

On the Rheodynamics of Powder Lubricated Journal Bearing: Theory and Experiment

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This paper describes experimental and theoretical development and treatment of solid/powder-lubricated journal bearings. The effect of side flow has been included in the analysis to elucidate suitability of MoS₂, WS₂ and TiO₂ as powder lubricants for high-speed, extreme-environment multi-pad journal bearings. Solid lubricants such as these have been widely used and the preference of one over the other has been the controversial subject of numerous papers. At first glance, some dry powders chosen for lubrication may appear to be attractive solid lubricants because they exhibit low values of friction coefficients. For example, experimental results from a conventional pin-on disk apparatus at low speeds have suggested tungsten disulfide, WS₂, as a superior lubricant to molybdenum disulfide, MoS₂, because it maintains a lower coefficient of friction for a higher temperature capability [8]. Irrespective of the value of coefficient of friction, high or low, it is essential that a lubricant possess the ability to diminish surface wear and to provide a mechanism of heat dissipation in the contact region vis-a-vis side flow. It is the intent of this paper to provide unorthodox criteria through the rheodynamics of third body, as a guide for the selection of solid lubricants, as well as elucidate behavior of third body with respect to tribosurfaces.

A two-dimensional quasi-hydrodynamic model has been developed to predict performance of powder lubricated system with particular emphasis on side flow in third body, since it accounts for heat removal rate from the interface and provides a measure of the wear rate in soft coated surfaces. This paper documents a parametric study with MoS₂, WS₂ and TiO₂ as powder lubricants. The effect of powder choice on velocity accommodation, pressure profile, load carrying capacity have been investigated.

Experiments carried out on a powder lubricated 35 mm journal bearing with speeds to 58,000 rpm are presented in this paper to document evidence of yield and limiting shear strength properties for MoS₂ and WS₂ powders. Theoretical corroboration of velocity accommodation across the third body along with bearing performance criteria are presented as well to elucidate the salient features of these solid lubricants with respect to their rheological properties.