INTERACTION OF DROPS IN VISCOUS FLOW IN THE PRESENCE OF SPONTANEOUS MARANGONI EFFECT

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We have employed an original 3D BIE code to study the effect of spontaneous thermocapillarity induced by cross interfacial transport on the pair-wise interaction of highly deformable drops in the course of their buoyancy induced motion in viscous flow. Our focus was on the case when the two drops are of the same material but unequal in size, with the smaller drop initially leading the larger one. Buoyancy and thermocapillary driven motion of a pair of adjacent drops in viscous medium is known to exhibit a rich variety of interaction patterns and critical phenomena capture, coalescence and break up [1,2,3]. Our previous simulations of axisymmetric deformations of heavy drops in an upward temperature gradient [4] have demonstrated that even weak thermocapillarity may drastically change the interaction pattern in near critical situations. Here we report an extension of the axisymmetric results on the motion under an external temperature gradient of [4] to 3 dimensional geometry and spontaneous Marangoni effect. Numerical simulation of the motion of two initially spherical drops with various aspect ratios and various initial offsets was carried out with and without the Marangoni effect.

Three different mechanisms of the influence of the spontaneous Marangoni effect on the interaction pattern are revealed. The first is due to the induced non-uniform decrease of surface tension, which increases deformability, decreases stability and promotes the break up of the drops. This results in a substantial change of an interaction pattern of highly deformable drops that may be caused in near critical situations even by a weak Marangoni effect. The second mechanism is operative in the cases when the buoyancy and thermocapillary forces are of the same order of magnitude. Tangential flow induced by concentration gradients results in a relative motion of the drops towards each other. This effect was studied in [5,6] for the cases of spherical and slightly deformed drops migrating solely under the action of Marangoni effect in the absence of gravity. The third is the suppression of drops' coalescence by thermocapillary flow [7]. The combined action of the latter two effects results in the appearance of a new interaction pattern revealed by our computations. The two drops form a long living stationary (or quasi-stationary) axisymmetric configuration of two considerably deformed drops moving at close proximity, with the larger drop leading the ensemble.

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Keywords: drops, deformation, thermocapillarity