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Aspergillus flavus: A degrader of commercial brake fluids

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Abstract

The role of; *Aspergillus flavus* during the deterioration of brake fluids; was identified. The impact of; *A. flavus* on used and unused brake fluids; were studied. This research was carried out at the University of Port Harcourt from September 2019 to November 2020. Abro and Jenox DOT3 brake fluids were the samples used for this research. The sample included their unused and used counterpart. Tests to identify microorganisms and physico-chemical parameters; were done. Total viable count, pH and optical density; were tested to check for the level of biodeterioration. Biodeterioration rate was more in Jenox brake fluid than Abro brake fluid. *Aspergillus flavus* is a major biodegrader in the brake fluid samples. Total viable count and optical density increased as the days progressed during biodeterioration while pH decreased. Brake fluid is an essential fluid needed by most vehicles to function. It is necessary to top-up brake fluid or substitutes; at the appropriate time. No two brands of brake fluid are the same. Therefore, it is advisable not to mix.

Keywords: *Aspergillus flavus*; Jenox and Abro brake fluids; Total viable count; Optical density; pH.

1. Introduction

Brake fluid is a type of hydraulic fluid. Hydraulic fluid or hydraulic liquid is; the route through which power and heat; are linked to a hydraulic machine and its management. Significant hydraulic fluids appear like mineral oil or water [1]. Some instruments may utilise hydraulic fluids such as excavators, hydraulic brakes, power steering apparatus, automatic transmissions, garbage trucks, aircraft flight control systems, lifts, and industrial machinery [2]. Brake fluid is a satisfactory sealing channel, Lubricant, enhances pump efficiency, has a rare purpose, should be environment friendly, and have a good shelf life. Brake fluid is; formed from different types of; glycols and is typically a blend of non-petroleum and other alcohol-based fluids. It is fundamental for brake fluid to conserve certain qualities. It is vital; to change brake fluid every two years and to; avoid leaving the cap of the reservoir for a longer time than necessary [3].

A typical brake fluid incorporates base stock, additives and other integrants [4]. Brake fluid can relay the force from a pedal to the wheel brakes [5]. The fluid; should also not cause harm to rubber seals and other parts of the brake system. Therefore, the fluid; should be able to curb rust and wear. Brake fluid can resist high temperature; otherwise, it may produce boiling. As the brake fluid boils, it yields vapour locks; that hinders vibrations from the brake to reach the wheel brakes, leading to brake failure.

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There are three predominant types of brake fluid; DOT3, DOT4 and DOT5. The DOT3 and DOT4 fluids are glycol-based, and the DOT5 is silicon-based. The glycol-based brake fluid absorbs water, but the silicon-based fluid does not suck up water. Absorption of water; contributes to a decrease; in the boiling point of the; fluid. Absorption of water begins when the containers of the brake fluids; are not sealed tightly, thereby exposing such containers to air [6].

This research was targeted at confirming the effect of *Aspergillus flavus* in brake fluids and also on how the fungi affects the pH, viscosity and Total viable counts of the samples.

2. Material and methods

2.1. Sample Collection

Abro and Jenox brake fluids were the samples for this research. With the aid of a syringe, the required volume of; used brake fluids; was withdrawn; into a sterile bottle. They; were taken from cars that had utilized them for more than six months. On the other hand, Unused brake fluids were bought; directly from the store. Cultural characterization of microbial isolates was achieved according to; Okpokwasili and Okorie (1988) [7]. *Aspergillus flavus* is the microbial isolate that; was used; for inoculation.

2.2. Fungal Isolates in the Brake Fluids

This research aimed to assess the contrast in the attributes of the brake fluids that were in connection to their usage by pure microorganisms. The medium used for this test was mineral salt broth; which includes; deionized water at 1 litre, NaCl at 10 g, $MgSO_4.7H_2O$ at 0.42 g, KCl at 0.29 g, KH_2PO_4 at 0.83 g, $NaHPO_4$ at 1.25 g, $NaNO_3$ at 0.42g and pH at 7.2 [8]. The medium; was apportioned at 99ml volumes into four 250 ml Erlenmeyer flasks. The sample; was added to two of the flasks. One flask had; used or unused while the other flask served as control [9]. After the autoclaving of the flasks at 121 ∘ C for 15minutes, they were allowed to cool. Then, they; were inoculated with the microorganism. However, the control flasks were uninoculated. The flasks; were placed in a rotary shaker which aided incubation at room temperature (30 ∘ C) at 140 rpm for 21 days. Variables such as; optical density, total viable count, and pH; were checked. Readings for; optical density were taken at 560 nm while values for; total viable count and pH were; taken at day 0, day 3, day 6, day 9, day 12, day 15, day 18 and day 21. Normal saline; was used for serial dilution, and Nutrient agar supported the growth of microorganisms.

2.3. Viscosity testing

A Canon-Fenske 150/601B viscometer; was employed to check the temperatures and flow rate of fluids at low and heated temperatures. The fluids contained; in a beaker were heated over flame [10].

3. Results

Abro brake fluid; is produced by Abro Industries, Inc., United States of America, while Jenox brake fluids; were made in U.A.E. Unused fluids were colourless. The change in colour of brake fluid to Amber occurred as the fluid; was utilized by microorganisms. Used brake fluids were cloudy and had sediments at the bottom.

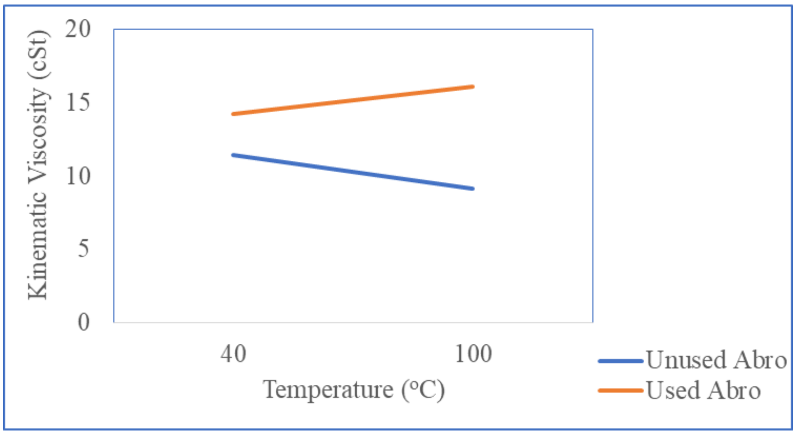

Figure 1 Viscosity against temperature of Abro brake fluid

Figures 1-2 are graphical illustrations of the viscosities of Abro and Jenox brake fluids. At 40 ◦ C, unused Abro brake fluid had a viscosity of 11.45cSt, and at 100 ◦ C, it had a Viscosity of 9.17cSt. The; viscosity of used Abro brake fluid was 14.26 at 40 ◦ C and 16.10 at 100 ◦ C. For unused Jenox brake fluid, at 40 ∘ C, it was 13.63 and 10.88 at 100 ◦ C. The Viscosity of used Jenox at 40 ∘ C was 15.39, and at 100 ◦ C, it was 16.47.

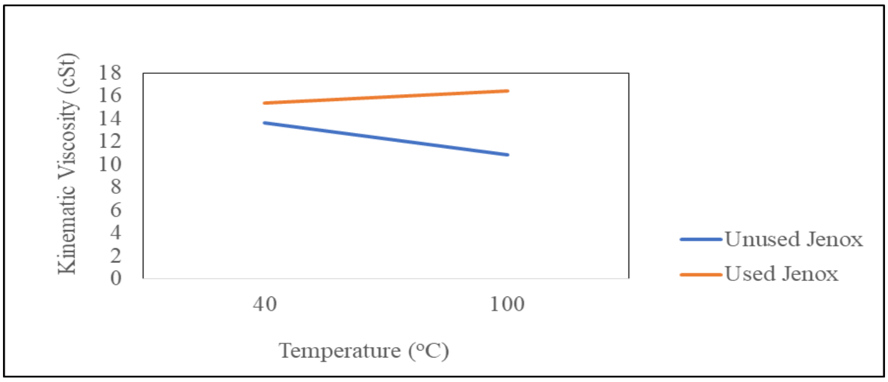

Figure 2 Viscosity against temperature of Jenox brake fluid

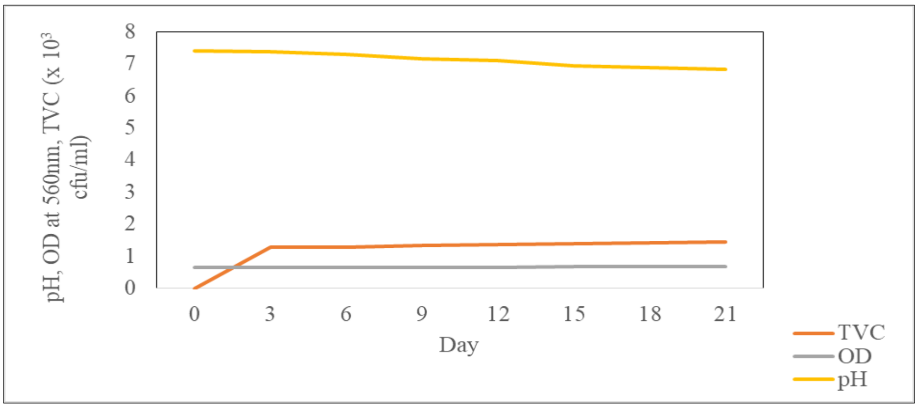

Figure 3 Growth profile of *A. flavus* in unused Abro brake fluid

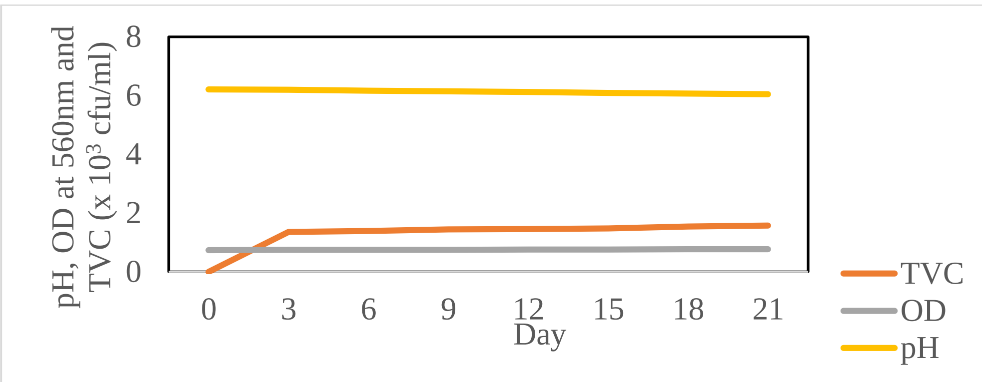

Figure 4 Growth profile of *A. flavus* in used Abro brake fluid

Figures 3-8; are graphs that represent the values from total viable counts, pHs and optical densities from *A. flavus*. The range for data from the brake fluids is as follows; from *A. flavus* in unused Abro brake fluid; the total viable count was 0 - 1.44 $x10^3$, pH was 7.41 - 6.82, and optical density was 0.637 – 0.673. The total viable count from *A. flavus*; in used Abro brake fluid was from 0-1.57 x 10^3, pH was 6.21-6.04, and optical density was 0.735-0.765. The control sample of unused Abro brake fluid had a total viable count of 0-1.32 x 10^3, pH was 7.57- 6.84, and optical density was 0.222- 0.261.

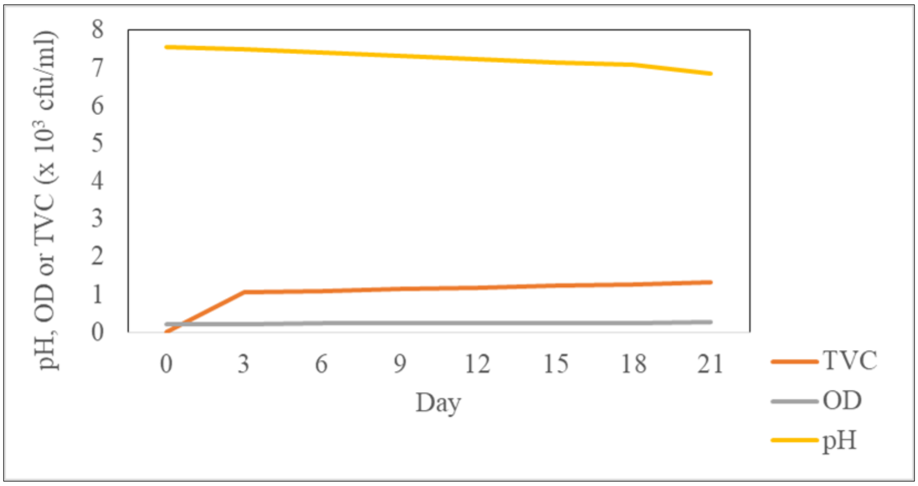

Figure 5 Growth profile of Abro brake fluid control

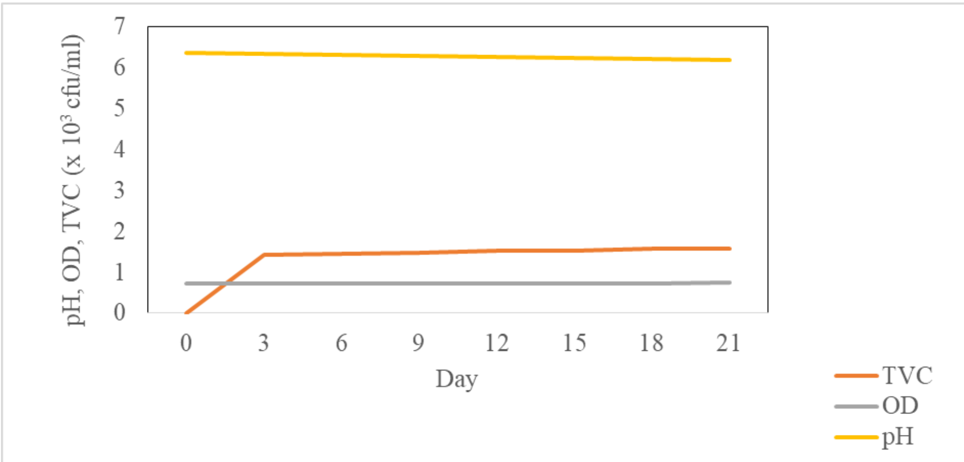

Figure 6 Growth profile of *A. flavus* in unused Jenox brake fluid

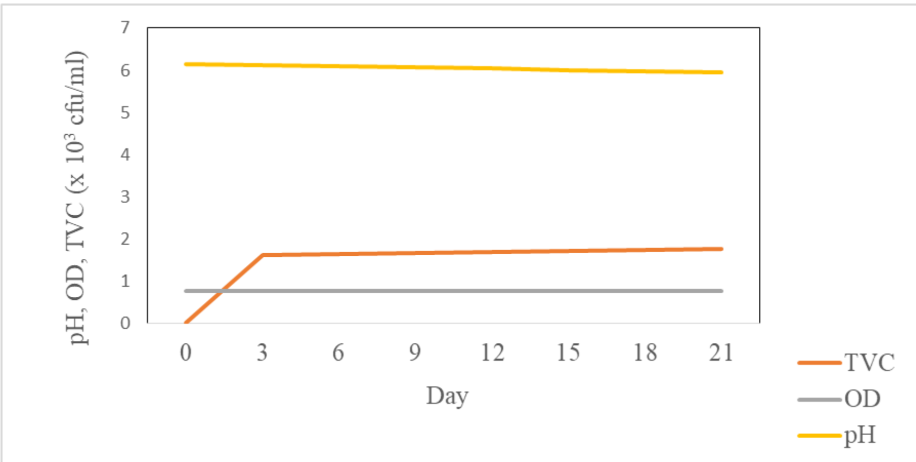

Figure 7 Growth profile of *A. flavus* in used Jenox brake fluid

The total viable count of; *A. flavus* in unused Jenox brake fluid was 0 - 1.59 x10^3, pH was 6.37- 6.2, and optical density was 0.722– 0.741. The total viable count from *A. flavus* in used Jenox brake fluid was from 0-1.77x10^3, pH was from 6.15- 5.94, and optical density was 0.751- 0.771. The control sample of; unused Abro brake fluid had a total viable count of 0-1.34 x 10^3, pH was 7.54- 7.43, and optical density was 0.241- 0.266.

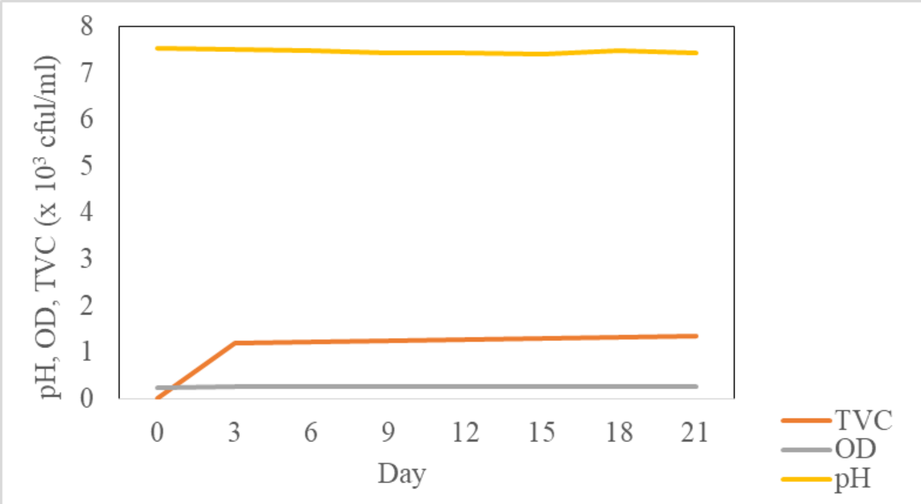

Figure 8 Growth profile of Jenox brake fluid control

4. Discussion

The morphology of *A. flavus* enables it; to adequately thrive in brake fluid; its hyphae and conidiophores are major body parts that support its ability to deteriorate brake fluids. *A. flavus* grows (rapidly) and survives various temperatures. That may suggest its ability to degrade brake fluids at (a swift) rate and to thrive at different temperatures. *A. flavus* play an active role in biodeterioration, spoilage or biodegradation [11;12; 13; 14].

There is usually a difference in colour between the Unused brake fluid and used brake fluid. Colour change in brake fluid may occur from; thermal stress and oxidation. Colour change does not necessarily mean that the brake fluid; should be substituted with a new one. Oxidation occurs when oxygen reacts with brake fluid's, while thermal stress could be a result of heat [15]. Temperature can promote a change in the colour of brake fluids which may designate; biodeterioration.

The change in colour of brake fluids may be in association; with turbidity, sediments and may possess a bad smell. These could enhance the proliferation of microorganisms in the; fluid, and maybe the contrast is used and unused brake fluid [16]. It could be that the microorganisms present in the brake fluid can utilize it [7].

From the figures, while the temperature increased, the viscosity reduced. Temperature plays a fundamental role in biodegradation. There is a relationship between temperature and viscosity; as the temperature increases, the brake fluid becomes thinner [17]. That means that biodegradation advanced at rising temperatures [18], and its rate could be higher in used brake fluid than unused brake fluid. Viscosity is a significant parameter for brake fluid. A reduction in viscosity of brake fluid represents biodeterioration [19].

The progressive rise in optical density in brake fluid could arise from the activities of microorganisms in the; fluid. The expressions of; microorganisms may promote the growth; and spread of microorganisms which can lead to an increase in total viable count. The higher the number of microorganisms in brake fluids, the more biodegradation [20]. One of the activities of microorganisms is the use of brake fluid as its food. During this process, microorganisms break down brake fluid and feed on it. The broken-down brake fluid provides energy and carbon to microorganisms [7; 21]. The continuous breakdown of brake fluid together with all other activities of; microorganisms leads to; the cloudiness of brake fluids observed as optical density. When the total viable count and optical density increase, the pH reduces. This reduction in pH provides an environment that enables the microorganisms to thrive. Consequently, the reduced pH is from the products formed after biodeterioration or biodegradation [7].

5. Conclusion

This research has shown that *Aspergillus flavus* can survive in brake fluids and is probably the cause of; brake fluid problems encountered in vehicles. Issues such as failure of brakes and blocked filters could arise as a result of contaminated brake fluids. Adulterated brake fluids reduce the quality and efficiency of brake fluids.

The survival of microorganisms in brake fluid is; largely dependent on the stability of the; fluid and the nutrient it contains. When a microbe; is introduced into an environment that has its requirements for survival, it thrives faster and better; but when the energy source depletes, the growth rate of the microorganisms reduces. There is also a reduction in microbial growth when there is a change within the microorganism's habitat.

Aspergillus flavus has proven to be a great degrader of brake fluid. *A. flavus* in the presence of other factors could hasten the degradation and deterioration of brake fluids. When *A. flavus*; is identified in brake fluid, the contaminated fluid has its viscosity, pH, and other parameters of the fluids altered. The microorganism grows rapidly under such conditions which are observed in the total viable counts and optical density because the brake fluid becomes more turbid.

Compliance with ethical standards

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Disclosure of conflict of interest

Authors have declared that there are no competing interests.

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