



Behavior of cyclopentane hydrates formation and dissociation in pure water and in the presence of sodium chloride

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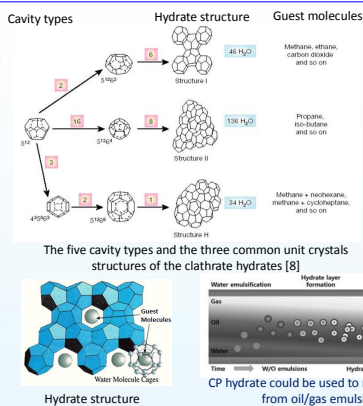
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Introduction

- Clathrate hydrates are crystalline solids composed of water and guest molecules [1]. In clathrate hydrate, cage-like structures formed by hydrogen-bonded water molecules surround different guest molecules that stabilize the structures

- Hydrate is potentially utilized in many applications such as natural gas storage [2], [3]; carbon dioxide capture [4]; especially desalination [5]. However, hydrate formation generally occurs under high pressure when the guest molecules are gases

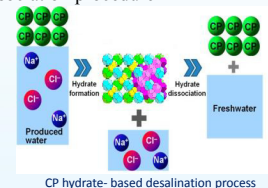
- Cyclopentane hydrate (Structure II) has been proposed to be used in desalination processes because it can form at atmospheric pressure at a temperature near 280 K in pure water [5], [6], [7]. For applying cyclopentane hydrate in salt-removal process, it requires a deep knowledge on cyclopentane hydrate in the presence of salts



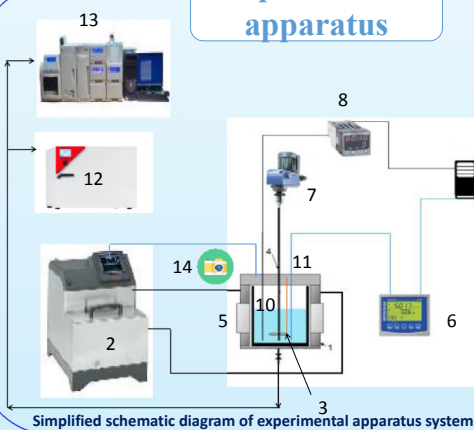
Objective

- Investigate the temperature and conductivity behaviors of cyclopentane hydrate formation and dissociation in pure water and in the presence NaCl

- Determine the equilibrium temperature of cyclopentane hydrate in presence of NaCl according to an environmental dissociation procedure



Experimental apparatus

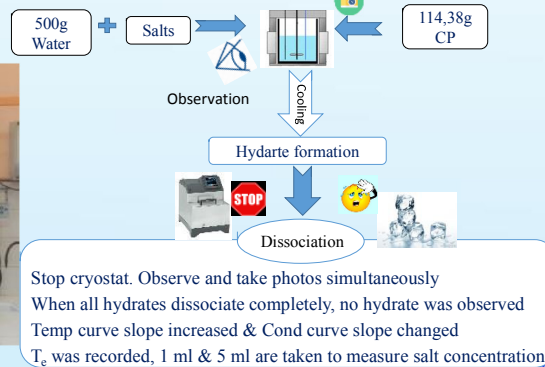


1. Reactor
2. Cryostat
3. Impeller
4. Agitation
5. Cooling jacket
6. Conductivity transmitter
7. Motor
8. Temperature transmitter
9. Computer
10. Temperature probe
11. Conductivity probe
12. Drying oven
13. Ion chromatography
14. Camera

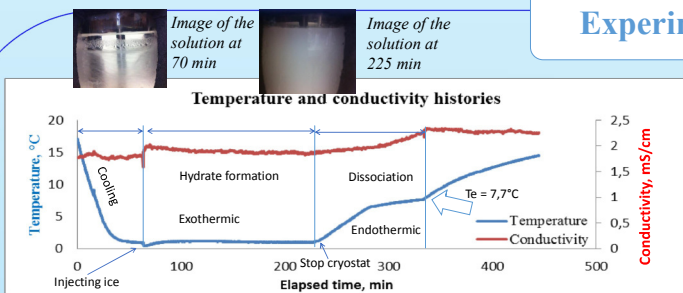


Experimental apparatus system

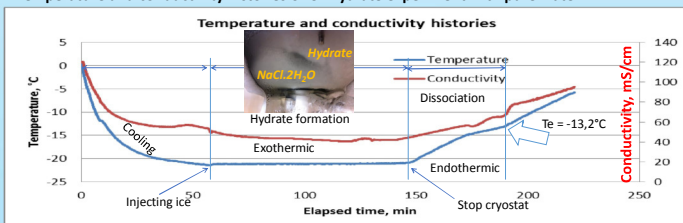
Experimental protocol



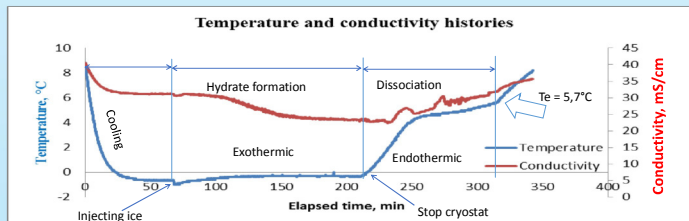
Experimental results



Temperature and conductivity histories of CP hydrate experiment with pure water



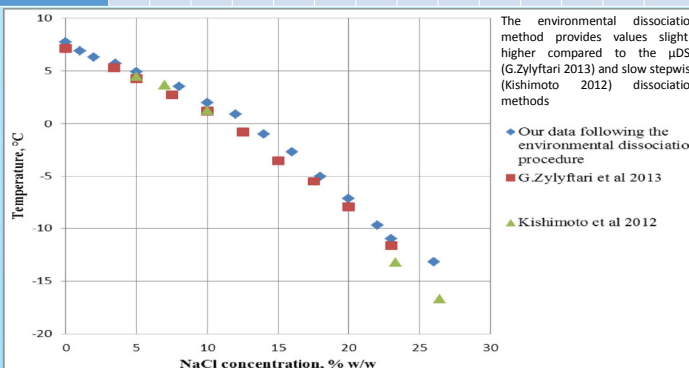
Temperature and conductivity histories of CP hydrate experiment in 26% NaCl



Temperature and conductivity histories of CP hydrate experiment in 3.5% NaCl

The equilibrium temperature of cyclopentane hydrate in the presence of NaCl

Salt concentration wt	0	1	2	3.5	5	8	10	12	14	16	18	20	22	23	26
The equilibrium temperature, °C, ±0.1°C	7.7	6.9	6.3	5.7	4.9	3.5	2.0	0.9	-1.0	-2.7	-5.0	-7.2	-9.7	-11.0	-13.2



The equilibrium temperature of cyclopentane hydrate according to the different dissociation methods in the presence of NaCl

Conclusions

- An increase in temperature was observed during CP hydrate formation because of the exothermic property of this process
- When hydrate dissociated strongly, the temperature was nearly constant due to the heat-releasing of dissociation process
- The conductivity showed some unexpected trends in pure water and also in the presence of salt due to the appearance of bubbles and hydrate slurry in the bulk and crystals on the electrode surface of probe
- When no hydrate was observed inside the vessel, the temperature and conductivity slopes immediately increased, the equilibrium temperature was simultaneously recorded
- The equilibrium temperature dropped strongly with increasing of salt concentration

References

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