International Journal of Surface Engineering and Interdisciplinary Materials Science
Volume 12 • Issue 1 • January-December 2024

Estimation of Friction for a Hydrodynamic Sliding Bearing for the Turbulent Regime From Single-Phase and Two-Phase Fluid Flow Behaviour

Bouchelaghem Imene
Faculté de Génie Mécanique, Université des Sciences et de la Technologie d'Oran Mohamed Boudiaf, Algeria

Bendaoud Nadia
Faculté de Génie Mécanique, Université des Sciences et de la Technologie d'Oran Mohamed Boudiaf, Algeria

Mehala Kadda
Faculté de Génie Mécanique, Université des Sciences et de la Technologie d'Oran Mohamed Boudiaf, Algeria

Khoussa Hadja
Faculté de Génie Mécanique, Université des Sciences et de la Technologie d'Oran Mohamed Boudiaf, Algeria

Khelif Fatima Zohra
Faculté de Génie Mécanique, Université des Sciences et de la Technologie d'Oran Mohamed Boudiaf, Algeria

Foullani Abdelhalim
Faculté de Génie Mécanique, Université des Sciences et de la Technologie d'Oran Mohamed Boudiaf, Algeria

Bendaoud Mohammed Habib
Faculté de Physique, Université des Sciences et de la Technologie d'Oran Mohamed Boudiaf, Algeria

ABSTRACT

The hydrodynamic plain bearing relies on the generation of a lubricant film through the rotational movement of the journal. As the journal rotates, it creates a layer of lubricant between the bearing and journal surfaces. This lubricant film separates the two surfaces, preventing direct contact and minimizing friction and wear. The high speeds can lead to severe conditions such as cavitation due to rapid oil evaporation, which introduces a new phase into the flow. In this study, it is anticipated that a two-phase flow will occur through the shaft-bushing conjunction because of the rupture of the lubricating film near the contact outlet. Pressure disturbances above these rupture zones may induce vapor-cavity formation at a small scale. A numerical analysis was conducted by solving Navier–Stokes continuity equations and vapor-transport equations. The k-epsilon model was used to analyze friction at the fluid-bearing interface for the turbulent regime. The results indicate that higher flow velocity values and pressure were observed in the case of two-phase flow compared to one-phase flow.

KEYWORDS

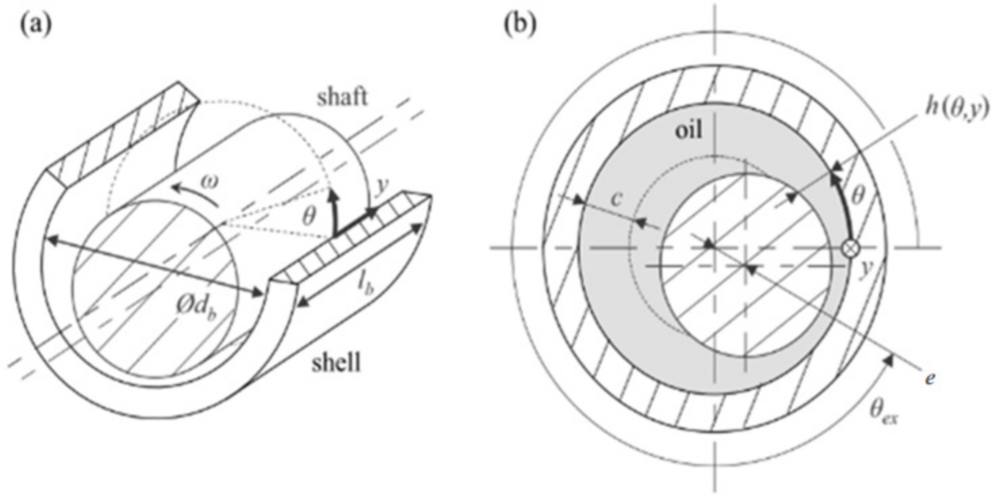
Sliding Journal Bearing, Two-Phase, Single-Phase, Friction, Fluid Flow Behavior, Turbulent Regime

INTRODUCTION

Etsion et al. (1997) discussed the misalignment of a two-phase mechanical seal, which poses unique challenges due to variations in temperature profile and phase distribution in the working fluid. The thermohydrodynamic approach takes these variations into account by incorporating sophisticated mathematical models that describe the thermal and hydrodynamic behavior of the system. Iterative solutions allow the equations governing heat transfer and phase change to be solved simultaneously,

DOI: 10.4018/IJSEIMS.351249

Figure 1. (a) sketch of a hydrodynamic journal bearing and (b) cross-section of a hydrodynamic journal bearing



providing an accurate representation of the boiling interface. It has been shown that, under certain operating conditions, particularly those characterized by a modified Sommerfeld number, it is possible to use several approximate solutions to calculate the boiling radius. The modified Sommerfeld number is a dimensional parameter that combines the effects of rotational speed, fluid viscosity, and applied load, thus influencing the characteristics of boiling and heat transfer in the packing.

A hydrodynamic journal bearing (Fig. 1) is a component that provides guidance during the rotation of rotating machines, such as turbines and reactors. This equipment is widely used due to its adequate load support, simplicity, and better damping characteristics when operating under very severe conditions, such as high rotational speeds and high radial loads (Pfeil et al., 2021). However, as the speed increases a portion of the oil will evaporate, adding a new phase to the flow. Therefore, it is essential to comprehend the impact of the multiphase flow.

Numerous industries, including petrochemicals and nuclear technology, use gas–liquid two-phase flows (Ozbayoglu & Ozbayoglu, 2009). As a result of the close connection between the distribution phase and many essential design and engineering parameters such as pressure, mass transfer, and heat transfer, determining the distribution, or rather determining the patterns of two-phase flow, is one of the main issues in two-phase flow analysis (Ishii et al., 2004).

Experimental approaches have been employed for analysis due to the two-phase flow's complexity and issues with using computational methods to represent these flows. One of the main drawbacks of experimental approaches is that the flow maps they produce are typically accurate for only a narrow range of flow parameters, making it risky to generalize them to other circumstances (Galbiati & Andreini, 1992).

Currently, computational techniques are used in investigations of the lubrication performance of sliding bearings due to their high calculation efficiency and low cost. Although computational fluid dynamics (CFD) software is useful for handling complex issues, it typically needs to be verified by theoretical analysis and experimental results.

The flow in a lubricant film is supposed to be laminar in fundamental lubrication theory. However, in high-speed machinery, the flow of a lubricant coating is no longer laminar, but rather turbulent (Ghosh et al., 2017). Over the past decades, several researchers have created varied ideas to analyze the turbulent flow and its influence in various lubrication conditions.

Related Content

Effect of Copper Addition on Tensile Behaviour of Al-Cu Alloy Used in High Temperature Applications

Sasmita Tripathyand Goutam Sutradhar (2022). *International Journal of Surface Engineering and Interdisciplinary Materials Science (pp. 1-16).*

www.irma-international.org/article/effect-of-copper-addition-on-tensile-behaviour-of-al-cu-alloy-used-in-high-temperature-applications/302238