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THE USE OF JATROPHA OIL FOR DETERMINING THE SOFTENING POINT OF NIGERIA BITUMEN SAMPLES

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Abstract

The occurrence of bitumen deposits in Nigeria has been estimated to be about 42 billion tones; almost twice the amount of existing reserves of crude petroleum" Nigerian Investment Promotion Commission (NIPC).For proper planning of extraction techniques for heavy crude oil such as Nigeria bitumen or oil sand, softening point is a paramount parameter need to be estimated for determining the temperatures at which bitumen will melt and when the slug start to flow into production systems.

The softening point (*SP*) and penetration index (*PI*) of bitumen from parts of south-western Nigeria are important properties needed for better design and optimization of the upgrading process of Nigerian bitumen. This study was carried out to design a cost effective and efficient softening point tester to classify bitumen into grades using jatropha oil as fluid bath instead of water.

Jatropha oil has higher specific heat capacity and dissipates heat faster than water. It takes shorter time to heat and soften a sample of bitumen compares to water. This saves time and cost as energy generation cost less. Use of Jatropha as bath fluid in the areas of processing bitumen would assist the operator to achieve higher output, less heat for softening and produces a higher softening point.

Key words: Softening point; Nigeria bitumen; Penetration index; Jetropha oil; Paving road.

1. Introduction

Most bitumen deposits contain mixtures of bitumen, sand, water, small amounts of heavy metals and other contaminants. In its natural state, bitumen is suitable only for paving roads. Countries like Canada use bitumen to manufacture synthetic crude oil [1-3]. Compared to conventional crude oil, bitumen contains too much carbon and too little hydrogen. In making synthetic crude oil, special refining processes are used to remove impurities and correct the carbon-hydrogen imbalance.

Bitumen does not have a distinct melting point. It gradually softens when heated. The softening point is also an empirical test and denotes the temperature at which bitumen would behave more like a liquid and less like a solid under standard conditions of heating and loading [4].

Softening Point test is therefore a very important test as it is a fair indicator of melting properties of bitumen. Whether the purpose of the bitumen would be for its usage in paving roads or in making synthetic crude oil, the knowledge of the softening point is vital [1,6]. Bitumen with lower softening point tends to melt on the road in summer and start flowing under the impact of temperature and traffic [5]. Subsequently when the bitumen cools down at night the road surface loses its original shape and becomes wavy. This mode of failure of roads due to bitumen is referred to as failure by rutting. Therefore it can be concluded that bitumen with higher softening point melt at higher temperatures and have better rutting resistance[4-6]. In the extraction of bitumen from deeper deposits, the knowledge of the temperatures at which bitumen will melt and then start to flow is useful in planning the extraction techniques whether it is Steam Assisted Gravity Drainage (SAGD) or Cyclic Steam Stimulation (CSS) [1].

2. Experimental work

Determination of softening point of bitumen extracted from oilsand samples from the South-Western parts of Nigeria. The materials used for the experimental work are oil-sand, jatropha oil, water.

2.1 Apparatus

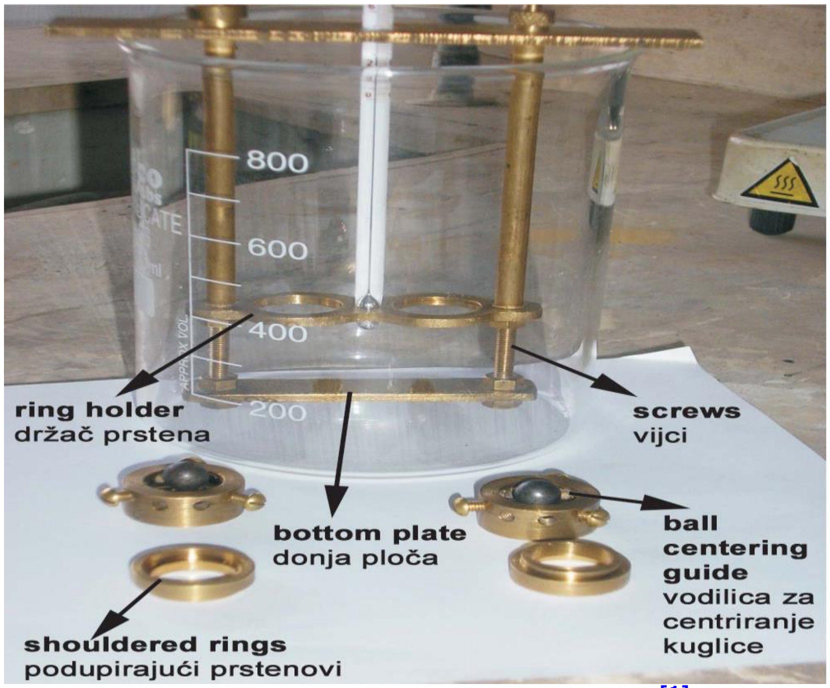


Figure1 Ring and ball apparatus [1]

2.2. Components of the ring and ball apparatus

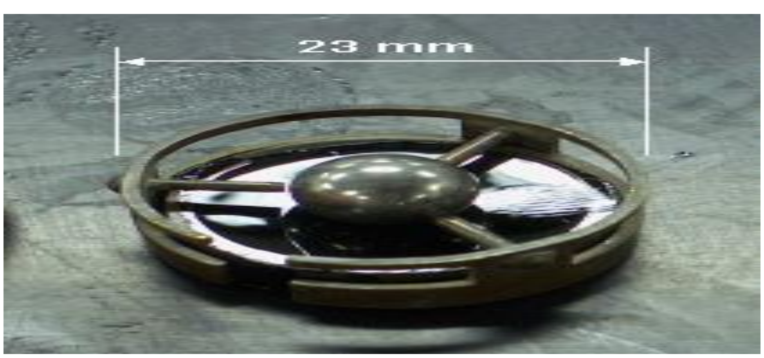
Pouring Plate: A flat, smooth, brass plate approximately 50 by 75 mm (2 by 3 in.).

Balls: Two steel balls, 9.5 mm (3⁄8 in.) in diameter, each having a mass of 3.50 6 0.05 g.

Bath: A glass vessel, capable of being heated, not less than 85 mm in inside diameter and not less than 120 mm in depth from the bottom of the flare.

Ring Holder and Assembly: A brass holder designed to support the two rings in a horizontal position. The bottom of the shouldered rings in the ring holder is 25 mm (1.0 in.) above the upper surface of the bottom plate, and the lower surface of the bottom plate is 166 3 mm (5⁄8 6 1⁄8 in.) from the bottom of the bath.

Thermometers: An ASTM Low Softening Point Thermometer, having a range from − 2 to + 80°C or 30 to 180°F, and conforming to the requirements for thermometer 15C or 15F as prescribed in specification was used.



2.3 Summary of the test method

Two horizontal disks of bitumen, cast in shoulder red brass rings, are heated at a controlled rate in a liquid bath whileeach supports a steel ball. The softening point is reported as the mean of the temperatures at which the two disks soften enough to allow each ball, enveloped in bitumen, to fall a distance of 25 mm (1.0 in.).

3. Result and Discussion

The table 1 shows the results of the softening point experiment.

Table 1 Softening point results

Sample	Bath Liquid	Temperature (°C)	Time	Softening Point (°C)
Agbabu bitumen	Water	5 °C and heating steadily at 5°C /min	1st ring	19
Ilubirin bitumen				36.5
Agbabu bitumen	Water	5 °C and heating steadily at 5°C /min	2nd ring	22
Ilubirin bitumen				36
Agbabu bitumen	Jatropha oil	27°C and heating steadily at 5°C /min	1st ring	33.2
Ilubirin bitumen				50.2
Agbabu bitumen	Jatropha oil	27°C and heating steadily at 5°C /min	2nd ring	30.8
Ilubirin bitumen				52
Agbabu bitumen	Water	Room temperature and heating steadily at 5°C/min	1st ring	31.5
Ilubirin bitumen				49
Agbabu bitumen	Water	Room temperature and heating steadily at 5°C/min	2nd ring	29.5
Ilubirin bitumen				48.2

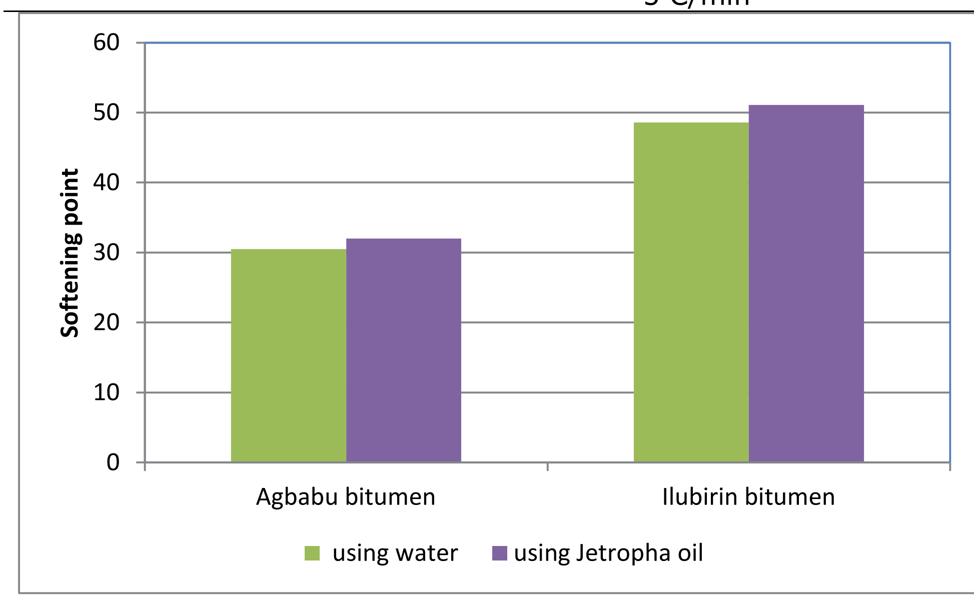


Figure 1 Showing the softening point of both samples

3.1. Precision and Bias

The applicable criteria for judging the acceptability of the results in accordance with ASTM D36– 95 are as follows:

1. Single Operator Precision using distilled water: The results of two properly conducted tests by the same operator on the same sample should not differ by more than 1.2°C. Using water, the results were found to differ by 1.2°C which is within the allowable precision.
2. Single Operator Precision using ethylene glycol: The results of two properly conducted tests by the same operator on the same sample should not differ by more than 2°C. This clearly

shows an increase in tolerance when a bath fluid more viscous than water is used. Using jatropha oil, the results were found to differ by 2°C which is within the allowable precision.

3. The use of jatropha oil gives a higher softening point, which is favourable to the construction industries as it takes less time and energy in softening the bitumen when desired. Most especially in the temperate regions where energy and

3.2. PENETRATION INDEX

The penetration of bitumen is the most widely used material for measuring the consistency of a bituminous material at a given temperature. Penetration index is a fair indicator of the ability of bitumen to resist repeated variations in the temperature of the pavement. The results of the penetration index are shown below using one of the relationship developed by Pfeiffer and Van Doormaal which states that: If the logarithm of penetration, P, is plotted against temperature, T, a straight line is obtained such that:

$$\log P = AT + K \qquad (1)$$

where: A = The temperature susceptibility; P = Penetration at temperature T; K = Constant.

Table 2 Penetration and penetration index results

Sample	Bath Liquid	Penetration (Decimilimeter)	Penetration Index
Agbabu bitumen	Water	330	-3.88
Ilubirin bitumen		58	-1.22
Agbabu bitumen	Jatropha oil	330	-2.61
Ilubirin bitumen		58	-0.58

According to the monograph [1], the penetration index can be deduced from the penetration and the softening point temperature and interpreted as follows.

Table 3 Guidelines for the interpretation of penetration index

Bitumen type	Penetration index
Blown bitumen	>2
Conventional paving bitumen	-2 to +2
Temperature susceptible bitumen	<-2

Penetration Index ranges from -3 for highly temperature susceptible bitumen to around +7 for highly blown low-temperature susceptible (high PI) bitumen.

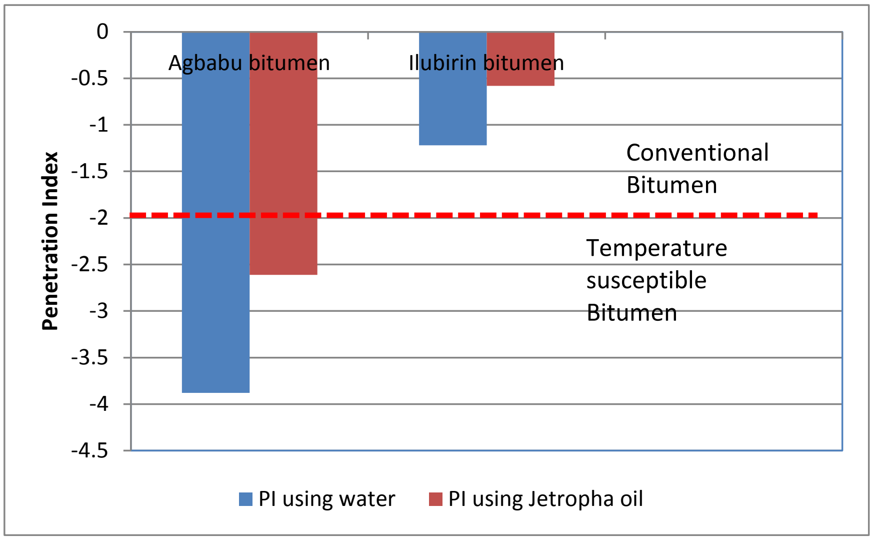


Figure 2 Showing Penetration Index of both samples

It is therefore clear that the Agbabu bitumen is temperature susceptible bitumen. Another observation is that the type of bath fluid affects the penetration index as Jatropha Oil results in a higher softening point and much lower penetration index.

4. Conclusion

The ring and ball apparatus was used to perform experiments on both Ilubirin and Agbabu bitumen. The experiments show that the Agbabu bitumen is of the temperature susceptible bitumen grade. As expected, the softening point determined using Jatropha Oil as the bath fluid was lower than that obtained using water as the bath fluid. However, Jatropha oil results in much lower values of Penetration Index.

Since Agbabu bitumen has been shown to be temperature susceptible grade, its usage in paving constructions will results in roads and structure that lose their shape due to temperature induced deformation. Studies should be done on how to improve the properties of the bitumen and how to gainfully use it in the oil and gas industry.

Jatropha oil has a higher specific heat capacity and as such can dissipate heat faster than water. That is it takes shorter time to heat/soften a sample of bitumen using Jatropha oil as against water. This saves time and cost as energy generation would cost less.

Also the use of Jatropha as bath fluid in areas of processing the bitumen would lead to a higher output since it requires less heat to soften the bitumen and at same time produces a higher softening point.

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