Comparison of the effect of shape factor of Cu-H_2O and Al-H_2O in Marangoni Magneto-Convection under Non-Uniform temperature gradients

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1. INTRODUCTION & OBJECTIVE

A mechanism was proposed by Bènard by which the cellular convection patterns can be instilled in a fluid layer by surface tension forces, rather than buoyancy forces. The surface tension forces can be introduced in the system with non-uniform temperature gradients or with non-uniform surfactant gradients[1]. The heat transfer rate is influenced by the presence of suspended nanoparticles in the Newtonian fluid layer for convection. The term "thermophysical properties" refers to the impact of the nanoparticles' physical characteristics on the thermal and viscous effects when they are suspended in a base liquid. Initially there was a discrepancy between the experimental and theoretical results on convection with nanoparticles. The thermophysical properties of the nanoparticles were learnt to cause the difference in the results and thus they gain their significance[2]. Depending on the shape, size and the nature of the particle the heat transfer efficiency could be increased or decreased in a convection system**[**3,4]. The use of nanofluids to enhance heat transfer in nuclear reactors, electrical equipment and automobiles is due to the thermophysical properties of nanoparticles[5]. This is why recent studies on nanoparticles and their thermophysical properties have been dealt with in much deeper aspects. Nanoparticles are engineered for enhancing heat transfer efficiency in convection systems by varying the dependent properties. Understanding Marangoni convection and the effect of nanoparticles is crucial in the application level for welding and crystal expansion[6].

A linear and non-linear stability analysis of Rayliegh-Bènard convection for Cu-H_2O nanofluid revealed that the presence of nanoparticles play a crucial role in the on-set of convection[7]. Marangoni convection on a layer of fluid due to non-uniform temperature gradients, under microgravity conditions, observed that parabolic temperature gradient is the most stabilizing function. Horizontal magnetic field and non-uniform temperature gradients are applied to enhance thermal transfer efficiency in the fluid system[8]. The literature does not show the study the influence of the shape factor on Marangoni Magneto-Convection under non-uniform temperature gradients for single phase nanofluids.

The objectives of this study are to perform

- A linear stability analysis to investigate the influence of shape of the particle, volume fraction and non-uniform temperature gradient on the thermal transfer rate of nanofluids under Marangoni Magneto-convection.

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- Develop a model for the thermophysical properties of nanofluids as a function of the properties of water as base liquid, copper and alumina as nanoparticles.
- The impact of various parameters under consideration on the on-set of convection is observed through graphical results.

2. RESULTS & HIGHLIGHTS OF IMPORTANT POINTS

A linear stability analysis to investigate the influence of shape of the particle, volume fraction and non-uniform temperature gradient on the thermal transfer rate of nanofluids under Marangoni Magneto-convection is performed. Single-phase nanofluids with a base liquid of water and suspended nanoparticles of alumina and copper are examined. The thermophysical properties of base liquid and nanoparticles are calculated using phenomenological laws and mixture theory for a volume fraction, X=0.06. The effect of shape of nanoparticles in the nanofluid is taken from literature and calculated for the nanofluid in this study.

The following observations are made from the study:
The linear stability analysis of Marangoni Magneto-convection is performed using classical normal mode analysis and the Marangoni convection is obtained through boundary conditions on the physical configuration. Critical Marangoni number, M_c, is evaluated using Galerkin method and the graphical results show the variation of onset of convection on the thermophysical properties of nanoparticles.

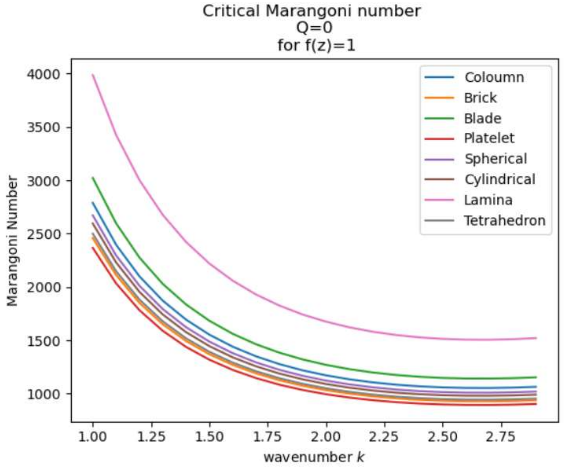

Figure 1

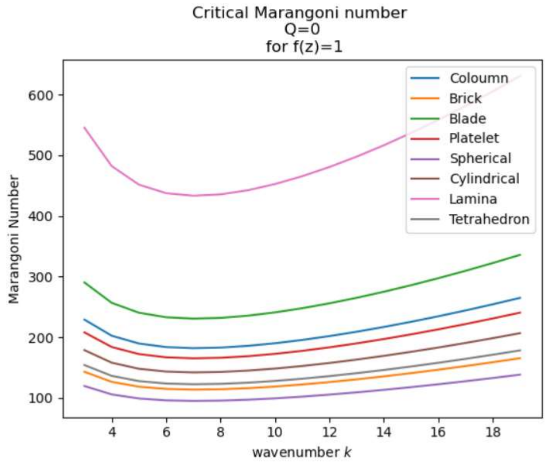

Figure 2

From Figure 1 and Figure 2, Lamina shape of nanoparticles is the most-destabilizing for on-set of convection for Marangoni Magneto-convection in both the nanofluids. The platelet shape is the most stabilizing shape in Cu-H_2O whereas in Al-H_2O the spherical shape is the most stabilizing. For non-uniform temperature gradients, parabolic function shows that the thermocapillary effect in the system is dominant than the viscous force acting on the fluid layer. Similarly, as the Chandrashekar number increases, the wave number increases, and it is also observed that the critical Marangoni number increases.

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