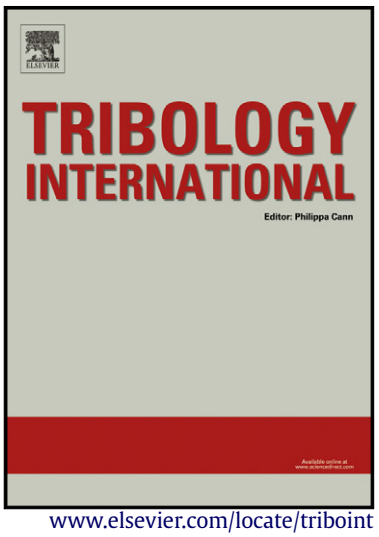

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Numerical Modeling for Gaseous Cavitation of Oil Film and Non-Equilibrium Dissolution Effects in Thrust Bearings

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Abstract

A gaseous cavitation model, considering probable non-equilibrium dissolution effects in thrust bearings with hydrodynamic lubrication, is proposed. The model is a generalization of physical background of an equilibrium dissolution model upon Bunsen solubility. Utilizing and developing original conception of solubility, the rate of gas absorption or release process is modeled to be related to local variables. A simplified formulation of the non-equilibrium model is also derived adopting the approximation of quasi-one-dimensional flow for specific situations. The model is applied to thrust bearings with groove-land type, to preliminarily explore the effects of limited absorption rate on their performance and flow characteristics.

Keywords

gaseous cavitation; hydrodynamic lubrication; numerical modelling approach; thrust bearings

Nomenclature

BN	bearing number
CV	control volume
e	the base of the natural logarithm
f	volume fraction
g	non-dimensional time
h	film thickness
n	rotation speed (rpm)
p	pressure
$\overline{p}$	average pressure
R	radius
r	radial position in cylindrical coordinate system
T	temperature
t	time
u	component of velocity vector
$\boldsymbol{u}$	velocity vector
V	volume
$\tilde{V}$	volume, at equilibrium state
W	thrust force
z	axial position in cylindrical coordinate system
α	frequency of macroscopic motion
β	coefficient of change rate of gas dissolved amount
γ	time scale ratio of macroscopic motion to non-equilibrium dissolution, $\gamma = \beta/\alpha$
Δt	infinitesimal time interval
Δx	infinitesimal distance
$\Delta\delta$	infinitesimal change of δ
$\Delta\theta$	angular grid size

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