Effect of a high-gradient magnetic field on particle concentration distribution in a magnetic fluid seal: Rivalry of the diffusion and magnetophoresis

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https://doi.org/10.1016/j.jmmm.2024.172095

A B S T R A C T

In this paper, the unsteady process of particle concentration distribution in a magnetic fluid is studied. Diffusion and the effect of a high-gradient magnetic field in a magnetic fluid seal (MFS) are taken into consideration. It is crucial to take into account how particle mobility and diffusion coefficient vary on particle concentration in order to determine the possibility and time of the formation of a close packing of particles. The Carnaghan- Starling approximation was employed. It is demonstrated numerically that the geometry of the MFS, namely its gap width and pole base width, as well as the magnitude of the magnetic field strength under the pole tooth of the MFS, both influence the time of the formation of a close packing of particles. This period can be regarded as the MFS's uptime. Depending on the design of the working gap, the uptime seal for magnetic fluid based on vacuum oil may require between two weeks and six months. The uptime seal also becomes shorter when the carrier fluid's viscosity decreases.