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A unifying framework for mass transfer dynamics in the Taylor flow of a dissolving train of bubbles GHATA NIRMAL, ARUN RAMCHANDRAN, University of Toronto — Operation in the Taylor flow regime in microfluidics for estimation of mass transfer coefficients in multiphase flows has gained popularity due to the presence of high interfacial areas and well-characterized flow profiles. Although there are multiple models available for data interpretation, these are accompanied by two major limitations. First, mass transfer from the lubricating liquid film to the bulk liquid segment between bubbles has been incorrectly estimated. Second, the liquid segment is assumed to be well mixed. Both assumptions fail in the normal operating limits for Taylor flow experiments of dissolving bubbles. In this work, we rectify the two limitations described above and present a unifying framework to comprehend experimental results in a dissolving train of bubbles in microchannels. Based on a scaling analysis, the experiments can be operated in four regimes controlled by L_B / R, L_L/ R, Peclet number and capillary number where L_B, L_L and R are the bubble length, the liquid segment length and the tube radius, respectively. Finally, we present the differences in the results due to a rectangular cross-sectional shape instead of a circular one, and in particular, on the additional leakage flux through the lubricating film around the corners of the cross-section.

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