituents. This study investigated the chemical properties of Ngamia oil field in Turkana County, Kenya. The crude oil samples were collected from the Ngamia oil field (Ngamia well sites nos. 3, 6 and 8) and analyzed for pH, moisture contents (MC), total acid number (TAN), sulphur contents and concentration of mineral salts (metals). The results show that the mean levels of Ngamia crude obtained during the study were: Moisture content 0.70 ± 0.17 %, Sulphur content 0.0924 ± 0.0022 %, total acid number 0.66 ± 0.39 Mg, KOH, pH 7.33± 0.45 and that of the metal ion concentrations for the presence of Zn, Cu, Pb, Mn, Cd, Fe, Na, K and Ca ions were Zn(8.90 ±1.03) $\mu gg^{-1}$, Cu(25.28±3.99) $\mu gg^{-1}$, Fe(12.91±1.63) $\mu gg^{-1}$ and Mn(8.10±1.84). The mean concentrations for Sodium, Calcium and Potassium were (70.50±2.52), (1983±2.58) and (22.0±3.57) respectively. The concentration levels of both Cadmium and Lead were below the detection limit. In conclusion, the Ngamia oil was found to be weakly acidic with low moisture content % (0.70± 0.17) and is free from high heavy metal ion concentrations.

**Keywords:** Crude oil; Moisture content; Petroleum; Sulphur content; Total acid

## 1. Introduction

Petroleum is a naturally occurring mixture, consisting predominantly of hydrocarbons and non hydrocarbons which may exist in the solid, liquid or gaseous states depending upon the conditions of pressure and temperature to which it is subjected [1]**.** Dead crude oil is oil that has been produced and stored over a long period of time [2]. All petroleum is produced from the earth in either liquid (crude oil) or gaseous (natural gas) depending upon the state of the hydrocarbon mixture [2]. It consists of volatile, light colored liquids to dark, viscous tar with low vapor pressure usually found in reservoirs or wells [3]. Crude oil is generally classified by the characterization of its physicochemical parameters. This characterization influences its quality, grading and also provides the basis for its economic valuation.

Crude oil characterization is also useful for the determination of specifications for transportation, storage and handling, assessment of optimum drilling conditions as well as assessing its potential as a source of environmental contaminants.

Crude oil source and in particular the geological formation of source rocks influence the quality of the oil [4]. Rajum Veil and Loui Clerk (2013) [5], in their study of Nigerian Delta crude oil, reported that crude oils studied from different geological reservoirs differ in their physicochemical characterizations and hence quality.

Petroleum occurs in liquid phase as crude oil and in gaseous phase as natural gas. The phase is dependent on the kind of the source rock from which petroleum was formed and the physical thermal environment in which it exists. Most petroleum reservoirs occur at varying depths below the ground surface i.e. at depths of not less than 20,000 feet (6500m) while natural gas is found both at shallow depths and at depths exceeding 30,000 feet. In some cases, crude oil may seep to the surface forming massive deposits of oil or tar sands. Most petroleum is found in sedimentary basins in sedimentary rocks [2]. Man's quest for petroleum began in the 1850's as an alternative to whale oil as an illuminant in lamps. Since then, man has continued to use this natural resource for both domestic and commercial use [4].

There are two geological theories that seek to explain the origin of petroleum (American Petroleum Institute, 2011). According to the biogenic theory, the origin of crude oil dates back to millions of years ago when small animals and plants died and settled at the bottom of the sea [3]. Their remains were covered by mud which eventually turned into rock. The rocks exerted pressure on the remains of the dead plants and animals and consequently the rocks around heated them up transforming them into dead petroleum. The impermeable rocks did not allow oil to pass through and was instead trapped underneath. It is in these impermeable rocks that the oil can be drilled today. This process leads to the formation of dead petroleum. The non biogenic theory emphasizes the formation based on non biological processes.

In this study, the chemical properties of Ngamia oil were characterized and the results obtained compared against the API limits. Results indicated that all the levels of the chemical parameters determined lie within the accepted limits.

## 2. Materials and Methods

### 2.1 Materials

Crude oil samples were obtained from the wells 3, 6 and 8 within Ngamia region Turkana County. Samples were collected from all the zones within the storage tanks from each of the wells (3, 6, and 8). Top surface sampling and downward sampling was used to obtain a homogeneous sample for analysis. Samples from the three wells were then blended in a uniform ratio to obtain a composite which was used for analysis. Sample collection was within block 10BB Tullow operating Block Ngamia cluster 13T and 10 BA – Ngamia region. All sampling bottles were rinsed properly with distilled water and air-dried. All samples were taken not more than two months after drilling from the production reservoirs and stored in amber glass bottles (Pyrex) of 500 ml capacity with well stoppered lids as per the sampling procedures. The samples were then transferred to the laboratory and kept at room temperature. The samples were prepared by warming in a water bath maintained at a temperature of 45.0 $^oC$.

## 2.2 Methods

### 2.2.1 Moisture Content (MC)

The moisture content was determined in accordance with the ASTM 4928-89 (2011) standard. In this regard, the standard Karl Fischer reagents were used for the determination of moisture content in crude oil samples. The titrant consisted of 50 ml of crude petroleum oil mixed and homogenized with 25.0 $cm^3$ of 2 % butanol, 10 ml of aqueous sodium hydroxide, sulphur (IV) Oxide and a known concentration of Iodine with Pyridine used as the base. The end point was detected by monitoring the color change in pure Iodine solution. The moisture content was obtained as a percentage of the actual crude sample tested.

### 2.2.2 pH Assessment

The moisture content was determined in accordance with the (ASTM D 7946) (2011) standard. The pH of petroleum was determined using an analytical pH meter model 350 UK Jenava. 10.0 g of crude petroleum oil sample was taken and dissolved in 75.0 ml of carbon free distilled water in a 250 ml beaker then thoroughly stirred and its pH recorded at 25.0 ºC. Four replicate readings were taken and averaged for this determination.



### 2.2.3 Sulphur Contents

The Sulphur content was determined in accordance with the ASTM D-4294) (2011) standard. 50.0 ml of petroleum sample was shaken with 0.1 M standard Sodium Plumbite solution, about three (3.0 grams) of powdered sulphur was added and the mixture shaken. The presence of Mercaptan sulphur or Hydrogen sulphide or both is a positive test (turns red) for the presence of sulphur. The sulphur content was obtained as a percentage of the actual crude sample tested.

### 2.2.4 Acid Number

This determination was performed as per the procedure described in (ASTM D 665) (2011) where 0.5 grams of the crude petroleum oil sample was weighed accurately and placed in a conical flask. 10 ml of propan -2- ol was added and 2 drops of P- naphtha benzene indicator was added and stirred using a glass rod. The resulting solution was titrated with 0.1 M, Potassium Hydroxide until a dark brown color was achieved. This was done in three replicates and the average volume recorded. The blank solution was titrated and the volume recorded.

### 2.2.5 Metal Ion Concentration

Analytical tests were performed for the determination of metal ion concentrations in accordance with the accepted International American Standard Test Methods (ASTM). 10.0 grams of petroleum was weighed in a porcelain crucible and heated on a hot plate at 130.0 $^oC$ in the hood for 4-5 hours. Sulphuric (VI) acid was added (1-3 ml) to dissolve organic matter and charring done at a constant temperature of 180.0 $^oC$. The samples were then placed in a muffle furnace (Model Kamp SG 46- UK) for 6 hours for ashing to take place. Commercial standards of the respective metal ions were used in 1000 ppm. Heavy metals in petroleum such as Copper, Lead, Zinc, Iron, Manganese and Cadmium were then determined using Atomic Absorption Spectrophotometer (AAS) - (Model Shimadzu AA-6200) Japan which uses single element hollow cathode lamp for all the elements. Potassium, Sodium and Magnesium ions were determined using a flame photometer.

## 4. Results and Discussions

The Chemical properties of the samples were determined routinely at a room temperature of 29 $^oC$ and the results measured against the American Petroleum Institute (API) Standards presented. The results of the chemical parameters were determined and recorded in Table 1.

Table 1: Chemical Properties of Ngamia Crude Oil

| Chemical Property | pH | Sulphur | Moisture Contents % | Free Acidity |
|---|---|---|---|---|
| Mean ±SD | 7.33 ±0.45 | 0.0924 ± 0.0022 | 0.70 ± 0.17 | 0.66 ±0.39 |
| Min-Max | 6.72 - 7.76 | 0.0897 – 0.0948 | 0.54 – 0.70 | 0.59 – 0.63 |
| API Limits | 5 -7.0 | +0.5 % Sour<br>- 0.5 % Sweet | 0.02 - 55.0 % | 1.0 mg KOH/g |
| n =1 | | | | |

The mean and standard deviations of sulphur in Ngamia oil lie within the accepted limits (less than 0.5) hence categorized as sweet. This is an indicator that the oil will have low sulphur induced corrosion when utilized. The presence of sulphur can also be attributed to the presence of the Mercaptans or Hydrogen Sulphides in the underlying geological source rocks. Similar results were obtained by [7] Fan Haijun and Li yajun (2014) in their study of the characterization of West Punjab crude oils. The means and standard deviations of moisture content in the Ngamia crude was reported within the accepted limits 0.70 ± 0.17. This is typical of dead waxy crudes. The levels of free acidity and API gravity indicate the oil is less acidic. This is likely attributed to the use of chemical additives in very low quantities to improve on the flow characteristics of the oil while on transit.

Table 2: Concentration of Metal Ions of Ngamia Crude Oil

| | Concentrations (μg $g^{-1}$) | |
|---|---|---|
| Ngamia crude | Mean ± SD | Min – Max |
| Sodium | 70.50 ± 2.52 | 68 - 74 |
| Calcium | 1983 ± 2.58 | 1979.0 – 1980.2 |
| Potassium | 22.0 ± 3.57 | 18 -26 |
| n =1 | | |



| | Concentrations (μg $g^{-1}$) | |
|---|---|---|
| Ngamia crude | Mean ± SD | Min – Max |
| Copper (Cu) | 25.28 ± 3.99 | 20.63 – 28.77 |
| Iron (Fe) | 12.91 ± 1.63 | 10.63 – 14.31 |
| Zinc (Zn) | 8.90 ± 1.03 | 7.88 – 10.34 |
| Manganese(Mn) | 8.10 ± 1.84 | 6.38 – 10.60 |
| Cadmium (Cd) | ND | ND |
| Lead (Pb) | ND | ND |
| n = 1 | | |

ND - Not Detected

The concentration levels of both Cadmium and Lead were not detected as they were reported below the detection limits. Calcium reported the highest levels ranging from 1979.0 – 1980.2 with a mean and standard deviation of 1983 ± 2.58. This is likely attributed to its presence in the geological source rocks. The mean concentrations levels of Copper, Iron, Zinc, Manganese and Cadmium were all detected within the accepted limits.

## 4. Conclusions

Based on the objectives of this study, the following conclusions can be reached:

1. The chemical property the levels of all metal ions in Ngamia oil lie within the accepted limits. Concentrations of Pb and Cd ions were below the detection limits with pH levels within IP limits.

2. The percentage moisture contents of the crude lie within the accepted limits. Low acid values indicate it will not influence the choice of catalysts (refinery) or be a source of environmental contaminant.

4. Ngamia crude is classified as sweet as the Sulphur content < 0.5; hence low sulphur induced corrosion. Results indicate Ngamia oil meets the accepted IP limits and can be classified as **Light Sweet- waxy crude.**

## 6. References

[1]. Eneh, O. C. (2011). A Review on Petroleum: Source, Uses, Processing, Products and the Environment. *Journal of Applied Sciences* **13**: 84–191.

[2]. Wang, T., Geng, A., Li, X., Wang, H., Wang, Z., & Qiufen, L. (2011). A Prediction Model of Oil Cracked Gas Resources and Its Application in the Gas Pools of Feixianguan Formation in NE Sichuan Basin, SW China. *Journal of Geological Research* **14**: 45– 65.

[3]. Jun Xu, Xingyu Z, Jie Sun, Li Li, and Xuhong Guo (2009). How comb-type poly (maleic acid alkylamide-co-α-olefin) assembles in waxy oils and improves flowing ability. *Journal of applied sciences* **4:** 57-89.

[4].Carey Hardaway, Joseph Sneddon & James N. Beck (2010). The determination of metal concentrations in crude oil by Atomic Spectroscopy. *International scholarly Research paper* **3:** 34-50.

[5]. Pei, G., Wang, C., & Liu, L. (2014). Experimental Study on the Cause of Inorganic Scale Formation in the Water Injection Pipeline of Tarim Oilfield. *Journal of Chemistry* **16**: 65-89.

[6]. Onojake, M. C., Osuji, L. C., & Oforka, N. C. (2013). Preliminary hydrocarbon analysis of crude oils from Umutu/ Bomu fields, south west Niger Delta Nigeria. *Nigerian Journal of Petroleum* ***22**:* 217–2

[7]. Fan Haijun and Li yajun (2014).Principles and Methods of Reservoir Engineering 3rd edition. Yuang Press, China pp 34-56.