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Numerical Modeling of Surfactant-Oil-Mixtures in Sea Water

Abstract

The Deepwater Horizon oil spill in the Gulf of Mexico in 2010 is unprecedented in the amount of crude oil spilled, dispersants used and in being the first sub-sea injection of dispersants right at the well head. Sub-sea injection aims at mitigating harm to on-site workers as well as coastal communities by keeping the oil entrained in the water column. Little is known about the appropriate amounts of dispersants needed to sufficiently break up rising oil droplets to the point were buoyant effects become less dominant.

This work describes the modeling of buoyant oil droplets rising through the water column. Different inter-facial tension coefficients are used as a proxy for different Dispersant to Oil Ratios and their influence on droplet break up behavior is investigated.

Based on experimental work by Nagamine (2014), different simulation methodologies within the Gerris Flow Solver are discussed and the most promising one is used to investigate the influence of different inter-facial tension coefficients on the fate of an axisymmetric oil droplet rising through the water column.

After validating the model with BP surrogate oil droplets of known properties and by qualitatively and quantitatively comparing to the results described in Nagamine (2014), the numerical data is used to show that decreased surface tension leads to decreased droplet rise velocities and increased breakup.

The report finishes with explaining the difficulties in accurately modeling dispersant effects on oil break up and gives recommendations for future work.