Anti-Adhesion Induced by Hydrophobic Silica Nanoparticles at the Interface Between Hydrate Particles and an Aqueous Phase

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Hydrate inhibitors have been used to prevent pipeline hydrate plugging in offshore gas/oil production fields. This study introduces nanoparticles as potential anti-agglomerants (AAs) of hydrate particles. Hydrophobic silica nanoparticles inhibited hydrate growth by preventing contact between cyclopentane hydrate particles and an aqueous phase.[1-3] The anti-adhesive behavior was observed as the degree of non-wetting even under the force of pushing hydrate particles to the aqueous phase in the presence of the nanoparticles at the interface. The anti-adhesive force was measured according to the amount of silica nanoparticles and analyzed by our microbalance system.[4-5] The nanoparticle inhibition was compared with the Span 20 system. Both the silica nanoparticle and Span 20 showed a tendency to increase the anti-adhesive effect as the amount increased, but they have different inhibition mechanisms. In the case of silica nanoparticles, by the hydrophobicity and aggregative property, a dense hydrophobic particle layer is formed and it blocks the contact. Contrarily, in the Span 20 system, the interfacial tension between the hydrate surface and the oil phase is reduced, and the oil wetted on the hydrate surface prevents contact with the aqueous phase. Even if the water-soluble agent, SDS, is added to the nanoparticle system, it does not affect the anti-adhesive behavior because it does not alter particle distribution or oil-wetting. However, in the case of the Span 20 + SDS system, the emulsion droplet was easily formed at the interface due to the low interfacial tension even without agitation, which could lead to the complete wetting and additional growth of hydrate particles. The hydrophobic silica nanoparticles provide anti-adhesive effect with much less amount than Span 20, and unlike Span 20, they are not affected by the water-soluble SDS. Therefore, they can be potential alternatives to molecular surface-active agents for hydrate inhibition in real systems.

References:

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