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On the effects of colloidal particles in controlled oil-water interfaces.

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The flow of colloidal particle suspensions in multiphase systems have become widely studied in applications such as oil recovery, drug delivery, and contaminant transport. In oil extraction processes, about two-thirds of the original oil in place remains underground after primary or secondary production. An important key factor contributing to the deficiency of recovery methods is the heterogeneity of the oil reservoirs. The morphology of the porous medium is heterogeneous with many distinct pore configurations, both in size and shape. For instance, oil may get trapped in cavities (dead-end pores) connected to conductive channels. The inherent geometrical restriction of a dead-end pore configuration inhibits the possibility to liberate the trapped fluid by displacement methods. Nanoscale particles placed at oil-water interfaces may produce a more uniform and elastic interfacial configuration when subjected to deformation. This elasticity may help oil to be drained from cavity confinements. Most nanoscale particles are either hydrophilic or hydrophobic and do not settle at the interfaces. Enabling particles to be surface activate by means of physicochemical interactions with natural surfactant molecules present in the crude oil such as asphaltenes, resins, and organic acids is a provident and not well-documented alternative.

In this work, we examine the in-situ particle activation at the oil-water interfaces subjected to a shearing flow field. We fabricate microfluidic chips with a well-defined pattern consisting of a main flow channel connected to multiple dead-end pores. We orchestrated a displacement methodology in which fumed silica particles in a carrier aqueous solution bypass a series of cavities saturated with an oil phase doped with surfactant. The interactions of silica suspensions at 1, 2, and 4 wt.% concentrations and oil-soluble surfactants above critical micellar concentrations are examined. We use a color camera and a confocal laser scanning microscopy to monitor and visualize the displacement process. We measure the dilatational interfacial viscoelasticity and dynamic interfacial tension of oil-water systems by means of a drop shape analyzer and the Spinning Drop Tensiometer.

The results show that notable particle-coated water-oil interfaces developed in the presence of surface-active particles. When dispersed particles on injecting water enter cavities saturated with the trapped micellar solution, oil in water emulsions at the oil-water interface are instantaneously formed. As water penetrates the cavity area, the residual oil films left behind the interface interact with the particles in the aqueous phase forming rigid and well packed micro-size droplets. The growth of the emulsion zone in cavities is a function of oil viscosity and decreases as the oil viscosity increases. A relationship between the oil-water interfacial viscoelasticity, dynamic interfacial tension, surfactant and particle concentrations, oil viscosity spontaneous in-situ emulsification, and consequently oil discharge from cavities is established and discussed.

Time Block Preference

Time Block A (09:00-12:00 CET)

References

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Primary authors: Mr CORDOVA-GONZALEZ, Mario (University of Calgary); HEJAZI, S. H. (University of Calgary)

Presenter: Mr CORDOVA-GONZALEZ, Mario (University of Calgary)

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