

Rapid and High Hydrogen Uptakes in Clathrate Hydrates with Blended Hydrate Seed and Liquid Promoter

Wonhyeong Lee¹, Kwangbum Kim^{2,S} and Jae W Lee^{1,C}

¹*Korea Advanced Institute of Science and Technology, Daejeon, Korea*

²*Chemical & Biomolecular Engineering, Korea Advanced Institute of Science and Technology, Daejeon, Korea*
jaewlee@kaist.ac.kr

The sluggish hydrogen hydrate formation poses a significant challenge to the practical use of clathrate hydrates as a medium for hydrogen storage. This study introduces the blending of a hydrate seed solution and a liquid thermodynamic promoter to facilitate the formation of hydrogen hydrates under static conditions. Two representative sII hydrate formers, cyclopentane (CP) and tetrahydrofuran (THF), were utilized as hydrate seed solution and additional liquid thermodynamic promoter. The introduction of CP hydrate seeds immediately initiated the growth of binary CP and hydrogen hydrates by providing abundant nucleation sites for hydrate formation. Increasing the amount of CP hydrate seeds accelerated the early-stage formation rate of hydrates. However, the total hydrogen storage capacities were decreased owing to the challenge of hydrogen molecules diffusing into the empty cages of pre-constructed hydrate crystals. To overcome this diffusion limitation, the ratio between CP hydrate seeds and CP liquid was adjusted, enabling the simultaneous formation of mixed CP + hydrogen hydrates with porous vertical growth. THF was found to be unsuitable for the blended hydrate seed and liquid promoter system. Its miscibility with water hindered the vertical growth of porous hydrates, resulting in low hydrogen uptakes. This talk highlights the crucial role of a liquid promoter combined with hydrate seeds in facilitating the formation of hydrogen hydrates.