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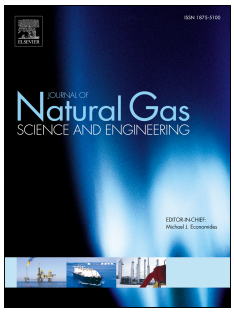

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M. Naveed Khan, Pramod Warrier, Cornelis J. Peters, Carolyn A. Koh

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Review of Vapor-Liquid Equilibria of Gas Hydrate Formers and Phase Equilibria of Hydrates

M. Naveed Khan[1,2], Pramod Warrier[1], Cornelis J. Peters[2], Carolyn A. Koh[1*]*

[1]Center for Hydrate Research, Chemical & Biological Engineering Department, Colorado School of Mines, Golden, CO 80401, USA
[2]Chemical Engineering Department, Petroleum Institute, Abu Dhabi, U.A.E

Abstract

There is significant interest in clathrate hydrates of natural gases for flow assurance in the oil and gas industries, and for their development as an energy resource. Numerous applications of gas hydrates, e.g., seawater desalination, gas separation, hydrogen storage, and natural gas transportation, require detailed investigations of their thermodynamic properties. Therefore, phase equilibrium measurements and predictions constitute a major portion of the scientific literature in the field of gas hydrates. There exists a wealth of experimental data over a wide range of temperature, pressure, and composition, in the absence and presence of thermodynamic inhibitors at low to moderate concentrations. These hydrate and vapor-liquid phase equilibria measurements and data are reviewed in this paper. These data are not only important in tuning hydrate phase equilibrium predictions, but also in process design of technological systems involving gas hydrates.

***Keywords*:** Gas hydrate, thermodynamics, phase equilibria, clathrates

1. Introduction

Gas clathrate hydrate phase equilibria behavior is critical to understand the thermodynamics and kinetics of gas hydrates. Hydrate phase equilibrium data are not only important for avoiding hydrate plug formation in subsea oil and gas flowlines (flow assurance), but also are fundamental to other applications, such as hydrates as an energy resource, seawater desalination, and gas separation. Clathrate hydrates are crystalline, non-stoichiometric inclusion compounds comprised of hydrogen-bonded water molecules. Hydrates are formed when small gas molecules

[*]Corresponding Authors: cpeters@pi.ac.ae & ckoh@mines.edu