Theoretical analysis of membrane based liquid desiccant air conditioning system

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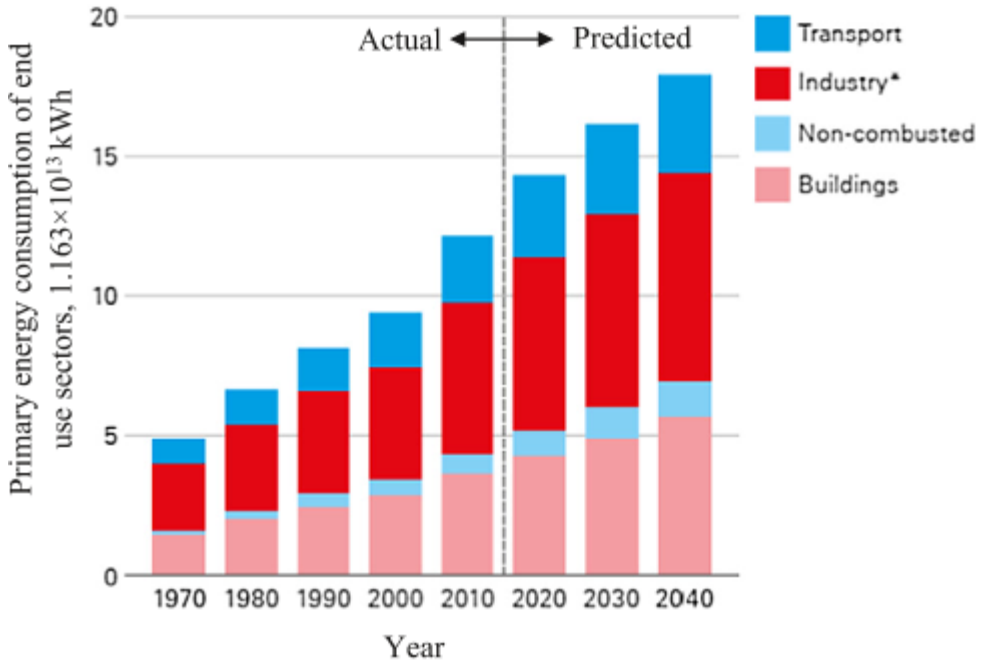
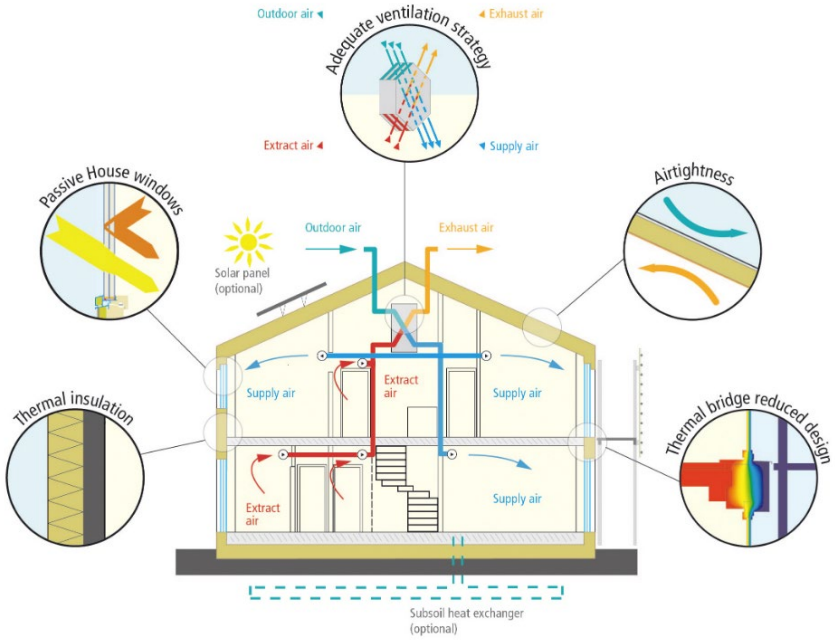
Introduction: Background

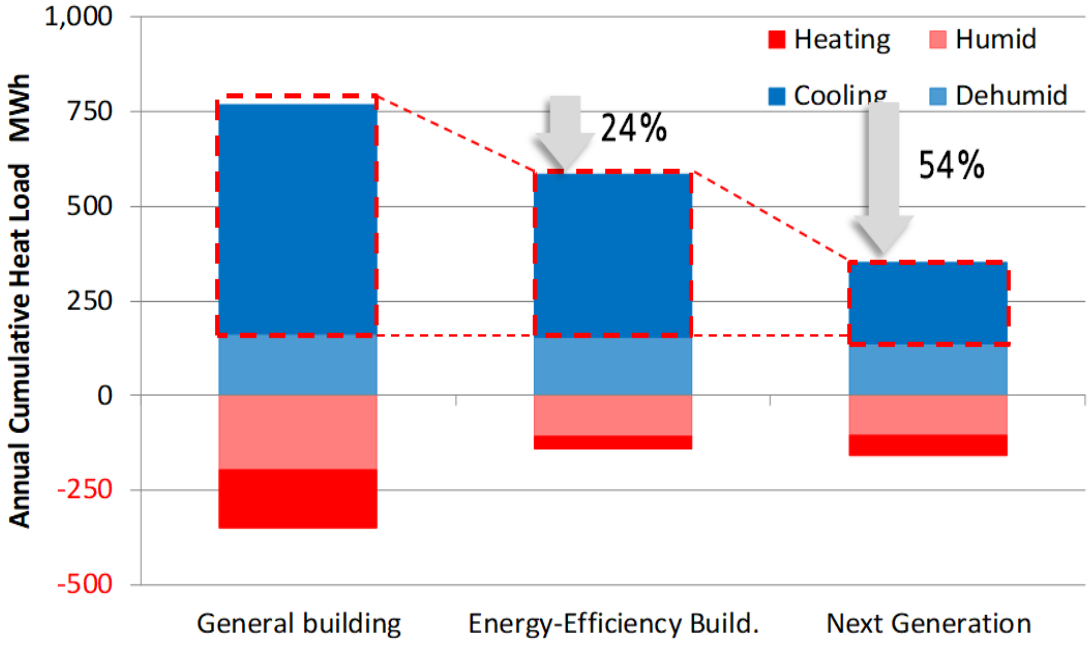
Buildings account for about 40 percent

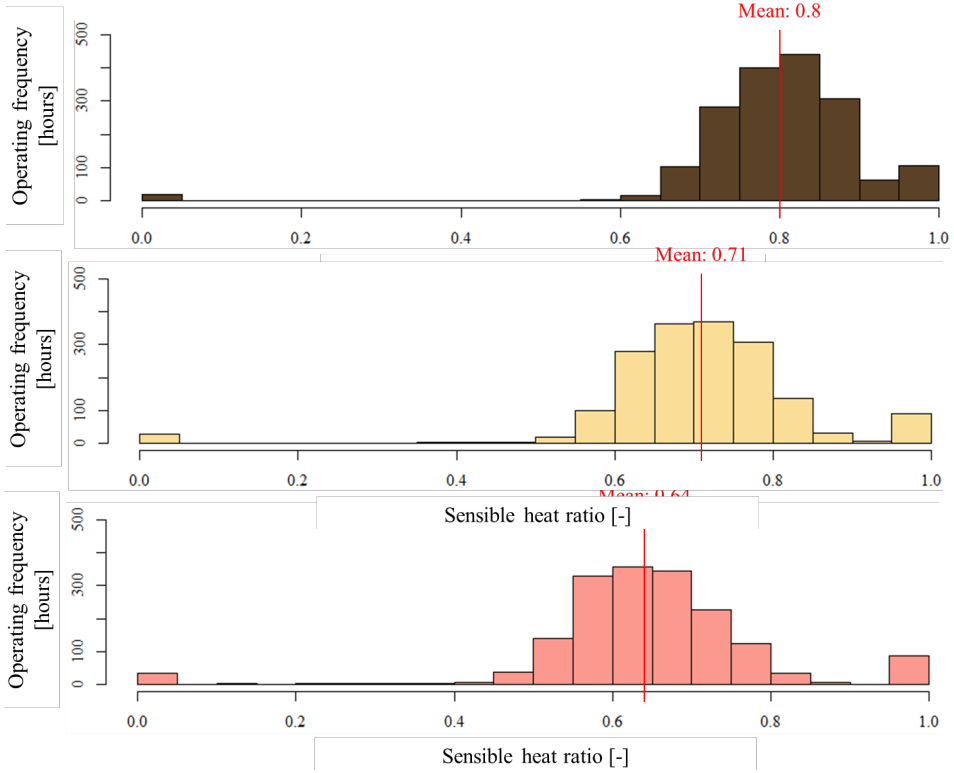


Low Energy Consumption Building



Introduction

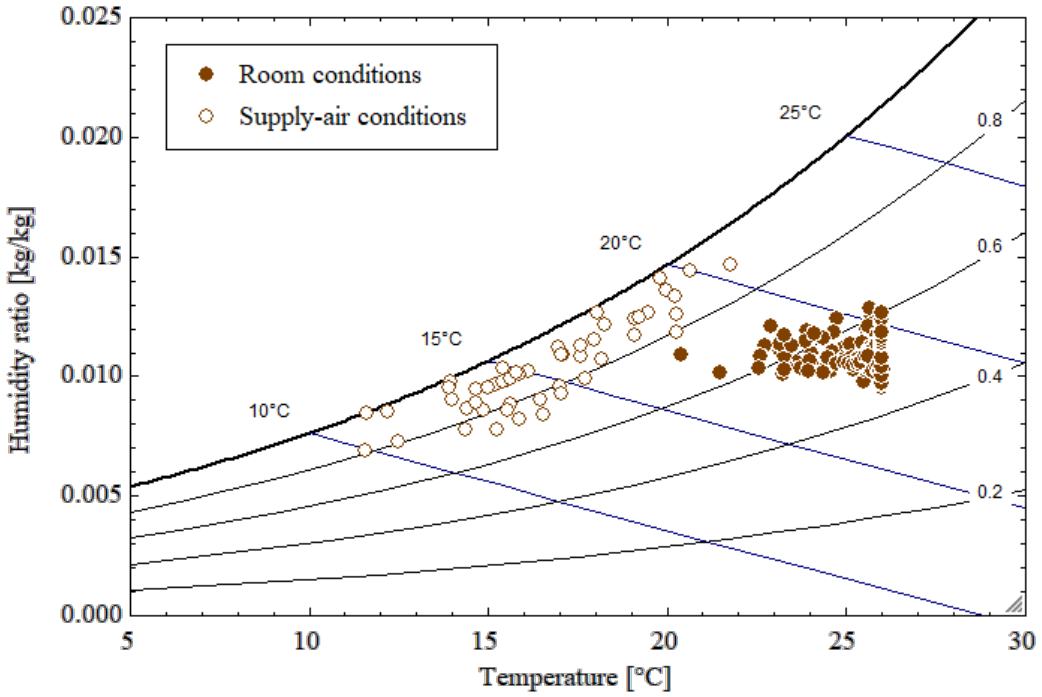




- As the energy performance of a building is enhanced, **sensible heat decreases** **rather than latent heat**.
- **Dehumidification** become more important in net ZEB.

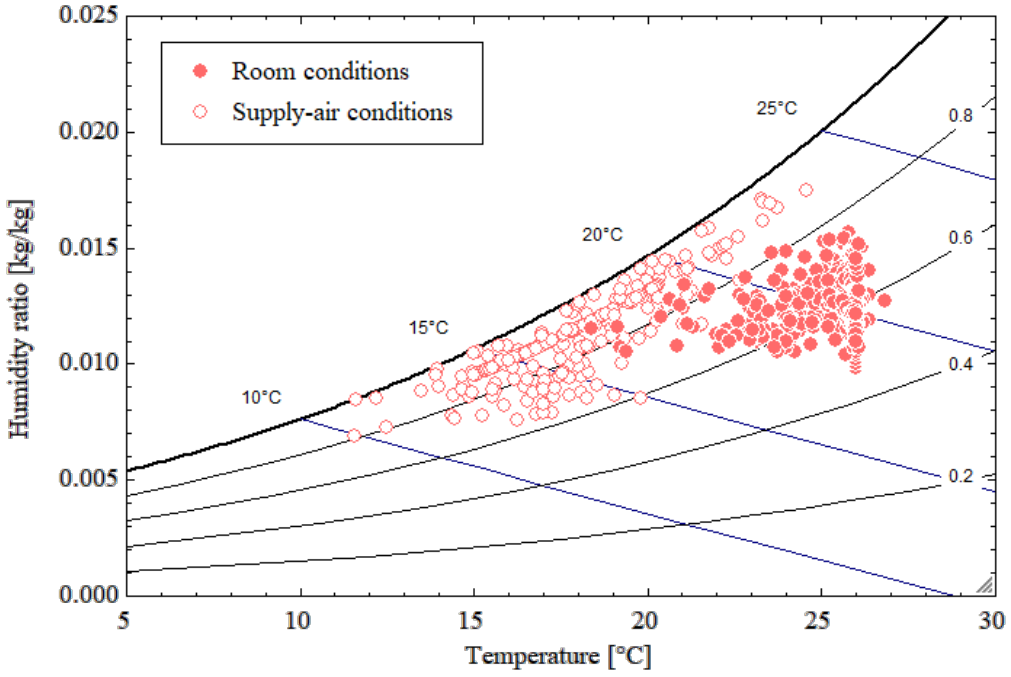
Introduction

Typical building



Frequency of satisfying the thermal comfort : over 95%

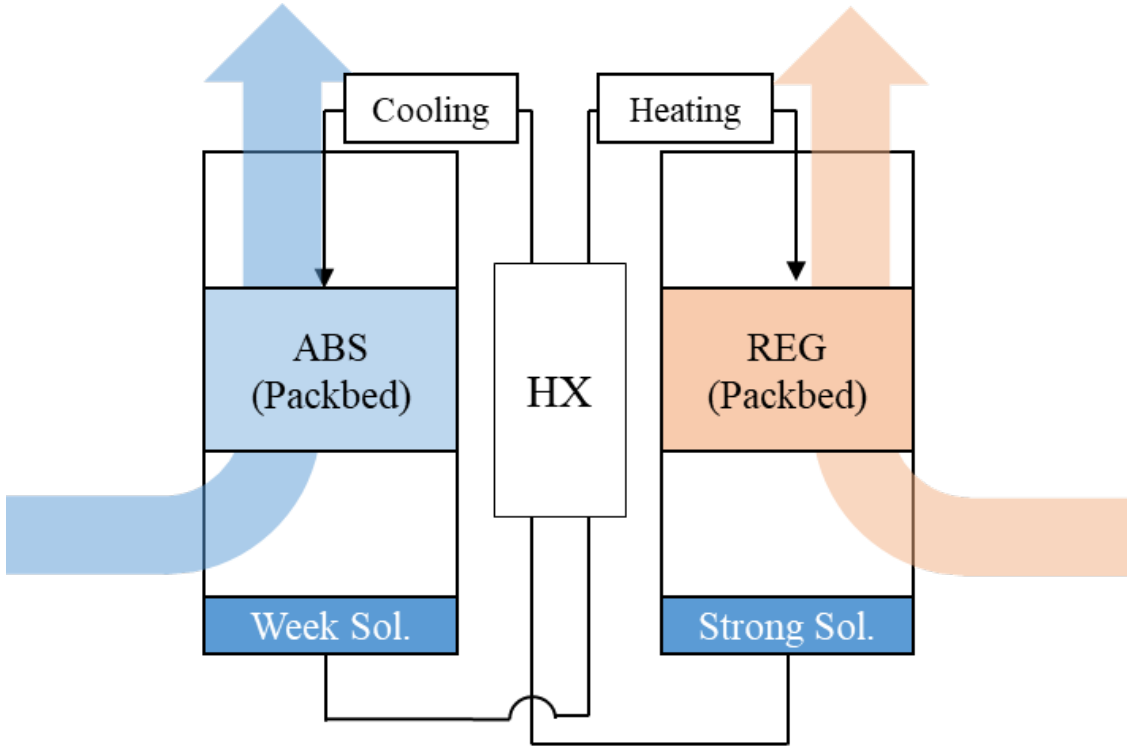
ZEB building

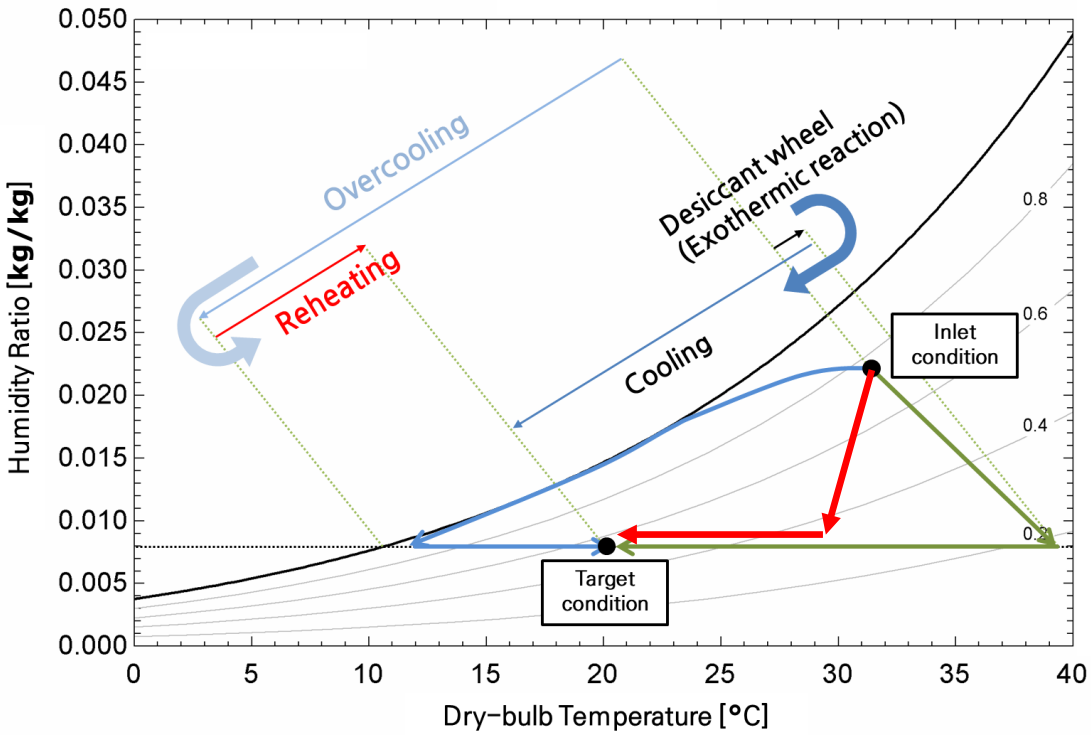


Frequency of satisfying the thermal comfort: less 50%

Introduction

- Liquid desiccant system





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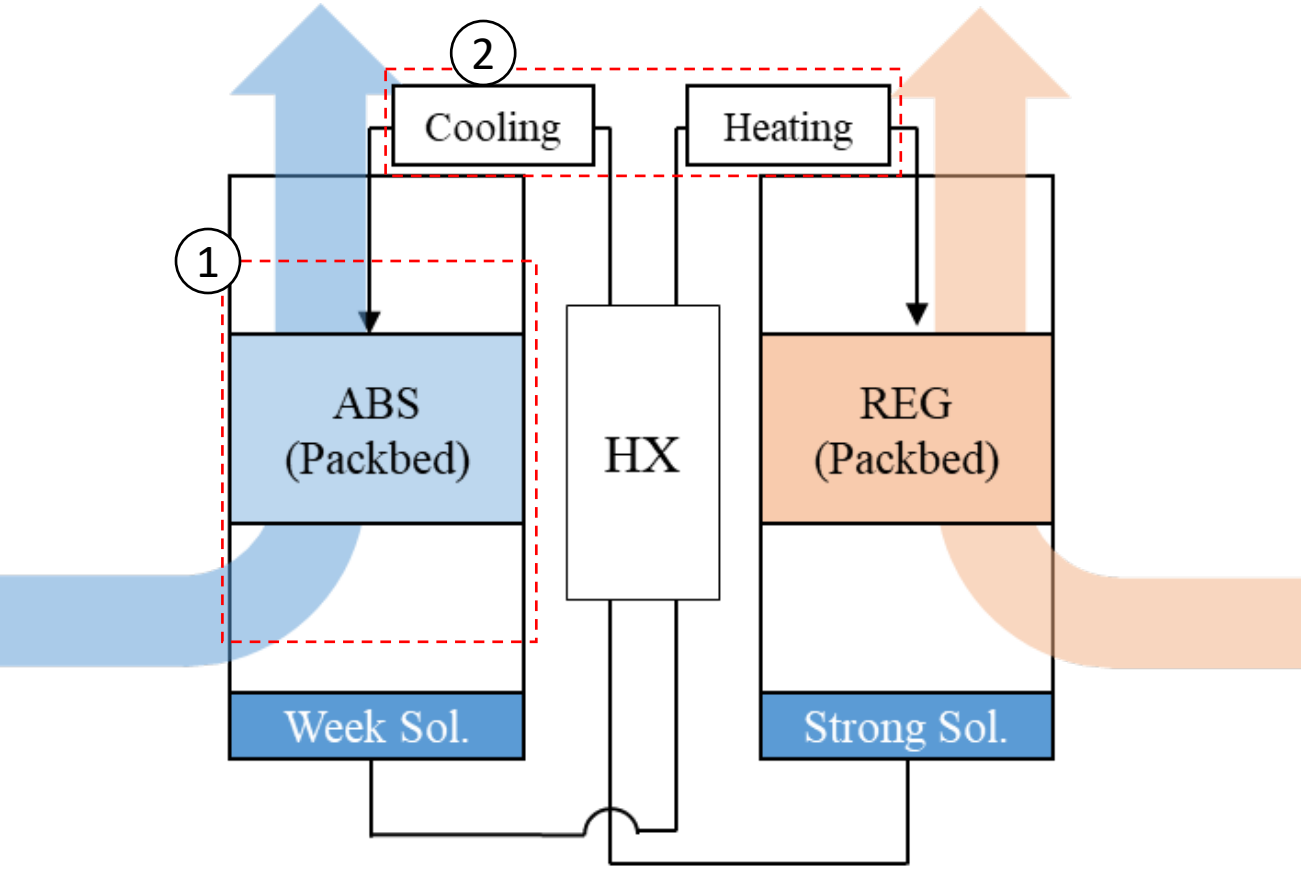
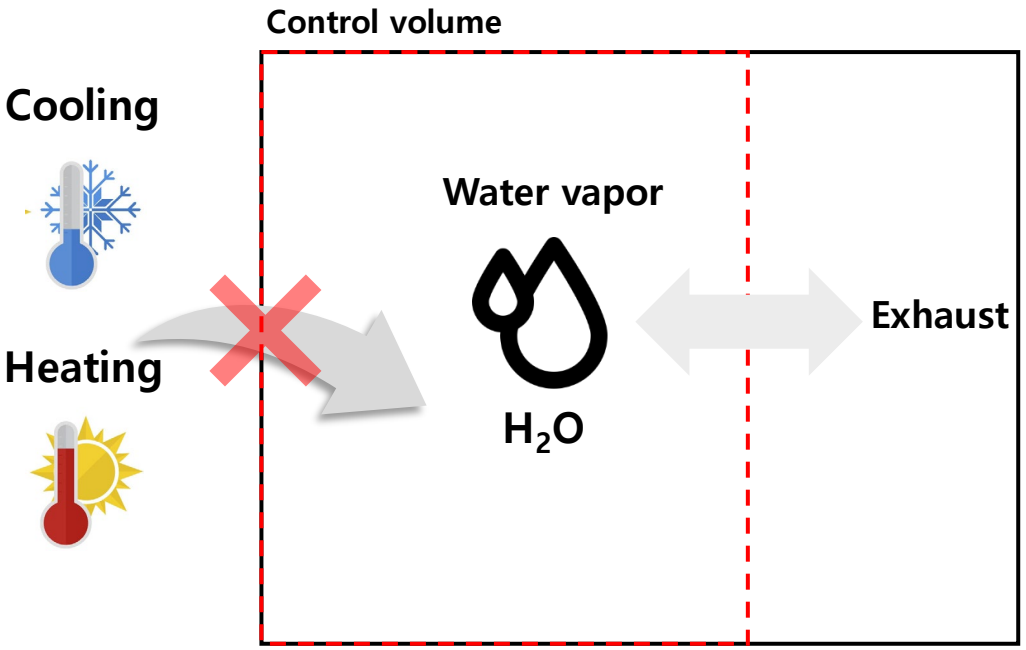


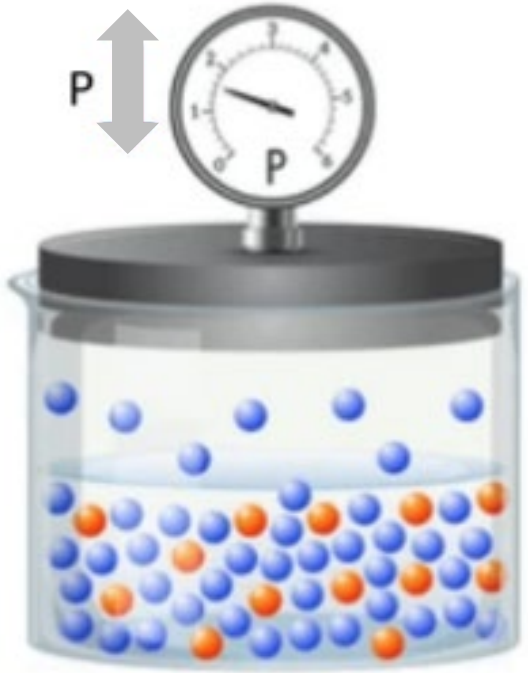
1) System configuration

2) Energy source

Introduction

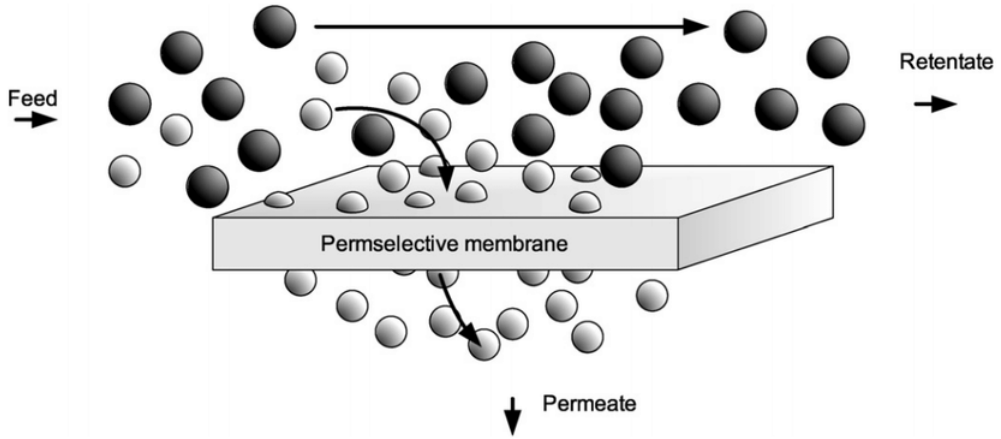


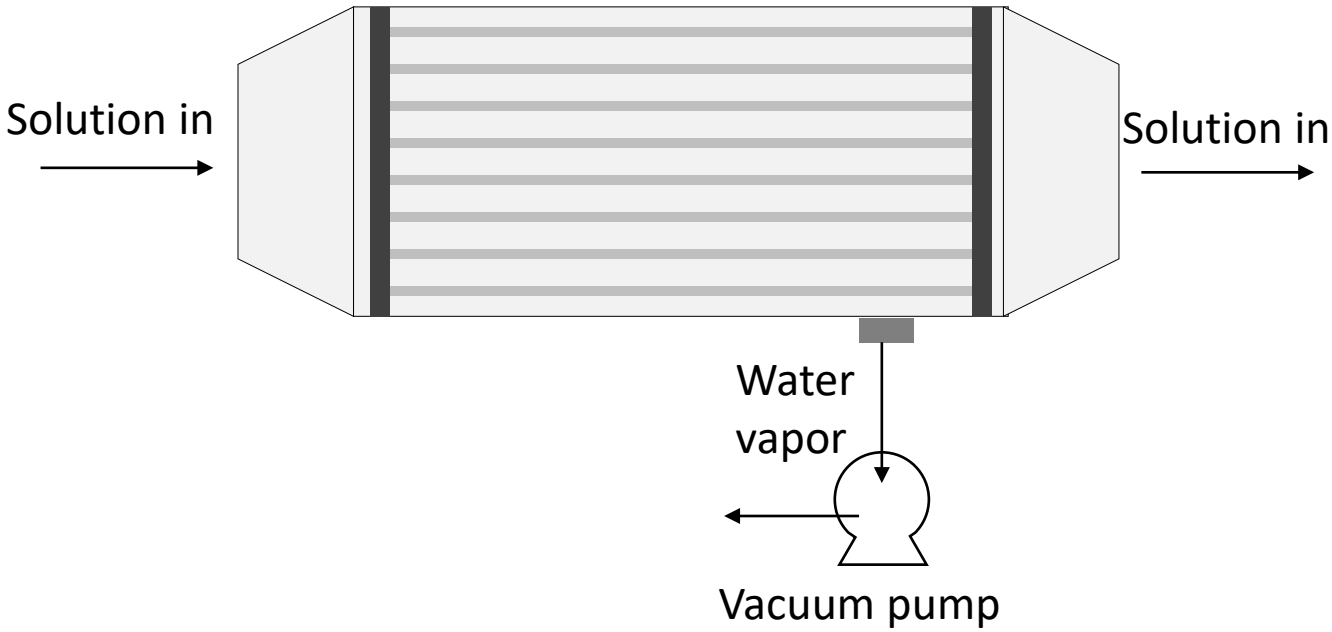
- **Pressure control**



Introduction

- Membrane: Separation technology





Introduction

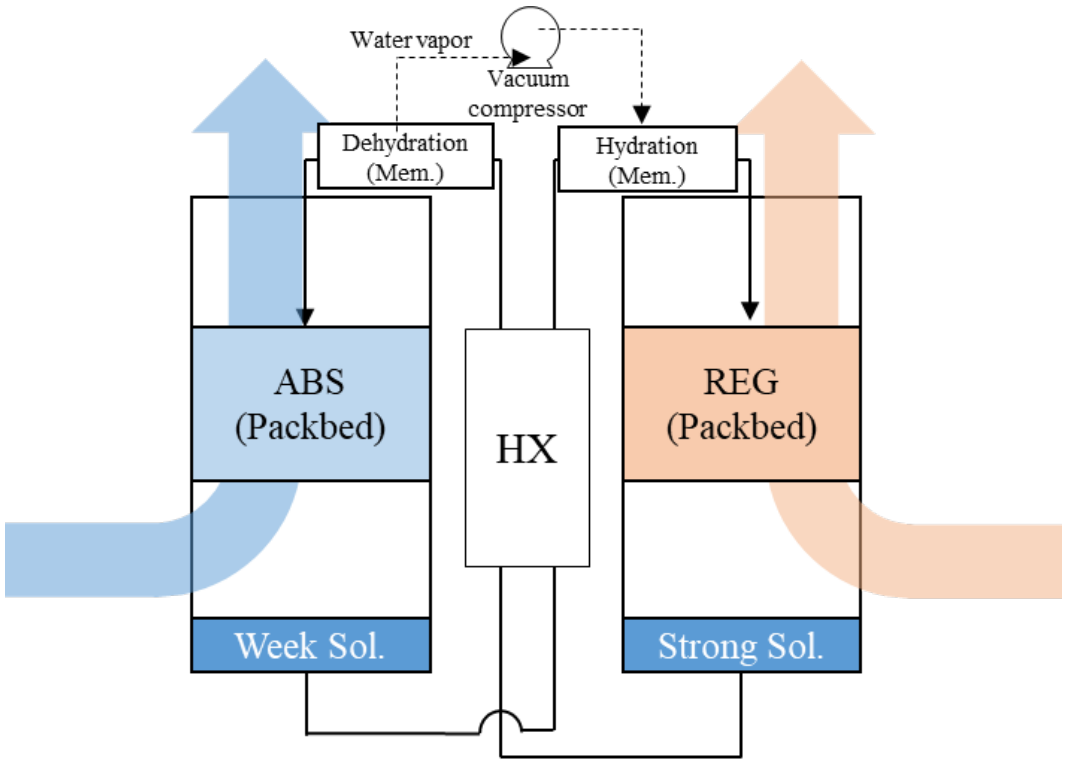
- Research Objective

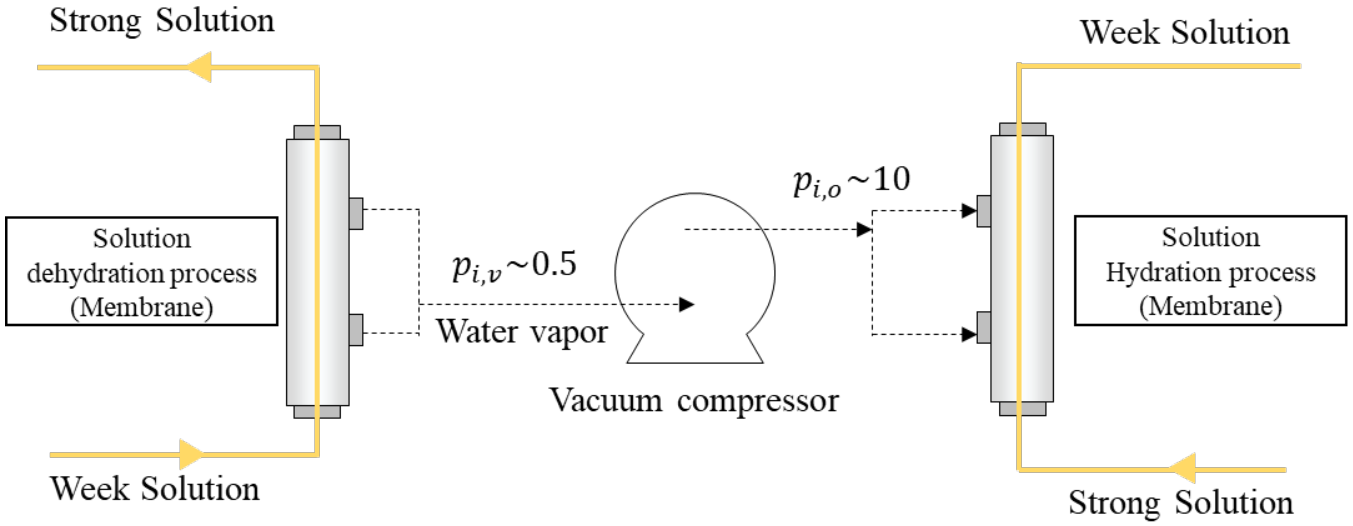
1) Proposal of a system that can dehumidify without using heat

2) Analyzing the analysis method and impact of the system

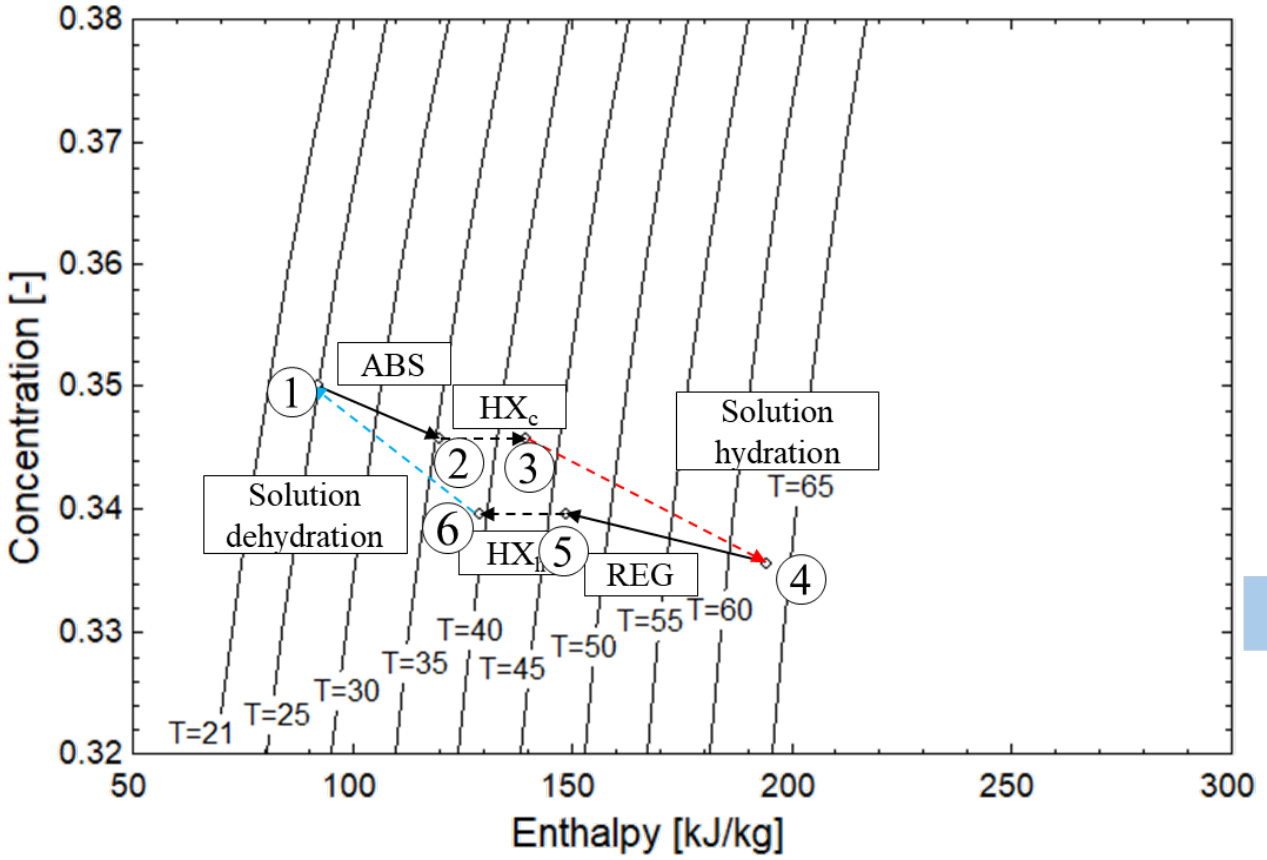
3) Heat and energy comparison with conventional systems

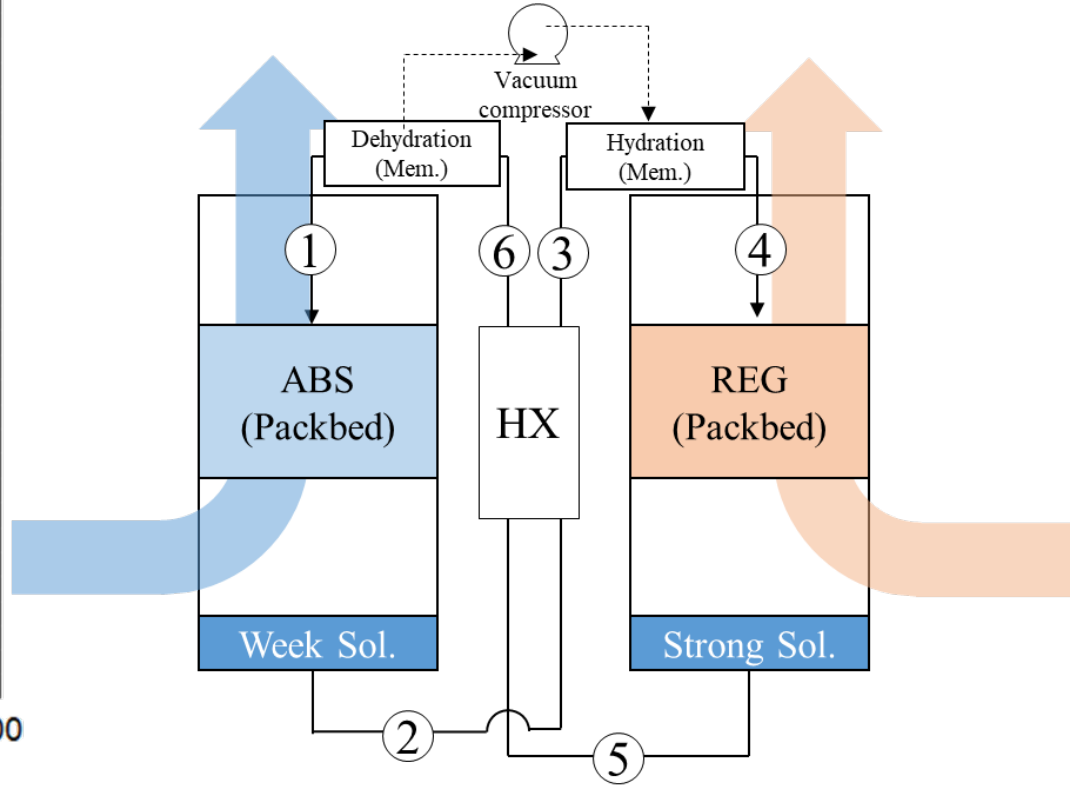
System overview



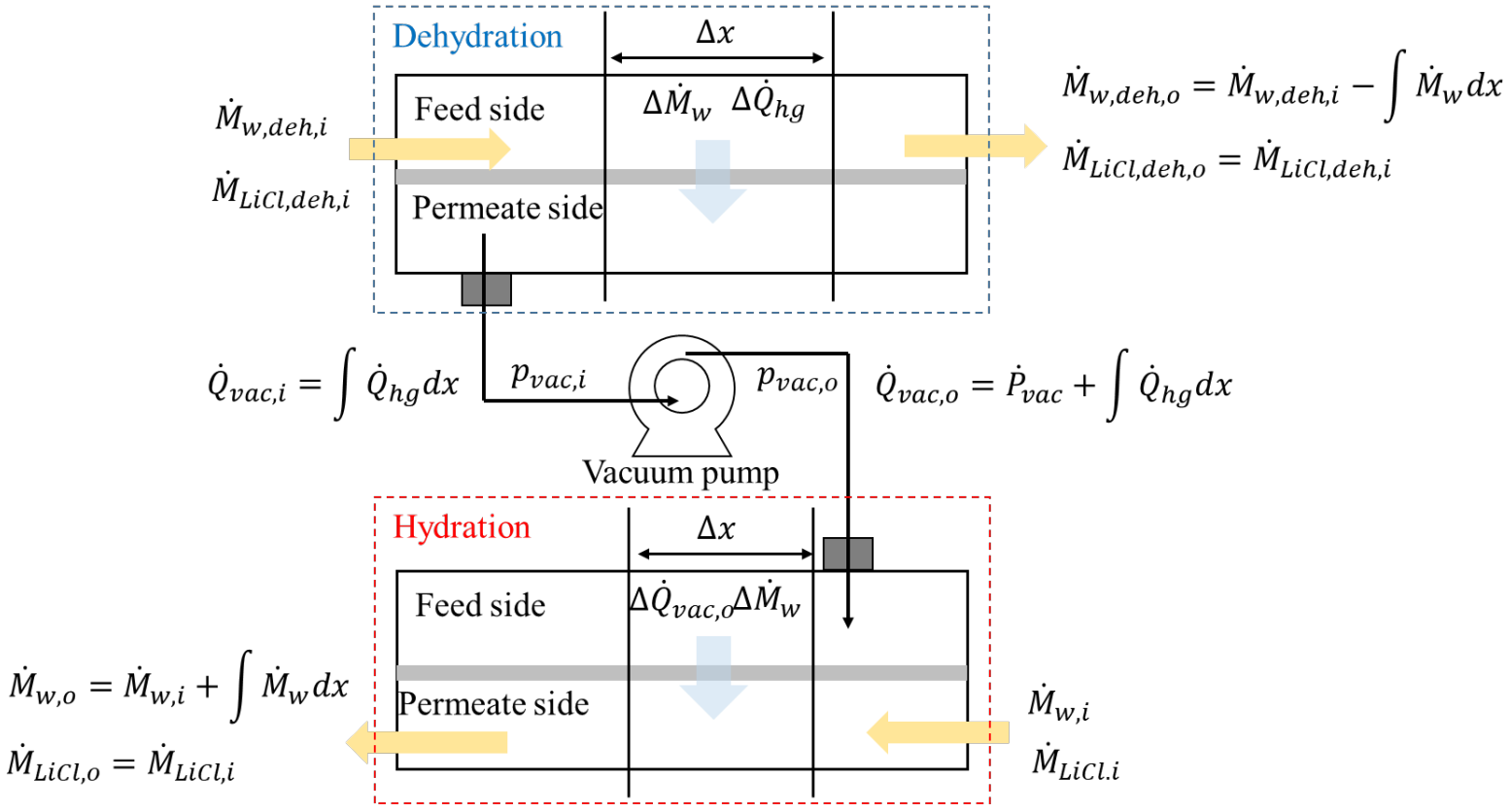


System overview

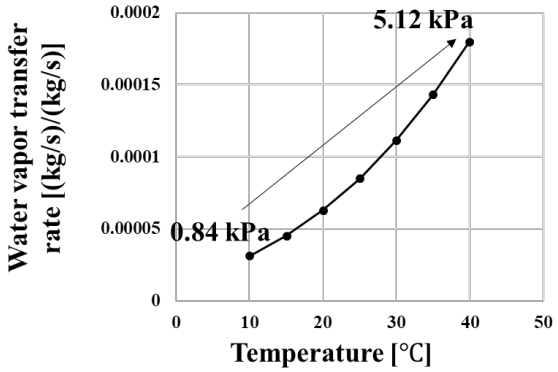


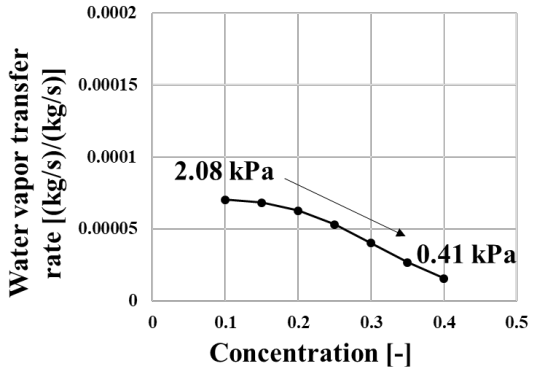


Simulation model



Results


Water vapor transfer rate [(kg/s)/(kg/s)]
0.0002
0.00015
0.0001
0.00005
0
5.12 kPa
0.84 kPa
0 10 20 30 40 50
Temperature [°C]


Water vapor transfer rate [(kg/s)/(kg/s)]
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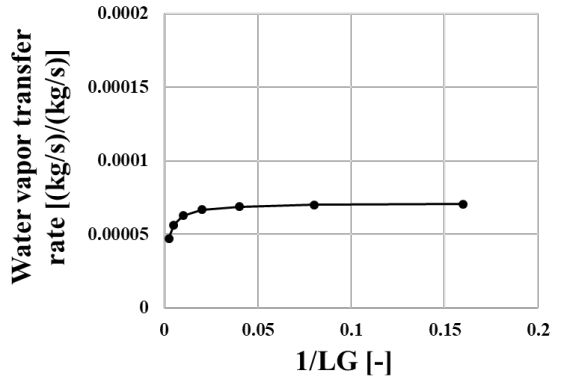
0.00015
0.0001
0.00005
0
2.08 kPa
0.41 kPa
0 0.1 0.2 0.3 0.4 0.5
Concentration [-]


Water vapor transfer rate [(kg/s)/(kg/s)]
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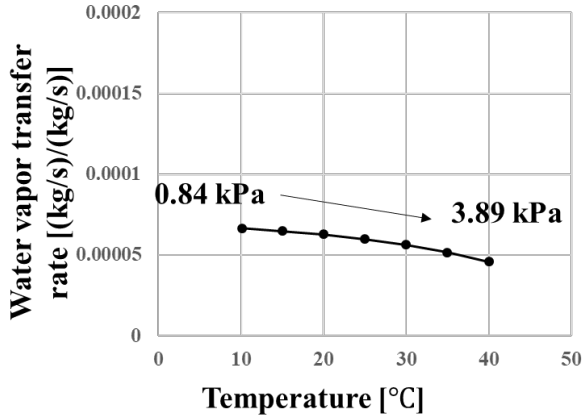
0.00015
0.0001
0.00005
0
0 0.05 0.1 0.15 0.2
1/LG [-]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0
0.84 kPa
3.89 kPa
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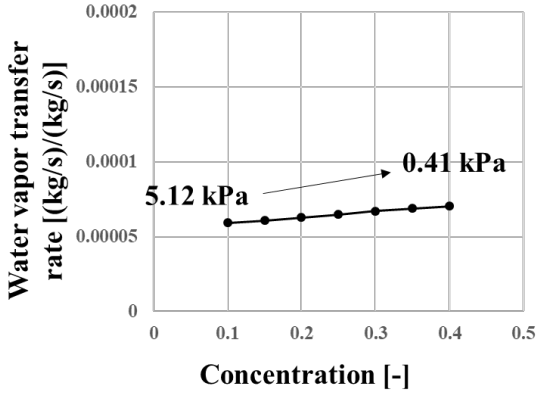
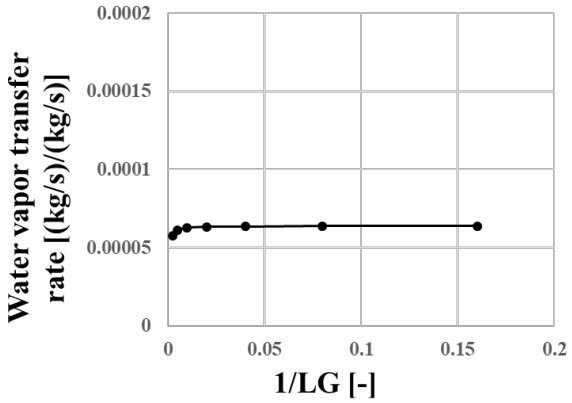
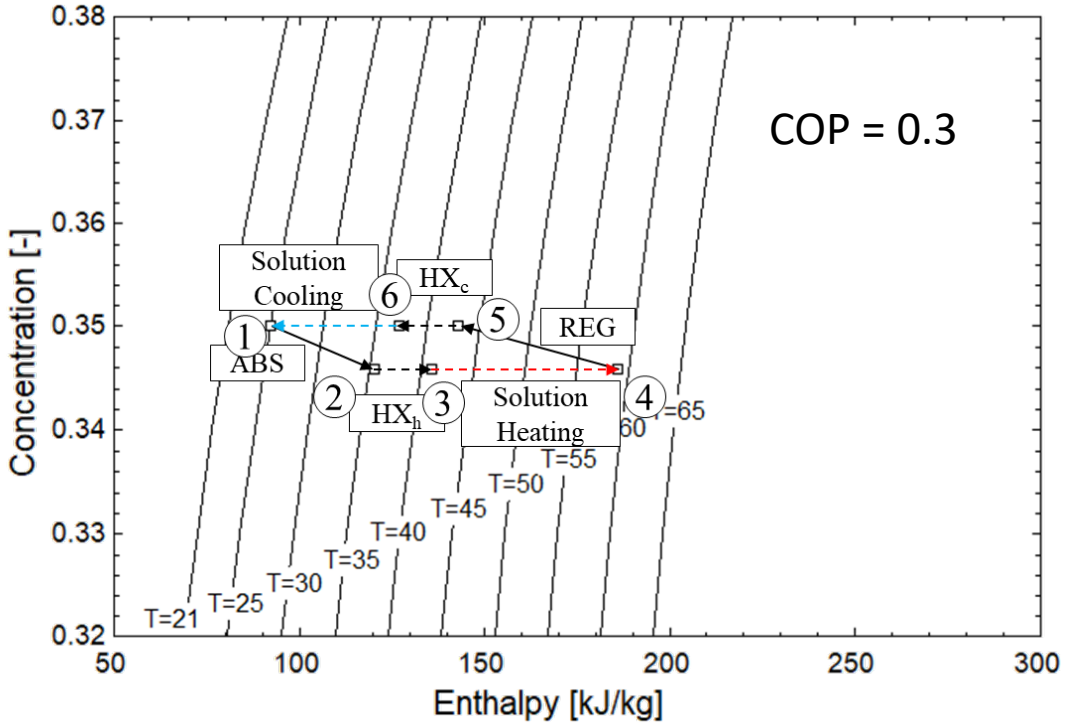
Temperature [°C]

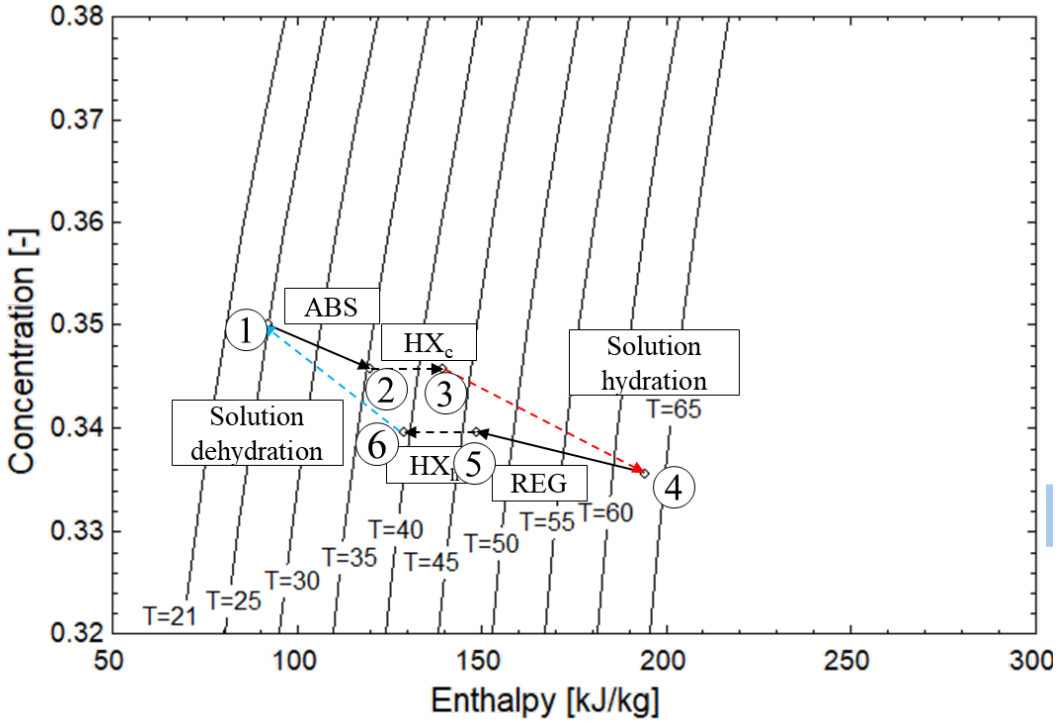

Water vapor transfer rate [(kg/s)/(kg/s)]
0.0002
0.00015
0.0001
0.00005
0
5.12 kPa
0.41 kPa
0 0.1 0.2 0.3 0.4 0.5
Concentration [-]


Water vapor transfer rate [(kg/s)/(kg/s)]
0.0002
0.00015
0.0001
0.00005
0
0 0.05 0.1 0.15 0.2
1/LG [-]

Results

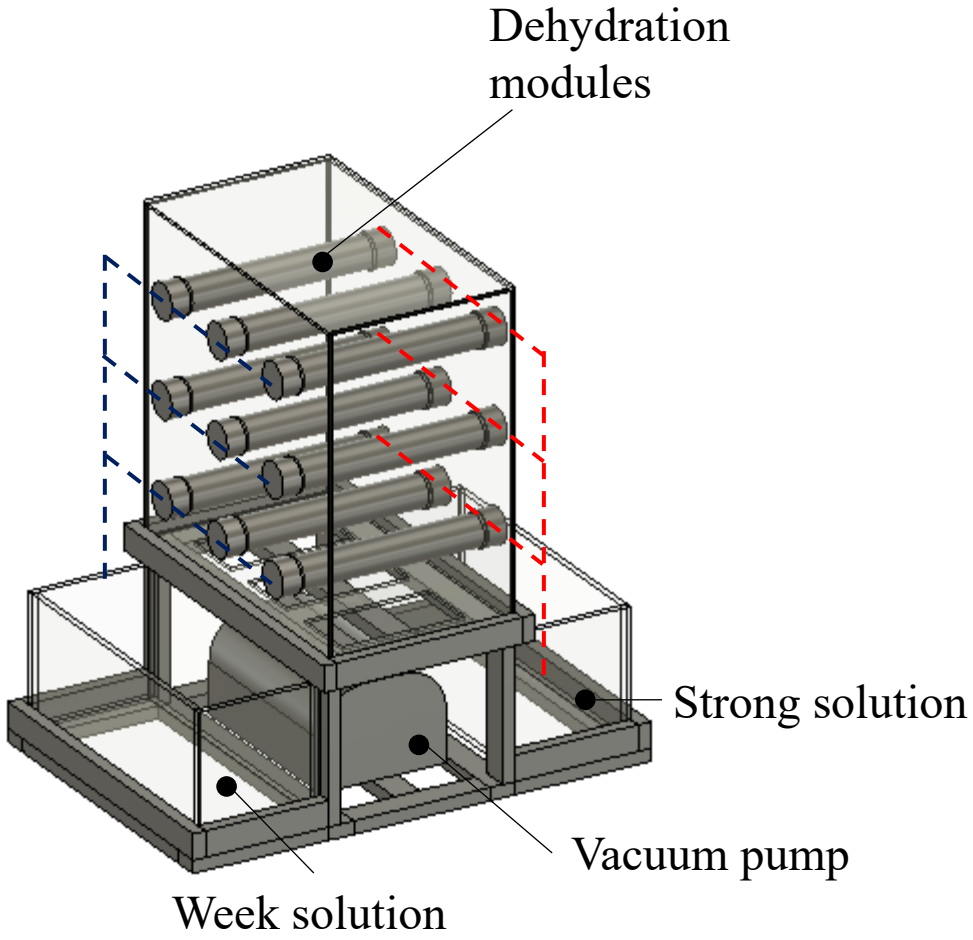


$$COP_{Ref} = \frac{Q_{a,c}}{Q_{h,s}+Q_{c,s}}$$



$$COP_{Pro} = \frac{Q_{a,c}}{P_{vac}} = \frac{Q_{a,c}}{Q_{Hyd}-Q_{dehyd}}$$

Further study



1) Experiment test for dehydration and hydration

2) Compare with numerical simulation

Conclusion

- Purpose
  - We proposed a membrane-based liquid desiccant air conditioning system and its thermodynamic performance evaluated by equation-based simulation.

- Results
  - The parametric study of the proposed system for dehumidification performance (mass transfer) showed that the solution temperature and concentration is mainly affected as driving force.
  - Ideal COP (coefficient of performance) of the proposed system in the thermodynamic analysis is 1.55, which is 5.17 higher than that of the conventional liquid desiccant
- In further studies
  - We will construct a prototype unit of proposed system, and experimentally analyze the effect of thermodynamic and energy performance of the proposed system.