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How Non Condensable gases modify phase change mass transfer[1]

SAIKAT MUKHERJEE, HECTOR GOMEZ, School of Mechanical Engineering, Purdue University, 585 Purdue Mall, West Lafayette, IN 47907, USA — Characterising mass transfer in a fluid from liquid to vapor phase is a classical problem in fluid dynamics which continues to be relevant even today. However, these fluids often contain dissolved non-condensable gases (NCGs), which can dramatically alter the rate of mass transfer from one phase to another. Here, we derive equations to quantify the role of these NCGs using balance laws for mass and momentum transfer. Numerical simulation of the equations point to a dual role of NCGs. We refer to the component primarily driven by the divergence of fluid velocity as hydrodynamic cavitation, which always reduces the rate of mass transfer in the presence of NCGs. On the other hand, there is another component primarily composed of the divergence of mass flux of NCG, which may either promote or impede mass transfer with an increase in the mass fraction of NCGs. We call this component mixing cavitation, and study physical scenarios where it dominates hydrodynamic cavitation. Expressing the rate of phase change in terms of velocity and mass flux of NCGs also opens up avenues to experimentally visualise phase change in multiphase fluids.

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