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Entrained Liquid Fraction in Annular Two-Phase Flow

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Abstract

Annular two-phase flow is one of the most frequently observed flow regimes in practical applications involving gas-liquid or vapor-liquid two-phase flow, such as steam generators, air conditioning and refrigeration systems, nuclear reactors, chemical processing plants and the piping in such systems, and small-scale heat sinks.

Annular flows are characterized by the presence of a continuous liquid film flowing along the channel wall and surrounding a gas core laden with entrained liquid droplets, so that part of the liquid phase is transported as a continuous film that steams along the channel wall, whilst the rest of the liquid phase is transported as a spray of droplets entrained within the gas core.

A crucial parameter in the analysis and modeling of annular flows is the entrained liquid fraction, representing the ratio of the mass flow rate of the entrained liquid droplets to the total liquid mass flow rate. The entrained liquid fraction is a dimensionless flow parameter bounded between zero and one: values close to zero characterize annular flows with an almost complete segregation between the liquid and gas phases and most of the liquid flowing in the film, whilst values close to one are typical of annular flows close to the transition to mist flow where most of the liquid is in the form of entrained droplets.

The talk is devoted to the entrained liquid fraction in annular flows: after discussing its practical relevance, illustrating the physical mechanisms underpinning the entrainment process and describing the measuring techniques developed to date, available experimental data and prediction methods are reviewed and critically analyzed.