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Extended Abstract

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External magnetic field of ferrofluids lubrication of journal bearing with twined solenoid

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As the key component of mechanical transmission, the bearing plays a vital role. Both the increase of temperature and bearing capacity would reduce the oil-film thickness of load area, and likely lead to friction or wear in contact areas between shaft and bearing. More seriously, it could lead to bearing failure and the actual production halt. Using magnetic liquid to lubricate bearing would help to improve the performance of bearing under the same condition. But the bearing performance was closely related to the magnetic induction intensity distribution. Therefore, studying the distribution of magnetic field in the inside of oil film bearing was crucial to improve bearing performance. Up to now, many experts and scholars have made a lot of researches on ferrofluids lubrication under magnetic field. The study proposed by Tze-Chi Hsu et al. indicated that magnetic field has a significant influence on the lubrication performance of short journal bearings.

The work of T. A. Osman showed that the bearing. performance mainly depends on the magnetic field distribution model at low eccentricity ratios. It follows that external magnetic field had a very important influence on journal bearings lubricated with ferrofluid. So some researchers conducted research on the distributed regularity of magnetic induction intensity. Har Prashad studied the magnetic flux density on the inner and outer surfaces of the inner race and outer race of a rolling bearing. Huang W. et al. analyzed the ferrofluids lubrication with an external magnetic field, and the results showed that the magnetic field intensity distribution on the rubbing surface has a significant influence on tribological properties of ferrofluids. Jianmei W. et al. used solenoid model to provide magnetic field for ferrofluids and preliminarily calculated the distribution of magnetic induction intensity. Aritro Pathak had provided a quantitative analysis for the field outside the solenoid and explained how the magnetic field behaves outside a uniform current density solenoid. AlShaikhli A. K. et al. presented the axial and radial magnetic field strength equations at any point inside or outside a finite solenoid with infinitely thin walls. The axial magnetic field of pulsed solenoids was also analyzed by J. Novickij et al. Foelsch K. calculated the distribution of magnetic field within a certain distance to the axis. Melody Xuan Lim and Henry Greenside used superposition and numerical approximations of an analytical expression to study the magnetic field generated by a finite solenoid and showed how the magnitude and uniformity of the resultant external field depend on the solenoid length and distances between solenoids. Fujiwara K. et al. studied the continuity of the magnetizing current density in 3-D magnetic field analysis with edge element.

The experimental device to measure magnetic induction intensity of the inner wall of bearing winded solenoid. The device is based on the principle that the movement of charged particles will produce deflection under Lorenz force and magnetic field. This deflection will make the charged particles that are constrained within solid material produce the accumulation of positive and negative charges along the vertical direction of magnetic field, thus forming an additional transverse magnetic field, i.e., that is Hall electric field. Using the measurement device, magnetic flux density distribution could be respectively given when the excitation current in solenoid respectively was 1A, 2A and 3A. The distribution of magnetic induction intensity with different exciting current s The shape of magnetic induction intensity distribution inside the solenoid. The magnetic induction intensity increases with the increase of exciting current. The magnetic induction intensity is gradually increasing along the axial symmetry plane to the end of bearing, which is opposite to the rule of magnetic induction intensity generated by single solenoid. So, it can be concluded that the derived field generated by magnetized bearing is contrary to the excitation field produced by solenoid. The magnetic induction intensity gradually increases firstly and then decreases from the radial symmetry plane to the inner wall of bearing. In the inside of bearing, the change of magnetic flux density becomes relatively average; but at the ends of bearing, the change displays larger. The reason for this phenomenon is that the influence of current on end region of bearing is more significant than that on other regions.

Bottom Note: *This work is partly presented at Global Summit and Expo on Fluid Dynamics & Aerodynamics*