Influence of Mechanical Condition of Automobile on Road Safety: A Case Study of Brake Fluid Alternatives in Nigeria

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Abstract- ***Transportation plays a major and significant role in facilitating trade, commerce, and social interactions. In Nigeria, road is a major means of transportation. Over 80% of transportation in Nigeria is done by road. Road traffic accident is a major factor leading to death, disability and loss of man-hour. Many reasons are responsible for these accidents some of which include: state of roads, over-speeding, human error, drunk driving, mechanical condition of the automobile etc. these causes can be broadly classified into four namely: driver factor, vehicle factor, roadway and environmental factors. This paper examines the effect of the mechanical condition of the automobile vis-à-vis the brake fluid on the safety of the automobile on the road. It examines the various alternatives used by commercial drivers in the study area. Through selected experiments, we determined the brake oil properties such as specific gravity, viscosity, and efflux time and pH value of these alternatives. It recommends ways of enhancing safety on Nigerian roads.***

Indexed Terms- ***Transportation, road traffic accidents, mechanical condition, brake fluids.***

I. INTRODUCTION

Mobility is the cornerstone of modern society and the automobile is the principal means of mobility for most Nigerians. Road transportation in Nigeria is the major means by which people move from place to place as over 80% of transportation in Nigeria is done by road (Oni and Okanlawon , 2010). The world first road traffic accident was in 1869. It involved the death of an Irish scientist Mary Ward but today the scenario is more appalling as about 1.4 million people died and about 54 million people have sustained various degree of worldwide in 2013 (Davies and Jacqueline , 2016). Road traffic accident is a situation when collisions occur between a vehicle and any of the following: another vehicle, pedestrian (unprotected road user), animal, road debris or other stationary obstruction such as utility pole. "Road traffic accident may also be defined as anything which happens by chance, anything occurring unexpectedly and un-designed" (Agbonkhese, Yisa, Agbonkhese, Akanbi, Aka, & Mondigha)

Agbonkhese et al. identified four classes of road accident factors: driver factor, vehicle factor, road way factor and finally environmental factor. Road accidents can be as a result of these factors in isolation or a combination of the basic factors.

II. DRIVER FACTOR IN CAUSING ROAD ACCIDENT

All factors that have to do with the driver and other road users are included in this factor. Such will include whether the driver is under the influence of alcohol or drug. His visual, auditory and decision making ability, over speeding, driving above speed limit and too fast for the prevailing road condition, also disregard of road warning signs are all included in this factor. Driver factors solely contribute to about 57 per cent of road traffic accidents and 93 per cent either alone or in combination with other factors (Lum and Reagan1995).

III. VEHICLE FACTOR

Mechanical condition of an automobile vehicle and its design are important safety factors. Vehicles with air bags, seat belt and well maintained braking and

suspension system are safer than vehicles lacking these features.

IV. ROAD DESIGN AND MAINTENANCE

The causes of road traffic accidents are not just human error or driver negligence. The state of Nigerian road is also a contributory factor in road accidents. Unfortunately, Nigerian highways are arguably one of the worst and most dangerous in the world (Agbonkhese et al.,) (Eze, 2012).

V. ENVIRONMENTAL FACTORS

Weather condition such as fog, rain, mist and sun rays affects road users in no small way. Mist and fog diminishes visibility while rain reduces tire grip leading to vehicles skidding and may result in road accident**.**

VI. MECHANICAL SYSTEM MOST RELEVANT TO SAFETY

The following systems in automobiles are of the most relevant significance in relations to safety in connection with road transportation:

- Suspension system: The suspension system makes riding in the automobile smooth as it helps to damping the influence of uneven roads on the passenger and goods the automobile is conveying. It isolates the vehicle body from the bumping effect on the automobile by the unevenness the roads. Suspension can be divide into two categories firstly Axle Suspension System and secondly Independent Suspension System

(i) Dependent Suspension System: This is usually used in automobiles with beam axles. In light automobiles it is in conjunction with leaf springs. It is simple and relatively inexpensive. It demerit arise from the fact that the automobile tilts when the road wheel rises or falls because of unevenness of the road.

(ii) Independent Suspension System: A road wheel up and down movement have little or no effect on the other wheels and the automobile body as a result the automobile remains at more even and constant ride height.

Dampers (Shock Absorbers): Dampers enhances smooth ride in the automobile as it offers a fluid resistance to the movement of the suspension spring and absorbs the stored energy ensuring the road wheel does not bounce up and down rather remains in contact with the road surface (18Ma).

- Steering system: The steering system of the automobile control and direct the direction the automobile moves and consist of the steering linkage, steering box, steering column and steering wheel (Read And Reid, 2005).
- Braking system: The braking system helps to slow down or stop a moving automobile thus enhancing the driver's ability to maneuver the vehicle. Stepping on the brake pedal is actually pushing against a plunger in the master cylinder which pushes hydraulic oil (brake fluid) through a network of tubes and hoses to the braking unit of each wheel. How soon an automobile stops depend on the static friction between the road surface and the tyres (Charles,2004).

Brake fluid.

The brake fluid is designed in such a way that in extremely cold temperatures it will not thicken up and during hot weather with high temperatures it will not boil. Most common brake fluid has a boiling point of 230^{o}C, it is hygroscopic in nature and provides lubrication for moving parts (Charles).

VII. BRAKE FLUID ALTERNATIVES

A common practiced among commercial vehicle operators is to use alternatives to brake fluid because of the exorbitant price of automobile parts and the prevailing economic situation in the nation. Such alternatives includes: urine, palm wine, detergent (Busari and Ayeni, 2005)

VIII. METHODS

Survey was conducted among commercial drivers on safety, some demanded for money before responding, and some were uncooperative and elusive. Drivers because of economic situation tend to replace faulty mechanical parts only when inevitable. Literary level among the drivers is low.

The following experiments were conducted on:

i standard Dot3 brake fluid,
ii palm wine
iii urine
iv water and detergent mixes: a liter of water with three different concentration 0f detergent(a) 90g (b) 50g (c) 23.5g

The experiment was to determine their: specific gravity, viscosity, efflux time and kinematic viscosity

IX. THEORY

Specific gravity

$$specific\ gravity = \frac{mass\ of\ fluid}{mass\ of\ equal\ volume\ of\ water}$$

Where

$mass\ of\ specific\ gravity\ bottle = 26.50g$26.50g

$Volume\ of\ specific\ gravity\ bottle = 50.50cm^3$

$Mass\ of\ equal\ volume\ of\ distilled\ water = 50.50g$

Viscosity

Each fluid was allowed to flow through the viscometer and the efflux time noted with a stop watch and recorded. The calibrating fluid (kerosene) now flow through the viscometer and the efflux time also noted The pressure causing the flow decreases during the flow but the viscometer always contains some volume of liquid, the average difference of level (h) is always the same, hence for liquid of density, ρ_1 and ρ_2, the average pressure differences are $h\,\rho_1\,g$ and $h\,\rho_2 g$ respectively. Thus for a steady flow of the first liquid of viscosity η_1

$$\frac{V}{t_1} = \frac{\pi\, h\, \rho_1\, g\, r^4}{g\, l\, \eta_1}$$

For the second fluid η_2 $\frac{V}{t_2} = \frac{\pi\, h\, \rho_2\, g\, r^4}{g\, l\, \eta_2}$

(Tom, 1978)

Where $\eta_1 = known\ viscosity\ of\ liquid$

$\eta_2 = unknown\ viscosity\ of\ liquid$

t_1= time taken for the liquid to flow in the viscometer cometer

t_2=time taken for the liquid with unknown density to flow in the viscometer cometer

ρ_1=density of known liquid;

$\rho_2 = density\ of\ liquid\ of\ known\ viscosity$

$$\text{Kinematic viscosity} = \frac{absolute\ viscosity}{density\ of\ liquid}$$

Density of kerosene$\rho_{Kerosene}$= 0.78 gm^3

$\eta = 1.85$ centistokes

pH value of the brake fluids

A pH meter (digital) was used to determine the pH value of the brake fluid

X. RESULT

Table 1: Specific gravity, Efflux time, and Absolute and Kinematic viscosity of brake fluids

Code	Brake fluid	Specific gravity	Efflux Time (s)	Absolute viscosity(centistokes)	Kinematic Viscosity
A	Dot3	1.049	890.0	16.28	15.52
B	Palm wine	0.990	78.0	1.34	1.35
C	Urine	1.019	85.0	1.51	1.48
D	Water detergent (90g)	1.079	154.0	2.89	2.67
E	50g	1.043	150.0	2.71	2.59
F	23.5g	1.009	88.0	1.54	1.52

Table 2: ph of brake fluids

Code	Fluid	Ph value
A	Standard Dot3	5,96
B	Palm wine	4.20
C	Urine	5.29
D	Water detergent (90g)	7.02
E	Water detergent (50g)	7.01
F	Water detergent (23.50g)	6.77

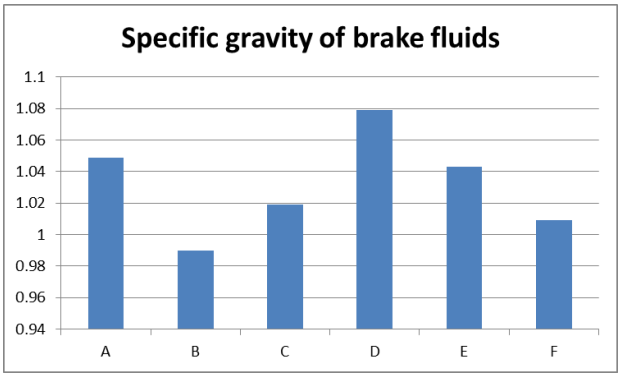

Figure 1: Specific gravity of brake fluids

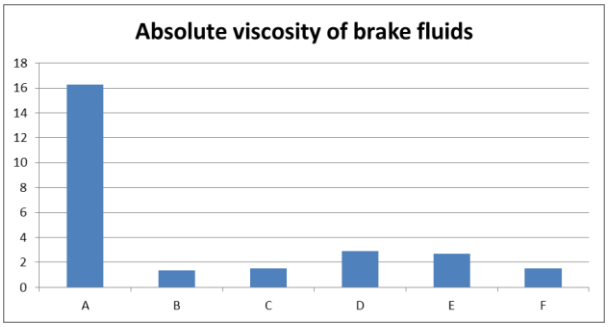

Figure 2: Absolute viscosity of brake fluids

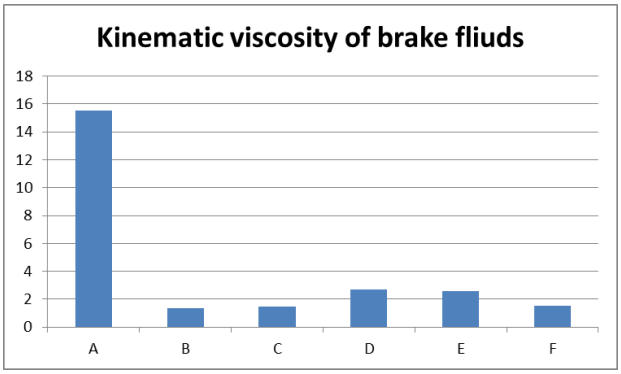

Figure 3: Kinematic viscosity of brake fluids

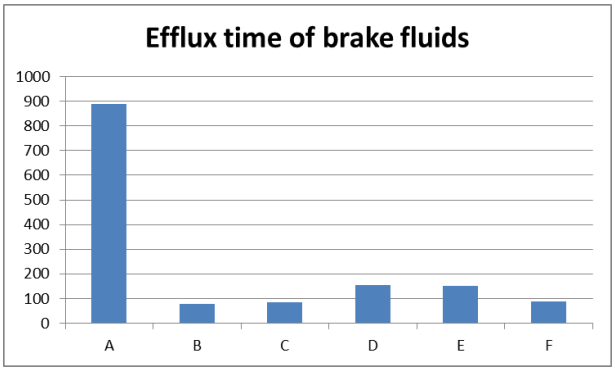

Figure 4: Efflux time of brake fluids

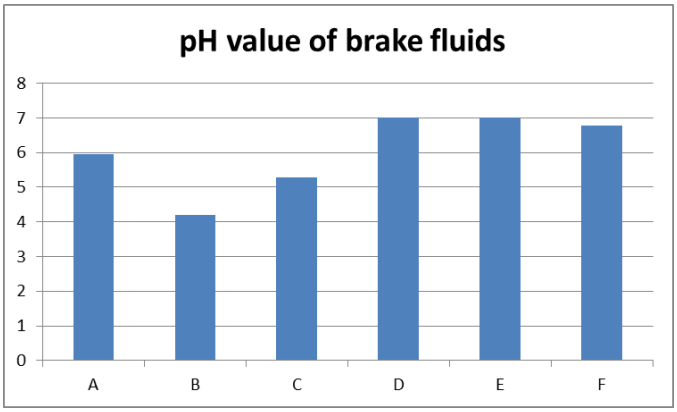

Figure 5: pH of brake fluids

XI. DISCUSSION

The nearness of the pH value of the alternatives might tempt one to make use of the alternatives.

A closer look at the remaining charts shows a wide difference in the viscosities (absolute and kinematics) of the standard Dot3 and the other alternatives. Therefore the alternatives must not be used. Standard Dot3 has the following advantages over the alternatives being used:

1. it has least water content
2. it is chemically stable and non-reactive
3. it does not affect the metal parts of the brake system does not affect the rubber seals

CONCLUSION

The investigation into the influence of mechanical condition of automobiles on road safety has shown that the mechanical condition of automobile has a great influence on road safety.

The use of original equipment manufacturers (OEM) part is a necessary factor in maintaining and ensuring safety on our roads.

RECOMMENDATIONS

From the fore going the following are recommended to improve the safety on our roads:

1. Traffic education should be improved upon. This a conscious training of all road users including drivers, motorcycle riders in areas including

a) Knowledge of road traffic laws and highway codes

b) Comprehension of roads signs and traffic signals
c) Respect for road users
d) Respect for traffic control officers and their directives
e) Periodic training for commercial drivers with scientific facts regarding alternatives they usually adopt

2. Introduction of a mandatory mechanical inspection program (MMIP).
3. Communication with commercial drivers and other road users must be in their local dialects.
4. There is the need to encourage the use of original equipment manufacturer (OEM), hence the need to subsidize these parts and encourage local manufacture.

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