MOLECULAR STORAGE OF HYDROGEN IN SIMPLE AND BINARY
CLATHRATE HYDRATES

Takeshi Sugahara*, Takaaki Tsuda, Kazunari Ohgaki
Division of Chemical Engineering, Graduate School of Engineering Science
Osaka University
Toyonaka, Osaka 560-8531
JAPAN

Pinnelli S. R. Prasad
Gas Hydrate Group, National Geophysical Research Institute
Council for Scientific and Industrial Research
Hyderabad 500 007
INDIA

Vahid Taghikhani
Department of Chemical and Petroleum Engineering
Sharif University of Technology
Tehran
IRAN

E. Dendy Sloan, Carolyn A. Koh, Amadeu K. Sum
Center for Hydrate Research, Chemical Engineering Department
Colorado School of Mines
Golden, Colorado 80401
USA

ABSTRACT
The effect of pressure, temperature, and enclathrated/non-enclathrated additives on the storage capacity of H₂ in clathrate hydrates has been investigated. In the tetrahydrofuran (THF)+H₂ binary hydrates, a new approach of formation by solid mixing resulted in a H₂ storage capacity as high as 3.4 wt% at 72 MPa and 255 K. Also the present work reveals that the 5\(1^6\)\(^4\)-cage occupancy of H₂ strongly depends on pressure as well as the concentration of additive enclathrated in the hydrate structure. For non-enclathrated additives, 1-butyl-3-methyl imidazolium tetrafluoroborate ([bmm][BF₄]) in aqueous solution resulted in accelerating the formation of simple H₂ hydrates and improving the H₂ storage capacity in hydrates compared to that without [bmm][BF₄] under the same temperature and pressure conditions. All the unusual behavior observed in the present study are suggested to be attributed to the properties of a quasi-liquid layer on ice surface, which facilitates and enhances the hydrate formation and storage of H₂.

Keywords: gas hydrate, hydrogen storage, cage occupancy, Raman spectroscopy, ionic liquid

*Corresponding author: Phone: +81 6 6850 6293 Fax +81 6 6850 6293 E-mail: sugahara@cheng.es.osaka-u.ac.jp