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Gas Hydrate Formation Kinetics in the Presence of Surface-Active Agents

By

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Gas hydrates are one group of clathrates consisting of host water and small guest molecules such as methane, ethane, propane, CO₂, etc. The presence of high-pressure gas induces a three-dimensional network of hydrogen-bonded water cages. Humphry Davy first discovered gas hydrates in 1810. Since 1930's, gas hydrates have been responsible for plugging natural gas process and transportation lines. Until now, research in the petroleum industry had been focused on avoiding the formation of gas hydrates. On the other hand, gas hydrates can play an important role in CO₂ separation/sequestration and can also be used for natural gas storage purposes. But to apply gas hydrate techniques to industrial processes, we have to overcome the two barriers: (1) Gas hydrates are usually formed at the interface between the bulk gas and water phases. Once the solid hydrates cover the interface, gas hydrate formation decreases significantly because the hydrate layer becomes a barrier for mass transfer, and thus hydrate conversion is very low. (2) The rate of gas hydrate formation is very slow. To overcome these obstacles, people have employed a small amount of surfactants and the gas hydrate formation was accelerated several hundred times faster than water/gas systems. This talk will mainly concern the kinetic mechanism of methane hydrate formation when SDS is involved and will show that the SDS does not form micelles using an in-situ measurement of SDS concentrations. The role of SDS in accelerating methane hydrate formation will be understood by the SDS adsorption to hydrate particle surfaces using zeta-potential and pyrene fluorescence measurements. Some aspects of other surface-active agents will also be discussed.

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