Hydrate Agglomeration in Crude Oil Systems

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The formation of gas hydrates in oil and gas pipelines constitutes a serious problem that can reduce and even arrest the hydrocarbon production. Several strategies have been developed to mitigate the plugging issue, the addition of thermodynamic hydrate inhibitors (THIs, e.g. methanol and mono-ethylene glycol) is the most extensively applied. In this method, hydrate formation is completely prevented by shifting the hydrate equilibrium to harsher conditions. Other methods for hydrate mitigation involve the addition of certain chemicals known as hydrate anti-agglomerants (AAs). AAs do not modify the hydrate equilibrium conditions but prevent hydrate agglomeration and thus plugging. AAs are surfactants, generally quaternary ammonium salts, which adsorb onto the hydrate surface, creating a hydrophobic film around the hydrate particles. This film generates an inter-particle repulsion that keeps the hydrates dispersed in the liquid (crude oil) phase. However, some crude oils, known as non-plugging oils, contain natural surfactants (e.g. acids, asphaltenes, resins) that can naturally prevent hydrate agglomeration. Thus, it can be said that these oils contain natural hydrate anti-agglomerants. In this work, the non-plugging potential of three crude oils was evaluated using a rocking cell apparatus. The maximum water content (water cut) at which hydrates remained dispersed in the oil phase was the main criterion for that evaluation. Additionally, since the effectiveness of natural hydrate anti-agglomerants may be linked to the oils' interfacial behavior, additional assessments such as emulsion stability, water-oil interfacial tension, viscosity of the hydrate slurry and hydrate wettability (water-hydrate contact angle) were performed and correlated with the hydrate agglomeration experiments.