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Development and testing of novel lateral force-controlled tribometer to evaluate the Stribeck curve

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In a lubricated tribosystem, the Stribeck curve is a convenient method to study all regimes of lubrication. The Stribeck curve can be used as a proper method to explain the lubricity. A novel force-controlled tribometer has been developed, and it can generate the Stribeck curve from a single experiment. The experiments were conducted on flat-on-flat contact over a range of velocities and measured the coefficient of friction with a higher resolution. Hexadecane and Hexadecane + 1% Steric acids were the lubricants used. The results support the fact that Steric acid is an efficient boundary lubricant additive.

Keywords: Stribeck curve, tribometer, force controlled, flat-on-flat, boundary lubrication

1. Introduction

In today's world, it is significant to use the available resources much effectively. Lubrication plays a vital role in the efficient use of resources and helps to attain a more cost-effective operation. With the help of the Stribeck curve effectiveness of the lubricant can be explored [1]. Stribeck curve is an appropriate method to study all regimes of lubrication. Understanding the nature of the Stribeck curve is an essential aspect to investigate all regimes of lubrication. The properties of a lubricant change exceptionally as the lubricant regime changes.
Currently, the majority of the experiments conducted to determine the Stribeck curve are in lateral displacement-controlled mode. Nevertheless, in real cases, many of the systems are lateral force-controlled. A novel lateral force-controlled tribometer has been developed, and it can generate the Stribeck curve from a single experiment. It was possible to record the measurements with a higher-resolution as the test undergoes through zero velocity. The high-resolution measurements at these points help to study the boundary lubrication regimes in greater depth. The absence of any stiffness altering sensors and higher stiffness of the tribometer ensured a very accurate frictional force measurement.

2. Methods

All the tests were carried out on flat-on- flat contact. The tribometer has the provision to adjust the dimensions and shape of the pin according to our requirements. Obtaining perfect flat-on-flat contact between the contacting surfaces is the main problem encountered while conducting these experiments. The Gimbal mechanism present in the pin holder minimizes this issue. The Gimbal mechanism assures a perfect flat-on-flat contact between the pin and the specimen. Here, the experiments' operating parameters were maximum sliding distance and sliding speed, the temperature of the lubricant, lubricant additives, sliding element material, sliding angle, normal load, and the roughness of the pin and specimen. These were fixed before starting each experiment. The normal load is kept constant and set to a value of 10 N. Energy method is used to find out the coefficient of friction, which ensures higher accuracy in the measurement. Figure 1. Show the obtained graph for the hexadecane test. A capacitive transducer is used to find out the lubricant film thickness.

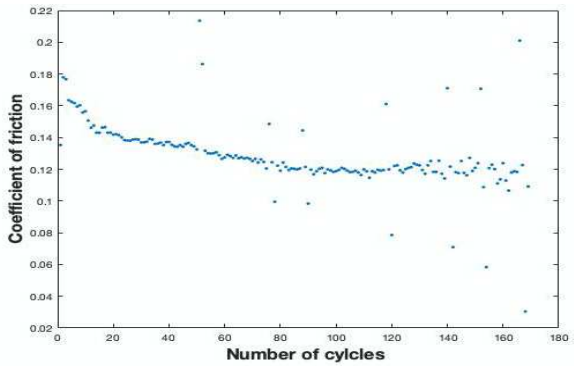

Figure 1: Coefficient of friction versus number of cycle graph for hexadecane.

3. Results and Discussion

The obtained Stribeck curve had a higher resolution. All the tests conducted were in the boundary lubrication regime: the lambda value, i.e., the ratio of film thickness to average roughness of the contacting surfaces, was found to be less than 0.5. The tests noted that both lubricants' coefficient of friction increases with velocity in the boundary lubrication regime. The sliding damages the boundary films, and an increase in the sliding velocity will not give enough time for the recovery of boundary films, further increasing the friction [2]. Among these two, one with Steric acid was considered to be more effective. The results support the fact that Steric acid is an efficient boundary lubricant additive. The adsorbed layer of Steric acid reduced the frictional force.

4. References

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