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MARANGONI EFFECT: AN INVESTIGATION INTO SURFACE TENSION DRIVEN MASS TRANSFER IN MICROGRAVITY

Abstract

Marangoni effect is the heat and mass transfer along the interface of two fluids as a result of a surface tension gradient. This gradient can arise either due to differences in temperature or concentration of the fluids. The hydrodynamic instability induced by the interfacial tension causes heat and mass to move towards the region of higher surface tension. This movement leads to some interesting observations in fluid behavior especially in microgravity environments. Plenty of manuscripts are available which describe accurate models to study this effect on earth. However, their potential for application in microgravity is something that has only been explored recently. It is also easier to study this effect in microgravity where surface tension effects play a larger role. Marangoni convection is also detrimental to the quality of crystal growth in semiconductors, bio-technology and optical devices. This makes it essential to study this effect and its implications in the manufacture of equipment for space use. Hence, an attempt at reliably modeling the mass-transfer induced Marangoni effect in microgravity has been made in this paper.

In order to better facilitate this research, CFD simulations were carried out under both microgravity and normal gravity conditions. The governing equations considered for the two phase flow were the standard Navier-Stokes equation and continuity equation. It was found that the flow due to surface tension gradients were easier to study in micro or nano-scale systems. So, the simulations were carried out using suitable low Reynolds numbers and channel dimensions. The obtained results are compared for both environments in this paper and the effect of concentration of the fluids were analyzed in both cases. The performed simulations of Marangoni flow provide the necessary basis for further work in the field of surface tension driven two phase flows in microgravity.