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Experimental and Numerical Study of the Thermomagnetic Convection of Ferrofluid Driven by Non-Uniform Magnetic Field around a Current-Carrying Wire

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Abstract : Thermomagnetic convection of a ferrofluid flow induced by the non-uniform magnetic field around a current-carrying wire was theoretically analyzed, numerically studied and experimentally validated. The dependency of the thermomagnetic convection on the current and fluid temperature has been studied. The Nusselt number for a heated 50um diameter wire in the ferrofluid exponentially scales with applied current to the micro-wire. This result is in good agreement with the correlated Nusselt number by curve-fitting the experimental data at different fluid temperatures. It was shown that at low currents, no significance is observed for thermomagnetic convection rather than the buoyancy-driven convection, while the thermomagnetic convection becomes dominant at high currents. Also, numerical simulations showed a promising cooling ability for large scale applications.

Keywords : ferrofluid, non-uniform magnetic field, Nusselt number, thermomagnetic convection
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