iJRASET
International Journal For Research in Applied Science and Engineering Technology

INTERNATIONAL JOURNAL FOR RESEARCH

IN APPLIED SCIENCE & ENGINEERING TECHNOLOGY

Volume: 11 **Issue:** IV **Month of publication:** April 2023

DOI: https://doi.org/10.22214/ijraset.2023.49930

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International Journal for Research in Applied Science & Engineering Technology (IJRASET)
ISSN: 2321-9653; IC Value: 45.98; SJ Impact Factor: 7.538
Volume 11 Issue IV Apr 2023- Available at www.ijraset.com

Physico-Chemical Studies on Crude Oil of Western Onshore

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Abstract: ***Crude oil is a complex mixture of hydrocarbons with non-metallic elements such as sulphur, nitrogen, oxygen, and other elements. Hydrocarbons are chemicals that are mostly composed of the elements carbon and hydrogen. Crude oil comprises a variety of hydrocarbon molecules that fall into three categories: alkane, cycloalkane, and aromatic. Crude oil is distinguished by a number of chemical and physical features that play an essential role in the oil industry. These qualities are critical in making decisions in the exploration and production of crude oil. Characteristics like density, specific gravity, API gravity, water content, and sulphur content, to name a few, contribute value to the price of crude before it is transported to markets and refineries, so controlling these parameters significantly saves damage to infrastructure like pipelines and refineries. As a result, the study of physical and chemical properties becomes crucial for the petroleum industry. The current work deals with the investigation of physico-chemical characteristics of crude oil of Western onshore.***
Keywords: Crude oil, Physico-chemical analysis, Petroleum, Pour point, oil and gas

I. INTRODUCTION

Petroleum is a fossil fuel, which means it was formed through the decomposition of organic materials from animals and plants. It's made up of the remains of microscopic sea plants and animals that perished millions of years ago. It is a naturally produced liquid that can be processed into fuel and is located beneath the earth's surface. Petroleum is primarily made up of gas and crude oil (liquid). Petroleum is made up primarily of crude oil. It is defined as a complex mixture of hydrocarbons with non-metallic components such as sulphur, oxygen, and nitrogen, as well as metal traces (Vanadium, Nickel etc.). Crude oil is used in practically every aspect of human life. It must be transformed before it may be used This transition is dependent on the chemical and physical properties of the substance.

Their qualities are critical for engineers in several sectors during their manufacturing (upstream), transportation (midstream), and refinement (downstream). Furthermore, depending on the kind, depth, and location of the underground deposit as well as the geology of the area, these properties vary from one field to the next. Indeed, while crude oil's general elementary composition is largely constant, the chemical and physical structures of its parts vary greatly. The analytical examination of crude oil's physico-chemical characteristics is critical from this standpoint.

As a result, following characteristics: The density, specific gravity, API gravity, water content, viscosity, pour point, cloud point, flash point, fire point all factors are taken into consideration. Wax content, Asphaltene, Paraffinic content, Aromatic are some of the physico-chemical characteristics.

II. MATERIALS AND METHODS

The crude oil utilised was obtained from a single oil field. It was collected from oil field of Western onshore region.

A. Water Content Determination

The crude oil's water content is the first and most critical metric. This allows us to estimate the quantity of water present in oil and, as a result, whether or not to dehydrate the crude. Crude oil must be dry in order to conduct tests on qualities such as density. The water content in crude oil is checked by Dean and Stark apparatus. If more water is present then demulsification of the crude oil has to be done in order to get dry crude oil. 50 ml of crude oil is taken along with Toluene solvent and it is allowed to reflux. The water present in the crude oil will be collected in the trap along with solvent in the form of azeotropic mixture. Further the water content is calculated.

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B. Density and API Gravity Determination

1) *Density:* The crude oil mixture is homogenised at 65°C. The contents of the beaker transferred into the 500ml measuring cylinder after removing the sample from the water bath. The hydrometer is dipped into the oil in the measurement cylinder. At the same time, the density and the temperature of the oil is checked. The density obtained at the temperature was converted to the density at 15°C ambient temperature using the Oil Density Table.
2) *Specific Gravity Determination:* For the determination of Specific Gravity (SG), we used the formula: SG = Density of Crude oil at 15°C / Density of water at 15°C
3) *°API Gravity Determination:* For °API Gravity we used API gravity formula by knowing Specific gravity. API Gravity = (141.5 / Specific Gravity at 15°C) – 131.5

C. Pour Point Determination

To obtain a representative sample, oil is heated in a water bath at 60°C. The pour point tube is filled up till mark closed with the cork assorted with thermometer. The tube is set aside to cool to ambient temperature (45°C). The tube is placed in the Pour point equipment for cooling process and is checked at interval of every 3°C for Pour point. Pour point is the minimum temperature at which oil is in flowable condition. Above this temperature oil ceases to flow.

Figure 1 : (a) Water content determination with Dean and Stark apparatus (b) Density determination with hydrometer (c) Pour point apparatus (d) Pour point determination

D. ASTM Distillation of Crude Oil

Heat the oil until it is completely homogeneous. The specified sample (50ml) is measured in the measuring cylinder, filled in the flask with a piece of porcelaine to prevent bombing, and corked with a thermometer (300°C) put on the flask's neck. The flask is then placed on the asbestos board and secured with a cork to the metal condenser. The flask is supported adequately by raising or lowering the asbestos board. To collect the droplet from the condenser, a measuring cylinder is put below the condenser outlet. The heater is then turned on, and the head is adjusted to ensure that the distillation process is uniform. Initial Boiling Point is defined as the temperature at which the first drop of distillate is captured in the measuring cylinder (IBP). The volume of IBP derived from the distillate is set aside. Each time the temperature reaches 25°C, the amount of distillate collected in the measuring cylinder is measured and set away until the temperature reaches 210°C. The amount of sample that remains in the flask after 210°C is referred to as residue.

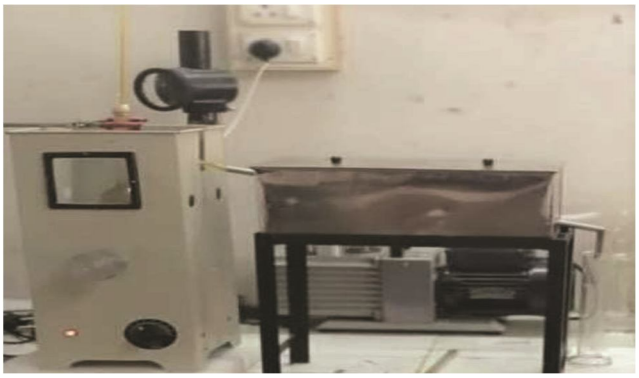

Figure 2: ASTM Distillation

E. SARA (Saturated Aromatic Resin and Asphaltene) Analysis

In the round bottom flask, put 1.5gm of 210°C oil residue and 60ml of hexane. To aid asphaltene precipitation, reflux it for about 2 hours and keep it in the dark (overnight). Divide the maltene in two parts. Take one part and continue the procedure. Filter the precipitated asphaltene with Whattman no 41-filter paper. Maltene is the name of the filtrate (used later for Aromatic and Wax determination). Reflux the asphaltene-containing filter paper (wash) with 40ml of hexane. Thimble refers to the filter paper that comes into touch with the asphaltene. In the Soxhlet device, the filter paper (thimble) is washed in hot toluene (25ml). To obtain asphaltene, evaporate the solvent (100mL toluene) via distillation. Filter 50ml of Maltene through the heated silica. Using hexane, wash the filtrate until it is colourless. To precipitate wax, mix the filtrate with acetone and keep it overnight in deep freezer for wax precipitation.

Take the other part of maltene and it is subjected to column chromatography for determination of Saturates, Aromatics and Resins. For Saturates, Petroleum ether is used as solvent for elution. For Aromatics and Resins, Toluene and Methanol are taken respectively.

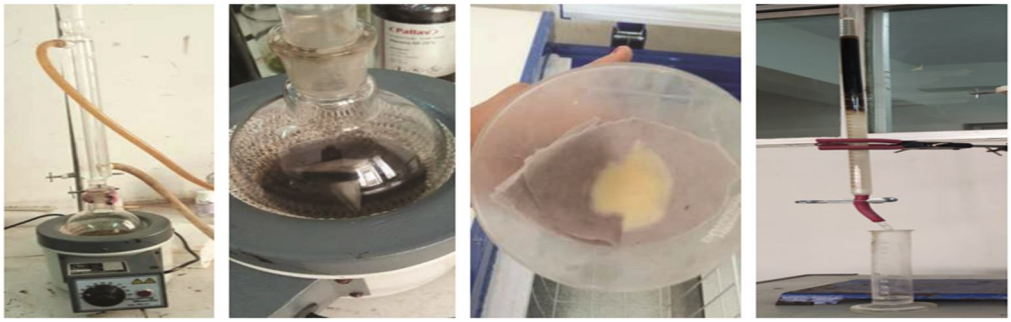

Figure 3: (a) Refluxing in hexane (b) Thimble washing for asphaltene determination (c) Wax determination (d) SARA Analysis through Column chromatography

F. Melting and Congealing Point of Wax

The melting point of wax is the temperature at which liquefaction will be detected. Allow the Thiele tube to cool after that. The temperature at which wax begins to solidify is known as the congealing point.

G. Flash Point & Fire Point

Flash point and Fire point are determined by Pensky Marten apparatus. Flash point is determined experimentally by heating the liquid in a container cup of apparatus and then introducing a small flame just above the liquid surface the temperature at which there is a flash /ignition is recorded as the flash point. The minimum temperature at which a liquid gives off vapor with a test vessel in sufficient concentration to form an ignitable mixture with the air near the surface of the liquid. The fire point of a fuel is the lowest temperature at which the vapour of that fuel will continue to burn for at least second after ignition by an open flame of standard dimension

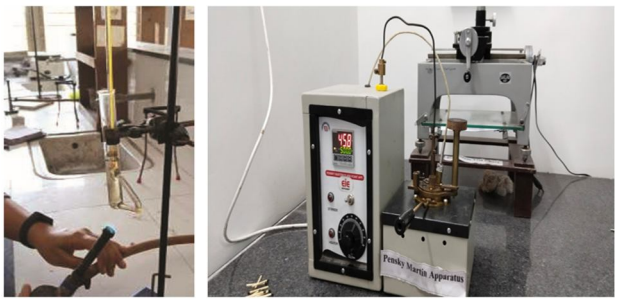

Figure 4: (a) Melting point and Congealing point of wax (b) Pensky- Martin apparatus

III. RESULTS

Table 1: Results of physico-chemical analysis of crude oil

S.N	Parameters	Results	Explanation
1	Water Content	0.2%	Crude contains a trace of water.
2	Density	0.8611kg/cm^3 at 15°C	Density low, means light oil.
3	Specific Gravity	0.8618	light crude oil
4	°API Gravity	32.69	°A high API gravity in conjunction with a low density indicates light crude oil.
5	Pour point	18°C	Crude oil ceases to flow below the Pour point.
6	Asphaltene content	0.54%	-
7	Saturates	37.45%	-
8	Aromatics	29.25%	-
9	Resins	32.76%	-
10	Wax content	2.5%	Waxy oil.
11	Melting point	54°C	-
12	Congealing point	50°C	-
13	Flash point & Fire point	50°C & 55 °C	-

IV. CONCLUSIONS

In the petroleum industry, the physicochemical properties of crude oil are critical. The examination of its parameter's aids decision-making. Water content, density, API Gravity, pour point, distillation, Asphaltene, and Wax content were among the parameters investigated. The water content of the crude oil is 0.2%. The Pour point of crude oil is 18ºC. The Wax content of the crude oil is 2.5%. The Saturates, Aromatics, Resins and Asphaltene content is 37.45%, 29.25%, 32.76 and 0.54% respectively. The crude oil under investigation is waxy in nature, with a trace of water. The physico-chemical characteristics of crude oil are even more vital at the upstream, midstream, and downstream levels because their knowledge aids in transportation, processing, specification, and even the sale of oil. These criteria also allow for a better understanding of crude oil during transportation and refining.

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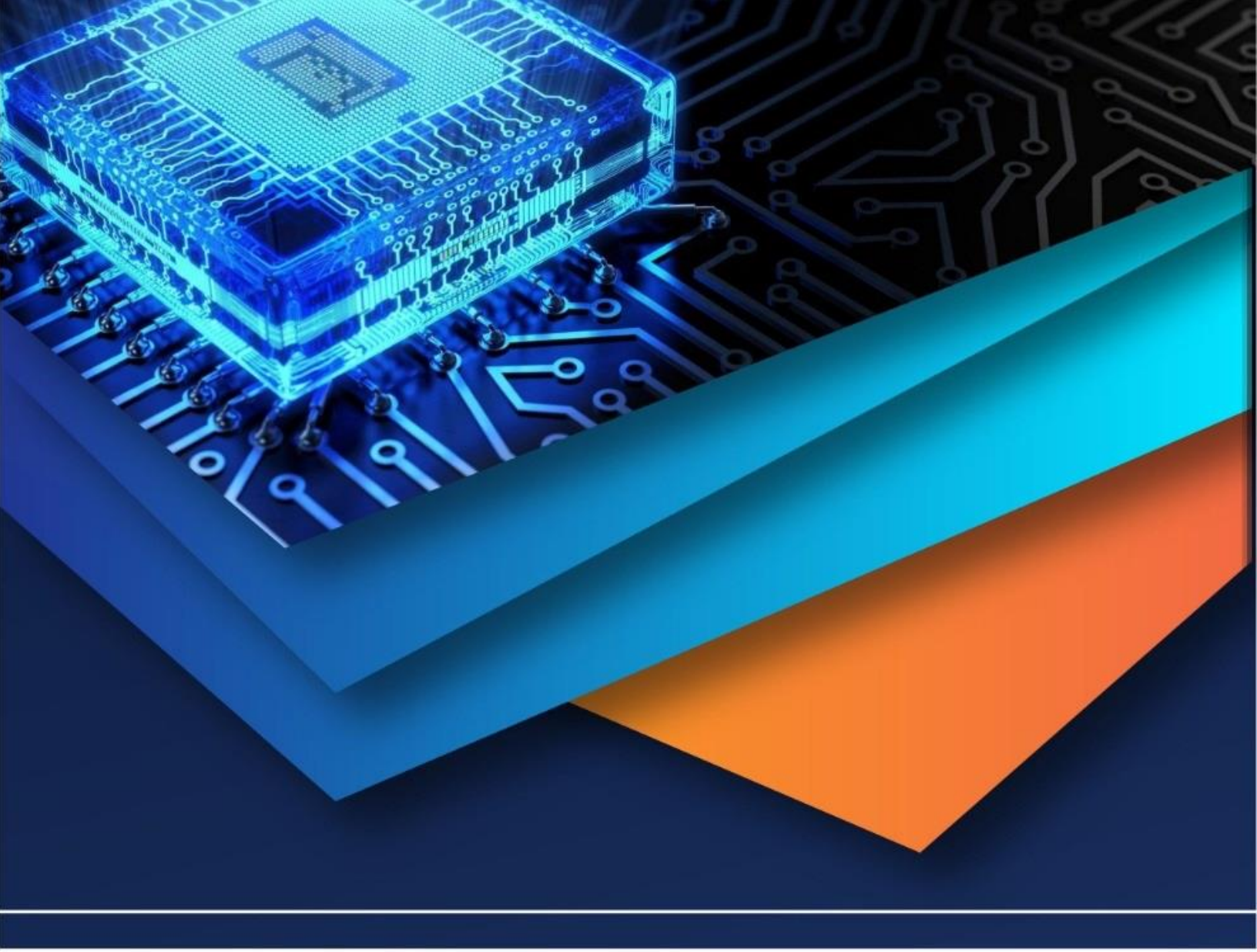

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