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Advancements in Hydrate Phase Equilibria and Modeling of Gas Hydrates Systems

*M. Naveed Khan^{1,2}, Pramod Warriar², Cor J. Peters^{*1,2}, Carolyn A. Koh^{*2}*

¹*Khalifa University of Science and Technology, The Petroleum Institute, Chemical Engineering Department, P.O. Box 2533, Abu Dhabi, United Arab Emirates.*

²*Center for Hydrate Research, Chemical & Biological Engineering Department, Colorado School of Mines, Golden, CO 80401, USA*

** Corresponding authors: ckoh@mines.edu Ph: 303-273-3237, cpeters@pi.ac.ae Ph: 050-143-8065*

Abstract

Reliable hydrate phase behavior predictions are critical to petroleum and natural gas processing and design, and operation of process equipment. Inaccurate predictions of phase equilibria can also lead to erroneous design of process facilities and subsequently may cause safety hazards and flow assurance issues. This work reviews the experimental data on hydrate phase equilibria in the presence of inhibitors (Salts + Organic Inhibitors). The statistical thermodynamic model of van der Waals and Platteeuw for hydrate phase equilibria prediction is also critically reviewed. Recent studies have shown that the basic assumptions of the van der Waals and Platteeuw model, including the spherical symmetry of molecules, no guest–guest interactions, and no lattice distortions (due to guest molecules) can introduce errors in the predicted results. In addition, the limitations of the fluid phase models, which do not account for the effect of hydrogen bonding and electrolyte contributions, can lead to severe prediction errors in hydrate forming systems containing polar hydrate formers, inhibitors, and salts, especially at high concentrations. Thermodynamic predictions of gas hydrate phase equilibria for polar hydrate formers and inhibited systems (e.g., $NaCl$, KCl , $CaCl_2$, and also methanol, ethanol, Ethane-1,2-diol) are of major concern because of the large errors in fluid phase equilibrium predictions. The unavailability of phase equilibria data, an appropriate electrolyte model, and an associative equation of state as well leads to various problems in predicting the properties of aqueous associating fluids and inhibited systems.

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