Investigation the combined effects of wear and turbulent on the performance of hydrodynamic journal bearing operating with couple stress fluids

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Mushrek A. Mahdi
Department of Automobile Engineering, University of Babylon, Babylon, Iraq, and
Ahmed Waleed Hussein
Department of Energy Engineering, University of Babylon, Babylon, Iraq

Abstract

Purpose – The purpose of this paper is to investigate the combined effect of wear and turbulence on the performance of a hydrodynamic journal bearing operating under Newtonian and couple stress fluids (CSF).
Design/methodology/approach – The analysis consists of a modified Reynolds equation of incompressible thin viscous films, and the film thickness model taking into account the wear effect. The governing equation was solved numerically using the finite difference approach.
Findings – The effect of both the wear parameter and the local Reynolds number on the performance characteristics of bearing has been presented and discussed. The obtained results observed that the characteristics of the intact and worn bearing in turbulent and laminar have been enhanced due to the non-Newtonian fluid (CSF) effect. Also, the results display that bearing worn and the turbulent regime cannot be neglected in calculating the performance characteristics of the bearing lubricated with Newtonian and non-Newtonian fluids. The results achieved from this study, specify that the bearing characteristics are significantly affected by these effects.
Originality/value – The paper investigates the behavior of hydrodynamic bearings considering different aspects simultaneously is interesting, and the application meets the current needs of improvement in modeling hydrodynamic bearings under different conditions.

Keywords Wear, Turbulent, Couple stress fluid, Hydrodynamic journal bearing
Paper type Research paper

Nomenclature

c	radial clearance (m)	P	hydrodynamic pressure (pa.)
d_o	defects depth (m)	$\overline{P}$	dimensionless hydrodynamic pressure, $p(c/R)^2/\mu\omega$
e	eccentricity (m)		
F_r	friction force (N)	Q_S	side leakage flow rate
$\overline{F}_r$	non-dimensional friction force, $\overline{F}_r = F_r/RLU\mu$	$\overline{Q}_S$	dimensionless side leakage flow rate, $\overline{Q}_S = Q_S L/UR^2c$
h	film thickness (m)	R	radius of journal (m)
$\overline{h}$	non-dimensional film thickness, h/c	Re	global Reynolds number, $R\omega C\rho/\mu$
		Re^*	local Reynolds number, $(R\omega C\rho/\mu)\overline{h}$
L	bearing length (m)		
K_θ, K_z	coefficients of turbulence	W	total load carrying capacity of the bearing (N)
l	characteristic length of additives, m $l = \sqrt{\eta/\mu}$	$\overline{W}$	dimensionless load – carrying capacity, $\overline{W} = W(c/R)^2/\mu\omega RL$
$\bar{l}$	couple stress parameter, l/c		

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