ON INTERFACIAL DYNAMICS IN HARD DISK DRIVES WITH FLUID DYNAMIC BEARINGS

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It is an acknowledged fact that ball bearing spindles of hard disk drives are rapidly being replaced by spindles using fluid dynamic bearings (FDB). During operation, the rotating part (rotor) of the hard disk drive is supported by pressures created in a thin oil film without solid/solid contact. The oil film pressures are created by slanted groves in either the rotor or the stator. We study the dynamics of the oil-air interface (OAI) of the fluid dynamic bearings of hard disk drives. The study is performed in two stages. Firstly, using a simplified analysis based on Reynolds' equation and ignoring boundary-layer dynamics near the interface, we derive a simple analytical expression for the evolution of the OAI of an herringbone-type journal bearing. This analysis sheds light on how the number of grooves and the groove angle affect the movement of the OAI. Numerical simulations follow the evolution of the interface toward cusp formation. Secondly, a linear-stability analysis is performed for the interfacial problem local to the free surface, where radial flows and contact-line effects are pertinent, however the groove amplitude is zero. Two modes are found that are neutrally stable in the zero Reynolds-number limit, and which are both independent of the azimuthal wavenumber. Extenstions from the zero-Reynolds-number limit will also be examined.

Keywords: hard disk drives, lubrication theory, tribology