Effect of additive addition in base oil of a lubricant – A Review

Kavindra Singh[1], Amit Suhane[2]

[1] *M-Tech Research Scholar, Mechanical Engineering, M.A.N.I.T, Bhopal, M.P. India*

[2] *Assistant Professor, Mechanical Engineering, M.A.N.I.T, Bhopal, M.P. India*

Abstract - *The usage of heavy machines is common these days in the industries and the machines are subjected to heavy wear and tear. Such wear and tear can be minimized by the usage of the lubricants which would reduce the friction between the surfaces and will ensure smooth working thus would reduce the chances of failures and increase availability of the entire system. Some elements are found in the nature which when mixed with other lubricants would enhance their properties, these are called additives. The paper aims to study the effects on the lubrication properties like frictional behavior, temperature rise, lubrication film stability, wear resistance by surface of the base oil on the addition of suitable additives like jatropha oil, viscosity modifiers, extreme pressure additives and nano- particles like silicon oxide in it in different blend ratios and based on these results the suitable mixture of the base oil and the additives are decided depending on the application of the lubricant so that a better option is available as a lubricant under the same operating conditions*

Key Words: Tribology, wear, lubricants, additives, maintenance.

1.INTRODUCTION

Tribology is the study of two surfaces which are in relative motion with each other. It is a science of managing and controlling friction, wear and lubrication.

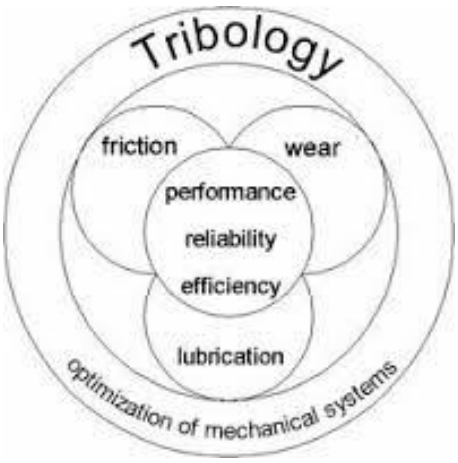

Fig.1 Tribological System [14]

This friction and wear are responsible for:
(i) Failure of mechanisms in different components like gear, bearing etc. which is part of a mechanical system.
(ii) Energy losses which may occur due to high friction between the surfaces in interaction. A rough estimate of 1/3 of the energy of fuel gets waste in the frictional losses. [13]

The most effective technique to overcome the above mentioned issues is lubrication. Lubricants are the fluids that are introduced between the surfaces in relative motion so as to ensure smooth operations in that system. It acts as an anti-friction media, ensures smooth working thus reducing the risk of undesirable failures. These lubricants are classified on the following basis: [4]

1.1 Physical Appearance

(a) Solid: Film of solid material composed of organic or inorganic compounds like graphite, molybdenum disulphide etc.
(b) Semi solid: Liquid suspended in solid matrix of additives and thickener like Grease.
(c)Liquid: Petroleum oil, Vegetable oil, Animal oil, synthetic oil etc.

1.2 Base Oil Resource

(a)Natural Oils derived from animal fats and vegetable oils.
(b)Refined Oils derived from crude / petroleum reserves like paraffinic, napthenic or aromatic oils etc.
(c)Synthetic Oils synthesized as an end product of chemical reactions which are tailored as per needs like Synthetic esters, polyalphaolefines etc.

1.3 Applications

(a)Automotive Oils used in transportation and automobiles like engine oils, transmission fluids,gear box oils and hydraulic fluids etc.
(b)Industrial Oil used for industrial purpose like machine oils, compressor oils. Metal working fluids and hydraulic oils etc.
(c)Special Oils used for special purpose as per specified operations like process oils,white oils, instrumental oils etc.

The selection of the lubricant is done on the basis of the load, speed, temperature conditions and environmental impacts of it. The different functions of the lubricant are:

- Reduction in the friction and wear.
- Reduction in corrosion.
- Removal of heat.
- Reduction in the contamination.
- Prevents deposits on the surface.
- Transmission of power.
- Provides seal.
- Neutralize combustion products. [12]

One of the apparatus to test the functioning of the lubricant is a modified four ball tester machine which uses the four steel balls at a given condition of load and speed (r.p.m.) with lubricant in between them. The four-ball wear tester has evolved as one of the primary tools for the evaluation of friction and wear of fluids and materials [16]. The point contact interface is obtained by rotating a 12.7mm diameter steel ball under load against three stationary steel balls immersed in the lubricant. The speed of rotation, temperature and the normal load can be adjusted in accordance with published ASTM standards. The anti-wear characteristics of the lubricant are evaluated measuring the subsequent wear scar diameters on the balls. To evaluate the load-carrying capacity of lubricants, the normal load at which welding occurs at the contact interface is measured. The setup of the machine is depicted below: [14]

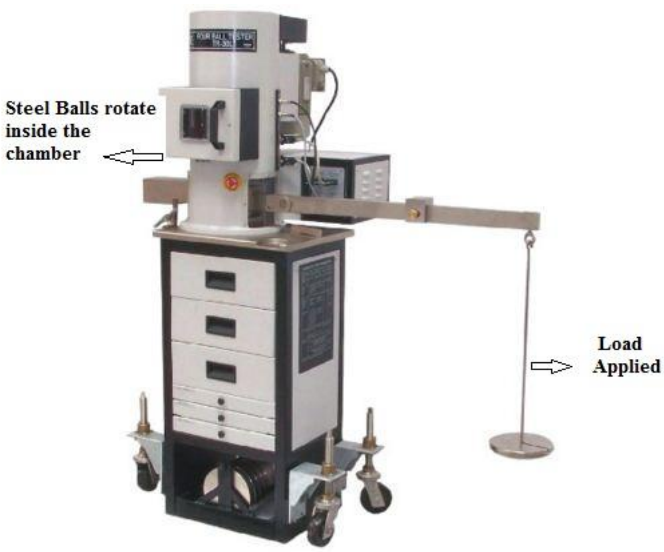

Fig.2. Four Ball- Testing Machine

The different properties of the lubricants that help in accomplishing the aforementioned functions are density, viscosity, pour point, viscosity index, flash point, fire point, cloud point, surface tension, oxidation stability, neutralization, acid value, environmental capability. [3]

There are materials which when added in the lubricants bring about a change in their physical and the chemical properties and these materials are called additives [10]. The addition of these gives better results and that too in an economical way as compared to refining of the lubricant alone. These additives are classified as per their intended functions. The classification is as follows: [12]

1. To protect the base oil
   - Antioxidants.
   - Corrosion and rust inhibitors.
2. Improvement in the base oil performance
   - Pour point depressants.
   - Viscosity index improvers.
3. Protects the lubricate surface
   - Anti-wear and EP additives.
   - Antifoaming additives.
   - Detergents and depressants.
   - Friction modifiers.

2. Research Approaches on effect of additives on the base oil:

A. Imran [1] used SAE 40 as the base lubricant and blended jatropha oil in it as an additive in percentages varying from 10% to 50% for the defined conditions of load and speed and used the Cygnus friction and wear test apparatus .It was experimentally concluded that the 10% jatropha blended lubricant (JBL) has lowest wear as similar to SAE40, JBL 10 and JBL 30 have similar coefficient of friction which was lower than other blend ratios and JBL 10 shows the minimum temperature rise in the lubricant.. It is thus observed that this blend is effective in lower percentages..

Amit Suhane [2] analysed castor oil blended with mahua oil as an additive as a lubricant in automotive application in comparison to servogear oil. The blends of castor and mahua oil samples was prepared varying from 10% to 50% by volume It was found that the gear oil and castor oil have higher coefficient of friction as compared to the blend of castor and mahua oil. The scar diameter was minimum in case of the blend in equal proportions and the temperature bearing capacity of the blend was much better as compare to the gear oil and castor oil. Thus it can be concluded that castor oil and its blend have better lubrication potential as compared to servo gear oil.

J.E. Johansson [7] experimentally analyzed the effect of addition of different anti-wear, EP additives and viscosity modifiers in the mineral based oils in different proportions and their result on the pitting life of mineral oils was analyzed in comparison to the unblended mineral oils which resulted in a higher life for the additive mixture.

Hongmei Xie [6] made a research on the manganese alloy/steel contacts without any additives and these results were compared with that on adding MoS_2 and SiO_2

nanoparticles as additives and an improvement in the Tribological properties was observed. The load carrying capacity, lubrication film stability was enhanced and a suitable reduction in the coefficient of friction was concluded.

Sheida Shahnazar [14] analysed different metal nanoparticles like Fe, Co, Cu individually as well as their mixture when added to SAE 10 oil and found that Cu nanoparticles has the most effective wear resistance and concluded that the mixture of the nanoparticles is much more effective.

Mohd. A. Abdullah [9] used the mixture of the lubricants and analysed wear reduction. The oil used were heavy duty engine oil (HDEO) and automatic transmission fluid (ATF).On the basis of experiments the mixture were compared in terms of coefficient of friction, wear scar diameter, viscosity index for wear reduction and was concluded that mixture with 20%- 40% ATF gives best friction resistance and the mixture of 30% composition gives better results for wear resistance.

R. Dinesh [11] analysed the zinc oxide nanoparticles in volume fraction of .005%,.02% added in SAE20W40 engine oil for tribological properties like wear resistance, coefficient of friction, viscosity, flash point, and compared that with the plain engine oil and concluded that kinematic viscosity of the oil increased and a remarkable improvement in the operating characteristics and lubrication action is observed.

Obasi [10] experimentally analysed the effects of introducing additives (B023233) and viscosity modifier (B23333) in the base oil (neutral solvent) on the properties like viscosity, density, flash point, foaming ability and concluded that properties like viscosity, density, flash point have significantly improved and there is a decrement in the foaming ability of the base oil.

David W. Johnson [5] analysed phosphate esters, thio-phosphate esters and metal thio-phosphates as anti-wear and EP additives in lubricants and concluded that an effective coating of phosphate esters with sulphur metal added reduces the friction and wear at the surfaces in contact.

Magdi F. Abadir [8] use the viscosity index improving additives i.e. 3 esters having different alkyl length and added it to the lube oil SAE30 and concluded that the additives were completely soluble in the lube oil and they improved the viscosity index of the lube oils and thus reduced the friction and wear traits at the contact surfaces when use a lubricant .

3. CONCLUSIONS

A brief of tribological systems, lubricants along with their types, functions and selection criteria, additives and their classification on the basis of their functions have been discussed in the paper. The review work is solely to identify different additives that could be added to the lubricant (base oil) under a given set of operating conditions. The conclusion can be summarized as follows:-

(1) Addition of additive is intended to achieve improvement in the basic property of lubricant.
(2) The aim should be to reduce ecological pollution by maintaining technical standard of operation and system efficiency.
(3) Extensive research needs to be carried out in exploring potential of variedly available vegetable crops and oil.

So that appreciable improvements in the antifriction and wear performance together with possible reduction in the emissions so as to make the process eco- friendly.

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BIOGRAPHIES

Kavindra Singh holds a Bachelor's Degree in Mechanical Engineering from UPTU Lucknow, Uttar Pradesh and pursuing M.Tech. in Mechanical engineering (Maintenance engineering and management) from Maulana Azad National Institute of Technology, Bhopal, Madhya Pradesh (India).

Dr. Amit Suhane holds a Master's Degree from IIT-D and a PhD. Currently, he is working as an Assistant Professor in the Department of Mechanical Engineering, MANIT, Bhopal, Madhya Pradesh (India) with specialisation in Industrial tribology, machine dynamics, maintenance engineering and automotive applications. He has contributed a significant number of research papers at the international level.