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Fault Detection of journal bearings and Simulation of Major Occurred Fault using Failure Mode and Effect Analysis Method to Evaluate its Effects

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ABSTRACT: During the operation of rotating machines in large industries such as power plants, the journal bearing failures are numerous. In order to avoid catastrophic damages in bearings and reducing the causes, evaluation of the root causes of bearing failures is important. In this paper, we investigate the root causes of failure in journal bearings, using one of the powerful methods of maintenance fields, which has been named failure mode and effect analysis. In order to collect bearing failures data, have been referred to the six power plants and failures information is obtained. Using this data and charts related to the occurrence probability, detection probability and severity rates which are the main parameters of this method for determining the risk priority number, the failure mode and effect analysis method has been implemented. According to this method, the main failure has been identified as wear. Then, using the well-known model of bearing wear geometries and computational fluid dynamics analysis for solving Navier-Stocks equations, effects of wear on the bearing load capacity, maximum lubrication pressure, in the different locations of wear, in the lower half of the bearing, has been investigated. Finally, the results of the finite element analysis have been compared to the results of the theory and solving the Sommerfeld-Harrison equation for bearing without wear. Also, to reduce the effects of this failure, another bearing geometry has been proposed in a similar situation with a load capacity greater than the custom one.

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1. INTRODUCTION

Most industries depend on rotating machinery. Among this equipment, sizeable and larger machines contain an element known as journal bearing [1]. A high percentage of these bearings last a considerable length of time [2]. Particularly those in power generation industries, refineries, petrochemical compounds, etc.

The formation of hydrodynamic film between journal bearings and the axel is the most vital function of a sound function in any large rotating machinery [3]. This has to occur to provide separation between the involved surfaces [4]. Consequently, when for any reason, the hydrodynamic film would not form the outcome would be disastrous in the shortest amount of time [5]. In other words failure and going out of order of the machine will become inevitable in such a case.

Moreover, in conditions when the operation of this equipment is not in accordance with the prescribed functioning guidelines, fretting, corrosion, cracks, etc. would also become an outcome of the malfunctioning [6].

2. METHODOLOGY

In order to obtain the desired parameters related to journal bearings, a Finite Element Method (FEM) approach along with solving Navier–Stokes equations has taken place [7]. Moreover, the Reynolds equation for alterations in pressure with respect to distance from the bearing along slippage direction was solved accordingly [8]. This was used as a base for the calculation of the capacity of loading for the bearing.

The number assigned to severity (S) would only be considered upon effects of failure. Reduction of severity would only become possible by alterations in the process and its procedure. Few quantitative parameters were expressed on a scale of 1 to 10 for severity.

The probability of occurrence (O) is typically estimated based on the chance of occurrence of failure during the part or product's lifetime. In other words, it is an expression as to what number could represent the probability of failure occurrence.

Probability of detection (D), is the chance of recognition and detection of the failure or its reason sensed by the controlling of the occurrence. The number assigned herein is indicative of the capability and ability of the present controls in the diagnosis of failure or reasons causing it.

Criteria suitable for all the above three elements have to be evaluated and presented on a fixed and contractual basis. The existing standards concerning proper utilization of values assigned to the elements discussed herein are presented by Ref. [14].

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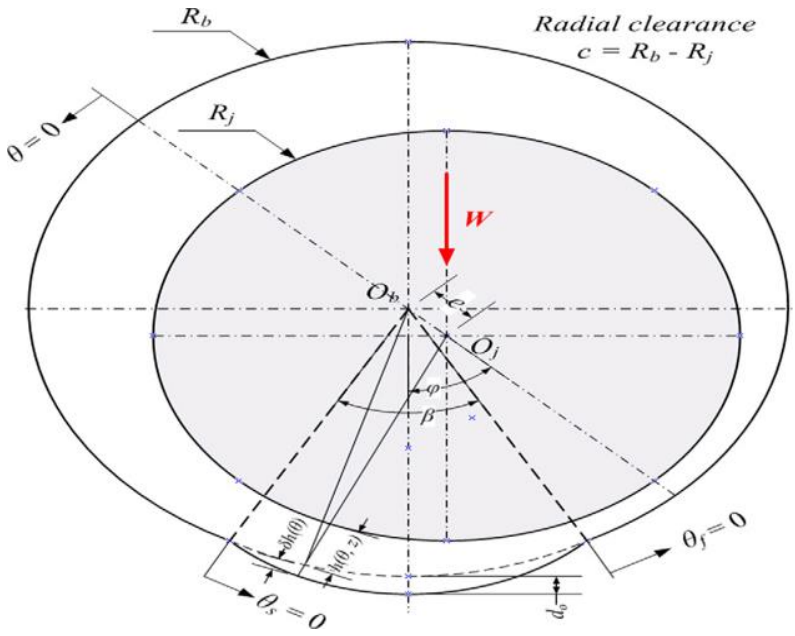

Fig. 1. Journal bearings geometry by considering abrasion

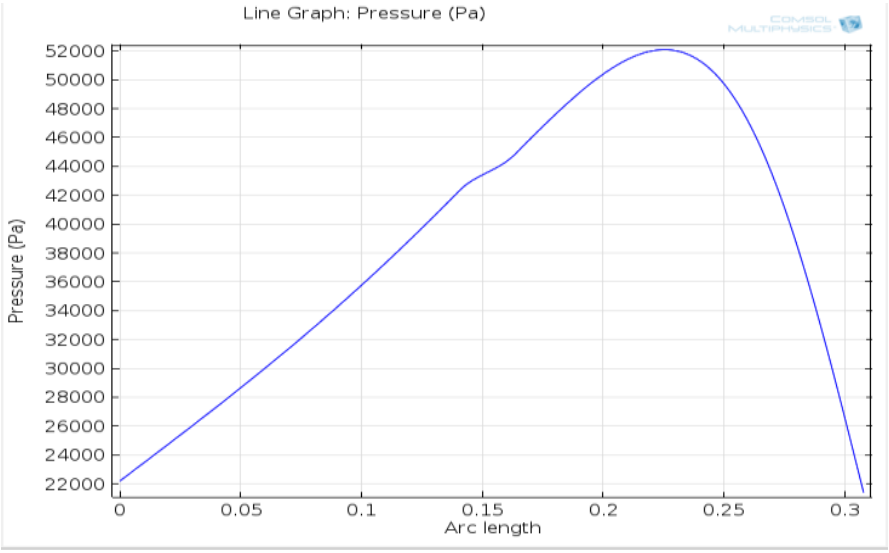

Fig. 2. Pressure at various arcs length with abrasion at φ=90°

$$RPN = S \times O \times D \quad (1)$$

$$h(\theta, z) = c + e_0 \cos\theta + \delta h(\theta) \quad (2)$$

$$\delta h(\theta) = c(\delta_0 - 1 - \cos\theta) \quad (3)$$

$$\cos\beta = \delta_0 - 1 \quad (4)$$

$$u \cdot n = 0,\ u \cdot t = U_w \quad (5)$$

$$\frac{dp}{dx} = \frac{6 * \mu * V}{h^3} * (h - h_1) \quad (6)$$

3. RESULTS AND DISCUSSION

Erosion is among the majority of faults that could occur in the performance of any bearing [9]. This is natural due to the fact outer layer of the bearing is normally softer than inner layer, so that in case of unforeseen damage, the bearings would not seriously become damaged, and in addition the axel would be saved prior to total destruction [10].

This notion is based on the collected data from different outlets throughout the region and at times this defect is at least twice in number in the case of power generation industries [11]. This finding was devoted to using out of order materials and alloys for surfaces, inappropriate casting operations, lack of correct installment procedures as well as poor maintenance [12].

The proposed geometrical profile presents a higher capacity receiving load when compared to the common round shape profiles [13, 14].

4. CONCLUSIONS

In this paper, through the utilization of Failure Mode and Effect Analysis (FMEA) coupled with field search problems associated with journal bearings of heavy rotating machinery major faults have been diagnosed. Based on findings herein, erosion is defect number one. Consequently, by using the analytic research method, the effects of erosion have been studied.

The procedure conducted was based on the comparison between obtained values for journal bearing's parameters link maximum pressure of lubricant, the capacity of loading, relevant to the location of erosion, and a fixed point on the surface with constant erosion. Hence, the most critical location and condition of the erosion was realized. Prescribed operation conditions would alleviate the deterioration steps of the bearing enormously.

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