# Pressure Volume Temperature Evaluation of Sapele Field, Niger Delta, Southern Nigeria

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Sapele field is a large, brown field with complex subsurface structure that has led to heavy compartmentalization of its reservoirs which has also resulted to low reservoir pressure in some parts of the field leading to low production output. Reservoirs were delineated at various depth, some at near surface area (Benin formation) while others at greater depth (Agbada formation), hence the field was further subdivided into two (Sapele Shallow and Sapele Deep) due to its structural complexity. Pressure Volume Temperature (PVT) laboratory analysis on different wells was available for this study and the viscosity of the reservoir fluid was measured using an Electromagnetic Viscometer (EMV) at reservoir temperatures of 129 $^0$F and 207 $^0$F. These data were used in determining hydrocarbon chemical composition, its viscosity, specific gravity, density, and American Petroleum Institute (API) unit. Sapele Shallow reservoir is made up of heavy oil as its hydrocarbon content as a result of biodegradation process in which micro-organisms degrade the light hydrocarbons due to the shallow nature of the reservoir in the field, making it rich in heavy molecular weight hydrocarbon compounds. While Sapele Deep is made up of heavily compartmentalized reservoirs with gas and light oil as its hydrocarbon content. Hence the field requires different exploitation and production approach to fully annex its reservoir hydrocarbon content.

**Keywords:** Pressure Volume Temperature (PVT), Electromagnetic Viscometer (EMV), viscosity, specific gravity, compartmentalization, biodegradation

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## INTRODUCTION

The oil and gas industry is a technology-driven industry, our ability to locate and extract hydrocarbons from beneath the ground surface is tied directly to the evolution of technologies, concepts, and interpretative sciences (Schlumberger, 2009). These technologies are seismic-based methods for imaging features beneath the ground's surface, advances in well logging techniques, improvements in the ability to drill in deep water beyond the continental shelf, the advent of horizontal drilling, micropaleontology, biostratigraphy, pressure volume temperature determination and so on (Airen & Mujakperuo, 2023). Hydrocarbon chemical composition study has evolved over the past decades from a simple engineering evaluation to multidisciplinary teams of geologists, geophysicists, petrophysicists, and petroleum engineers working together. The integration of these various disciplines has changed our perception of the characteristics of oil and gas reservoirs. Whereas it used to be commonly perceived that hydrocarbon were relatively simple chemical components, the reality is that they are quite complex, and they can be subdivided into light and heavy hydrocarbons on the basis of several chemical components and features (Mujakperuo & Airen, 2024).

The physical and chemical properties of hydrocarbon in the Niger Delta are extremely unpredictable and the hydrocarbon within the Niger Delta has a gravity range of 16-50° API, with the lighter oils having a greenish brown colour (Whiteman, 1982). However, heavy oils are formed because of biodegradation and usually occur in giant shallow formations in marginal geological basins formed by non-consolidated sand (Santos et al., 2014), and microbial degradation reaches optimal temperatures below 80ºC, promoting oil oxidation, reduction of the gas/oil ratio (GOR), and reduction of API value (Head *et al*., 2003).

Sapele field is an onshore field of OML 41, located in the Northwestern part (Greater Ughelli depobelt) of the Niger Delta oil province (Figures 1 and 2). It lies within Latitude 50 53' 54.43" N and Longitude 50 33' 42.22" E.

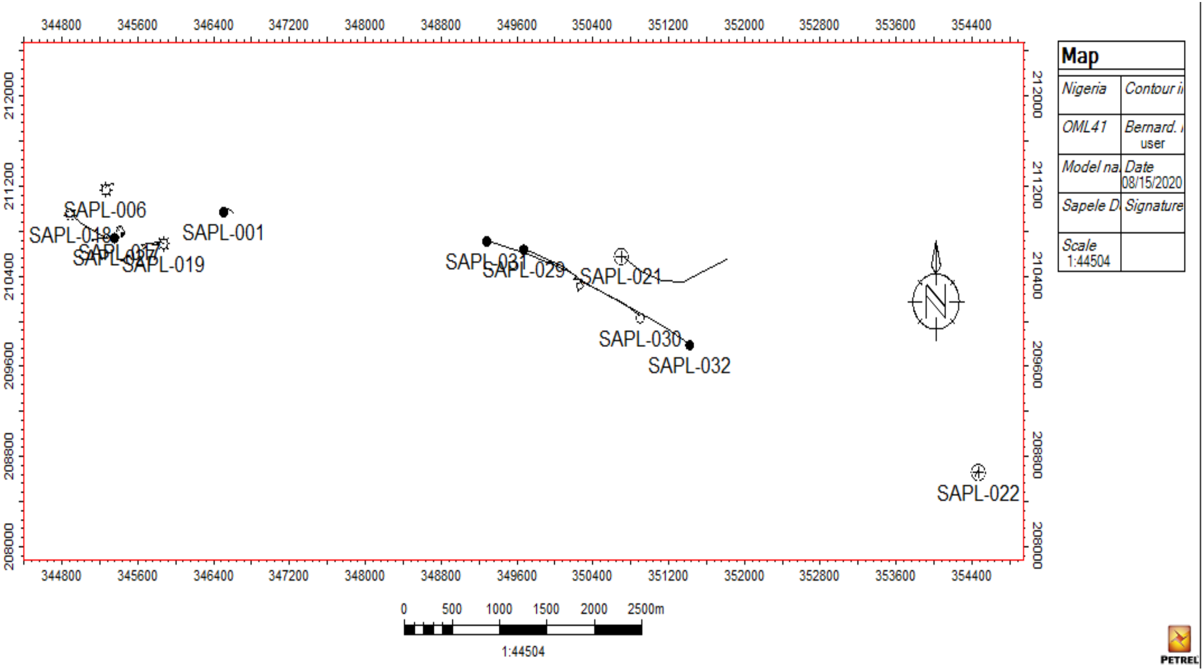


**Figure 1: Base map of oil wells in the study area (Using Petrel®2016)**

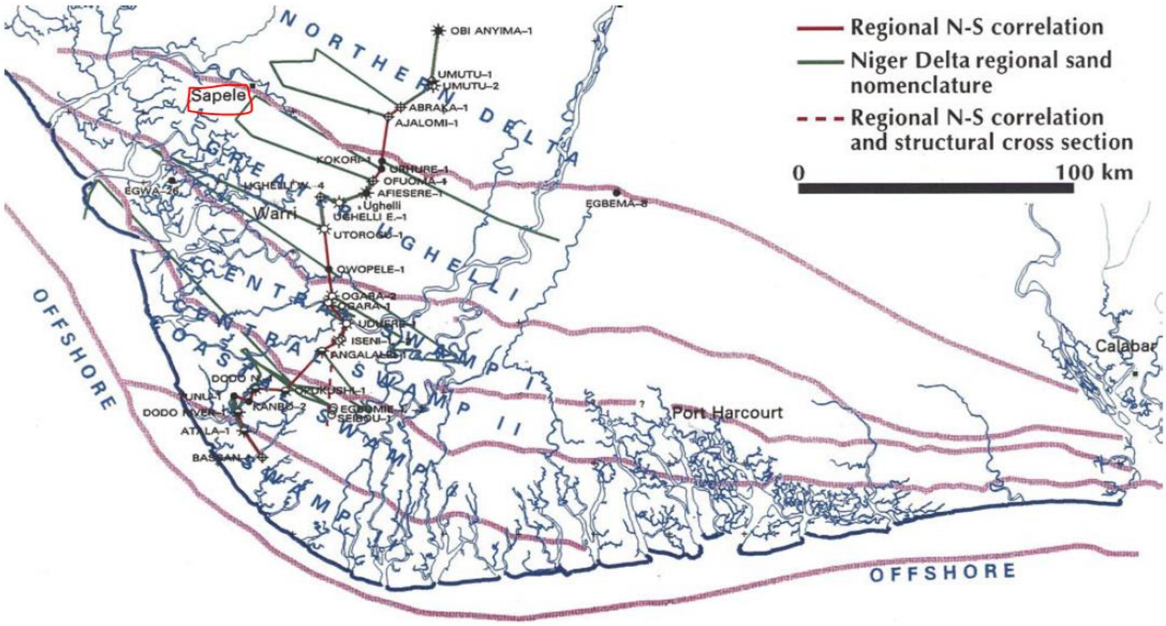


**Figure 2: Niger Delta Depobelts, Showing the Study Area (**Reijers, 2011).

Santos *et al.* (2012) undertook an overview of heavy oil properties and its recovery and transportation method using Pressure Volume Temperature (PVT) data. They established that heavy oils are formed because of biodegradation and usually occur in giant shallow formations in marginal geological basins formed by non-consolidated sand.

Head *et al.* (2003) carried out a study on biological activity in the deep subsurface and the origin of heavy oil. They established that microbial degradation reaches optimal temperatures below $80^0$C, promoting oil oxidation, reduction of the gas/oil ratio (GOR), and reduction of API value. Whiteman (1982) established that the physical and chemical properties of oil in the Niger Delta are extremely unpredictable. He established that the oil within the Niger Delta has a gravity range of 16-50° API, with the lighter oils having a greenish brown colour. While Thomas, 1995 stated that 56% of Niger Delta oils have an API gravity between 30° and 40°, and that oils with less than 25° API account for only 15% of the Niger Delta reserves.

Ologe *et al.* (2013) delineated the complexity of faulted subsurface structural features and retaining capacity of the reservoir for hydrocarbon in a 3D seismic structural analysis of part of Aloo-Field, Southwestern Niger Delta. The 3D seismic data was analysed, using Petrel software where horizons and fault interpretations from the seismic section were used to generate structural maps which revealed different structural styles present in the studied area. They mapped three distinct horizons. Depth structural maps generated for all surfaces of interest show subsurface features such as the geometry of the identified horizons, W-E trending growth fault and fault strata of which most of them dip to the east and fault assisted closures at the north-western-central part of the studied section. The dipping pattern of the identified faults coincides with that of the growth fault which enhances trapping mechanism for the hydrocarbon. Two principal structural trapping mechanisms presents are growth fault and rollover anticline which are synonymous with Niger Delta. According to them, the study demonstrated the importance of seismic structural interpretation in understanding the structural styles present and their retentive ability for hydrocarbon.

Soronnadi *et al*. (2013) undertook a palaeoenvironmental and sequence stratigraphic study of the D7000 sand 'Erne' field of the Niger Delta using integrated core samples, biostratigraphic data and wireline logs analyses of the D7000 sand. The environments of deposition were established as marine to estuarine settings which revealed that a period of regression was followed by a transgressive phase. Core analysis revealed the existence of ten lithofacies, which were grouped into facies association in a vertical sequence with genetic significance using primary structures and shape of wireline logs.

## MATERIALS AND METHODS

### Pressure Volume Temperature (PVT) Data

PVT laboratory analysis by Schlumberger on well 06 (1975), well 17 (1978), well 18 (1989), well 19 (1989), well 23 (1989), well 27 (2014), well 29 (2015) and well 30 (2015) were available for this study and these data were useful in determining hydrocarbon chemical composition, its viscosity, specific gravity, density, and API unit.

The bottomhole samples were restored and homogenized at specified respective reservoir temperatures provided by Seplat Petroleum Development Company PLC. Following sample conditioning, the bottomhole samples were subjected to heat cycling at elevated temperatures and pressures above specified reservoir conditions of temperature and pressure to help break down water/emulsion in the samples. Once the samples got cleared of water/emulsion, they were stabilized at the specified respective reservoir temperatures and at 3515 Psi. The Constant Composition Expansion (CCE) experiment were performed by transferring a sub-sample of reservoir fluid into the PVT cell at reservoir temperatures of 129°F and $207^0$F, and suitable working pressure (3517 Psi).

The viscosity of the reservoir fluid was measured using an Electromagnetic Viscometer (EMV) at reservoir temperatures of $129^0$F and $207^0$F. The pressure of the reservoir fluid is reduced in the single-phase region and the viscosity measured at predetermined steps. The pressure of the reservoir fluid is then reduced to a predetermined pressure below saturation pressure, the evolved gas removed, and the viscosity of the equilibrated oil measured (Schlumberger, 1989). This process is repeated by use of a Solid Detection System (SDS) as shown in Figure 3 at selected pressure until atmospheric pressure is reached. Reservoir fluid density were measured at a suitable working pressure and calculated at other single-phase pressures using the measured relative volume. A controlled atmospheric flash was conducted on the various samples, the gas-liquid ratio was measured and both flashed gas and flashed liquid were collected for further compositional analysis. These subsamples were analysed using Gas Chromatograph to obtain chemical compositions of the reservoir fluids.

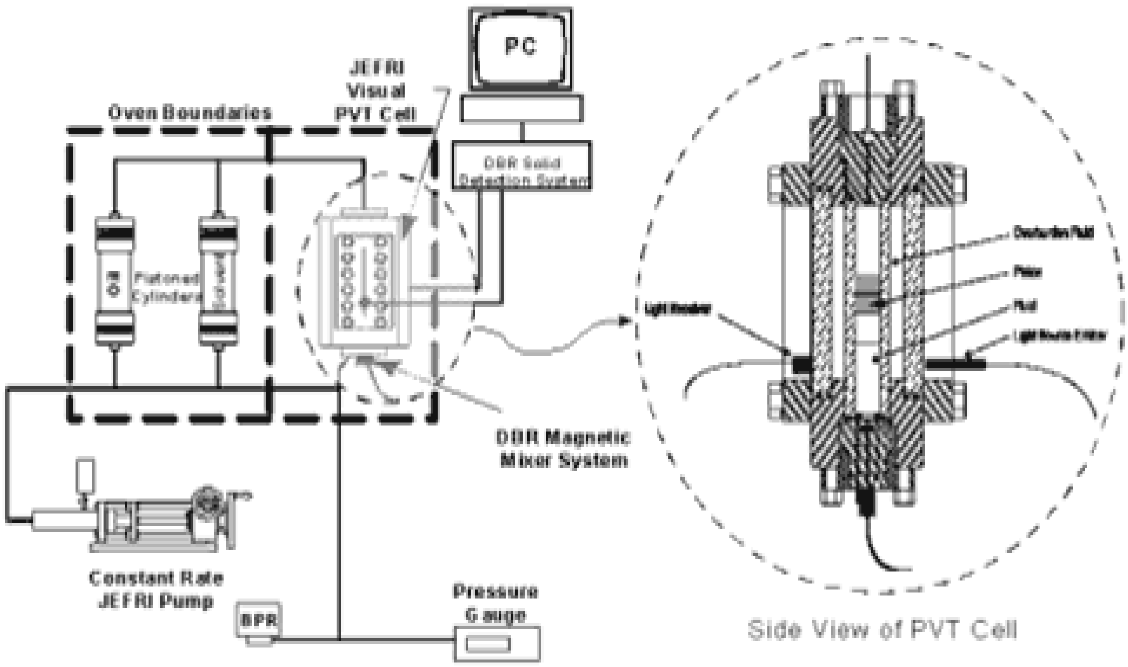


**Figure 3: Schematic Diagram of Schlumberger PVT Cell Equipped with Solid Detection System (SDS) (Schlumberger, 2015)**

For the viscosity measurement of the reservoir fluid at selected pressures in single phase above the saturation pressure, and liquid phase during the DL test, a Cambridge Electromagnetic Viscometer (EMV) is used. In some special cases, a capillary viscometer is also used in addition to the EMV as shown in Figure 4.

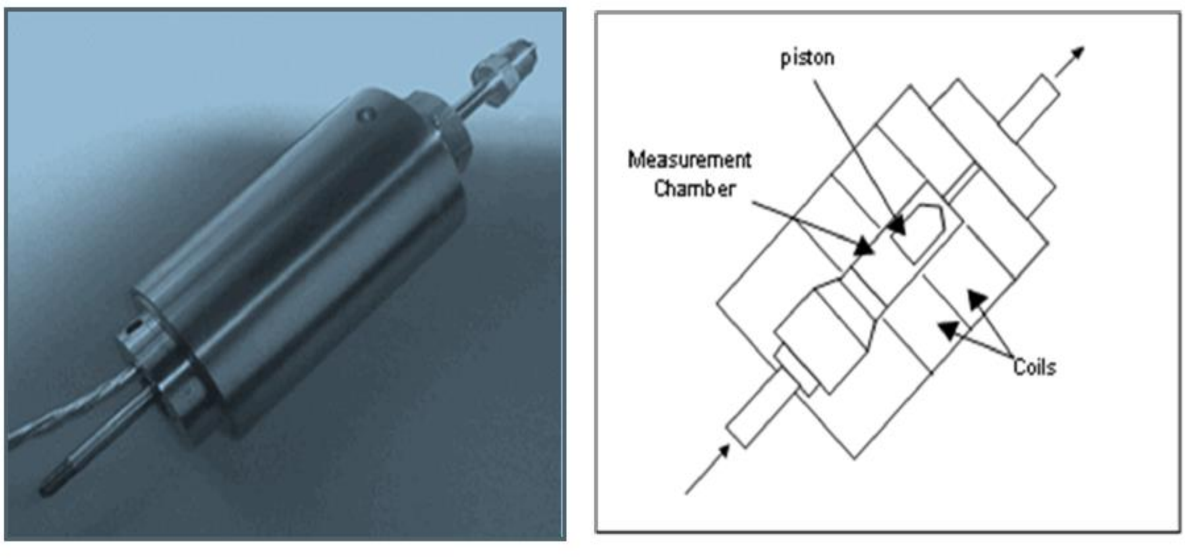


**Figure 4: Schematic Diagram of Cambridge Electromagnetic Viscometer (Schlumberger, 2015).**

The test fluid is charged to the pre-cleaned and evacuated vessel, and the piston is surrounded by fluid. Subsequently, the piston is moved inside the vessel by imparting a force on the piston using two electromagnetic coils inside the sensor body. After traveling the length of the test vessel, the piston is returned to its starting location by reversing the magnetic field of the electromagnet. The motion of the piston inside the vessel is impeded by viscous flow around the annulus between the piston and the measurement chamber wall. Viscosity is determined by measuring the piston transit time for a complete cycle of piston movement and comparing this to times obtained using calibrated standards.

**Capillary Viscometer (CV)**

The CV is rated to 10000.0 psi and 374.0 °F. The CV set-up consists of two high pressure cylinders (50 $cm^3$ each) connected to a 183 ft, 0.076 cm diameter capillary coil. A differential pressure transducer is used to monitor the pressure drop across the capillary coil. The fluid sample is pumped from one cylinder to the other through the capillary coil by an opposed pump (as shown in Figure 5). From the measured fluid flow rate and pressure drop, the viscosity can be determined using the Hagen-Poiseuille relationship for laminar flow in tubes as shown in equation 1.

$$\mu = \frac{\Delta p}{Q}\left(\frac{\pi r^4}{8L}\right) = \frac{\Delta p}{Q}\,k \qquad (1)$$

Where:

$\mu$ is the fluid viscosity

$\Delta$p is the pressure drop across the capillary tube of length

L is the length of the tube

r is the radius

Q is the volumetric flow rate.

The tube constant k is determined by calibrating the viscometer using standards of known viscosity at test pressures and temperatures.

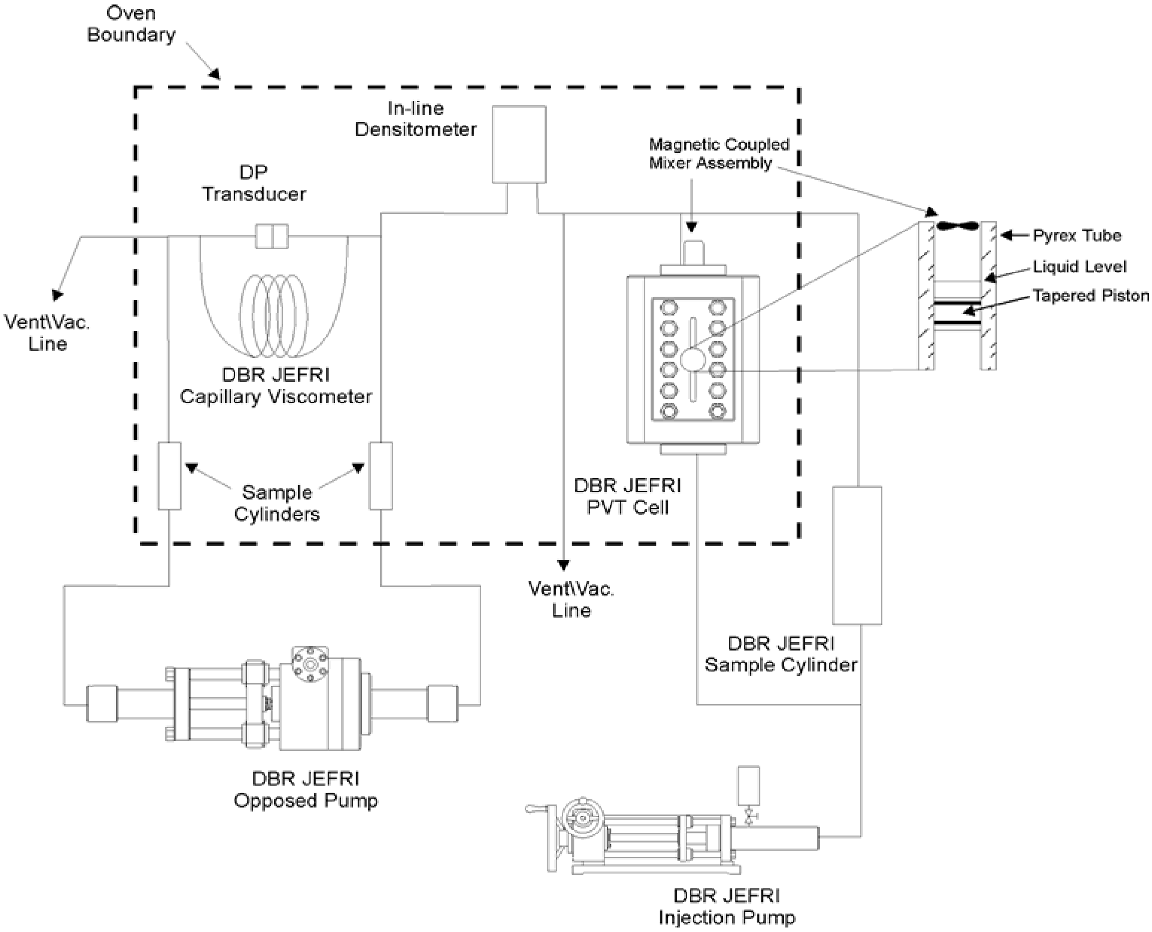


**Figure 5: Schematic of Capillary Viscometer Setup (Schlumberger, 2015)**

## RESULTS AND DISCUSSION

### Pressure Volume Temperature Analysis (PVT)

PVT data were available for 8 wells across both fields (five wells from Sapele deep and three wells from Sapele shallow). With the aid of this data, the fields were further categorized into

1. Conventional (Sapele deep) field
2. Unconventional (Sapele shallow) field.

According to Kulke (1995), majority of oils fall within two groups. The first being light paraffin based, waxy oils from deeper reservoirs (wax content up to 20%, but commonly around 5%; high n-paraffin/naphthene of 0.86). The second being oils that are biodegraded and from shallow reservoirs. They are of lower API gravity (average API of 26°) and are naphthenic non-waxy oils (n–paraffin/naphthene = 0.37). Biodegradation and washing are extreme in some Pleistocene sands of the Benin formation, forming extra heavy oils with API range of 8-20°. (Kulke, 1995; Doust & Omatsola, 1990).

*Conventional (Sapele Deep) field*

PVT data available for five wells (Well 06, 17, 18, 19 and 27) from the field, shows that the hydrocarbon possesses high content of light molecular weight hydrocarbon compounds such as Methane, Ethane, Propane, Butane, Pentane, Hexane, Heptane, Octane and contains small number of impurities such as $N_2$ and $CO_2$ (Table 1). The presence of these light hydrocarbon fractions resulted in the low density, low viscosity, low specific gravity and high API gravity of the crude oil samples from the field, which implies that the hydrocarbon will flow at ease to well heads due to these aforementioned properties. With API unit ranging within 32.0 – 49.30 across the field, the hydrocarbon type present in Sapele deep are light hydrocarbon (Conventional Oil). Also, the extreme high amount of methane presents also suggest that the field is made up of not just oil but both oil and wet gas (Sour or Lean Gas). This agrees with the work of Jin *et al.* (2010) who stated that if $CO_2$ is greater than 2% or $H_2S$ is greater than 0.1%, then the gas can be described as Sour/acidic/lean gas.

**Table 1: Sapele Deep Hydrocarbon Chemical Components**

| Component | Formula | Mole Mass | Sapele 06 | Sapele 17 | Sapele 18 | Sapele 19 | Sapele 27 |
|---|---|---|---|---|---|---|---|
| Nitrogen | $N_2$ | 28.01 | 0.09 | 0.37 | 0.09 | 0.11 | 0.07 |
| Carbon Dioxide | $CO_2$ | 44.01 | 3.15 | 3.47 | 5.45 | 5.91 | 2.23 |
| Hydrogen Sulfide | $H_2S$ | 34.08 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Methane | $CH_4$ | 16.07 | 83.87 | 80.55 | 80.38 | 78.19 | 54.06 |
| Ethane | $C_2H_6$ | 30.07 | 7.08 | 6.22 | 5.88 | 6.33 | 6.85 |
| Propane | $C_3H_8$ | 44.10 | 3.53 | 3.28 | 2.89 | 3.37 | 4.53 |
| i-Butane | $iC_4H_{10}$ | 58.12 | 0.66 | 0.64 | 0.54 | 0.63 | 1.11 |
| n-Butane | $nC_4H_{10}$ | 58.12 | 0.84 | 0.99 | 0.85 | 0.99 | 1.90 |
| i-pentane | $iC_5H_{12}$ | 72.15 | 0.24 | 0.40 | 0.63 | 0.37 | 1.50 |
| n-Pentane | $nC_5H_{12}$ | 72.15 | 0.17 | 0.34 | 0.37 | 0.33 | 1.34 |
| Hexane | $C_6H_{14}$ | 84.00 | 0.10 | 0.43 | 0.49 | 0.45 | 2.76 |
| Methylcyclopentane | $C_6H_{12}$ | 84.16 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Benzene | $C_6H_6$ | 78.11 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Cyclohexane | $C_6H_{12}$ | 84.16 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Heptane | $C_7H_{16}$ | 98.19 | 0.05 | 0.68 | 0.41 | 0.84 | 2.05 |
| Methylcyclohexane | $C_7H_{14}$ | 98.19 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Toluene | $C_7H_8$ | 92.14 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Octane | $C_8H_{18}$ | 112.22 | 0.01 | 0.58 | 0.77 | 0.99 | 1.56 |
| Ethylbenzene | $C_8H_{10}$ | 106.17 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| M & P-Xylene | $C_8H_{10}$ | 106.17 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| O-Xylene | $C_8H_{10}$ | 106.17 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Nonane | $C_9H_{20}$ | 122.50 | 0.21 | 0.52 | 0.50 | 0.56 | 1.31 |
| Decane | $C_{10}H_{22}$ | 134.00 | 0.00 | 0.27 | 0.38 | 0.33 | 1.23 |
| Undecane | $C_{11}H_{24}$ | 147.00 | 0.00 | 0.21 | 0.26 | 0.17 | 1.17 |
| Dodecane | $C_{12}H_{26}$ | 161.00 | 0.00 | 1.05 | 0.00 | 0.43 | 1.14 |
| Tridecane | $C_{13}H_{28}$ | 175.00 | 0.00 | 0.00 | 0.00 | 0.00 | 1.28 |
| Tetradecane | $C_{14}H_{30}$ | 190.00 | 0.00 | 0.00 | 0.00 | 0.00 | 1.24 |
| Pentadecane | $C_{15}H_{32}$ | 206.00 | 0.00 | 0.00 | 0.00 | 0.00 | 1.19 |
| Hexadecane | $C_{16}H_{34}$ | 222.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.97 |
| Heptadecane | $C_{17}H_{36}$ | 237.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.95 |
| Octadecane | $C_{18}H_{38}$ | 251.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.87 |
| Nonadecane | $C_{19}H_{40}$ | 263.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.85 |
| Icosane | $C_{20}H_{42}$ | 275.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.82 |
| Heneicosane | $C_{21}H_{44}$ | 291.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.79 |
| Docosane | $C_{22}H_{46}$ | 305.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.75 |
| Tricosane | $C_{23}H_{48}$ | 318.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.75 |
| Tetracosane | $C_{24}H_{50}$ | 311.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.72 |
| Pentacosane | $C_{25}H_{52}$ | 345.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.69 |
| Hexacosane | $C_{26}H_{54}$ | 359.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.65 |
| Heptaeicosane | $C_{27}H_{56}$ | 374.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.59 |
| Octaeicosane | $C_{28}H_{56}$ | 388.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.51 |
| Nonaeicosane | $C_{29}H_{60}$ | 402.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.41 |
| Triacontane Plus | $C_{30}H_{62}+$ | 750.00 | 0.00 | 0.00 | 0.00 | 0.00 | 1.16 |
| **Total** | | | **100.00** | **100.00** | **100.00** | **100.00** | **100.00** |
| **I-Reservoir Press** | | | **5142** | **5430** | **6053** | **5649** | **5818** |
| **Reservoir Temp** | | | **228$^0$F** | **224$^0$F** | **236$^0$F** | **231$^0$F** | **232$^0$F** |
| **Viscosity (cP)** | | | **0.45** | **0.43** | **0.35** | **0.39** | **0.40** |
| **API Unit** | | | **42.10** | **47.05** | **53.41** | **49.30** | **51.96** |

*Unconventional (Sapele Shallow) field*

PVT data from well 23, well 29 and well 30 of the field, indicates that the hydrocarbon has high content of heavy molecular weight hydrocarbon compounds such as Dodecane, Tridecane, Tetradecane, Pentadecane, Hexadecane, Heptadecane Octadecane, Nonadecane, Icosane, Heneicosane, Docosane, Tricosane, Tetracosane, Pentacosane, Hexacosane, Heptaeicosane, Octaeicosane, Nonaeicosane, Triacontane Plus and contains small number of impurities ($N_2$ and $CO_2$). The presence of these heavy hydrocarbon fractions resulted in the high density, high viscosity, high specific gravity and low API gravity of the crude oil samples from the field, which implies that the hydrocarbon will not flow at ease to well heads except external stimulation is applied to enable hydrocarbons flow. The API unit value across the field is within 12.80 – 19.82, which denotes heavy hydrocarbon (Unconventional oil). Also, the low or near absence of methane suggests that the field is made up of only oil as seen in Table 2. The results obtained align with Oliveira and Carvalho (1993) and Santos *et al.* (2012) who concluded that microbial degradation reaches optimal temperatures below $80^0$C ($176^0$F), promoting oil oxidation, reduction of the gas/oil ratio (GOR), and reduction of API value. Thereby, increasing density and viscosity as well as the relative proportion of sulfur and heavy metals.

**Table 2: Sapele Shallow Hydrocarbon Chemical Components**

| Component | Formula | Molecular Mass | Sapele 23 | Sapele 29 | Sapele 30 |
|---|---|---|---|---|---|
| Nitrogen | $N_2$ | 28.01 | 0.020 | 0.072 | 0.050 |
| Carbon Dioxide | $CO_2$ | 44.01 | 0.130 | 0.002 | 0.140 |
| Hydrogen Sulfide | $H_2S$ | 34.08 | 0.000 | 0.000 | 0.000 |
| Methane | $CH_4$ | 16.07 | 3.660 | 0.093 | 2.530 |
| Ethane | $C_2H_6$ | 30.07 | 0.790 | 0.000 | 0.440 |
| Propane | $C_3H_8$ | 44.10 | 1.070 | 0.001 | 0.900 |
| i-Butane | $iC_4H_{10}$ | 58.12 | 0.360 | 0.000 | 0.210 |
| n-Butane | $nC_4H_{10}$ | 58.12 | 0.880 | 0.000 | 0.530 |
| i-pentane | $iC_5H_{12}$ | 72.15 | 1.420 | 0.001 | 1.720 |
| n-Pentane | $nC_5H_{12}$ | 72.15 | 1.450 | 0.001 | 1.246 |
| Hexane | $C_6H_{14}$ | 84.00 | 3.180 | 0.022 | 2.891 |
| Methylcyclopentane | $C_6H_{12}$ | 84.16 | 0.001 | 0.002 | 0.001 |
| Benzene | $C_6H_6$ | 78.11 | 0.002 | 0.001 | 0.001 |
| Cyclohexane | $C_6H_{12}$ | 84.16 | 0.002 | 0.001 | 0.001 |
| Heptane | $C_7H_{16}$ | 98.19 | 0.004 | 0.028 | 0.005 |
| Methylcyclohexane | $C_7H_{14}$ | 98.19 | 0.006 | 0.002 | 0.003 |
| Toluene | $C_7H_8$ | 92.14 | 0.087 | 0.007 | 0.064 |
| Octane | $C_8H_{18}$ | 112.22 | 0.043 | 0.055 | 0.087 |
| Ethylbenzene | $C_8H_{10}$ | 106.17 | 0.001 | 0.002 | 0.002 |
| M & P-Xylene | $C_8H_{10}$ | 106.17 | 0.006 | 0.004 | 0.004 |
| O-Xylene | $C_8H_{10}$ | 106.17 | 0.005 | 0.003 | 0.005 |
| Nonane | $C_9H_{20}$ | 122.50 | 0.090 | 0.088 | 0.182 |
| Decane | $C_{10}H_{22}$ | 134.00 | 0.524 | 0.376 | 0.304 |
| Undecane | $C_{11}H_{24}$ | 147.00 | 0.221 | 1.527 | 0.151 |
| Dodecane | $C_{12}H_{26}$ | 161.00 | 2.891 | 3.483 | 3.316 |
| Tridecane | $C_{13}H_{28}$ | 175.00 | 5.174 | 6.102 | 3.924 |
| Tetradecane | $C_{14}H_{30}$ | 190.00 | 8.525 | 8.448 | 7.725 |
| Pentadecane | $C_{15}H_{32}$ | 206.00 | 8.525 | 8.372 | 7.725 |
| Hexadecane | $C_{16}H_{34}$ | 222.00 | 5.446 | 6.800 | 5.619 |
| Heptadecane | $C_{17}H_{36}$ | 237.00 | 5.446 | 6.135 | 5.619 |
| Octadecane | $C_{18}H_{38}$ | 251.00 | 4.274 | 5.200 | 3.173 |
| Nonadecane | $C_{19}H_{40}$ | 263.00 | 4.274 | 5.560 | 3.173 |
| Icosane | $C_{20}H_{42}$ | 275.00 | 4.361 | 4.940 | 4.614 |
| Heneicosane | $C_{21}H_{44}$ | 291.00 | 4.193 | 5.458 | 4.114 |
| Docosane | $C_{22}H_{46}$ | 305.00 | 3.512 | 4.036 | 5.941 |
| Tricosane | $C_{23}H_{48}$ | 318.00 | 3.365 | 3.859 | 5.242 |
| Tetracosane | $C_{24}H_{50}$ | 311.00 | 2.453 | 3.294 | 3.093 |
| Pentacosane | $C_{25}H_{52}$ | 345.00 | 2.752 | 2.988 | 3.100 |
| Hexacosane | $C_{26}H_{54}$ | 359.00 | 3.154 | 3.668 | 2.958 |
| Heptaeicosane | $C_{27}H_{56}$ | 374.00 | 2.900 | 2.561 | 2.001 |
| Octaeicosane | $C_{28}H_{56}$ | 388.00 | 2.468 | 2.764 | 1.885 |
| Nonaeicosane | $C_{29}H_{60}$ | 402.00 | 2.274 | 2.484 | 2.004 |
| Triacontane Plus | $C_{30}H_{62}$+ | 750.00 | 10.061 | 11.559 | 13.307 |
| **Total** | | | **100.00** | **100.00** | **100.00** |
| **I-Reservoir Press** | | | **2175.09** | **2557.98** | **2420** |
| **Reservoir Temp** | | | **$129^0$F** | **$140^0$F** | **$134.0^0$F** |
| **Viscosity (cP)** | | | **45.62** | **39.94** | **42.41** |
| **API Unit** | | | **12.80** | **19.82** | **16.47** |

## CONCLUSION

The heavy oils found in the Sapele Shallow field are as a result of biodegradation process in which micro-organisms degrades the light hydrocarbons due to the shallow nature of the reservoir in the field, making it rich in heavy molecular weight hydrocarbon compounds resulting to the low pressure and generally lower recovery factors in comparison to the light oil found in Sapele deep field. Also, the heavy oil found in Sapele shallow is more complex and expensive to produce because it requires novel or unconventional production technologies and is also a low-quality oil that must be upgraded to a lower density, viscosity, and specific gravity before been sent to the refineries (Synthetic crude or Syncrude) compared to the light oil of Sapele deep which does not need any of these processes. However, volumetric loss occurs when upgrading the lower quality oil to a standard conventional oil, which therefore implies that the shallow field reserve cannot be accurately estimated. Also, light crude oil receives a higher price than heavy crude oil on commodity markets because it produces a higher percentage of gasoline and diesel fuel when converted into products by an oil refinery. Heavy crude oil has more negative impact on the environment than its light counterpart since its refinement requires the use of more advanced techniques and the use of contaminants.

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