# Free surface heat transfer effect on thermocapillary flow in liquid bridges

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An important class of thermocapillary flows, which is connected with the floating-zone crystal growth technique, is that of flows in a cylindrical liquid bridge. The liquid bridge is liquid volume confined between two solid rods supported at different temperatures. In a finite cylindrical zone, a number of instability modes with different azimuthal wave numbers have been found but as a rule the phenomena in the gas surrounding the liquid bridge have been ignored.

Recently, the effect of ambient gas on the stability of flow inside a liquid bridge has become an object of investigation. Moreover, a future Space experiment JEREMI (Japanese European Experiment on Marangoni Instability) will investigate control of thermocapillary flows by gas stream around liquid bridge. At the first step we have studied experimentally and numerically two phase shear driven flow in isothermal system [1]. This is one of the first studies in non-isothermal liquid bridge on the way of preparation of the Space experiment JEREMI.

The effect of the free surface heat loss/gain on thermocapillary flow is analyzed in liquid bridge of Pr=68 to understand the nature and extent of the interaction between the liquid flow and the surrounding air. At the absence of forced gas motion the surrounding hot gas decrease the interface velocity and, especially, its maximal value. It may lead to the stabilization of flow. When ambient gas temperature is equal to the mean temperature or colder, the free surface is thermally active almost over the entire length. Correspondingly, the velocity on the free surface is much larger than in usually considered thermally insulated case.

We also present results of numerical study on thermocapillary (Marangoni) convection when the interface is subjected to an axial gas stream. The gas flow is co- or counter-directed with respect to the Marangoni flow. In the case when the gas stream comes from the cold side, it cools down the interface to a temperature lower than that of the liquid beneath, and in a certain region of the parameter space that cooling causes instability due to a temperature difference in the direction, perpendicular to the interface. The mechanism of this new oscillatory instability is discussed.

**References**

[1] Yu. Gaponenko, I. Ryzhkov, V. Shevtsova, "On flows driven by mechanical stresses in a two-phase system," *Fluid Dynamics Material Processes (FDMP)*, Vol. **6**, pp. 75-97, (2010)