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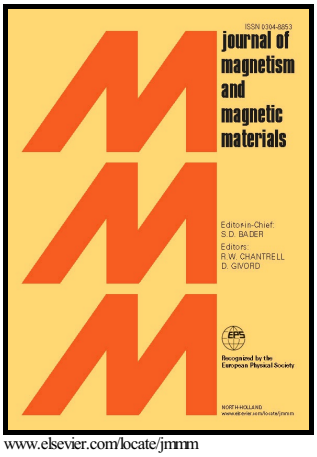

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Assessment of magnetic fluid stability in non-homogeneous magnetic field of a single-tooth magnetic fluid sealer

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ABSTRACT

A special experimental stand has been developed and made to test magnetic fluid. It represents a single-tooth magnetic fluid sealer. The type of dependence of the pressure differential on magnetic fluid sealer operation time is used as a criterion to determine magnetic fluid stability and magnetic fluid sealer service life under such conditions. The siloxane-based magnetic fluid was used as the test sample. The colloidal stability as well as stability of the synthesized magnetic fluid in magnetic fields in static mode were determined. It has been found that the obtained magnetic fluid is stable in static mode and, consequently, can be used to conduct necessary tests on stand. Short-term and life tests on stand have shown that MF remains stable and efficient for at least 360 days of continuous utilization.

Keywords: magnetic fluid, magnetic field, test, sealer, stability.

1. Introduction

Magnetic fluids (MF) are colloidal solutions of ferro- or ferromagnetic particles (disperse phase), with the average diameter of about 10 nm, stabilized by a surfactant and dispersed in a carrier fluid (dispersion medium) [1]. Magnetic fluids combine properties of a magnetic material and a liquid and their rheological, thermophysical, optical and other characteristics are controllable by magnetic field. A combination of these properties unknown in natural materials has made it possible to design technical devices with a MF as the working medium [2-5]. One of the main application fields of magnetic fluids is their use in magnetic fluid sealers (MFS) belonging to non-contact groove seals where the magnetic fluid is held by magnetic field in the working gaps between the contacting parts [6-11]. MFS are currently used in space and aviation engineering, vacuum, chemical and biochemical equipment, optical instrument engineering [3-5]. MFS service life mainly depends on the working medium, i.e. magnetic fluid. The possibility of MF application depends, firstly, on their colloidal stability [12] and a complex of necessary technical characteristics (saturation magnetization, viscosity, operation temperature range, etc.) [5], and secondly, on their ability to seal off gaps and for a long time compensate for the pressure differential affecting MFS and caused by the influence of high and low temperatures [13], aggressive media, magnetic and gravitational fields [10,14]. An important tool to determine the possibility of applying MF and its efficiency is testing magnetic fluids on stands representing magnetic fluid sealers with adjustable and controllable parameters such as diameter and rotation frequency of the sealed shaft, temperature and critical pressure differential, magnetic induction in the gap [4,5]. This work studies magnetic fluid stability in non-homogeneous magnetic field of a single-tooth magnetic fluid sealer.

2. Method

Feeding magnetic fluid into the working gap of a magnetic fluid sealer causes the static pressure differential Δp_{st} to rise [4,5]. It results from redistribution of the initial concentration of ferromagnetic particles over the MF volume in MFS non-homogeneous magnetic field. The particles are concentrated in the MF area with the highest induction but their concentration increase is limited by repulsion forces caused by dipole-dipole interaction, surfactant molecule protective coating on the particle surface and disjoining effect of the carrier fluid. The higher is the magnetic field gradient in the MFS gap (sometimes reaching the value of $\nabla B = 1000$ T/m), the more intensive