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# MODEL FOR PREDICTING PROPORTION OF DIESEL FUEL AND ENGINE OIL IN DIESEL ADULTERATED SAE 40 ENGINE OIL SAMPLE

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ABSTRACT

Viscosity of diesel adulterated SAE 40 engine oil at varying proportions of the mixture is presented. Regression, variation of intercept and the power parameters methods are used for developing polynomial and power law functions for predicting proportion of either diesel or engine oil in diesel adulterated SAE 40 engine oil sample.

**KeyWords** : SAE 40 engine oil, diesel, viscosity, adulterated.

## INTRODUCTION

One of the major problems designers of mobile engine have to overcome is how to reduce or eliminate friction, the force which opposes the movement of one surface sliding or rolling over another with which it is in contact. A situation, if not properly handled, can result in wear and tear of mechanical parts. In order to overcome this problem, viscous liquids such as engine oil are generally used to lubricate moveable mechanical parts, therefore reducing friction between solids in contact and in relative motion (Ekpe and Essien 1999). Oil of different grades are used for lubrication of different engines considering the thermal environment of the engine based on the usage.

In rotary compressors, whose proper operation depends on maintaining a continuous film of oil on the cylinder, roller and blade surfaces. A good lubricant, for compressors for example, must have the correct viscosity, free of moisture, wax and foam, and must be free of impurities which cause carbon to form around the exhaust (Marsh and Olivo 1979).

Viscosity, the quality of a fluid that causes it to resist flow, has been discussed by Flowers and Mendoza (1978), Alexander (1967), Evwaraye et al (1989), Brown (1980), Althouse et al (1996), Elbashbeshy et al (1993), Collieu and Powney (1977). According to Essien and Ekpe (1999) engine oil is graded based on the rated range of viscosity.

When oil outside the rated range for a particular type of engine is used, the performance of engine is affected. It is common knowledge that most road-side dealers in engine oil mix the engine oil with diesel fuel in order to increase the quantity and maximize profit. This leads to engine oil being adulterated, which results in changing the original properties which include density, optical density, refractive index, concentration or colour hence viscosity (Etuk et al 2001a, 2001b). Recently the adulteration of engine oil with diesel fuel has been studied using gamma rays irradiation technique (Ekpe and Essien, 1999; Essien et al, 1999). Also reported is the determination of viscosity of adulterated engine oil sample with diesel using relative permittivity. Relationship between relative permittivity and viscosity for determination of adulteration and grades of engine oil sample had been determined and a mathematical model developed (Etuk et al 2001a). In this study, we seek to establish a relationship between the proportion of engine oil and viscosity in diesel adulterated engine oil sample in order to predict the level of adulteration or percentage of diesel in such adulterated sample.

## MATERIALS AND METHOD

Sealed pure engine oil (SAE 40) and specially ordered pure diesel fuel were obtained from Petroleum oil station, Aka Road, Uyo in Akwa Ibom State, Nigeria. The engine oil and diesel fuel samples were subsequently mixed in various percentage ratios by volume.

Ostwald viscometer was used in the determination of the viscosity of each sample by comparing with that of distilled water.

## RESULTS AND DISCUSSION

Table 1 shows the experimental results of viscosity for the various percentage ratios of diesel adulterated engine oil samples. The measured viscosity for the percentage engine oil and diesel fuel in ten different proportions of mixture was used in developing the models

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Table 1: Experimental result for the viscosity of diesel adulterated engine oil (SAE 40) at different percentage mixture at temperature of 301k

| SAMPLE | | Measured viscosity (mPas) |
|---|---|---|
| Proportion of Diesel Fuel (%) | Proportion of Engine oil (%) | |
| 90 | 10 | 2.5 |
| 80 | 20 | 6.0 |
| 70 | 30 | 16.3 |
| 60 | 40 | 28.0 |
| 50 | 50 | 47.7 |
| 40 | 60 | 74.1 |
| 30 | 70 | 107.5 |
| 20 | 80 | 170.0 |
| 10 | 90 | 227.5 |
| 0 | 100 | 296.6 |

presented in Table 2. Data in Table 1 were regressed using Polynomial regression as well as power law (line) regression with percentage of engine oil (x :10-100%) as the predictor variable in equations 1 and 3; while equations 2 and 4 have percentage diesel fuel, $x_d$, as predictor variable. The best curves were judged by the size of the coefficient of determination, $R^2$ indicated in table 2.

The correlation coefficient for each fit is above 99%. Figs. 1 and 2 show strong positive correlation of percentage engine oil with viscosity in diesel adulterated engine oil sample, while Fig. 3 indicates strong negative correlation between percentage diesel and viscosity in the same mixture.

Equation 1 is the polynomial model for predicting the level of engine oil (SAE 40) in percent in a sample of engine oil adulterated with diesel fuel. Equation (3) gives the power law (line) equation, based on the regression constants, variation of intercept and the power parameters, for predicting the percentage of engine oil in such a mixture, the value of $\eta$ in eqn. 3 is in mPas.

Similarly, eqn. 2 is the polynomial model while Eqn. 4 is the line equation based on power law for

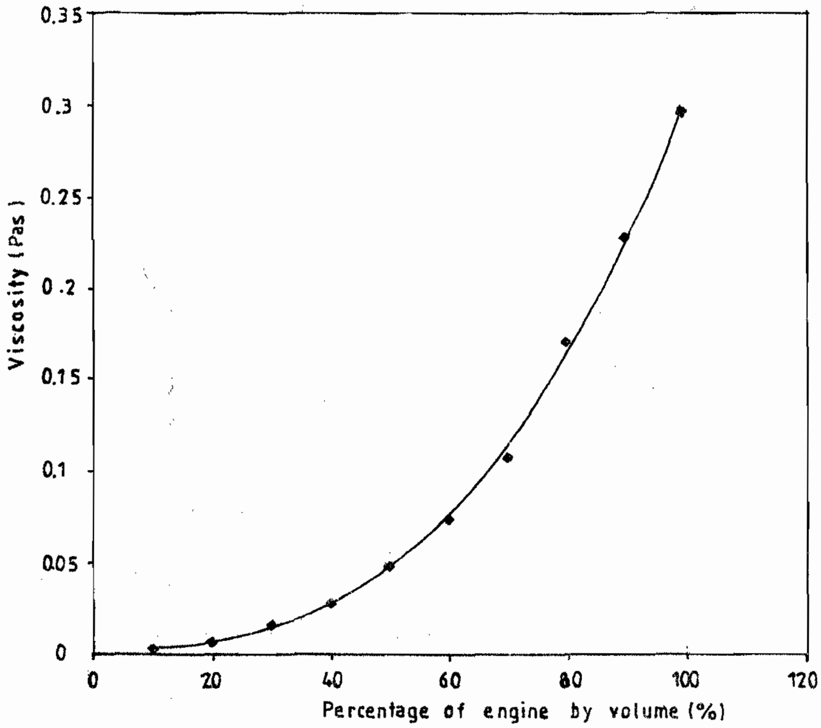


FIG. .1 Variation in Viscosity of engine oil-diesel mixture with Percentage of engine oil

Table 2: Model for determination of % engine oil (SAE 40) and diesel fuel in diesel adulterated engine oil sample at temperature of 301k.

| $R^2$ | Regression equations | |
|---|---|---|
| 0.9987 | $\eta = 2E - 07x_e^3 + 8E - 06x_e^2 - 3E - 05x_e + 0.0019$ | (1) |
| 0.9986 | $\eta = -2E - 07x_d^3 + 7E - 05x_d^2 - 0.008x_d + 0.297$ | (2) |
| 0.9921 | $\eta = 0.0059\, x_e^{2.34}$ | (3) |
| 0.9917 | $\eta = 0.32\exp(-0.038x_d)$ | (4) |

Note: The viscosity, η in eqn. (3) is in mPas η in eqns (1), (2) and (4) is in Pas.

Table 3: Comparing calculated values of Viscosity with the measured values using the developed models

| Test sample | Composition of sample | | Viscosity (mPas) | | | | |
|---|---|---|---|---|---|---|---|
| | Engine Oil % | Diesel Oil % | Measured | Calculated from Eqn 1 | Calculated from Eqn 2 | Calculated from Eqn 3 | Calculated from Eqn 4 |
| Oil sample | | | | | | | |
| 1 | 10 | 90 | 2.5 | 2.6 | 1.8 | 1.3 | 10.0 |
| 2 | 20 | 80 | 6.0 | 6.1 | 2.6 | 6.5 | 15.3 |
| 3 | 30 | 70 | 16.3 | 13.6 | 11.4 | 16.9 | 22.4 |
| 4 | 40 | 60 | 28.0 | 26.3 | 24.8 | 33.0 | 32.7 |
| 5 | 50 | 50 | 47.7 | 45.4 | 47.0 | 55.8 | 47.8 |
| 6 | 60 | 40 | 74.1 | 72.1 | 76.1 | 85.5 | 70.0 |
| 7 | 70 | 30 | 107.5 | 107.6 | 114.6 | 122.6 | 102.3 |
| 8 | 80 | 20 | 170.0 | 153.1 | 163.4 | 167.5 | 149.7 |
| 9 | 90 | 10 | 227.5 | 209.8 | 223.8 | 220.7 | 219.0 |

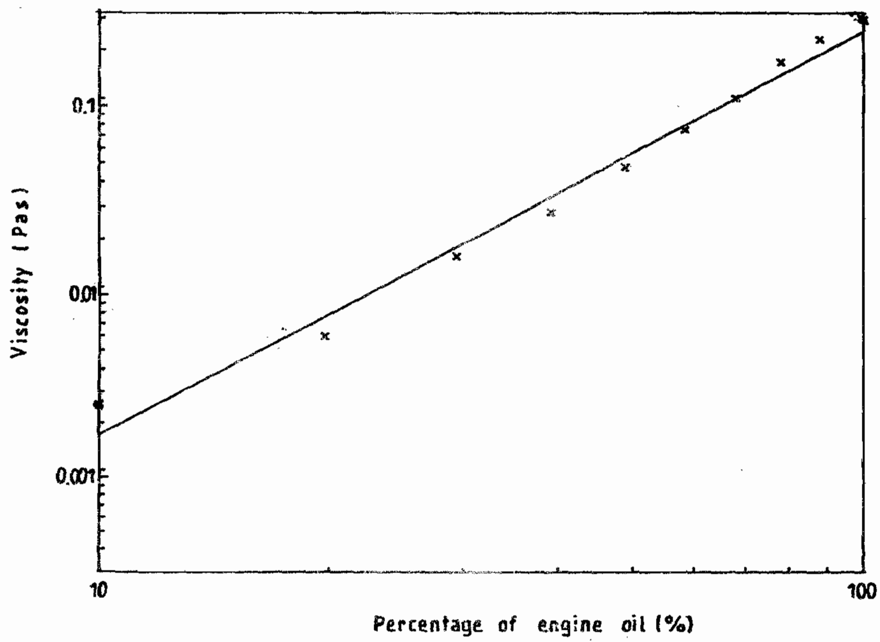


FIG. 2 Variation in Viscosity of engine oil-diesel mixture with Percentage of engine oil (using log-log scale)

predicting the percentage of diesel fuel in the same sample.

Comparing calculated values using our developed models with experimental (measured) values in table 3, regression function in eqn. 1 shows good agreement with measured (experimental) data. Equations (2) and (4) show

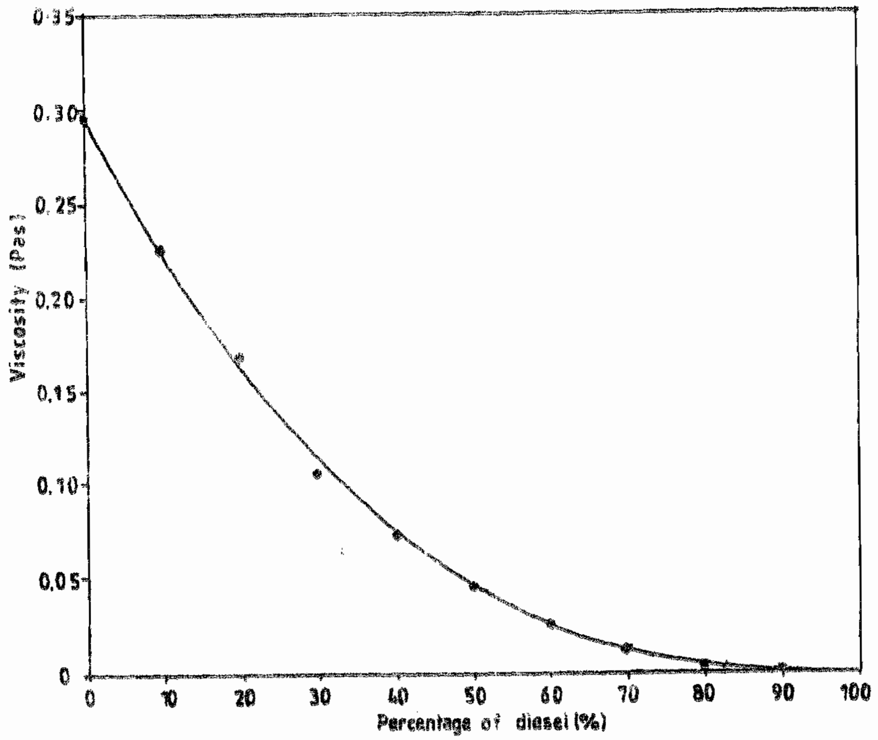


**FIG.3** Variation in Viscosity of engine oil-diesel mixture with Percentage of diesel fuel

good agreement with measured data at percentage engine oil higher than 40% or percentage diesel fuel below 60%.

## CONCLUSION

Regression models are presented for the engine oil (SAE 40) adulterated with diesel fuel at various percentage of adulteration. Best fits determined by high coefficient of determination were observed.

The function presented for the parameters in equation 1 should enable the determination of percentage engine oil, hence, percentage diesel fuel in engine oil (SAE 40) adulterated with diesel fuel, while equations 2 and 4 should be used for such determination for sample with percentage engine oil above 40% or percentage diesel fuel below 60%.

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