Magnetic Fluid Lubrication of a Rough, Porous Composite Slider Bearing

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ABSTRACT

The purpose of this paper is to analyse the performance of a magnetic fluid based rough, porous composite slider bearing. The bearing surfaces are assumed to be transversely rough. The random roughness of the surfaces is characterized by a stochastic variance with non zero mean, variance and skewness. The associated Reynolds Equation is stochastic averaged with respect to this random roughness parameter solving this Equation in view of suitable boundary conditions. The expression for pressure distribution is obtained leading to the calculation of load carrying capacity. Friction is also computed. It is clearly observed that the load carrying capacity increases due to the magnetization parameter and the bearing surfaces owing to transverse surface roughness in general. However this investigation offers some scope to mitigate the negative effect of roughness by the magnetic fluid lubrication at least in the case of negatively skewed roughness. It is interesting to note that the magnetization fails to alter the friction.

Keywords: Composite Slider Bearing, Friction, Load Carrying Capacity, Magnetic Fluid, Porosity, Pressure, Roughness

INTRODUCTION

(Bhat, 1978) conducted a theoretical study on the performance of a porous composite slider bearing. It was observed that the porous composite slider had more load capacity and friction than the corresponding porous inclined slider baring. (Puri & Patel, 1981) analyzed the squeeze film behaviour in a porous composite slider bearing. It was proved that the load carrying capacity and friction increased due to the squeeze and the position of centre of pressure moved slightly towards the inlet edge. Further, the response time for a composite slider bearing was more than that for an inclined slider bearing. (Puri & Patel, 1982) studied the performance of a porous composite slider bearing taking in to account the slip velocity at the interface of

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fluid film and the porous matrix. (Puri & Patel, 1983) discussed the performance of a porous composite slider bearing taking into account the anisotropic permeability and slip velocity at the interface of the fluid film and the porous matrix. It was concluded that the composite slider bearing had a greater load capacity and higher friction but a lower coefficient of friction than the equivalent inclined slider bearing. 

(Sulaiman & Abdallah, 2011) investigated the optimum shape of the surfaces of the sliders to meet the load and centre of pressure demands specified by the designers. Here it was shown that the aspect ratio needed to be reduce to optimize the shape of slider bearing.

All these above studies considered conventional lubricants. (Shukla, 1964) considered the case of a composite slider bearing with a magnetic field applied tangentially to the bearing and perpendicular to the direction of motion and showed that the load carrying capacity increased as the strength of the magnetic field increased. (Agrawal, 1970) investigated theoretically the magnetohydrodynamic conducting composite slider bearing in the presence of a transverse magnetic field. It was found that the load carrying capacity increased as the conductivity and the thickness of the boundaries increased. (Gupta & Bhat, 1979) discussed the performance of a hydrodynamic inclined porous slider bearing with a transverse magnetic field and it was found that the load carrying capacity and friction increased with increasing Hartmann number. Bhat and Deheri (1991) embarked on the study of porous composite slider bearing lubricated with a magnetic fluid. It was seen that magnetic fluid increased the load carrying capacity, did not alter the friction and shifted the centre of pressure towards the inlet. Das (1998) made a theoretical study of slider bearings considering the lubricant to be an isothermal, incompressible electrically conducting couple stress fluid in the presence of a uniform magnetic field and observed that both the values of maximum load capacity and the corresponding inlet-outlet film ratio depend on couple stress and magnetic parameters and the shape of bearings conjointly. Here it has been sought to study and discuss the behaviour of a magnetic fluid based transversely rough porous composite slider bearing. Wang Li-Jun et al. (2011) obtained a journal Reynolds Equation based on magnetic fluid model with regards to analyzing the static characteristics of a journal bearing lubricated with a magnetic fluid. It was shown that under the effect of magnetic field the bearing capacity increased with the increasing of magnetic field intensity. Further, it was observed that when the eccentricity remained small the side leakage was highly decreased. (Wei Huang et al., 2011) showed that the magnetic field intensity distributions on the rubbing surface had a significant influence on the tribological properties of ferrofluid. Recently (Singh & Ahmad, 2011) presented a theoretical model for the performance of a porous inclined slider bearing lubricated with a magnetic fluid considering the thermal effects with slip velocity. It has been proved that the magnetization parameter, slip parameter and the thermal parameter significantly affected the performance characteristics.

In the above investigations the bearing surfaces were considered to be smooth. 

Patir and Chang (1979) considered the application of average flow model to lubrication between rough sliding surfaces. Here the application of the averaged Reynolds Equation to analyze the roughness effects in bearing was demonstrated on a finite slider. The effects of operating parameters as well as the roughness parameters on mean hydrodynamic load mean discussed friction and mean bearing inflow wear illustrated.

The stochastic model presented by Tzeng and Saibel (1967) was further developed by Christensen and Tonder (1969a; 1969b; 1970) to study the effect of surface roughness (transverse as well as longitudinal) on the performance of bearing systems. This model of Christensen and Tonder was used by many investigators. Prakash and Peeken (1985) presented a numerical study dealing with the effect of two sided roughness and elasticity in a one dimensional slider bearing. The effect of sinusoidal roughness on
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