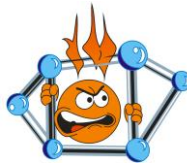


# Non-equilibrium crystallization of mixed gas hydrates involving hydrate volume and composition

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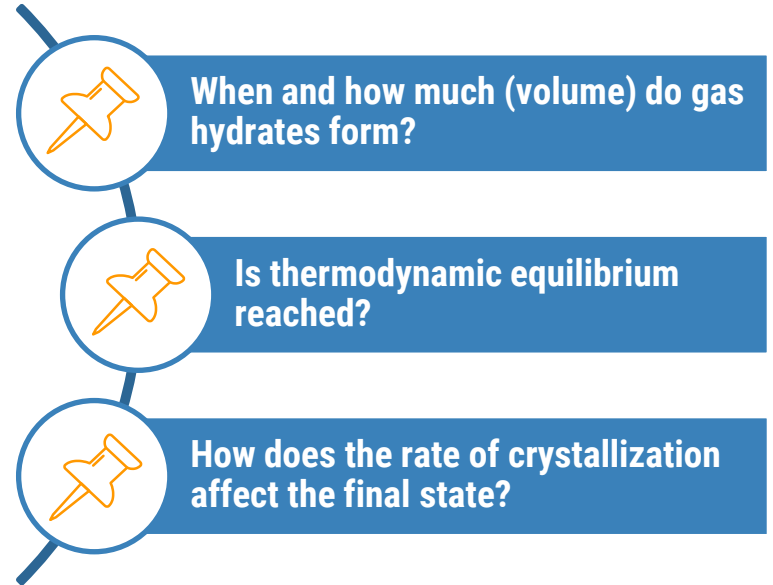


# Introduction and Problematics

## What roles do clathrate hydrates play?

- Flow assurance
- Energy resources
- Gas separation
- Water desalination
- CO<sub>2</sub> capture and sequestration
- Gas storage and transportation

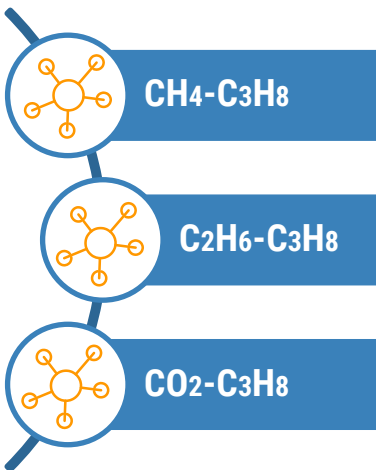
Thermodynamics and crystallization mechanisms of clathrate hydrates



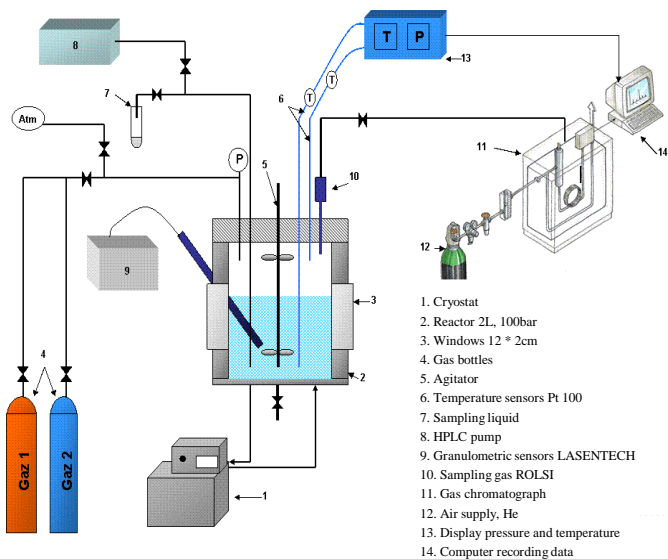


# Experimental section

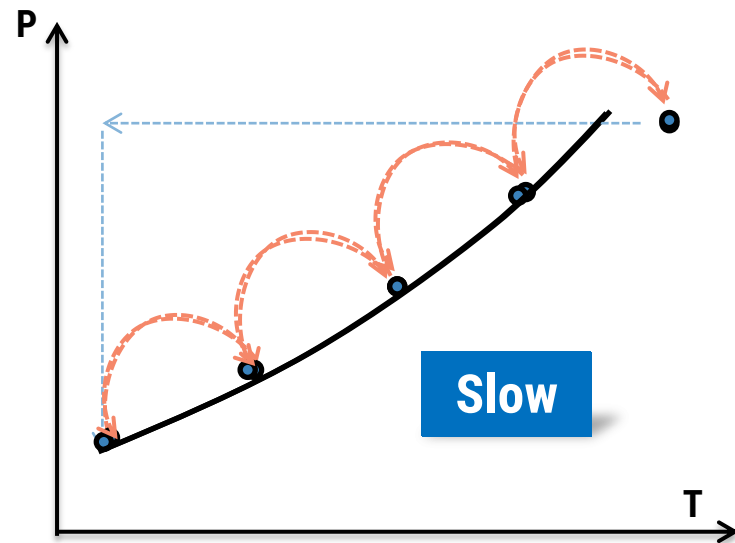
## Materials



## Set-up

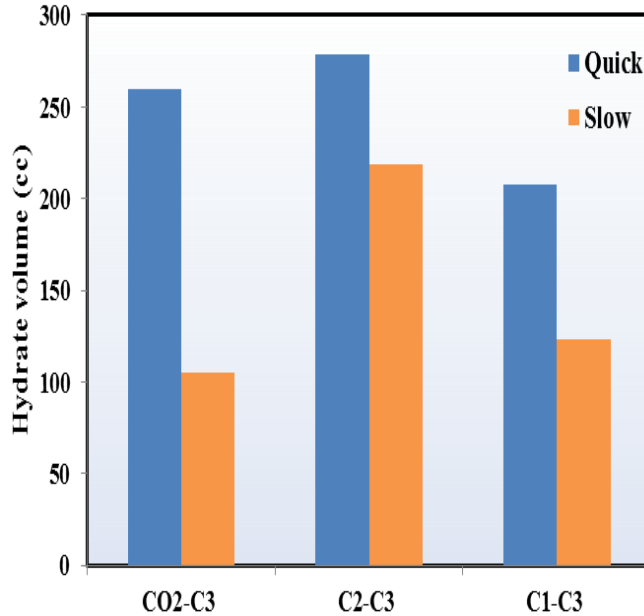
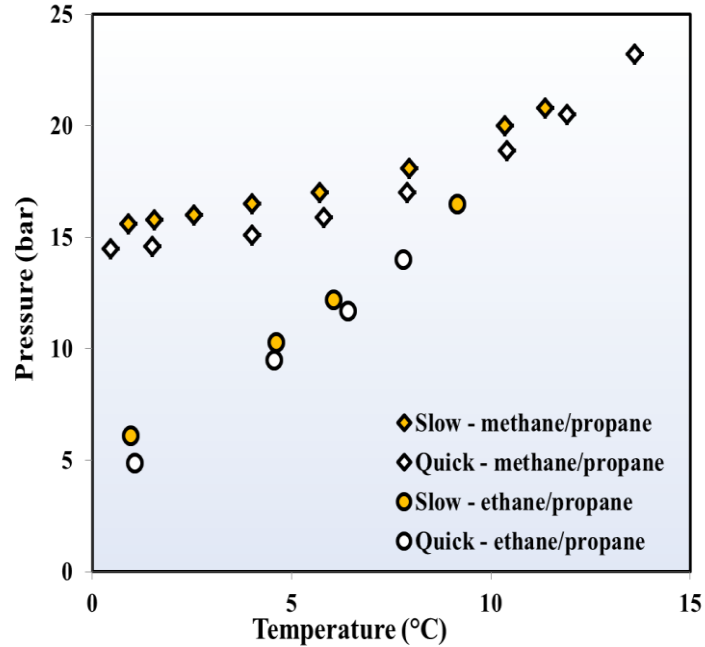


## Procedures



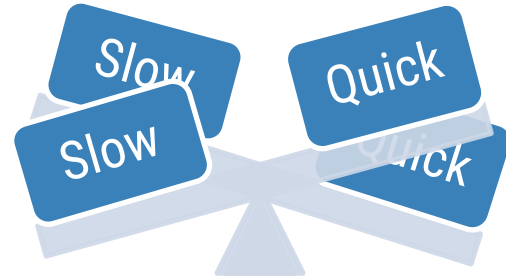


# Results and Discussion



## Hydrate Density

+1332%



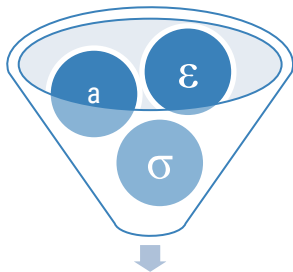


# Modeling

vdW &  
Platteeuw

Kihara  
Parameters

Optimization



**Propane**

$\epsilon=195.0$   $\sigma=3.34$   $a=0.6502$



Results of thermodynamic model for quick and slow crystallization

CO <sub>2</sub> -C <sub>3</sub>	Hydrate Composition	Equilibrium Pressure
Slow	9,6 %	12,3 %
Quick	19,30 %	15,5 %

0 Ng Barkan Sloan This work



## Conclusion

**Different rate of crystallization**

**Pressure**

**Volume**

**C<sub>3</sub>H<sub>8</sub> content**

**Quick**

**Slow**

**Slow crystallization**

**Less kinetic effects**

**Thermodynamic equilibrium**



**THANKS FOR YOUR ATTENTION**