

Characterization of lubricant viscosity dependence with temperature

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Abstract

This project presents the results obtained from the determination of the viscosity of different lubricant oils as a function of the temperature. The oil is dropped in the gap between two cylindrical pieces that simulate a shaft inside the bearing. The assembled cylindrical pieces are set up inside a Rheometer (Figures 1 and 2) and a water tank controls the operation temperature up to one centesimal of Celsius degree. For each temperature, the shaft is subject to different rotation speeds into a predefined range of frequencies. An average value of the viscosity is obtained for each temperature. Finally, the viscosity data are adjusted by a non-linear curve as a function of the oil temperature.

Key words: Hydrodynamic Lubrication, Rheometer, viscosity..

Introduction

The lubricant viscosity is extremely important in a hydrodynamic bearing to guarantee failures due to the lack of lubrication do not occur during the shaft operation. In this work, the function that better relates the oil viscosity and its operating temperature is the Vogel equation ¹.



Figure 1. Rheometer used in the experiment



Figure 2. Cylindrical parts used to simulate the shaft and the bearing

To correctly characterize the oil viscosity dependence on its temperature, the rotation speed must be limited, and then, the average value of the viscosity can be obtained for each controlled temperature. Finally, the data can be fitted to an exponential curve (Figure 4).

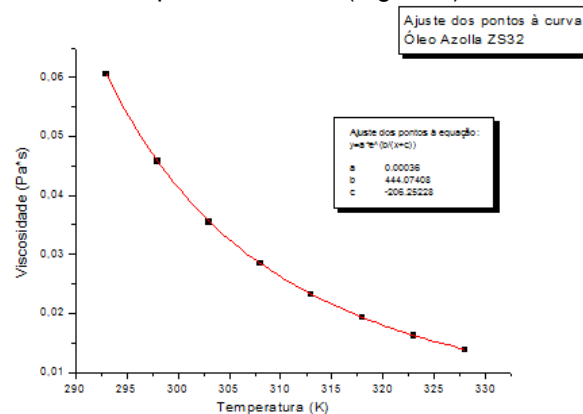


Figure 4. Exponential fitting (Vogel equation)

Results and Discussion

Figure 3 shows the results of the experiments with the Azolla ZS32 Oil. After a certain rotation speed, the viscosity can also varies even for the same temperature controlled at the oil tank. This effect is due to the change of lubrication condition from Hydrodynamic to Thermohydrodynamic increasing the oil temperature due to viscous friction.

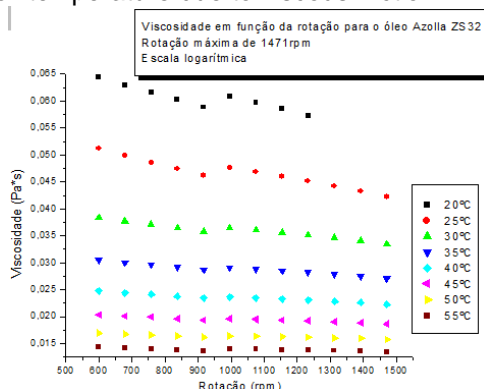


Figure 3. Viscosity versus Rotation Speed with maximum of 1471rpm (Azolla ZS32).

Conclusions

From the results of this work, the function that relates the oil viscosity to its operation temperature was obtained and, consequently, the lubricant can be characterized in terms of its viscosity. The model to the viscosity dependence on the temperature is fundamental to the application in rotating shafts supported by hydrodynamic bearings.

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¹Viswanath, D.S.; Ghosh, T.K., Prasad, D.H.L., Dutt, N.V.K., Rani, K.Y. "Viscosity of Liquids: Theory, Estimation, Experiment, and Data", Springer, 2007.