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Laboratory Investigation of API gravity, Basic Sediment, and Water Content in Niger-Delta Crude Oil

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In this research, the characteristics of crude oil from two distinct oil fields in the Niger Delta were compared. Nigeria's Niger-Delta is a rich source of crude oil, but it consists unwanted contaminants such as basic sediments & water that cannot be avoided in the petroleum sector. The BS&W standard for the shipment of crude oil to a pipeline company is one %. Prior to actually sales, the physical and chemical properties of these crude oils must be addressed in attempt to reach standards. Comprehensive review of the physicochemical characteristics properties of various oil oils from Niger Delta oil wells (Ogbele and Kokori oil fields, respectively) shows the following BS&W (percent) values for un -treated and dry crude to be 34 percent and 44 percent, respectively in comparison to un - treated crude oil and ^{o}API 34.97 and 35.87 at 53°F respectively.Treated crude oil has a BS&W of < 1 percent. The above physical and chemical properties were determined using Standard test method and ^{0}API. the importance of crude oil's physicochemical parameters cannot be overstated in chemical engineering analysis, shipping, transportation, optimizing, storage, as well as the pricing of crude oil at the point - of - sale.

Keyword: Crude Oil, Treated, Untreated ASTM, BS&W, ^{O}API, Physiochemical Properties, Oil Field, Standards.

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1. INTRODUCTION:

Hydrocarbons is among the world's most influential energy sources today. Overpopulation and technological advancement have led to a rise in crude oil consump- tion. Here are several explanations for the beginnings of Nigeria's petroleum. However, it is impossible to determine the precise origin because it is impossible to pinpoint the precise location or materials from which a particular accumulation originated. The main emphasis is on the extraction and utilization of the natural resource. In addition, the existence of silt as well as water in crude oil samples, as well as the forming of emulsions, is extremely alarming (23). The Niger Delta is situated along the Guinean continental margin in southern Nigeria. It is also one of the most renowned petroleum deltas in the entire globe. With 2,2 percent of the globe's discovered oil, it became listed as the 12th world's wealthiest petroleum province [18]. Although a growing number of petroleum oil fields produce both petroleum oil and water at present. The co-production of water and crude oil can lead to emulsification. At the well head. choke as well as valve, there's really significant volatility, which leads to the formation of water-in-oil emulsion. [15]

API GRAVITY: It compares the relative density of oils at a specified temperature of 60^{o}F. Petroleum products are affirmed in terms of their relative density relative to water. Because oil is typically less dense than water, its relative density is defined by a number below 1.0. It is determined by the following formulas: The light oil has an API greater than 31,1, the medium oil has an API between 23,3 and 31,1, and the heavy oil has an API less

than 23.2. The light weight the crude oil, the greater its API gravity and, consequently, its price. Measuring instruments are frequently employed to measure the density, relative density, and API gravity of petroleum oil (3, 1). Trying to find the relative density as well as determining the degree of API gravity are the two means of obtaining API gravity.- Employ a hydrometer that is directly optimised with the oAPI gravity scale. The gains and losses in cost for each barrel will be multiplied by the overall number of bbl in the run or batch when there is a mistake in gravity (2).

Basic Sediment and Water (BS & W): It is a technical standard of certain contaminants retrieved from an oilfield along with crude oil. From the reservoir formation, crude oil always contains a good amount of salt, water, as well as fine particles (13). The particles are also referred to as dirt or sediment. The water content varies considerably from location to location and may be abundant. These fundamental sediments consist of silts, mud, sand, scale, and dissolved solids precipitate. It varies considerably between producing fields and zones. During the processing of raw oil, an emulsification of oil and water would also form. Since crude oil cannot be obtained without debris, emulsion, and water, it is needed to ascertain the BS&W of crude prior to actually treating to identify the type of emulsion-breaking chemical to also use, and then after treating to determine if the oil meets the sales requirements or standards. On a volume basis of 42 gallons (1 barrel) at a reference temperature of 60oF and <1.0 BS&W, crude oil is bought and sold (12).

BS&W in oil can result in the mentioned negative outcomes:

I. Deterioration of refining apparatus
II. sand clogging a pipeline, resulting in a flow blockage
III. Pipeline radius reductions caused by deposits of sediments or scales
IV. Over flowing of treatment vessels due to sand and sediment buildup
V. Imbalanced heat distribution on the heating surface consequently as a result of sand and sediment deposits
VI. Shipment of emulsified petroleum incurs expensive transportation costs.

All measured physical and chemical variables are indicative of dry oil due to the low water composition of the treated crude oil. Low water content decreases growth of microorganisms, deposits, and high-temperature corrosion, and improves oil quality there by making the BS&W of the crude oil meets sales specifications. A reduction in debris and water results in increase in fuels energy production. Because of this, the Basic sediment and level should not exceed 1 percent; if it ever does, often these oil vendors will modify the cost of bunkered fuel to make up the difference. Specific gravities quantify the quality of the oil as well as identify the presence of light or heavy molecular weight hydrocarbons. Low specific gravity corresponds to light oil (17)

Procedure: Crude oil is a complex combination of carbon and hydrogen-based chemical components. Its composition and qualities vary widely, and this is true not only of crude oil from various fields but also of oil wells. There are numerous contaminants linked with hydrocarbons, including silt and water. The quantity of water and sediments, as well as the API gravity of petroleum, must be determined daily and monthly. The material used for analysis was gathered from various locations, which are Ogbele field is located south of Rumuchakara, Portharcourt ,Rivers State, , and Kokori field is located in Ethiope East Local Government Area ,Delta state. The sampling was conducted according to ASTM standards (1,2,3,4,5,6).

Description OF Testing Method: Here, a sample of raw, unprocessed crude oil is gathered and placed in an electric shaker to obtain a homogenous solution. After shaking the sample, 50ml of xylene is added to a l00ml centrifuge tube containing 50ml of crude oil. It is sealed up and continued shaking is performed to obtain a uniform solution. The sample is submerged in a 60°C 3°C water bath and centrifuged. After spinning, the volume of the higher-density water and sediment phase is observed and measured at the tube's base. Apparatus: Electric trembler. Electrically powered centrifuge with a water bath 100, 2 liter rubber centrifuge tubes, a thermometer, and a tube holder. Reagents. Solvent devoid of suspended bubbles in xylene. Demulsifier, Tetrolite, 5 drops, to facilitate the separation of silt from sample water (1,2,4).

As shown in the table below, the procedure was repeated til 2 sequential reliable readings were obtained.

Table 1: UNTREATED CRUDE OIL SAMPLE -OGBELE OIL FIELD

Fresh Crude Oil sample (ml)	Fraction of sediment (ml)	Fraction of water (ml)	Fraction of BS&W (ml)	% Water	% sediment	%Dry Crude Oil	% BS&W
100.0	10.0	24.0	34.0	10	24	66	34

Basic Sediment and Water (BS&W) in Crude Oil by Centrifuge Method:

The assessment was carried out for both the fresh crude oil (raw crude oil) as well as treated crude oil (dry crude for export), to evaluate the % of BS&W in the samples.Below is The mathematical expression for each fraction (1):

Total volume of crude sample = l00M

% of water $= \frac{fraction\ of\ water}{total\ volume\ of\ crude\ oil} \times \frac{100}{1}$ ----------1

Fraction of Petroleum = total volume of Petroleum oil – BS&W ----------2

percentage of dry crude oil= $\frac{fraction\ of\ crude\ oil}{total\ volume\ of\ crude\ oil} \times \frac{100}{1}$ ----------3

percentage of BS&W = $\frac{fraction\ of\ BS\&W}{100} \times 100$ ----------4

Table 2: UNTREATED CRUDE OIL SAMPLE – KOKORI OIL FIELD

Fresh Crude Oil sample (ml)	Fraction of sediment (ml)	Fraction of water (ml)	Fraction of BS&W (Ml)	% Water	% sediment	%Dry Crude Oil	% BS&W
100.0	15.0	29.0	44.0	29	15	56	44

BASIC SEDIMENT & WATER (BS&W) Assessment IN TREATED CRUDE OIL:

This test was done on treated crude oil after it had been treated. The processing of a crude sample that has been treated using standard method was carried out. The BS&W test is used to ensure that the oil being processed complies with API pipeline specifications. Petroleum Measurement Specifications Manual (API 2011). (1,3,5)The purpose is to evaluate a sample of treated petroleum oil's basic sediment & water (BS&W).

3.3.1 **Standard Test DESCRIPTION:**

A sample of processed crude oil is obtained and put in an electric shaker to obtain a homogeneous mixture. Following the agitation of the specimen, 50ml of xylene is added to a l00ml centrifuge tube holding 50ml of crude oil. To achieve a homogeneous mixing, it's also closed and agitated. It is spun after being soaked in a 60°C 3°C water bath. Following centrifugation, the volume of water with a greater specific gravity as well as the sediment layer are examined and quantified at the tube's bottom. (1,7) The following table summarizes the findings:

Table 3.TREATED -OGBELE OIL FIELD SAMPLE –

Dry Crude Oil sample (ml)	Fraction of sediment (ml)	Fraction of water (ml)	Fraction of BS&W (ML)	% Water	% sediment	%Dry Crude Oil	% BS&W
100.0	0.25	0.75	1.0	0.75	0.25	99	1.0

Table 4. TREATED CRUDE OIL SAMPLE – KOKORI OIL FIELD

Dry Crude Oil sample (ml)	Fraction of sediment (ml)	Fraction of water (ml)	Fraction of BS&W (ML)	% Water	% sediment	%Dry Crude Oil	% BS&W
100.0	0.3	0.6	0.9	0.6	0.3	99.1	0.9

3.4 **Crude Oil Api Gravity Assessment**: The conversion of measured volume to a volume at the standard temperature of 60°F requires accurate estimation of API gravity of crude oil. It is a factor that determines crude quality and serves as a foundation for economic transactions. It also gives an idea of the oil's burning characteristics (1). AIM: To determine crude oil weights (gravity) (treated crude.)

Test Method Summary: A sample of dry crude oil was taken. The specimens were placed in a jar with a hydrometer. Using a thermometer and a hydrometer, the temperature of the sample and its associated relative density were determined. The API gravity was computed and adjusted to the API specification of 15 degrees Celsius (60 degrees Fahrenheit) (1, 3,5).

3.4.1 API GRAVITY OF CRUDE OIL BY HYDROMETER METHOD – OGBELE OIL FIELD – TREATED CRUDE OIL

Temperature of crude = 53°F, Hydrometer reading = 0. 85
The mathematical expression to convent relative density to °API is given as:

$$\text{°API gravity} = \frac{141.5}{Relative\ density} - \frac{131.5}{1}$$

$$\text{°API gravity} = \frac{141.5}{0.85}$$

= 166.47 – 131.5`= 34.97
Observed API gravity of 34.97° at 53°F and corrected to API standard of 15°C (60°F)
= 35.6° API (A Light oil)
The need of upholding crude oil standards such as API gravity as well as BS&W in crude oil is critical in the oil business. Tables 1 and 2 reveal a high percentage of BS&W (34 percent and 44 percent, respectively) in fresh crude oil for the Qua Iboe and Nembe Oil fields, in comparison to dry crude oil (66 percent and 56 percent, respectively). The BS&W is higher than the 0.5 percent criteria for crude oil shipment to a pipeline company for custodian transfer to refineries.

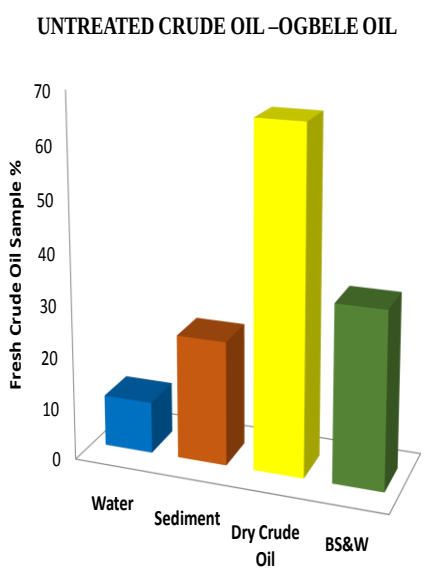

FIG 1. UNTREATED CRUDE OIL SAMPLE -OGBELE OIL FIELD

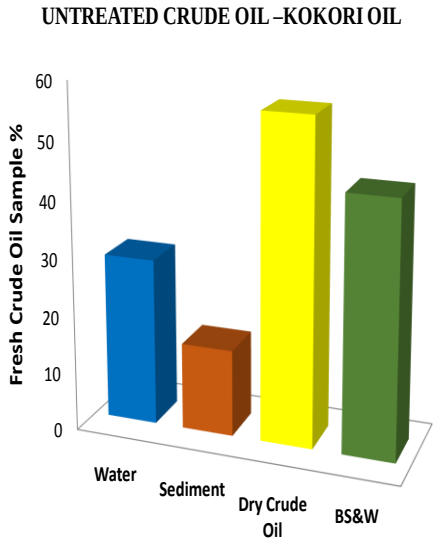

FIG 2: UNTREATED CRUDE OIL SAMPLE –KOKORI OIL FIELD

Tables 3 and 4 illustrate that treated crude oil has a low BS&W of 1% in comparison to dry crude oil, which has a BS&W of 99.0%. The BS&W criterion is met, resulting in decreased lifting costs and a greater profit at the wellhead for the oil producing business. It will also lessen the need for refmery processing. The study will also assist the chemical engineer in deciding the type of emulsion breaking reagent to be used in the processing of the crude oil in order to achieve the specified requirements (16,17). Both the Ogbele Oil field and the Kokori Oil field's API gravity for processed dry crude oil was analyzed and found to be 34.97 and 35.87 °API at 53°F, respectively. The API gravity increases as the relative density decreases. The temperatures are adjusted to the API specification of 15°C (60°F), which corresponds to a light oil. The incapacity of the producing company to effectively assess relative density and rectify the API gravity to the API benchmark of 60°F (150°C) will result in a reduced price at the well head (24).

The reason for this is that crude oil prices are typically expressed in degrees API. As a result, a gravity miscalculation means that the price gain or loss for each barrel is multiplied by the actual number of barrels in the run or batch. Obviously, this may be a hefty sum of money. It's also been discovered that processed crude has a low BS&W and a high API gravity, both of which are important in crude oil handling (21,20).
The impacts of sediments are the most noticeable on the production tubing's inside walls. When scale forms on the walls of the tubing, the inner diameter of the tubing reduces. This effect affects production rate and, if not examined on a regular basis, might result in a major restriction in crude flow from the well head. Sediments settle in separators and storage tanks, resulting in inaccurate measurements and readings if not examined (22).

Crude Oil's Economic Importance: Crude oil products are extremely important to the global economy. Its applications include fuel, building heating, lubricants, and energy generation. It is used as a raw ingredient or feedstock in the petrochemical sector for polymers, polyurethane, chemicals, cosmetics, and textile materials, among other things.

2. CONCLUSION:

Based on the findings of this study, it is clear that sediment and water are unavoidable in the oil sector. Before treating crude oil to satisfy the specification, the current BS&W is necessary, and failure to meet the requirement would result in significant losses. Before shipment, the API gravity of the crude is critical since it helps to prevent volumetric shrinkage and is used by the crude oil dealer to assess the value of the crude. Knowing the content of a contract's specification helps the engineer optimize revenue, save expenses, and meet agreed-upon specifications while remaining on stream.

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