Gas Hydrate-Based F-Gas (CHF_3 and C_2F_6) Separation: Thermodynamic and Spectroscopic Approaches

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CHF_3 (fluoroform, HFC-23) and C_2F_6 (hexafluoroethane, R-116) are the most common F-gases which are primarily utilized in the semiconductor industry and refrigeration system due to their high stability compared to other industrial gases. However, since they have significant global warming potential and long atmospheric lifetime, their emission to the atmosphere should be reduced in order to mitigate the accelerating global warming effect. Therefore, gas hydrate-based F-gas capture was recently suggested as the solution for the prevention of F-gas emission. To examine the feasibility of the gas hydrate-based F-gas separation, the N_2 + CHF_3 (10, 20, 40, 60, 80%) and N_2 + C_2F_6 (10, 20, 40, 60, 80%) gas hydrates were investigated with a primary focus on phase equilibria and preferential partitioning of guest molecules. Also, the composition changes of the vapor and hydrate phases and the gas uptake during the hydrate formation were investigated at two different temperature conditions. Furthermore, in-situ Raman spectroscopy revealed the cage filling behaviors of CHF_3 molecules in CHF_3 + N_2 mixed gas hydrates.