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Simultaneous PLIF and PIV measurement of a near field turbulent immiscible buoyant oil jet fragmentation in water using liquid-liquid refractive index matching[1] XINZHI XUE, JOSEPH KATZ, Johns Hopkins University — Very little experimental data exits on the flow structure in the near field of a crude oil jet fragmenting in water because of inability to probe dense droplet cloud. Refractive index-matching is applied to overcome this challenge by using silicone oil and sugar water as a surrogate liquid pair. Their density ratio, viscosity ratio, and interfacial tension are closely matched with those of crude oil and seawater. Simultaneous PLIF and PIV measurements are conducted by fluorescently tagging the oil and seeding both phases with particles. With increasing jet Reynolds and Weber numbers, the oil plume breakup occurs closer to the nozzle, the spreading angle of the jet increases, and the droplet sizes decrease. The varying spread rate is attributed to differences in droplet size distributions. The location of primary oil breakup is consistent with the region of high strain rate fluctuations. What one may perceive as oil droplets in opaque fluids actually consists of multi-layers containing water droplets, which sometimes encapsulate smaller oil droplets, creating a "Russian Doll" like phenomenon. This system forms as ligaments of oil and water wrap around each other during entrainment. Results include profiles of mean velocity and turbulence parameters along with energy spectra.

[1]Gulf of Mexico Research Inititave

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