Experimental Study of the Formation and Deposition of Gas Hydrates in Condensate and Mineral Oil Systems

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Gas hydrates are crystalline structures of water stabilized by light natural gas molecules. Increased understanding of hydrate deposition and other hydrate formation mechanisms in oil and gas pipelines can result in reduced risk for hydrate blockage, reduced inhibitor injection and, in some cases, lead to introduction of new hydrate management strategies for decreasing operational costs. This paper presents results from experimental measurements of hydrate formation in a rocking cell setup with visual capabilities. The constant volume experiments were performed at initial pressure of 38 bar and temperature of 20 °C and then cooled to stable hydrate conditions. 42% of the cell volume was filled with fresh or saline water, 28% with gas condensate or mineral oil, and the rest was gas phase containing a methane/ethane mixture. Pressure and temperature were measured during the experiment to enable calculation of amount of water converted to hydrates. Windows in the side wall of the rocking cell facilitated video recording of the hydrate formation process. Hydrate growth both in the bulk and on the surface, sloughing of hydrate deposit, bedding of hydrate particles in a hydrate slurry and conversion of bedded particles to hydrate deposits were some of the mechanisms identified. Prior to hydrate formation, phases were dispersed, and upon hydrate formation onset the liquid phases appeared to completely separated until some visible amount of hydrates had formed. This phenomenon is fundamentally intriguing and potentially of significant practical interest. It might be explained by the sudden change in fluid properties, such as viscosity, density and interfacial tension of the oil phase due to fast gas uptake in initial formation of hydrates. Another proposed explanation could be that the hydrate particles forming at the oil/water interface destabilize emulsions due to the hydrate surface energy properties, similarly to how clay particles stabilize a Pickering emulsion.