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Interfacial instability in vertical counter-current gas-liquid film flow: theory, direct numerical simulation and experiment PATRICK SCHMIDT, The University of Edinburgh, ILJA AUSNER, Sulzer Chemtech, LENNON Ó NÁRAIGH, University College Dublin, MATHIEU LUCQUIAUD, PRASHANT VALLURI, The University of Edinburgh — The dynamics of vertical counter-current gas-liquid flows are largely determined by interfacial instability, which gives rise to a multitude of complex wave patterns and internal flows. To study the genesis and evolution of the instability in detail, we employ theoretical stability analysis, experiment and a newly developed level set method based in-house solver to carry out direct numerical simulations. Crucial results of these simulations, such as growth rate and phase velocity of interfacial waves, are rigorously compared against linear and weakly nonlinear theory; thereby showing remarkable agreement. The analysis also reveals the spatio-temporal character of the waves, depicting regimes of absolute and convective instability. Complementing the benchmark set by (non-)linear theory, we perform film thickness measurements of a real gas-liquid system (air-silicone oil) by means of a non-intrusive light-induced fluorescence technique to further validate the solver regarding its capability of capturing interfacial dynamics accurately. These measurements are in good agreement with the results of the nonlinear direct numerical simulations with respect to wavelength and wave shape of the most unstable mode.

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