Elastohydrodynamic Lubrication with mixtures of oils and operating fluids

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Two types of mixture in EHD lubricated point contact are investigated in this study. The first one is oil mixed with refrigerant. A two-phase flow approach based on Reynolds equations accounting for cavitation phenomenon is developed. Numerical results show excellent agreement with published experimental data. Comparison is addressed between results obtained and those using other cavitation approach. The second one is water in oil mixture. The effect of water in lubricated contacts is investigated experimentally. We intend to develop a model to study the behavior of water at the entrance of the contact and its effect on film thickness.

Keywords (from 3 to 5 max): Elastohydrodynamic lubrication, Mixtures, multi-phase lubrication, Numerical modeling

1. Introduction

Classical elastohydrodynamic lubrication theory assumes that a single piezo-viscous fluid lubricates rolling contacts. In reality, lubrication systems often involve fluids other than neat lubricants. Depending on different applications, the lubricating fluid could be a mixture of lubricant and environmental fluid. It should be noted that these mixtures give rise to behavior that is very different from neat oil. Therefore, this study aims to develop an EHL approach for lubrication with mixture in order to investigate their effects on the performance of rolling bearings.

Two types of mixture are identified. The first one is oil mixed with refrigerant; the latter is volatile and miscible with the former in refrigeration compressor application [1], [2]. The second one is the water in oil mixture, where water can exist as dissolved water, emulsified water or free water[3], [4]. Depending on the applications, the key questions are different. In the first case, the main question is the possible evaporation of part of the mixture at the exit of the contact. In the second case, we will address the problem of modeling water entrance into the contact and its effect on film thickness.
In the following, methods and results will be developed for the first mixture.

2. Methods

The Finite Element Method is used to solve Reynolds and elasticity equations in a fully coupled way. An original method is developed to take into account gaseous cavitation (i.e. separation of gaseous operating fluid from liquid lubricant), different from the classical vaporous cavitation model.

3. Results

As shown in Figure 1, the quantity of liquid refrigerant that remains in lubricant and that of gaseous refrigerant released could be predicted at any position of contact.

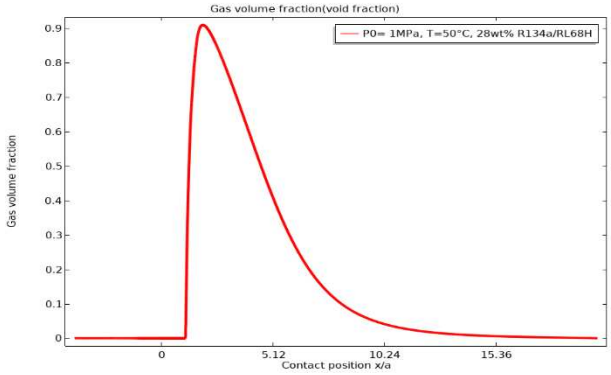

Figure 1: Centerline refrigerant gas volume fraction profile

4. Discussion

The developed model for oil/refrigerant mixture is validated for both full film region and cavitation region. Improvements have been achieved for cavitation modeling compared to the published models.

5. References

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