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Determination of the amount of petrol as an adulterant in kerosene using a locally constructed viscometer

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Abstract
A locally constructed simple capillary viscometer was used to study the variation of viscosity of various volumes of petrol added to a fixed volume of kerosene. The density and viscosity of petrol-kerosene mixtures decreased with increasing petrol concentration in a fixed amount of kerosene. The study revealed that estimation of petrol concentration in petrol-kerosene mixture was much easier and better done by using calibrated curve of viscosity-petrol concentration than density-petrol concentration.

Keywords: Petrol, kerosene, density, viscosity, concentration, mixtures, adulteration.

1. Introduction
Kerosene is a combustible hydrocarbon liquid. The name is derived from Greek, (*keros*) meaning wax. The word "Kerosene" was registered as a trademark by Abraham Gesner in 1854, and for several years, only the North American Gas Light Company and the Downer Company, to which Gesner had granted the right were allowed to call their lamp oil Kerosene in the United States, (Asbury, Herbert (1942) [5]. It eventually became a generalized trademark. It is sometimes spelled kerosene in scientific and industrial usage, (Webster's New World College Dictionary). The term "kerosene" is common in much of Canada, the United States, Australia and New Zealand, (Anonymous, 2006).
Kerosene is widely used to power jet engines of aircraft and some rocket engines, but is also commonly used as a cooking and lighting fuel and for fire toys such as poi. In parts of Asia, where the price of kerosene is subsidized, it fuels outboard motors on small fishing boats. Kerosene lamps are widely used for lighting in rural areas of Asia and Africa where electrical distribution is not available or too costly for widespread use. Total kerosene consumption is equivalent to about 1.2 million barrels per day, (Wikipedia. 2014). Kerosene in some jurisdictions such as the U.S. is legally required to be stored in a blue container to avoid it being confused with the much more flammable gasoline, which is typically kept in a red container. In other jurisdictions, like many in Europe, there are no specific requirements for the storage of kerosene other than the container has to be closed and marked with its contents.
Kerosene, a thin, clear liquid formed from hydrocarbons, with a density of 0.78–0.81 g/cm^3, is obtained from the fractional distillation of petroleum between 150 °C and 275 °C, resulting in a mixture of carbon chains that typically contain between 6 and 16 carbon atoms per molecule. Kerosene is immiscible in water (cold or hot), but miscible in petroleum solvents. (American Institute of Petroleum, 2010).
According to NNPC, (Ajuonuma, (2011) [12], Adulteration is defined as the introduction of foreign substance or materials into the fuel illegally with the result that the product does not conform to the requirements and specifications of the product. Adulteration of fuel is very rampant, this is because the products of comparable quantities have different price. The fuel dealers do this adulteration so as to make maximum profit from the product neglecting the harmful effects to human lives and properties. For example, when kerosene is adulterated with petrol it can be very dangerous because it can be highly inflammable. Kerosene may be adulterated by adding other liquids which may be miscible or immiscible.

In some African countries like Nigeria, kerosene Adulteration comes from the addition of water or petrol, or diesel depending on the price deferential between the product and the adulterant (Adeniran, 2010) [1]. One major cause of kerosene adulteration is the scarcity of the product in the market (Shosanya, 2011 [12] and Babalola, 2011). Kerosene scarcity has been the major cause of kerosene adulteration which has forced consumers to the use of other alternative hydrocarbon substances which has also led to deforestation, generation of large quantity of carbon monoxide and other ozone layer depleting substances. It has also put pressure on domestic gas demand thus forcing the price of cooking gas upwards. Kerosene adulteration had been implicated in all the various kerosene explosions in many African countries.

The first major kerosene explosion in Nigeria occurred in March 1984 in Lagos ((Emewu, 2001). There have been several other kerosene explosions in Nigeria since then particularly in the oil petroleum producing areas of the south-south Zone of Nigeria (Enogholase, 2007). The recent being the ones that occurred almost at the same time in the Rivers and Edo states of the south-south zone of Nigeria. Each time such explosion occurred, people have been incapacitated or disfigured. Loss of lives and property has also been recorded (NAN, 2011).

2. Materials Method

The petrol and kerosene used in this study were bought from NNPC mega station in Yola, Nigeria. The NNPC mega station in Nigeria is a Federal government established fuel station and is considered to have the non adulterated fuel. Various amount of the mixture were prepared by adding different amount of petrol to a fixed amount of kerosene and stirred very well. The densities ρ of the pure liquids and mixtures were determined using the simple relation of density = mass/volume.

A simple constructed capillary viscometer, Figure 1, (Dikko and Yerima, 2014), was used to determine the time of flow t of distilled water (reference liquid), pure kerosene, pure petrol and various mixtures of petrol and kerosene at average room temperature of 308 K.

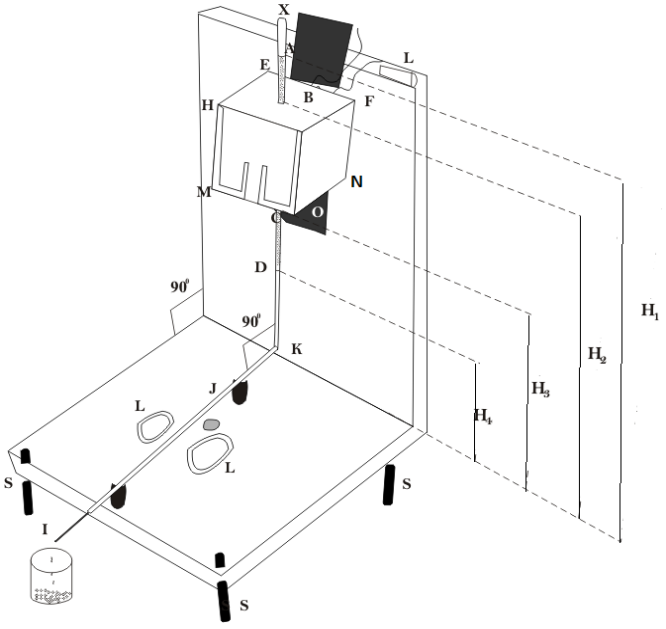

Fig 1: Schematic diagram of the constructed Simple Viscometer

The viscosities μ, of the pure liquids or mixtures were calculated using the equation

$$\mu = (\mu_w \rho_m t_m) / (\rho_w t_w) \quad (1)$$

where, subscript $_m$ and $_w$ stand for the mixture and water respectively.

Results and Discussion

The density and viscosity values of the petrol-kerosene mixtures studied are presented in Table (1). The viscosity of all of the mixtures decreased with increase in petrol concentration in kerosene. We can see that as petrol concentration is increased from 0%, the viscosity of the resulting mixture is reduced from that of kerosene. It is obvious that the rate of change of viscosity with respect to petrol concentration is higher at low concentration of petrol than that at high concentration (see Fig 1).

Table 1: Variation of viscosity (millipoise) and density (g/cc) of petrol concentration in kerosene at 308 K

Concentration of petrol in kerosene C_p (%)	Density of mixture ρ (g/cc) ±0.005	Viscosity of mixture μ (millipoise) ±0.01
0	0.808	12.73
5	0.807	10.89
10	0.806	9.52
15	0.805	8.41
20	0.805	7.22
25	0.804	6.43
30	0.803	5.73
35	0.803	5.52
40	0.802	5.39
45	0.802	5.33
50	0.801	5.22

The observed decreasing of viscosity of petrol-kerosene mixtures with increase of petrol concentration can be attributed to the decreasing of activation energy from that of pure kerosene. Petrol molecules can influence the bond between the kerosene molecules, and this influence will depend on how petrol molecules arrange themselves among the kerosene molecules and the concentration of petrol in the mixture (Dilip *et al*, 2002).

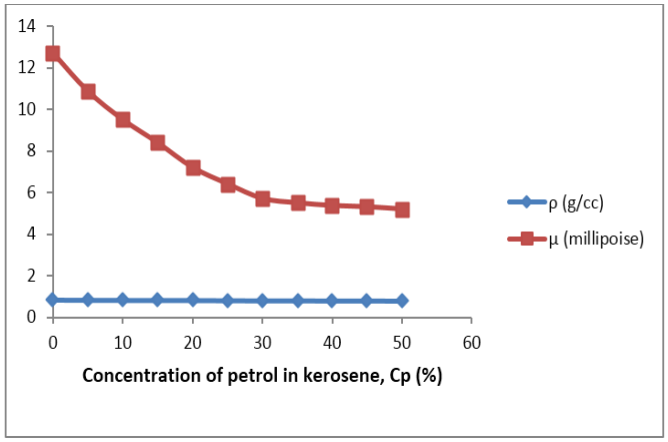

Fig 2: Viscosity and density variation of petrol concentration in kerosene at 308 K

To estimate the amount of petrol in known kerosene, Figure (2) can be used. Obviously, looking at Figure (2) and Table (1), the variation of density of petrol-kerosene mixture with petrol concentration in kerosene is not much, and hence, this will not give a good estimation of petrol content in the mixture. However, the variation of viscosity of the mixture with petrol concentration is sharper, and can fairly be used to estimate petrol concentration in the suspected kerosene-petrol mixture. The viscosity value of the suspected petrol-kerosene mixture can be placed on the calibrated curve of Figure (2) to get the concentration of petrol in the mixture.
Going by this study, the viscosity value of pure kerosene was 12.73 millipoise at 308 K. Therefore, any viscosity value gotten from suspected petrol-kerosene mixture which is less than that of pure kerosene indicates some presence of petrol in that kerosene content, and the concentration can be estimated by placing the viscosity value on the calibrated curve of Figure (2).

4. Conclusion

The estimation of petrol content in petrol-kerosene mixture can be done via a locally constructed simple capillary viscometer. The density and viscosity of petrol-kerosene mixtures decreased with increasing petrol concentration in a fixed amount of kerosene. The study revealed that estimation of petrol concentration in petrol-kerosene mixture was much easier and better done by using calibrated curve of viscosity-petrol concentration than density-petrol concentration.

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