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Investigation the influence of the curvature ratio on the frictional moment in rolling bearings

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Abstract

The article presents the results of the impact coefficient of the curvature ratio on the frictional moment in rolling bearings. Using the least squares method and the MatLab software to designated a numerical mathematical model of linear dependence of the resistance frictional moment from curvature ratio. Calculations take into account the theoretical and actual values of the curvature ratio. Analysis of the results showed that even the smallest change in the curvature ratio causes a significant difference in the frictional moment. In conclusion, attention was drawn to the act that given by the bearings manufacturer the theoretical values wrap distinctly different from the actual values, which may hinder the theoretical determination of the frictional moment as a function of the curvature ratio.

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Keywords: Ball bearings ; frictional moment ; coefficient of friction ; curvature ratio

1. Introduction

Bearings are elements used in many devices in which there is rotation. The task of bearings in these devices is to support the rotating parts, transferred the load and reducing friction. As a result, the device can work longer and more efficiently. For this it is important that the bearings work flawlessly within the prescribed time work. Parameters such as durability and frictional moment predict both the work time and efficiency of the bearings. Due

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to the large number of factors affecting the value of the durability, it is most commonly accepted that it applies to 90% of the bearings, in the given series and working in the given conditions. Which means that 10% of these bearings probably will show less durability. While the frictional moment can determines the energy losses in bearings. These two parameters are closely related to each other. The larger the energy loss the quicker the wear will occurs. Both of these parameters are affected by the same factors. These factors can be divided into internal (type of lubricant manufacturing accuracy, purity) and external (speed, temperature, load, dust, humidity, etc.) [1].

Because of the easy, accurate and relatively shorter measurement time, the frictional moment was investigated in this article. In order to determine the theoretical frictional moment they are used appropriate mathematical models. An example of such a model is the model presented by the company SKF [2]. This relationship takes into account the many sources of friction and divides them into four groups:

$$M = M_{rr} + M_{sl} + M_{seal} + M_{drag} \quad (1)$$

where: M_{rr} - rolling frictional moment; M_{sl} - sliding frictional moment; M_{seal} - seals frictional moment; M_{drag} - moment of friction resulting from the lubrication system, the resistance movement in the oil, kneading grease splashes.

$$M_{rr} = G_{rr}(v\, n)^{0,6} \quad (2)$$

where: G_{rr} - variable dependent (type of bearings, bearing mean diameter, radial load Fr, axial load Fa); v - kinematic viscosity of the lubricant at the operating temperature; n - rotational speed.

$$M_{st=}G_{st}\,\mu_{st} \quad (3)$$

where: G_{st} - variable dependent (type of bearings, bearing mean diameter, radial load Fr, axial load Fa); μ_{st} - coefficient of sliding friction in conditions of a full film lubricant.

$$M_{seal} = K_{S1} d_s^{\beta} + K_{S2} \quad (4)$$

wherein: K_{S1}; K_{S2} - coefficients depending on the type of bearings and seals; ds - diameter of the seal contact; β - exponent depending on bearing and seal.

$$M_{drag} = V_M\, K_{ball}\, d_m^5\, n^2 \quad (5)$$

where: V_M - a variable that depends on the level of oil; K_{ball} - coefficient depending on number of rows of balls and bearing geometry; d_m - mean diameter of the bearing.

Equation (1) takes into account a number of design parameters such as the diameter of the outer or inner bearing, bearings type, lubrication and seals. The equation doesn't taken into account other design parameters, namely the curvature ratio, accuracy of track and a utility parameter which is run-out (axial, radial). These are the parameters which have an influence on the frictional moment. The influence of the curvature ratio was confirmed in studies that have been published in articles [3,4]. Two values of the curvature ratio may be used. One provided by the manufacturer (i.e. the theoretical curvature ratio), second through the measurement of the disassembled bearing (i.e. the actual curvature ratio). This article attempts to determine the difference between the theoretical and the actual value of the roller bearing curvature ratio in relation to the experimentally determine frictional moment.

2. Measurement data

In the study 5 groups of ten bearings 6203, open with grease were used. The most important feature of these bearings was that the bearings from the same group were from the same production batch. This allowed the adoption of the precision of the manufacturing accuracy was the same in each bearing group.