Fluids and Space Engineering Seminar

Date: Thursday, December 15, 2022 at 14:00
Location: ZARM, Room 1730

Investigation of surface stability during the filling of a tank in reduced gravity

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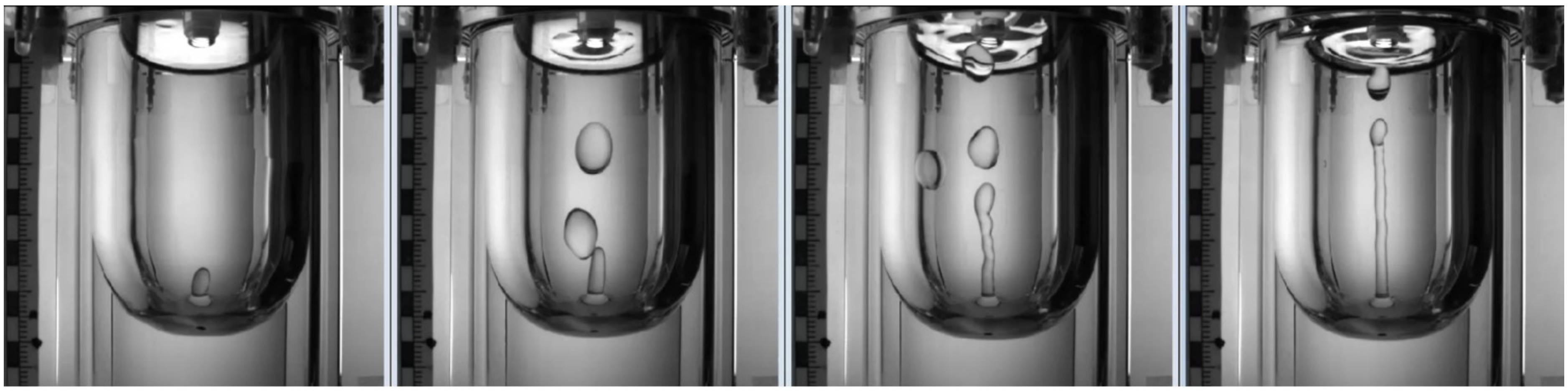

$Q_L = 1.20\ \mathrm{mL\,s^{-1}}$ $Q_L = 1.30\ \mathrm{mL\,s^{-1}}$ $Q_L = 1.38\ \mathrm{mL\,s^{-1}}$ $Q_L = 1.50\ \mathrm{mL\,s^{-1}}$

Fig.: Geyser patterns formed during the filling of a tank in microgravity

Storage and transfer of propellants in space will become a primary requirement for future long-range long-term space missions. A propellant depot can store the propellants in space and thereby help to refill the docked spacecraft tank. It is challenging to understand the flow physics related to storage and refilling in orbit. While in normal gravity the free surface remains flat for a tank filled with liquid, in reduced gravity capillary forces dominate and lead to a new configuration of the free surface.

In this talk, the experimental and numerical results of surface stability during the filling of a tank in reduced gravity are presented. The numerical simulations were carried out using the ANSYS Fluent – Multiphase Volume of Fluid (VOF) model. The reduced gravity experiments were carried out at the ZARM drop tower as well as in the 39th DLR parabolic flight. HFE-7500 was used as the test liquid. In the drop tower experiments and numerical simulations, the stability of the free surface and its interaction with an incoming liquid during the filling of the tank was investigated for different volumetric inflow rates. Furthermore, the stability of the liquid jet injected into an initially empty tank was studied in the parabolic flight experiments. The behavior of the free surface can be classified into three regimes of subcritical, critical, and supercritical flow. The non-dimensional Weber number can be used to represent the flow regimes. These experimental and numerical results contribute to designing an international space station (ISS) experiment.