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Extraction of oil from the tar sands of ofosu and environs, Edo State, Mid-Western Nigeria: A way to meet increasing energy demand

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ABSTRACT

Tar sands are primarily, aggregates of sands, clay that is rich in minerals, heavy oil and sometimes water. The Nigerian tar sand belt lies on the onshore areas of the Eastern Dahomey (Benin) Basin, and extends right up to parts of Edo State, Mid-Western Nigeria. Extraction techniques involved heating of the tar sand samples to a temperature of 140^{o}F in order to reduce the apparent viscosity of the tar sand. This method of extraction makes use of a coupling agent known as sulphunated fatty acid, alkali metal salt. Results show that the volume of oil extracted from 50g of tar sand ranges between 1.8ml to 2.5ml; while the water residue is quite low, ranging from 2.1ml to about 3.86ml. The tar sands here possess a relatively large quantity of naphthenes, aromatics and asphaltenes that are similar to conventional oil. When compared with the quality of the Canadian tar, which produces 168l of oil per day from 2,000kg of tar sand, this makes the Nigerian tar sand useful alternative source of petroleum hydrocarbon and a potential feedstock for petrochemical industries.

Key Words: Tar sand, Extraction, Dahomey Basin, Ofosu, Nigeria.

INTRODUCTION

Tar sands are immature petroleum deposits, in which the breakdown of large molecules has not progressed to completion. Alternatively, tar sands could be formed when the lighter compounds have migrated, leaving the dense material behind, as a result of which, the tar becomes too thick to flow out of rocks.

Exploration of tar sand (Bitumen) in Nigeria dates to as far back as 1905 when Mineral Survey of Southern Nigeria drilled sixteen (16) shallow boreholes in the western part of a line of oil seepages known as the tar sand belt; In the present day, this belt lies on the onshore areas of the Eastern Dahomey (Benin) Basin.

The first attempt on commercializing bitumen deposits in Nigeria was by the defunct Nigeria Bitumen Corporation between 1908 and 1914. The company drilled boreholes that penetrated various thicknesses of bitumen impregnated sands and grits totaling 286.6m. Being the only direct indication of the presence of oil in Nigeria at the time; the tar sand belt attracted a number of oil companies. Since then till date it has been a site of attraction to various companies and research institutes.

The total hydrocarbon fraction of the Nigerian tar sand (saturated plus aromatic alkanes), on the average, corresponds to ca. 50wt$^{o}/_{o}$ of bitumen as in the case with similar non-conventional oils from other parts of the world (Ekweozor, 1991). Various researchers and writers like Coker and Ekweozor have compared the physio-chemical characteristics of the Nigeria bituminous sand to that of Alberta and Athabasca in Canada where oil extracted from tar sand contributes about 40$^{o}/_{o}$ to the oil supply of the country.

Following the increase in the consumption of conventional oil supply, it is important to search for other alternative source of oil production. This work is aimed at proposing tar sands from Ofosu as an alternative source of oil, in the event of an increase demand in oil use and/or depletion and exhaustion of the current Nigerian oil reserves which stand at 36billion barrels. With the current exploitation rate of 2.4million barrels per day, it is estimated that the current reserves will be exhausted by the year 2060, at which time, tar sands could constitute an important alternative resource.

Reserve Estimate

Adegoke *et al.*, (1981) put the recoverable bitumen in Nigeria exploitable by open-cast mining techniques at 1.079billion barrels. The heavy oil in-place for an area of 550 x $10^6 m^2$ south of the outcrop area with overburden in excess of 100m was put at 32.58 billion barrels. Coker (1988) reported the recoverable reserves for areas designated as suitable exploitation by surface mining to be 3.6 x 10^6 bbl bitumen.

Tar sand reserve in the south-western area of Nigeria is estimated at about 15 billion barrels. The total possible area covered by bitumen is estimated at about 189 sq.km, with an estimate of average thickness of pay at about 20m (65.6) and mean hydrocarbon content of about 112$^{o}/_{o}$. Table 1 shows the some details on the estimate of tar sand resource, existing in two layers separated by an oil shale.

Table 1: Estimate of Bitumen Reserve (Source, Fayose 2001?)

Level	BBIs x 10^9	Metric Tons x 10^9
Bitumen Oil X	6.60	1.01
Bitumen Oil Y	6.60	1.01
Oil Shale	1.66	0.254
Total	14.86	2.274

MATERIALS AND METHODS

Extraction of oil from tar sand

Materials: Weighing balance, Oven with Thermostat, Separating Funnel, beaker, Measuring cylinders, Mortal & Pestle.

Reagents: Sulphunated fatty acid (Sulphite compound + Fatty Acid), Deionized distilled Water, & Sodium Metal

Procedures

The tar sand samples used for this work were collected from the Ofoso tar sand field. The study area lies between Latitudes N006^{o}51^{1} and Longitudes E05^{o}30^{1}. The samples were disaggregated with the help of mortar and pestle. A known weight (50g) of each tar sand sample was heated in an oven at the temperature of 60^{o}C degree for 30minutes to melt out the oil present. Then, prepared reagents i.e. Sulphunated fatty acid of a known volume was added to the sample and stirred vigorously and then allowed to stand for 15-20 minutes. 20ml of Sodium Hydroxide was then added to separate the residue (coagulate) from oil. The time allowed for sediment separation to occur is known as the residence time. The solution was stirred properly and poured into the separating funnel, where the oil and the residue were collected separately and measured using a measuring cylinder .The residue was then separated by decanting the water and drying off the water in the oven to know the final weight of the residue. Results of the volumes of obtained oil and residue plus water are presented in Tables 2-4.

RESULTS

Table 2: Oil and Residue Volume in Samples from Location 1(L_1)

SAMPLE 1	WEIGHT OF TAR SAND (gm)	VOLUME OF OIL SEPARATED (ml)	VOLUME OF WATER & RESIDUE ml
Tar Sand	(a_1) 50gm	2.10ml	3.91ml
Tar Sand	(b_1) 50gm	1.80ml	2.18ml
Tar Sand	(c_1) 50gm	2.30ml	9.75ml
Tar Sand	(d_1) 50gm	2.20ml	7.92ml

Table 3: Oil and Residue Volume in Samples from Location 2(L_2)

SAMPLE 2	WEIGHT OF TAR SAND (gm)	VOLUME OF OIL SEPARATED (ml)	VOLUME OF WATER & RESIDUE ml
Tar Sand	(a_2) 50gm	2.50ml	3.86ml
Tar Sand	(b_2) 50gm	2.20ml	2.10ml
Tar Sand	(c_2) 50gm	2.25ml	9.75ml
Tar Sand	(d_2) 50gm	2.40ml	7.79ml

Table 4: Oil and Residue Volume in Samples from Location 3(L_3)

SAMPLE 3	WEIGHT OF TAR SAND (gm)	VOLUME OF OIL SEPARATED (ml)	VOLUME OF WATER & RESIDUE ml
Tar Sand	(a_3) 50gm	1.80ml	3.83ml
Tar Sand	(b_3) 50gm	1.85ml	2.15ml
Tar Sand	(c_3) 50gm	2.30ml	9.85ml
Tar Sand	(d_3) 50gm	2.40ml	7.87ml

DISCUSSION AND CONCLUSION

In Alberta (Canada), where oil produced from tar sands contribute 40% of the required oil needs, bituminous sand is considered economically viable if 2,000,000g of mined sand produces

168litre per day of oil. Considering the laboratory results of the samples tested from the study area, it is seen that the volume of extracted oil range from 1.8ml to 2.3ml (L_1), 2.2ml to 2.5ml (L_2) and 1.8 to 2.4 (L_3). These ratios compete favorably with the acceptable limit of the tar sands from Alberta.

From the afore findings, it leaves no doubt that it will be profitable to extract oil from the studied tar sands using the current technical know how. Also, the tar sands in Nigeria occur mainly at the surface which is an added advantage as it is cheaper to mine by open pit methods.

Recommendation

The present estimated conventional oil reserves of Nigeria are put at 36 billion barrels. At the current consumption or exploitation of 2.4 million barrels/day, with further research in exploration, it is estimated that this oil will last for 50 yrs that is by the year 2060 this oil will be exhausted, if and only if the current estimate is maintained. Also currently, the instability in the Middle East, activism and terrorism, the cost of exploiting conventional oil could rise tremendously. It is therefore expected that with the aforementioned reasons, the energy industry should consider the exploration of unconventional oil in the country as another alternative to meet global energy demand.

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