The Effects of Surfactants on Adhesion between Hydrate Particles and the Flow of Hydrate Slurries

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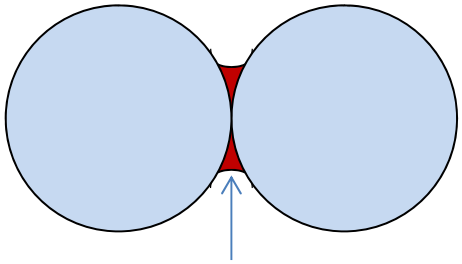
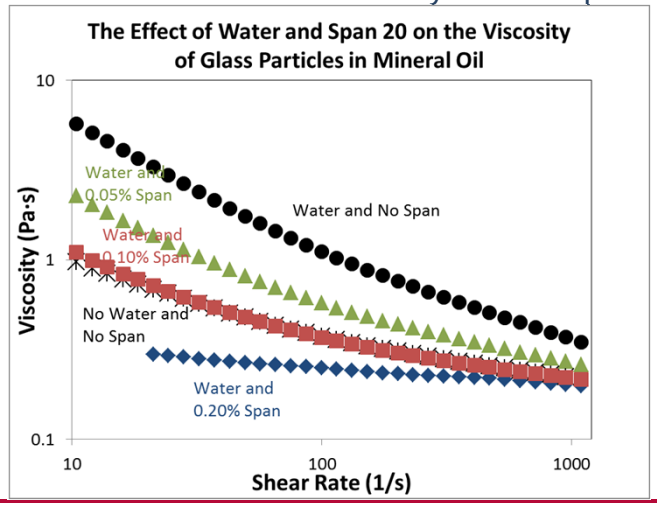
The formation of natural gas hydrates in gas pipelines is highly undesirable; the hydrates plug pipelines and are costly and hazardous to remove. Often, thermodynamic inhibitors are added to lower the hydrate formation temperature; however, this requires large amounts of solvent such as methanol. An alternative is to use low dosage hydrate inhibitors that can prevent plug formation at low concentrations and for which there are many economic and environmental advantages. Specifically, there has been much interest in anti-agglomerants – surfactants that act by preventing adhesion between hydrate particles. However there is not a good, fundamental understanding of how anti-agglomerants affect hydrate adhesion and plug formation.

The goal of this project is to better understand the effects of surfactants (anti-agglomerants) on the interactions between particles by examining the flow behavior of particle slurries. Since the strong adhesion between hydrate particles is believed to be due to capillary forces, the project focuses on providing a better fundamental understanding of (1) the role of capillary forces on adhesion between particles and the flow behavior of the slurries and (2) the effects of surfactants on the adhesion between particles.

We have investigated model suspensions consisting of glass microspheres dispersed in mineral oil with various amounts of added water and surfactant. The addition of small amounts of water led to large increases in viscosity due to the formation of water bridges between particles. Some hydrophobic surfactants were found to reduce the viscosity of the dispersions with water added and cause the flow profile to be less shear-thinning.



Liquid Bridge



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