KINETIC STUDIES ON METHANE HYDRATE FORMATION WITH HYDRATE INHIBITOR AND PROMOTER VIA IN-SITU RAMAN SPECTROSCOPY

Sang Yeon Hong, Kyeong Nam Park, Kyung Chan Kang, Jin Woo Lee, Man Sik Lee
Ju Dong Lee*

Green Technology Center, Korea Institute of Industrial Technology
421 Daun-dong, Jung-gu, Ulsan 681-802
Republic of Korea

ABSTRACT

In an attempt to more fully understand the kinetics of gas hydrate formation, we investigated the influence of addictives (inhibitor and promoter) on the gas hydrate formation at constant temperature and pressure with real-time Raman spectroscopy. Kinetic experiments were carried out in CH₄ hydrate formation in the presence of kinetic inhibitor (PVCap) and surfactant (SDS). In-situ Raman spectroscopic analysis is helpful for understanding the time-dependent characteristics of gas hydrate and the kinetics of capturing guest molecules. Fractional occupancies for methane hydrate were measured from the areas of real-time Raman spectroscopy corresponding to the large (51262) and small (512) cavities. In this study, we compared with kinetic data of inhibitor and that of surfactant at the same conditions. Kinetic studies involve the measurement of the induction time for crystallization, the determination of the rate of hydrate crystal growth.

Keywords: gas hydrate, kinetic inhibitor, surfactant, Raman spectroscopy

INTRODUCTION

Gas hydrates are non-stoichiometric ice-like solid compounds consisting of small gas molecules and water molecules [1]. Generally, gas hydrates have three basic crystal structures (structure I, structure II, and structure H) where gas molecules (guest molecules) are enclathrated in cavity structures that are formed by hydrogen-bonded water molecules (host molecules) [2,3]. They have attracted attention because of their great potential to be used as gas storage and capturing medium. However, natural gas hydrate formation can cause blockages in subsea gas and oil flow lines, which can lead to catastrophic economic and safety concerns [7]. Therefore, many researchers have tried to apply various inhibitors to delay the formation rate of gas hydrates because the prevention and removal of hydrates during natural gas and oil subsea production and transportation are major concerns of the energy industries. [10,11]

The hydrate inhibitors are divided to thermodynamic and kinetic inhibitor with purposed application of gas hydrate technology. Thermodynamic prevention methods control or eliminate elements necessary for hydrate formation: the presence of hydrate forming guest molecules, the presence of water, high pressure or low temperature. Eliminating any one of these four factors from a system precludes the formation of hydrates. Unfortunately, elimination of these hydrate elements is often impractical or even impossible [5,6]. Kinetic hydrate inhibitors (KHIIs) are a class of low dosage hydrate inhibitor (LDHI) and the commercial materials often use in the upstream oil and gas