HOW DOES MICROEMULSION SIZE AFFECT DIESEL FUEL-WATER SEPARATION?

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Small amounts of water can enter diesel fuel during usage, potentially causing damage or failure in engine operation. The small droplets of water are stabilized in the fuel through a number of surface-active additives, including lubricity enhancers and deposit control chemicals such as polyisobutylene succinimides (PIBSI). Amphiphilic additives partition to the fuel-water interface, therefore lowering the fuel-water interfacial tension (IFT) and resulting in time-dependent or dynamic IFT. It this work, we explore the effect of emulsion size on the dynamic IFT and the timescales associated with additive transport to the fuel-water interface. We find from pendant drop experiments, that smaller droplets reach equilibrium IFT faster than large droplets, suggesting that droplet size (or interface curvature) affects additive transport timescales. We then push the limit of droplet size to the micron range using a biphasic microfluidic platform to mimic real fuel-water emulsions. Droplets in the size range of tens of micrometers in diameter are formed using a flow-focusing microfluidic design, and IFT measured in a contraction-expansion geometry. We measure dynamic or time-dependent IFT between water and diesel fuels, including model fuel (methyl laurate 1-decene 4:1 v/v), ultra-low sulphur diesel (ULSD) and clay-treated ULSD, with PIBSI and mono-olein additives. We find a strong size dependence on IFT values, and the micron-sized droplets reach the low equilibrium IFT orders of magnitude faster than large millimeter-sized drops. The results obtained with microfluidic tensiometry using micron-sized droplets suggest that standardized tests for qualifying diesel fuels and fuel-water separation testing should account for droplet-size dependent effects, towards improved liquid-liquid filtration.