Clathrate Hydrate Contact Angle/Wettability Investigations for Multiphase Agglomeration Models

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Gas clathrate hydrates are inclusion compounds composed of water cages filled with guest molecules that form at low temperatures and high pressures. Subsea petroleum pipelines are an ideal environment to form gas hydrates and potential plugs, which can both impede production and cause a severe safety hazard. At the interfacial level, hydrate wettability gives important insight into how well hydrates can form and agglomerate to cause plugs. Interfacial properties also help understand agglomeration and viscosification at the macroscopic level. When hydrates have higher wettability (lower contact angles), this indicates that their interactions with other hydrates/water droplets are more favorable than with the bulk hydrocarbon, causing more hydrate growth and agglomeration. The water content in a system can also affect this behavior through dilution of the surfactants. Understanding these interfacial phenomena and their impact on hydrate growth and agglomeration are also important, as these inputs may be used for hydrodynamic multiphase flow modeling of hydrates. This paper presents investigations of hydrate surface wettability without and with surfactants from contact angle measurements that will be compared with molecular simulation predictions that will be used to continue to help in the development of improved viscosity and agglomeration models.