Impact of “Rough” Hydrate Particles in Slurry Rheology Modelling

Yahua Qin, Zachary Aman [C, S], Paul Pickering, Eric May and Michael Johns
Fluid Science and Resources Division, University of Western Australia, Perth, WA, Australia
zachary.aman@uwa.edu.au

Gas hydrates are ice-like solids that may readily form in oil and gas flowlines under high pressure and at low temperature. Once formed, hydrate particles can aggregate in the oil phase and impose an extra pressure drop on the line, and in severe cases, lead to a blockage. To quantify the risk of plug formation, a predictive model for the effective viscosity of hydrate-in-oil slurries is of great significance. However, currently there is only one model available, and further improvement is needed. This work deploys a temperature-controlled, high-pressure rheometer with a vane blade rotor to study the rheological properties of methane hydrate-in-crude oil slurries, converted from water-in-oil emulsions, both with and without anti-agglomerates (AA). The results indicate that during the hydrate formation process in systems with the same watercut, the presence of an AA greatly decreased the hydrate growth rate. After the hydrate reaction had reached a steady-state condition, the presence of AA also reduced the magnitude of the hydrate-in-oil slurry flow curve, while maintaining shear thinning behavior. The infinite shear viscosities determined from the measurements showed that the roughness of the hydrate particles in the slurry has a great impact on its slurry rheology, which is not considered by the current model. By using a parameter to account for the particle shape and roughness, a new model for the hydrate-in-oil slurry was developed with a significantly improved predictive accuracy.