

Observation of the Flow Behavior for a Rising Droplet in a Mini-Slot

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Abstract : The passage of oil droplets through a vertical mini-slot were investigated in this study. Oil-in-water emulsion can undergo coalescence of finer oil droplets forming droplets of a size that need to be considered individually. This occurs in a number of industrial processes and has important consequences at a scale where both body and surfaces forces are relevant. In the study, two droplet diameters of smaller than the slot width and a relatively larger diameter where the oil droplet can interact directly with the slot wall were generated. To monitor fluid motion, a particle shadow velocimetry (PSV) imaging technique was used to study fluid flow motion inside and around a single oil droplet rising in a net co-flow. The droplet was a transparent canola oil and the surrounding working fluid was glycerol, adjusted to allow a matching of refractive index between the two fluids. Particles seeded in both fluids were observed with the PSV system allowing the capture of the velocity field both within the droplet and in the surrounds. The effect of droplet size on the droplet internal circulation was observed. Part of the study was related the potential generation of flow structures, such as von Karman vortex shedding already observed in rising droplets in infinite reservoirs and their interaction with the mini-channel. Results show that two counter-rotating vortices exist inside the droplets as they pass through slot. The vorticity map analysis shows that the droplet of relatively larger size has a stronger internal circulation.

Keywords : rising droplet, rectangular orifice, particle shadow velocimetry, match refractive index

Conference Title : ICFMHTT 2017 : International Conference on Fluid Mechanics, Heat Transfer and Thermodynamics

Conference Location : Venice, Italy

Conference Dates : June 21-22, 2017