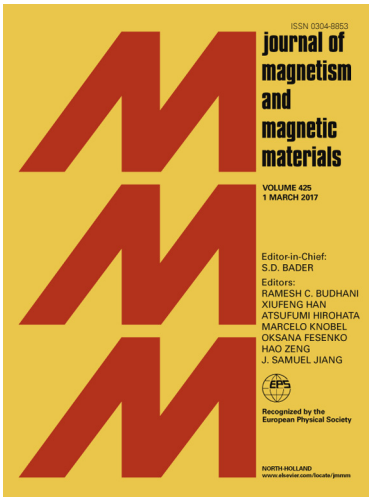

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Influence of thermomagnetic convection and ferrofluid thermophysical properties on heat transfers in a cylindrical container heated by a solenoid

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Abstract

The thermal convection in a cylindrical container heated by a solenoid and cooled with an oil-based ferrofluid is numerically studied. The temperature and the velocity fields are compared to those obtained with pure oil to assess the benefits of using ferrofluids for cooling systems like electrical transformers. The influence of the magnetic body force on the flow and the temperature in the system is investigated in various configurations. One original result established in this paper is that the changes in the fluid properties due to the presence of nanoparticles, such as viscosity and thermal conductivity, have a significant impact on the heat transfers. A second result is that the use of a ferromagnetic core enhances the cooling.

Keywords: Ferrofluid, Natural convection, Thermomagnetic convection, Finite element method, Power transformer

1. Introduction

Ferrofluids are suspensions of magnetic nanoparticles in a liquid carrier. Thermal agitation and the addition of a surfactant prevent sedimentation and aggregation of the nanoparticles. If well prepared, the suspension stays stable even under the action of a magnetic field. It is common to use the continuum hypothesis to model ferrofluids. In the presence of a magnetic field, the nanoparticles generate a body force that depends on the gradient of the amplitude of the magnetic field. Among the various models for this effect that are available in the literature, we are going to consider in this paper the so-called Kelvin

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