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Performance Analysis of Moringa Oil Used as a Brake Fluid in Mechanical Brake Systems

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ABSTRACT
This studyinvestigates the performance analysis of Moringa oil used as a brake fluid in mechanical brake systems. Experimental approach was used to determine the hydraulic properties of Moringa oil. The experimental test was carried out at various laboratory across the country. The experimental tests are: flash point, pour point, compressibility, boiling point, PH value, viscosity and actuating force of the oil. The study will determine whether Moringa oil can be used as a brake fluid by comparing the findings from the hydraulic properties of the oil with standard values of hydraulic brake fluids. The results for Flash Point, Boiling Point, Pour Point, Viscosity, PH, Density, Compressibility, Actuating force and Torque absorbing capacityare 282℃, 168℃, -10℃, 28.20mm^2/s, 5.2 and 1.005g/mol, 1540MPa, 3050N and 305Nm respectively. Properties like flash point, viscosity, boiling point, compressibility, actuating force, torque absorbing capacity and density are all within the ISO standard for hydraulic fluid, while additives will be needed in order to enhance pour point and PH of the oil.
Keywords: Hydraulic Properties, Actuating Force, Torque Absorbing Capacity

I. INTRODUCTION

Moringa tree (leaves, seeds, roots and flowers) are suitable for human and animal consumption. The leaves, which are rich in protein, minerals, β-carotene and antioxidant compounds, are used not only for human and animal nutrition but also in traditional medicine, Olson, M. E. (2010). The seeds, instead, have attracted scientific interest as M. oleifera seed kernels contain a significant amount of oil (up to 40%) with a high-quality fatty acid composition (oleic acid > 70%) and, after refining, a notable resistance to oxidative degradation, "Moringaoleifera". Germplasm Resources Information Network (GRIN), 2017. Indeed, Moringa oil could be a good substitute for olive oil in the diet as well as for non-food applications,Lea and Michael (2010) like biodiesel, cosmetics, and a lubricant for fine machinery. Moreover, after oil extraction, the seed cake can be used in waste water treatment as a natural coagulant, Kalibbala, et al., (2009).or as an organic fertilizer to improve agricultural productivity, Mpagi et al., (2012).

This project seeks to provide an alternative brake fluid that is reliable, efficient and provide optimal actuating force where all cars and vehicle users will have a better and cheaper brake fluid. The aim of this project is to investigate the hydraulic properties of Moringa oil (Moringaceae oil)which will be compared to an existing hydraulic fluid. The objective of this project is to determine the hydraulic properties of moringa oil, compare the actuating force (braking force) of this oilwith an existing hydraulic fluid and evaluate the torque absorbing capacity of the oil, which if established can be recommended as brake fluid in an internal expanding brake system.

Brake fluids are aimed at producing lubrication and sufficient torque absorbing capacity in an internal expanding brake system. The most available brake fluids here in Yola is DOT 3, hence there is a need to exploits more natural/organic sources of brake fluid with better quality, less toxicity and nonflammable than the existing ones.

This project when completed will provide an alternative brake fluid made locally and works efficiently. Alternative brake fluid may be a promising solution to industrial, innovation and infrastructural development to the nation. It will also solve the problem of health issues that the

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existing ones cause to the user. Moreover, it will provide employment and income to the society.
When this research is successfully completed, there will be an alternative brake fluid locally and will also have a solution to the problem of health issues affecting the users.
Our limitation is based on the determination of actuating force and hydraulic properties of Moringa oil (Moringaceae oil). Moringa (Moringaceae) comes in various species, but here we are focused on the specie MoringaOleifera.

II. MATERIALS AND METHODOLOGY

Quantities and Specie of Sample

Moringaof specie M. Oleifera is used for the extraction and experimental process. Five (5) liters of the oil is needed to be extracted from a substantial amount of the seeds.

Extraction of The Oil

Moringaoleifera seed oil can be extracted base on the traditional method, descried by Abu-futuh (2015) and Ramachandran (2013) as described below:

The nuts were cracked open and the kernels were obtained. The kernels were dried and grind into pure powder using pestle and motor. Water was added and the oil was collected with moisture after constant stirring and pressing to the walls of the container. The oils were finally heated to remove moisture and a good quantity of the oil extracted was recovered, Al Futuh, (2015).This method of extraction is also cost effective hence the less privileged can have the access to the oil for their small-scale soap production and for other uses.

Calculation

Actuating force is given by the equation below:

$$F_t = \frac{E}{\pi dNt} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots 1$$

Where, F_t is the Actuating force (N),
E is the energy absorb (J)
d is the diameter of the drum (m)
N is the speed of the drum (rpm)
t is the braking time (s)

$$\text{Torque } (T) = F_t \times r$$

$$= F_t \times \frac{d}{2} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots 2$$

Diameter of brake drum is 0.2m
Compressibility can be determined by:

$$\frac{\Delta V}{V_{initial}} = \frac{1}{\beta} P \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots 3$$

Where β is the compressibility in MPa,
P is the pressure applied in MPa (2.5MPa)

Equipment

Table 3.1 shows the equipment, models and location.

S/N	Equipment	Model	Location
1.	Viscometer Bath	Multi-span DTT 3000	ABY Lubricant, Kano State
2.	Seta PM-93 Flash Point Tester	D93A (C) closed cup tester	ABY Lubricant, Kano State
3.	Pour Point Analyzer	SETA-LEC	ABY Lubricant, Kano State
4.	Boiling Point Tester	MF3-18KR	Chem. Engr. Dept. ABU Zaria
5.	PH meter	H18424	
6.	Compressibility machine	1620H	
7.	Digital Weighing balance	OHAUS Adventurer Pro AV264	Chem. Eng. Dept. ABU Zaria
	Hydrometer		Chem. Eng. Dept. ABU Zaria
8.	Friction Testing Rig	FTR2000	Mech. Eng. Dept. ABU Zaria

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III. RESULTS

Table 1. Hydraulic properties of Moringa Oil

SN	Hydraulic Property	Value
1.	Flash Point	282℃
2.	Boiling Point	168℃
3.	Pour Point	-10℃
4.	Viscosity	28.20mm^2/s
5.	PH	5.2
6.	Density	1.005g/mol

Source: Experimental Data.

Table 2. Change in Temperature and Pressure at a given Time interval.

S/N	Initial Temperature (℃)	FinalTemperature (℃)	Change in Temperature (℃)	Pressure Applied (KN/m^2)	Time (Min)
1	30.0	33.0	3.0	78.5	5
2	33.0	35.0	2.0	98.0	10
3	35.0	38.0	3	98.0	15
4	38.0	40.0	2.0	117.6	20
5	40.0	43.0	3.0	117.6	25

Source: Experimental Data

IV. DISCUSSION

Flash Point is the temperature or point at which a flammable compound (fluid) gives off enough vapour to ignite in air. From table (1.1a). it can be deduced that Moringa Oil has a flash point of 282℃ whichsatisfies the ISO Standard for hydraulic fluids (160-336)0C.

Viscosity of oil is defined as the measure of its resistance to flow which is caused by internal fluid friction. Low viscosity oil flows freely while high viscosity oil flows sluggishly. From the result presented (Table 1.1a) the viscosity of Moringa oil is 28.20mm^2/s at 100℃ which is also withinthe ISO standard of viscosity (10.05 – 150)mm^2/s.

The pH value Moringaoil is 5.2 which is acidic. This value did not fall within ISO standards for pH value (7.0-14)

Moringaoil has a relatively high boiling point of 168, indicating that with a little rise in temperature Moringa oil will not boil i.e. it can be applicable at high temperature condition.

Pour Point is a property which describes the fluid ability to flow at low temperature. It is the lowest temperature at which the fluid ceases to flow. From the result in table 1, Moringa oil has a pour point of -10℃ which is a bit high and more work is needed to lower it further.

From equation 3, the compressibility of moringa oil is found to be 1540MPa which is within the ISO standard for hydraulic fluid.

From tables 2.1 the average change in temperature of moringa oil is 2.6^{0}C. This shows that the thermal conductivity of moringa oil is high which is good for hydraulic fluid.

From equations 1and 2, the actuating force and torque absorbing capacity of moringa oil are 3050N and 305Nm respectively. The value shows that Moringa oil possesses high actuating force which is also very good in brake fluids.

V. CONCLUSION

From the outcome of our work within this short period, we strongly believe (in the spirit of Engineering) that Moringa oil can be used as a cheap, available and locally produce fluid for braking system.

VI. RECOMMENDATION

Moringaoil is regarded as straight oil because there are no additives added to improve some properties that are necessary for brake fluid, considering this and other factors, the following are our recommendation.

1. Pour point depressant could be added at a proportion to reduce the outset of solidification at lower temperature.
2. In any system, it is believed that 15-20% of the power of the fluid is converted to heat, and properties like specific and thermal

conductivity of the fluid is expected to be high for effective heat transfer. From our readings, it is noticed that Aduwa oil dissipated heat more than Abbro DOT 3 indicating that Aduwa oil thermal conductivity is higher than that of hydraulic. Therefore, other properties of Aduwa oil should be worked on.

3. There is a need to improve the actuating force and torque absorbing capacity of Moringa oil for efficient braking to occur.

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