**A predictive thermodynamic model for phase behavior of gas hydrates**

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Gas hydrates are ice-like crystalline solids in which water molecules form a three-dimensional structure that is stabilized by the encapsulation of small gas molecule like methane, ethane and carbon dioxide. A predictive thermodynamic model is proposed to describe the phase boundary of gas hydrates. The Peng-Robinson-Stryjek-Vera equation of state combined with the COSMO-SAC activity coefficient liquid model through the modified Huron–Vidal mixing rule are chosen to describe the vapor and liquid phases. The van der Waals and Platteeuw (vdW-P) model is applied to describe the hydrate phase. In the vdW-P model, the Langmuir adsorption constant is pressure- and temperature-dependent and designed to produce a reduced free volume available to the encapsulated gas molecules as the pressure increases. It is found that three- phase-coexisting conditions of gas hydrates, from vapor-ice-hydrate equilibrium at low temperatures, to vapor-liquid-hydrate equilibrium at higher temperatures, and even to liquid-liquid-hydrate equilibrium at high pressures, can be well described by this predictive model. In addition, this proposed model is able to predict the phase boundary of gas hydrates in the presence of organic inhibitors, electrolytes and ionic liquids.

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