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NUMERICAL PROTOTYPING OF DROPLET GENERATORS

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Abstract. Computational mechanics allows the development of numerical prototypes that facilitate the process of designing and optimizing devices for microdroplet generation through different virtual experiments. The formation of microdroplets from one fluid (dispersed phase) into another (continuous phase) can occur in a controlled manner in a discontinuous flow ('dripping'), or a continuous jet ('jetting') which eventually breaks into droplets far downstream in an uncontrolled manner. Although experimental systems that are able to produce droplets of up to three phases have been reported, the transition from dripping to jetting regime is not yet fully understood even for simple two-phase (co-flow) systems. Moreover, the operating conditions (flow ratio, surface tension, geometries) needed for microdroplets to be experimentally produced in two-phase systems are still under study. To achieve a model that facilitates the analysis of the conditions involved, results available in the literature will serve as a starting point while developing a numerical prototype that condenses the main characteristics of the co-flow. This will allow us to evaluate and adjust the conditions under which the dripping regime occurs, at a given frequency and droplet size. The validation with experimental results, will allow the evolution of the numerical prototype to a more complex version involving the transport of reactive substances for synthesis simulation. For the computational model, Basilisk, a free software program for solving flow equations based on the volume-of-fluid method, is used. Basilisk is designed to perform curvature and surface stress calculations, efficiently and accurately, for these types of microfluidic applications. The results obtained in the computational study of a coaxial system, in the dripping regime, for a two-phase model are presented and compared with experiments present in the literature.