INVESTIGATION INTO THE USE OF VEGETABLE (PEANUT) OIL AS A POSSIBLE ALTERNATIVE TO HYDRAULIC BRAKE FLUID

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Abstract
There is a growing concern over the problem of biodegrability of hydraulic fluid especially when spilled or disposed and its non-renewable source. This research is aimed at investigating the use of peanut oil as an alternative to hydraulic brake fluid. In this research, nine samples with different proportions of hydraulic brake fluid and peanut oil were analyzed to determine the following properties; viscosity, kinematic viscosity, boiling point, density, specific gravity, flash point and fire point. The result of this analysis shows that the properties of unblended or blended peanut oil with hydraulic brake fluid conform to the required specification. Therefore, it is concluded that unblended or blended peanut oil with hydraulic brake fluid could be used as hydraulic brake fluid. The use of peanut oil could be said to have advantage over conventional hydraulic fluid because of its biodegradability in the environment and renewable source, while the blend of hydraulic brake fluid with peanut oil may improve the biodegradability of the mixture.

Introduction
Vegetable oil lubricants are emerging as an environmentally preferable alternative to established petroleum products. Vegetable oil can offer even better performance in some applications, with added benefits of being less toxic, renewable and biodegradable. Vegetable based oil pose greatly reduced threat to human health and the environment (King, 2001; Miller, 2012; Berth, 2008).

While the use of vegetable oil may be somewhat surprising at first, when examined in an historical context we can see that the compression engine first developed to a usable level of functionality by the French born Rudolf Diesel near the end of the 19^{th} century was originally designed to work on vegetable oil. In 1900, Rudolf Diesel demonstrated his new compression ignition engine at the world exhibition in Paris running on peanut oil. In 1911 he wrote "the engine can be fed with vegetable oil and would help considerably in the development of agriculture in the countries that use it". It was about this time that new drilling technology and exploration were developed and together this ushered in the age of cheap and plentiful fuels (Biodiesel, 2011).

Peanut oil is obtained from peanut crop. The seed of the peanut contains 40-45% oil. Peanut has traditionally being used as a source of oil (Singh, 1991). Its major component fatty acids are oleic acid (46.8% as olein), linoleic acid (33.4% as linolein), and palmitic acid (10.0% as palmitin) (Nutrient, 2011). Extraction of oil from peanut seed is done by pressing and then solvent extraction. The peanut oil extracted is not pure as it definitely contains unwanted minor which must be removed for better quality performance. Refining is a process of removal of unwanted components in oil (Macrae *et al*, 1997).

Hydraulic power is one of the engineers' most versatile tools for ensuring that adequate force is provided in places where more conventional power transmissions would have found the task difficult or impossible. Today hydraulic power is found in countless applications ranging from the operation of automobile brakes to the raising and lowering of control surfaces, flaps and landing gear on board aircraft (David, 2000; Philips, 2000). Hydraulic fluid is utilized in large quantities in a variety of applications and is susceptible to spillage. When spilled, they pose an immediate threat to the surrounding environment. Spilled oil can contaminate streams, kill vegetation and harm wide life and remediation is costly (King, 2001).

Consequently hydraulic industries have being working hard to develop new types of highly biodegradable and environmentally friendly fluid which can still do their jobs of transmitting power as efficiently as ever, but without the unwanted result of contamination caused by even the smallest accidental spillage (David, 2000).

Materials and Method

The samples used in this experiment are refined peanut oil and (conventional) hydraulic brake fluid. The refined peanut oil was obtained from Golden Nut Oil industry (a peanut oil processing industry) in Minna, while the hydraulic brake fluid was obtained from market outlet in Minna.

Sample Preparation

The hydraulic brake fluid and peanut oil collected were represented as x and y respectively. Nine samples represented as A, B, C, D, E, F, G, H and I were prepared (blended) with different proportions of x and y as follows:

Sample	**Composition %**		**Volume (cm^3)**	
	x	**y**	**x**	**y**
A	100	0	300	0
B	87.5	12.5	262.5	47.5
C	75.0	25.0	225.0	75.0
D	62.5	37.5	187.5	112.5
E	50.0	50.0	150.0	150.0
F	37.5	62.5	112.5	187.5
G	25.0	75.0	75.0	225.0
H	12.0	87.5	37.5	262.5
I	0	100	0	300

Determination of Viscosity

Procedure

The viscometer was charged with the sample and the suction was applied through the thicker arm. The sample was drawn up to the upper timing mark of the inverted viscometer. The thinner arm was wiped and the instrument turned to its normal vertical position. The viscometer was then placed into a holder and inserted into a constant temperature bath at 40℃ and 100℃ at which the sample viscosity was determined.

The sample was placed in the bath for about 10 minutes to come to the bath temperature at 40℃ and 15 minutes at 100℃ respectively. Suction was then applied to the thinner arm and the oil drawn slightly above the upper turning mark and the efflux time was obtained by timing the flow of the sample as it flows freely from the upper timing mark to the lower timing mark.

The kinematic viscosity was calculated by multiplying the efflux time in second by the viscometer constant (0.014).

Determination of Flash Point and Fire Point

Procedure

A test tube was filled to a specific level with the sample to be tested. The burner was set on to heat the sample rapidly initially and slowly as the flash point is approached. At 200°C a small swivel test flame application was passed across the centre of the test tube with a smooth continuous motion. At a point, the vapour above the surface of the sample ignited the test flame applicator and the temperature at this point was noted and recorded as the flash point.

The test was continued and at a certain temperature the flame caused the fluid sample to ignite and burnt continuously for about 5 seconds. The temperature at which this occurred was noted as the fire point.

Determination of Density and Specific Gravity

Procedure

A 50cm^3-measuring cylinder was weighed while empty. Then a given 50cm^3 of the sample was poured into the measuring cylinder and weighed. The difference between the weight of the empty measuring cylinder and weight of the cylinder with 50cm^3 of sample was found. The difference which is the weight of the sample was then divided by the volume.

Therefore density =

$$\frac{\text{Wt (g) of measuring cylinder with sample – wt (g) of empty cylinder}}{\text{Volume of sample}}$$

For the specific gravity, the same procedure above was applied for water at equal volume by subtracting the weight of the measuring cylinder with water from the weight of the empty cylinder to obtain the weight of pure water at the same temperature.

Therefore, specific gravity (S.G) =

$$\frac{\text{Weight of a given volume of sample}}{\text{Weight of equal volume of pure water at the same temperature}}$$

Determination of Boiling Point

Procedure

The sample was heated on heating mantle with a thermometer inserted in the sample until bubbles started to form, the temperature was noted and observed for any possible change when vapour starts to form. The temperature was recorded as the boiling point of the sample.

Results

The results obtained are presented in the Tables below:

Table 2: Efflux time of samples

Sample	Efflux time (sec)	
	40°C	100°C
A	75	55
B	94	58
C	113	61
D	123	83
E	140	105
F	152	115

G	163	125
H	180	149
I	189	172

Table 3: Kinematic viscosity, density and specific gravity of samples

Sample	KV(40) cm^2/s	KV(100) cm^2/s	Density g/cm^3	Specific Gravity
A	1.05	0.77	1.0142	1.025
B	1.32	0.81	1.0076	1.0194
C	1.58	0.85	1.0008	1.0136
D	1.78	1.16	0.9912	1.0055
E	1.96	1.47	0.9816	0.997
F	2.13	1.61	0.9476	0.963
G	2.28	1.75	0.9134	0.9392
H	2.52	2.09	0.9056	0.9326
I	2.65	2.41	0.8978	0.926

Table 4: Viscosity, boiling point, flash point and fire point of samples

Sample	V(40) g/cm sec	V(100) g/cm sec	Flash point (°C)	Fire point (°C)	Boiling point (°C)
A	1.065	0.781	202	211	161
B	1.326	0.818	207	219	162
C	1.583	0.008	209	221	164
D	1.762	1.154	214	222	165
E	1.924	1.443	219	226	165
F	2.015	1.526	220	230	170
G	2.084	1.600	221	237	173
H	2.282	1.880	226	238	173
I	2.476	2.160	228	241	175

Discussion of Results

Table 3 shows that kinematic viscosity was increasing as the proportion of the peanut oil increases in the blend. It is also observed that the kinematic viscosity of unblended peanut oil (2.758 at 40℃ and 2.408 at 100℃) is greater than that of the unblended hydraulic brake fluid (1.05 at 40℃ and 0.77 at 100℃).

Also on the same Table, the density is observed to be decreasing as the proportion of the peanut oil increases. This implies that unblended peanut oil (density of 0.8975) is less dense than unblended hydraulic brake fluid (density of 1.0142), however density of all the samples conforms to the specification of 0.85 to 1.057(Sunoco, 2001).

Table 4 shows that at 40℃, the viscosity was increasing as the proportion of peanut oil increases in the blend. The viscosity of the samples (A, B, C, D, E, F, G, and H), are observed to conform to the specification of 1.05 - 2.35 (Sunoco, 2001), except that of the sample I, but the variation is very small and can therefore be considered negligible. On the same table, at 100℃ the viscosities of the sample are observed to be increasing as the proportion of peanut oil increases in the blend. Viscosity of all the samples are observed to conform to specification of 0.8 - 2.25 (Sunoco, 2001).

The flash point and fire point of all samples on Table 4, are observed to be within the acceptable limit, that is all conform with the specifications of 190-330℃ and 205-250℃ for flash and fire point respectively. On the same table, boiling point of all samples are observed to also conform to the specification of 155-270^{o}C (Sunoco, 2001).

Conclusion

It is therefore concluded that unblended peanut oil or a blend of peanut oil and conventional hydraulic brake fluid could be used as a possible alternative to hydraulic brake fluid. The use of peanut oil could be said to have advantage over conventional hydraulic fluid because of its biodegradability in the environment and renewable source, while the blend of hydraulic brake fluid with peanut oil may improve the biodegradability of the mixture.

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