Numerical Analysis of Different Magnet Shapes on Heat Transfer Application Using Ferrofluid

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Abstract

Ferro fluid cooling system is the next generation passive cooling systems for micro heat transfer applications. Using Ferro-fluid in integration with heat and magnetic field can provide better solution to heat transfer problems. The synergize effect of magnetization and temperature gradient produces a flow & thus cooling takes place. In ferro fluid set-up, the uniform flow of the fluid is dependent upon the position & shape of the magnet. A ferrofluid is a temperature sensitive magnetic fluid which means that its magnetization is function of temperature. The Ferro fluid cooling system works under thermo magnetic convection using virtual pump by using Ferro fluid & external Magnet. The equations governing the ferrofluid flow under the effect of applied magnetic and gravitational field are magnetostatic equation, the mass conservation equation, momentum equation and the energy equation in the frame of Boussinesque approximation. All these equations were modelled in COMSOL Multiphysics® in different domains and it involves the coupling of various physical phenomenon such as fluid dynamics, thermal boundary conditions and temperature dependent magnetic properties of the ferro fluid. The flow of the fluid is significantly dependent upon the position of the magnet & flux lines behaviour changes accordingly & thus flow rate varies. In the proposed work, a uniform flow of fluid is achieved by using different shapes of the magnets irrespective of the change in position. The work discusses numerical analysis using COMSOL Multiphysics to study the heat transfer and flow characteristic of ferro-fluid by changing the shapes of magnets, which leads to different magnetic lines paths. It was concluded that convex shape magnet gives better solution as compared to other shapes of magnet and a velocity of 1.592 mm/sec and fluid temperature of 331 K was obtained.

Reference

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Figures used in the abstract

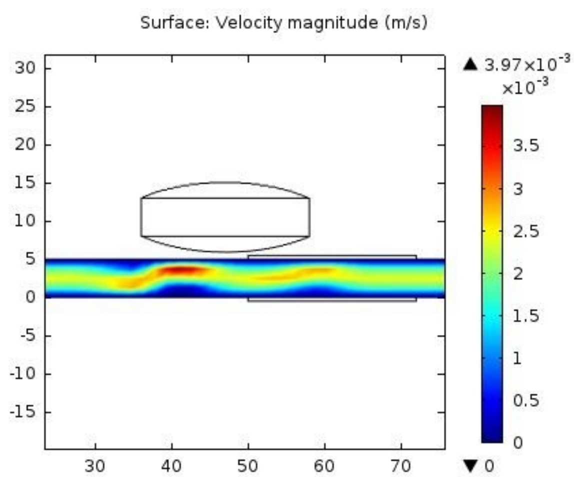

Figure 1: Figure 1. Velocity Contour in Convex Shape.

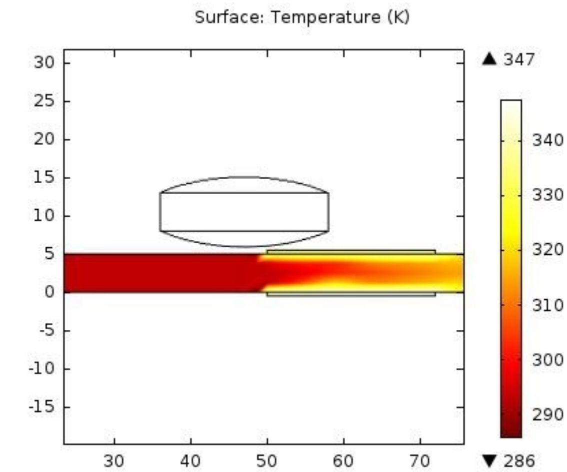

Figure 2: Temperature in Convex Shape.

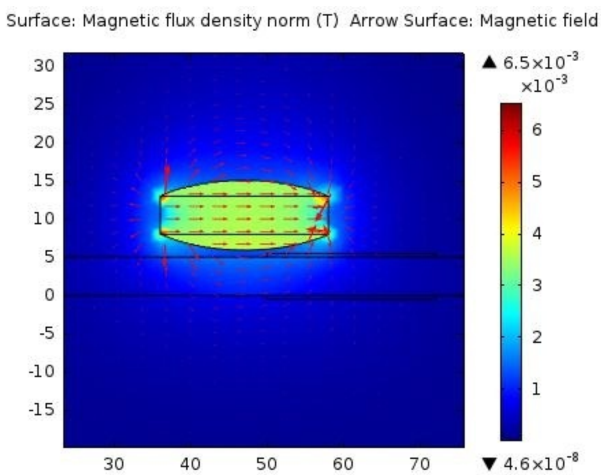

Figure 3: Magnetic Flux in Convex Shape.

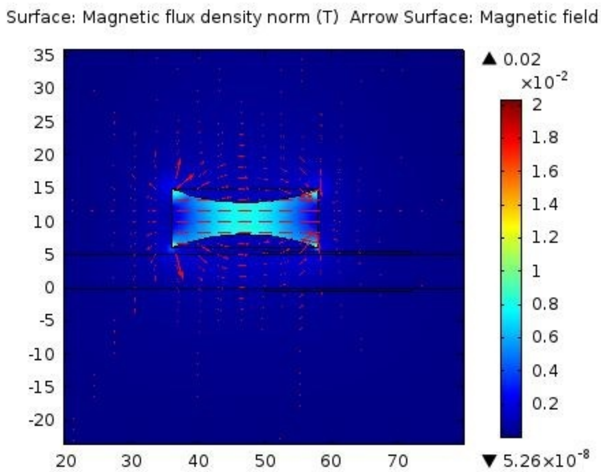

Figure 4: Concave Shape of Magnet.