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GEOMETRY DRIVEN COALESCENCE OF WATER DROPLETS IN A HIGHLY VISCOUS FLUID

Doston Shayunusov[1], Hongbo Zeng[1], Dmitry Eskin[2], Petr Nikrityuk[1*]
[1]Department of Chemical and Materials Engineering, University of Alberta, Edmonton, Canada
[2]Center for Hydrocarbon Recovery, Skolkovo Institute of Science and Technology, Moscow, Russia
*nikrityu@ualberta.ca

I. ABSTRACT

This work is dedicated to numerical studies of coalescence of water droplets moving in diluted bitumen. The Navier-Stokes equations coupled with the Volume of Fluid model (VOF) using adaptive mesh techniques, available in the commercial CFD software Ansys Fluent 20R1, are solved numerically. Behavior of water droplets with diameters from 10 µm to 100 µm moving in a rapidly converging and diverging microchannels of different sizes is investigated. Effects of mesh resolution, droplet and geometry sizes, and the geometry dimension (2-D and 3-D) are studied for the liquid-liquid flow. Dependence between the interaction scenario (coalescence, slipping, and dispersion) and certain combinations of inlet velocity and interfacial tension values within given ranges are tested. The results are validated against experimental data published in the literature. The simulations show that the main parameter influencing coalescence is the bulk flow velocity in the channel. Analysis of unsteady simulations reveal the existence of the critical flow velocity, above which no coalescence occurs. This velocity corresponds to Capillarity number $Ca < 0.5$ for droplets Reynolds number $Re < 0.1$. Additionally, the effect of a converging channel width on coalescence is studied for randomly allocated polydisperse droplets. The results demonstrate no direct relation between the constrictor's width and the coalescence efficiency.

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