



Inclusion chemistry in clathrate hydrates: an alternative process for pollutant gas immobilization technique

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The influence of solid surface in the presence of sediment and electrolyte type on the formation and dissociation of clathrate hydrates has been identified in this study. Clathrate hydrates are composed of water and small non-stoichiometric molecules. They have a hydrogen bonded structure like ice and are enclosed by water cages. Understanding the hydrate formation and dissociation equilibria has an environmental significance on the application of immobilization techniques of pollutant gases from combustion sources such as combustion facilities and power plants. Further evaluation of the hydrate formation and dissociation equilibria in the presence of sediments and electrolytes will add to the better understanding of the influence of surface and salinity on equilibrium conditions. This immobilization technique could also be applied in deep-sea pollutant gas sequestration.

Preliminary experiments were carried out to characterize the formation and dissociation of hydrates in colloidal suspensions containing different sediments and electrolytes. Carbon dioxide was used as the representative pollutant gases and the trapped guest molecule for hydrate inclusion. The colloidal suspensions (10 g/L) were prepared with 3.5 % NaCl, KCl, MgCl₂, and CaCl₂ electrolytes. The colloidal suspensions were prepared with pyrite, common soil, and clays (bentonite, kaolinite and nontronite). Gaseous carbon dioxide was bubbled into the colloidal suspension. Hydrate formation during vessel pressurization was detected a through 50 cm³ pressure vessel. The hydrate formation kinetic experiments were conducted under isobaric and isochoric conditions (30 bar and 273.3 K), which could very well represent extreme environments under the oceanic conditions. Hydrate formation kinetic experiments were conducted in pure deionized water and electrolytes and their kinetics were com-

pared. The reaction kinetics for the formation of hydrate in pure water was faster than that in the electrolytes. The addition of soil and soil minerals can accelerate the reaction kinetics for the hydrate formation in the electrolytes. Any significant different results between in pure water and in solid suspensions were not observed for the hydrate dissociation experiments.

Results from this investigation can provide insight on the application of hydrate inclusions to other pollutant gases such as sulfur dioxide and nitrogen dioxide. They can also provide the basic knowledge for the geochemical reactions between water and soil mineral interfaces.