S2.2.6 and PP5 - *Detachment of Compound Droplets from Fibers and Associated FEA Modelling of Four-Phase Coalescence*

Jake Holweger[1], Mohammad Jamali[2]
[1]Virginia Commonwealth University, [2]North Carolina State University

This work presents a novel combined experimental and computational study on the centrifugal detachment of a compound droplet (e.g., a primary water droplet cloaked by an immiscible oil) from a fiber in a standard atmosphere. The primary intention of this work was to establish a method for quantifying the force needed to detach two-phase compound droplets of different compositions from a fiber. Fundamentally however, our study aimed to understand the interplay between interfacial and external forces acting on a compound droplet during detachment at forces above those of gravity. The experiments were conducted at standard temperature and pressure using deionized water for the primary droplet, and low volatility immiscible oils (silicone or mineral) for the cloaking fluid on smooth, low-pinning nylon fibers. Silicone oil was chosen for its frequent use and quantification in prior works as well as its molecular homogeneity, and mineral oil was chosen for its prevalence in literature in addition to its composition appealing to the filtration interests of the petroleum and environmental industries. It was observed from the experiments that the silicone-oil-cloaked droplets behave differently from the mineral-oil-cloaked droplets during the detachment process and in terms of force of detachment. It was also observed that generally, detachment force decreases when increasing the oil-to-water volume ratio relative to the fiber's cross-sectional area (and thus the total wetted areas of both phases).The simulations were performed using the Surface Evolver (SE) finite element code programmed for the complicated four-phase (air, water, oil, and solid) interfacial problem at hand. Our simulations revealed the evolution of the interfacial forces between the interacting phases under an increasing external body force on the droplet. Tuning the simulations using image analysis with recorded video of physical droplet profiles also allowed us to define effective interfacial tensions and contact angles for detaching compound droplets, which is the first time to our knowledge that these data have been quantified for four-phase droplets at the detachment moment. Reasonable agreement was observed between the experimental observations and measurements, and the computational results.

Jake Holweger

Jake Holweger is currently finishing a Bachelor's degree in mechanical engineering at Virginia Commonwealth University. Between 2017 and 2020, Jake worked in the Porous Media and Multiphase Flows lab directed by Dr. Hooman Tafreshi where they developed the equipment and methods used to observe single and multiphase droplet detachment via centrifugal force. Jake is currently engaged in agricultural research, food security, and urban community resilience through the Virginia Commonwealth University Office of Sustainability. When they are not online for class, in a vegetable patch, or distributing affordable produce by bicycle at local clinics, Jake serves as the deputy director of a 501(c)(3) organization, the Earth Hacks Foundation, dedicated to mitigating climate change through youth-led, equitable, and sustainable innovation.

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