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SOLAR ACADEMY SHC FOR HEATING & COOLING IN BUILDINGS & INDUSTRY

Component development for a liquid sorption thermal energy storage system

- Activities in the IEA SHC Task 58 "Material and Component Development for Thermal Energy Storage" - Subtask 4T: Component Design for Thermo Chemical Materials
- Practical application in liquid sorption heat storage with aqueous sodium hydroxide

Webinar, Nov 27, 2019 14:00 - 15:30 GMT

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Schweizerische Eidgenossenschaft
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Confederazione Svizzera
Confederaziun svizra

Bundesamt für Energie BFE
Swiss Federal Office of Energy SFOE

HeStorage
Swiss Competence Center for Energy Research

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Subtask 4T: Motivation

- There are many different demonstrator and lab scale systems under design, construction and testing.
- These vary highly in reported process, power, capacity and application.
- In addition to heat transport, components for thermo chemical storage systems have to provide an optimised heat and mass transport.
- The actual heat/mass exchanger design is crucial for the achievable storage capacity and power output.
- The possibilities in designing such a reactor are multiple, and so are the testing methods.

A common basis is required

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Subtask 4T: Component Design for Thermo Chemical Materials

- four performance criteria:
  - gross temperature lift (temperature effectiveness)
  - volumetric energy density
  - volumetric power
  - round trip efficiency
- four evaluation scales:
  - material (mg)
  - bulk (g)
  - component (kg)
  - system (Mg)

- varying system process types
- many different testing profiles

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Realistic temperatures

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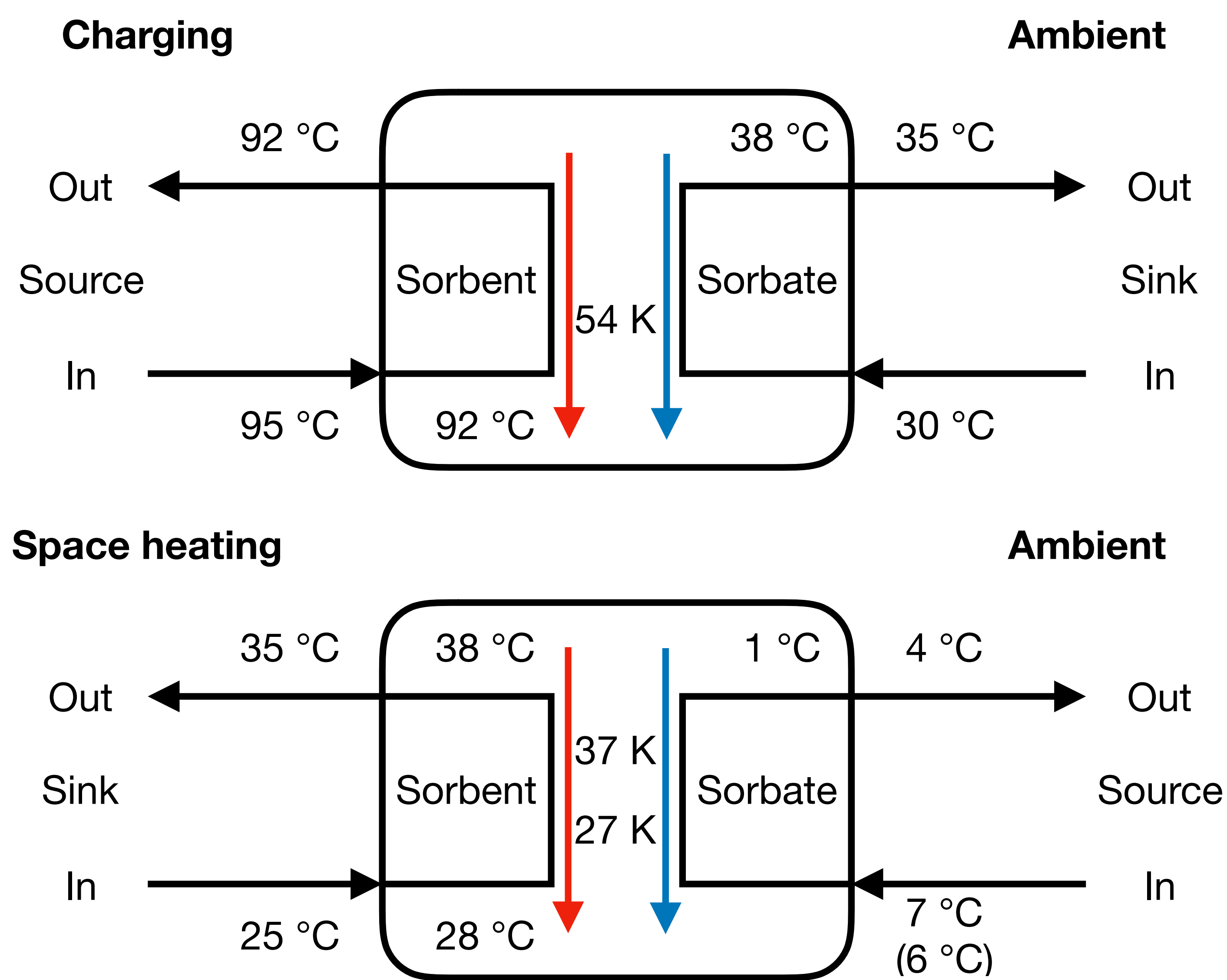
Realistic operating temperatures for building application



Guideline from EN 14511-2

Fumey B, et al. Building application specific temperatures for the testing of phase change and thermo chemical materials, components and systems, Publication submitted.

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Pros and cons

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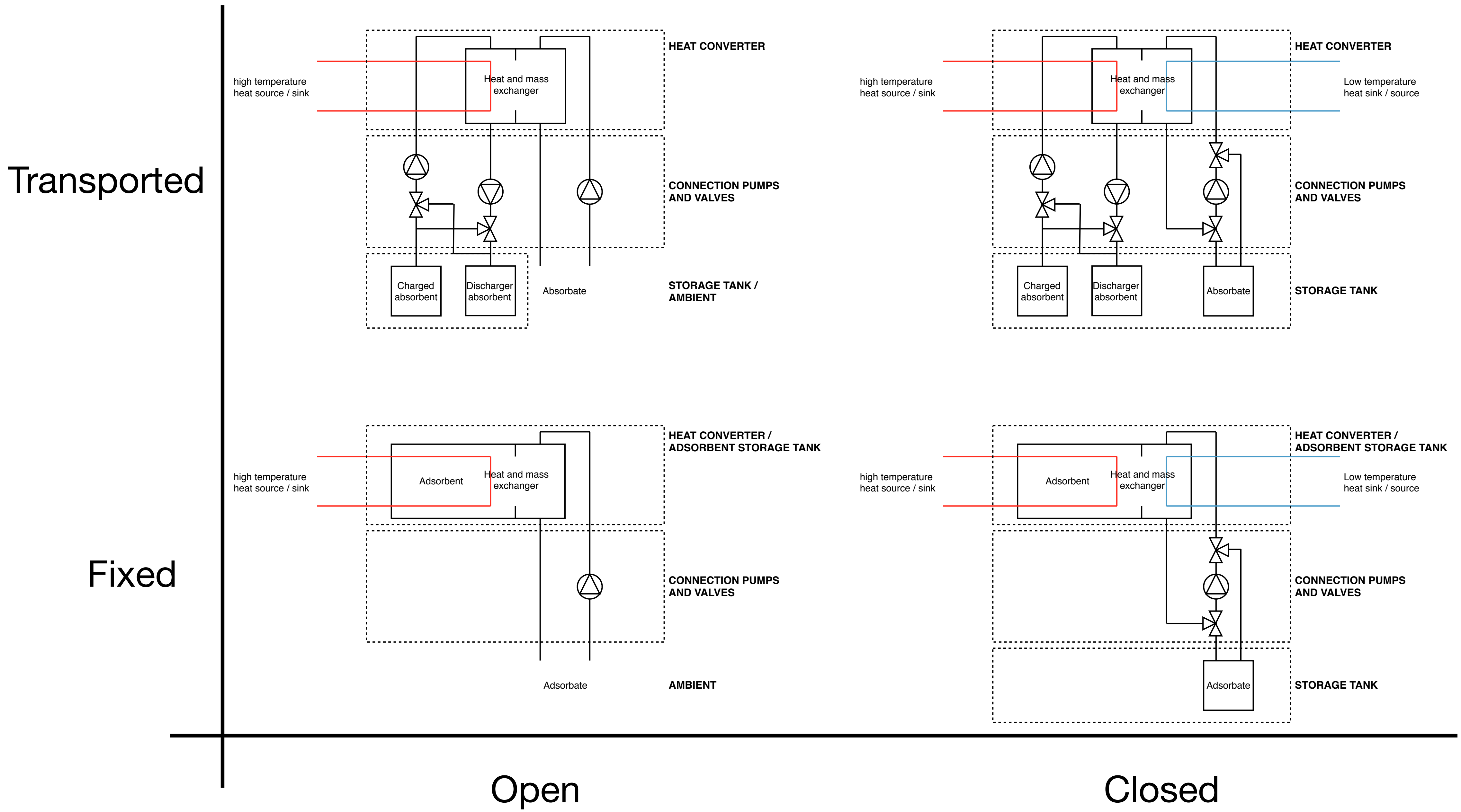
Basic sorption heat storage processes



Fumey B, Weber R, Baldini L. Sorption based long-term thermal energy storage – Process classification and analysis of performance limitations: A review. Renewable and Sustainable Energy Reviews 2019;111:57–74

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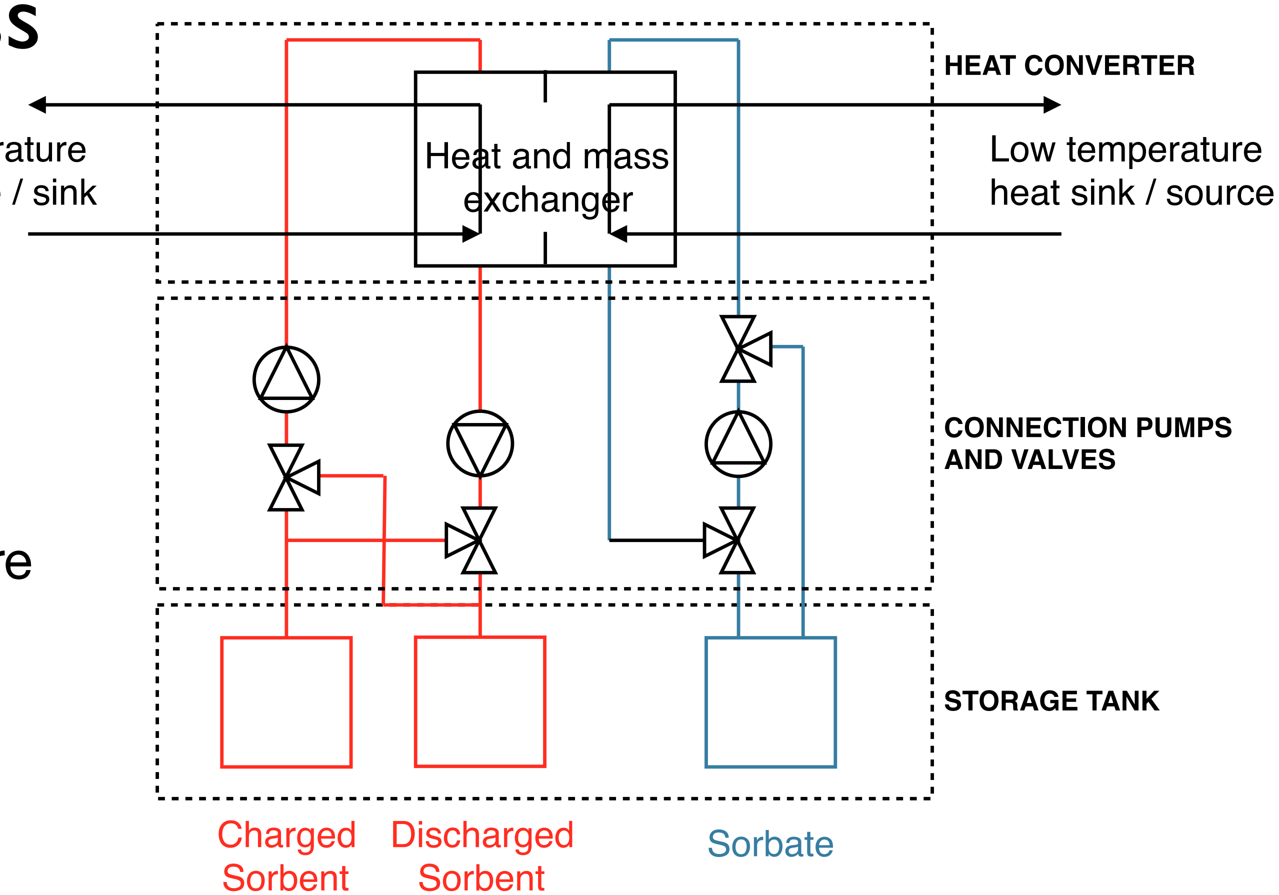
Closed and transported process



Advantages

- **increased vapour pressure and density**
- no external fouling
- steady state process
- **continuous charging and discharging**
- capable of single pass and counter flow
- maximum GTL
- **discharge to minimum input temperature**

Disadvantages

- operates at sub atmospheric pressure
- requires condenser and evaporator
- **sensitive to non-condensing gases**
- requires sorbate storage
- **Increase in complexity, storage vessels and means of transport**

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Theoretical evaluation

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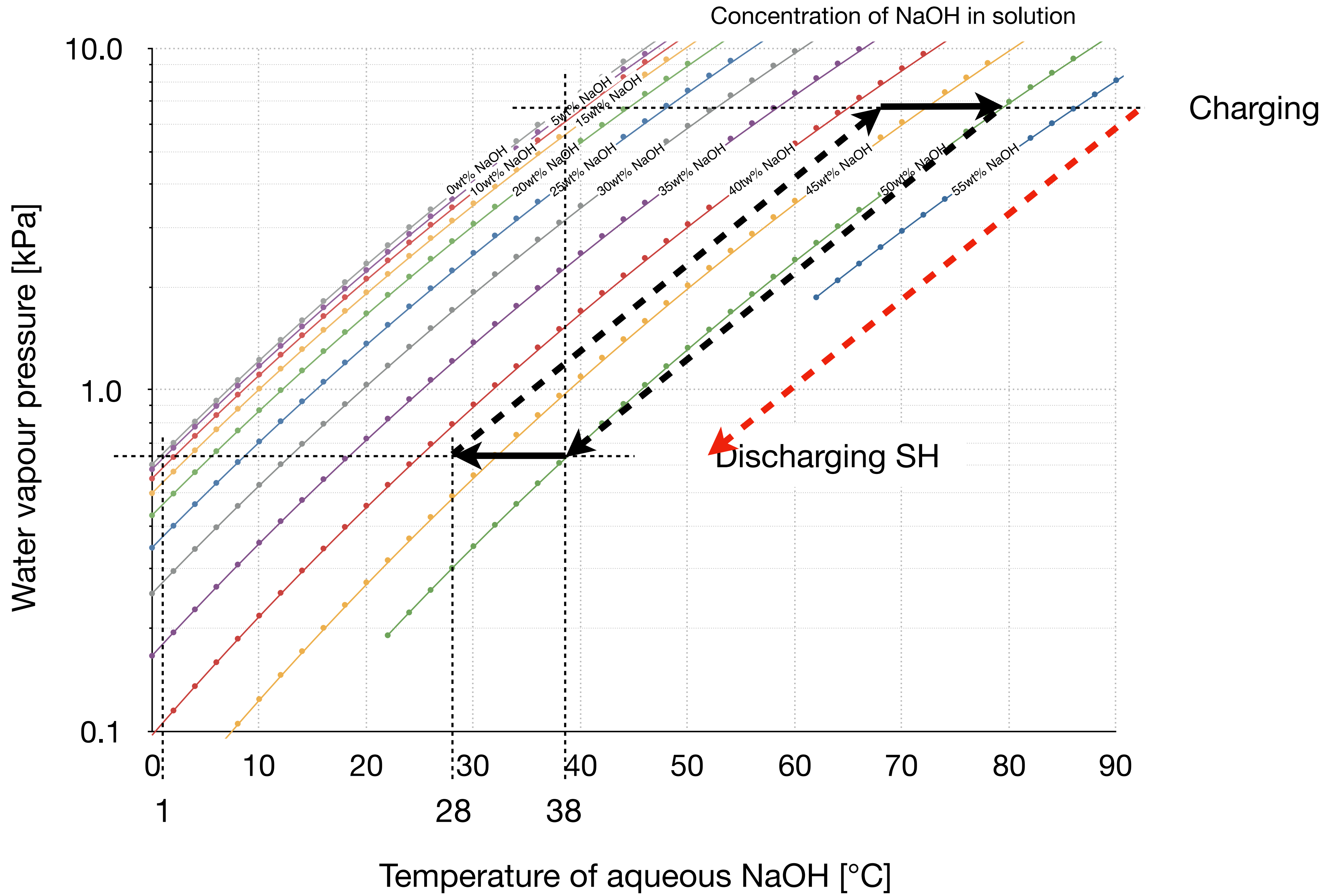
Aqueous sodium hydroxide



Olsson J, Jernqvist Å, Aly G. Thermophysical properties of aqueous NaOH H2O solutions at high concentrations. Int J Thermophys 1997;18:779–93.

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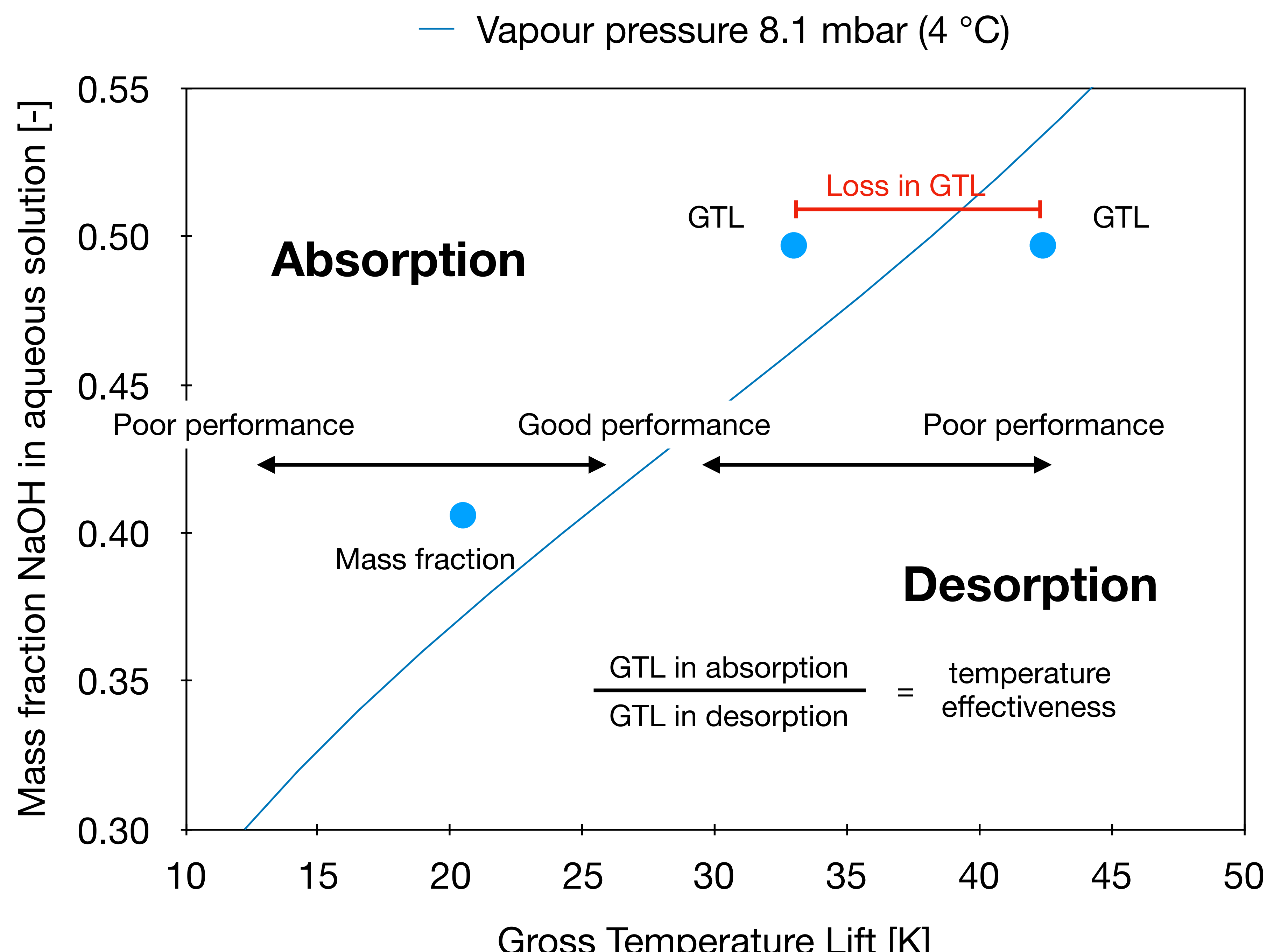
Gross temperature lift and temperature effectiveness



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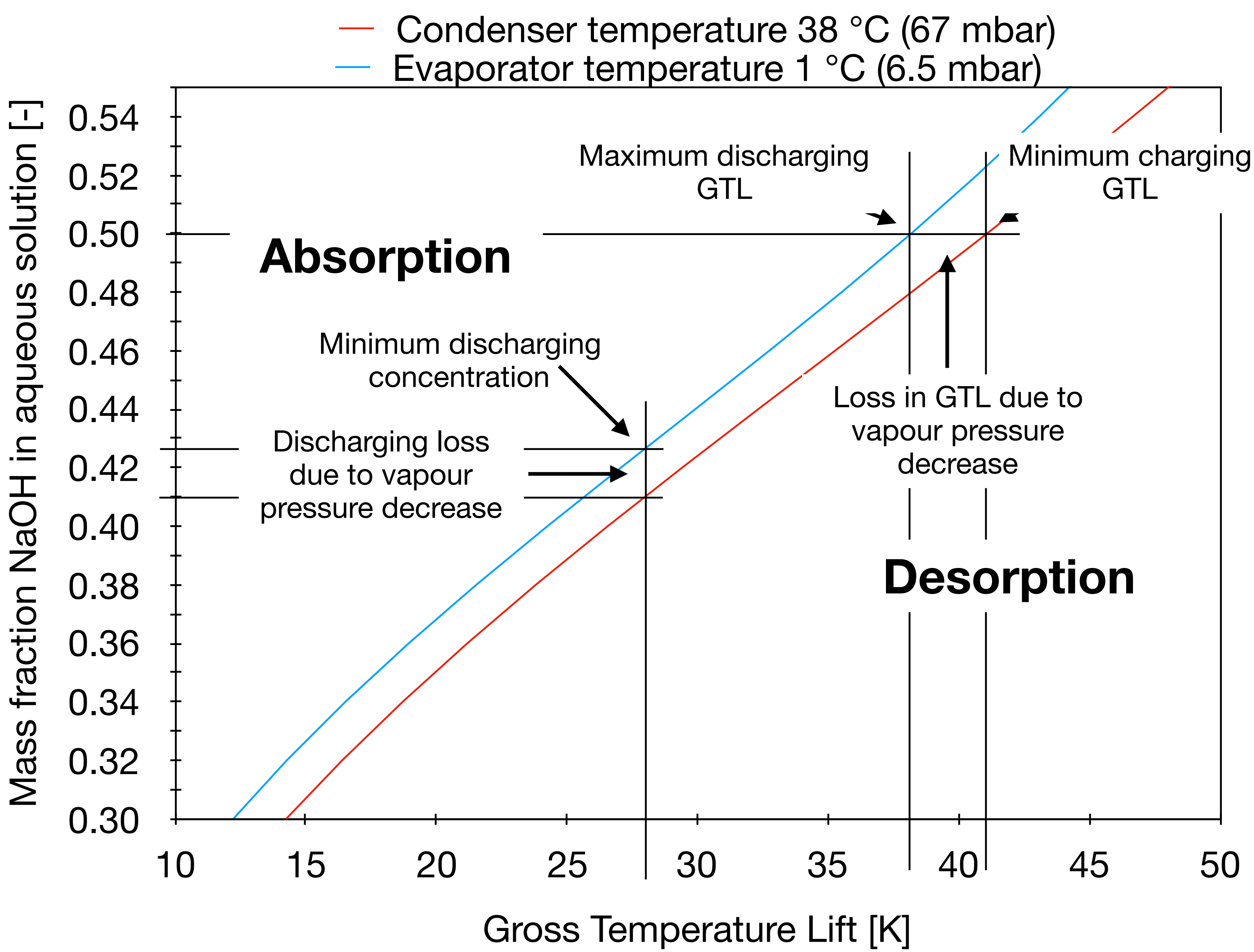

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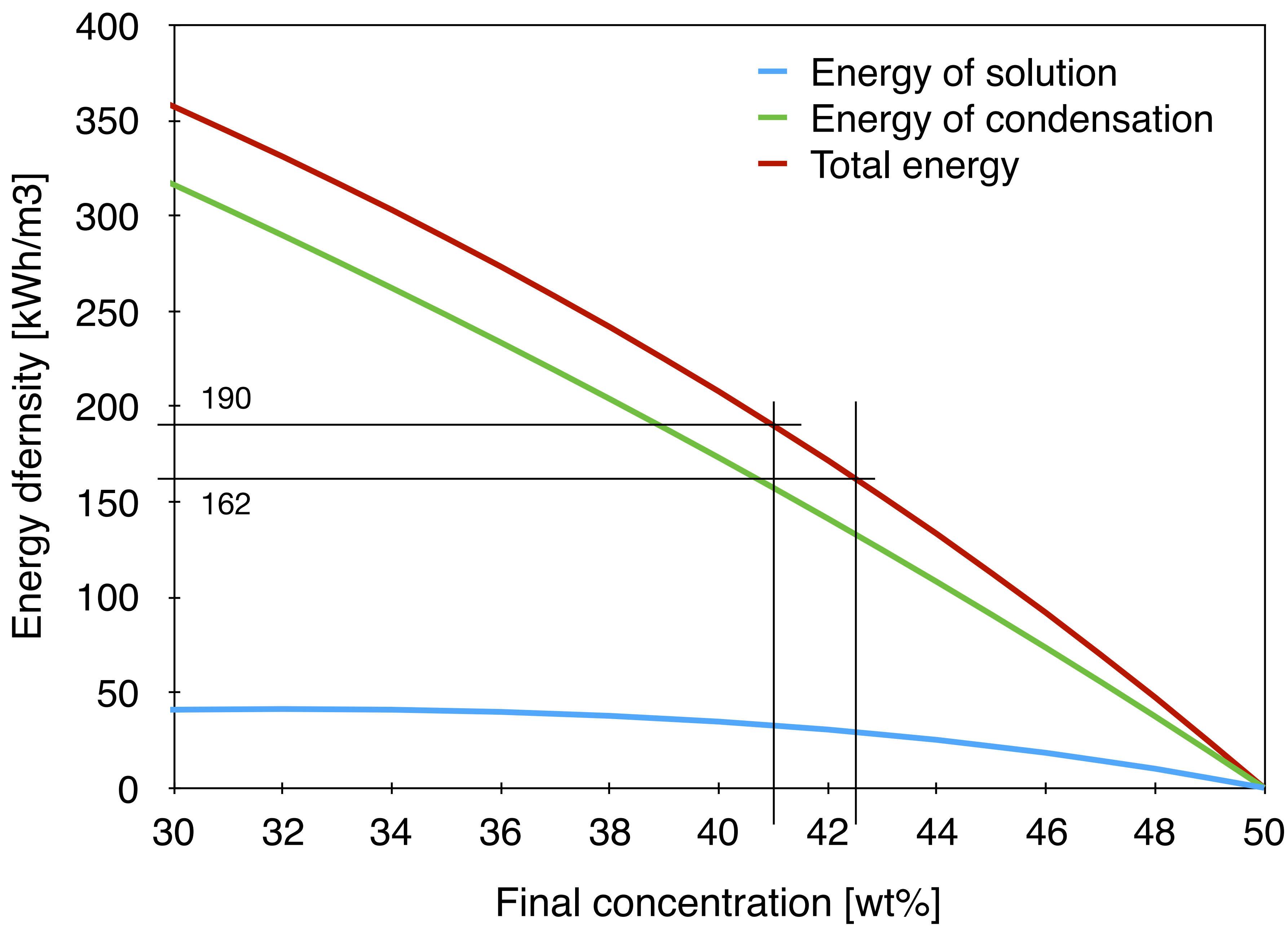
Volumetric energy density



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Mass and heat transport

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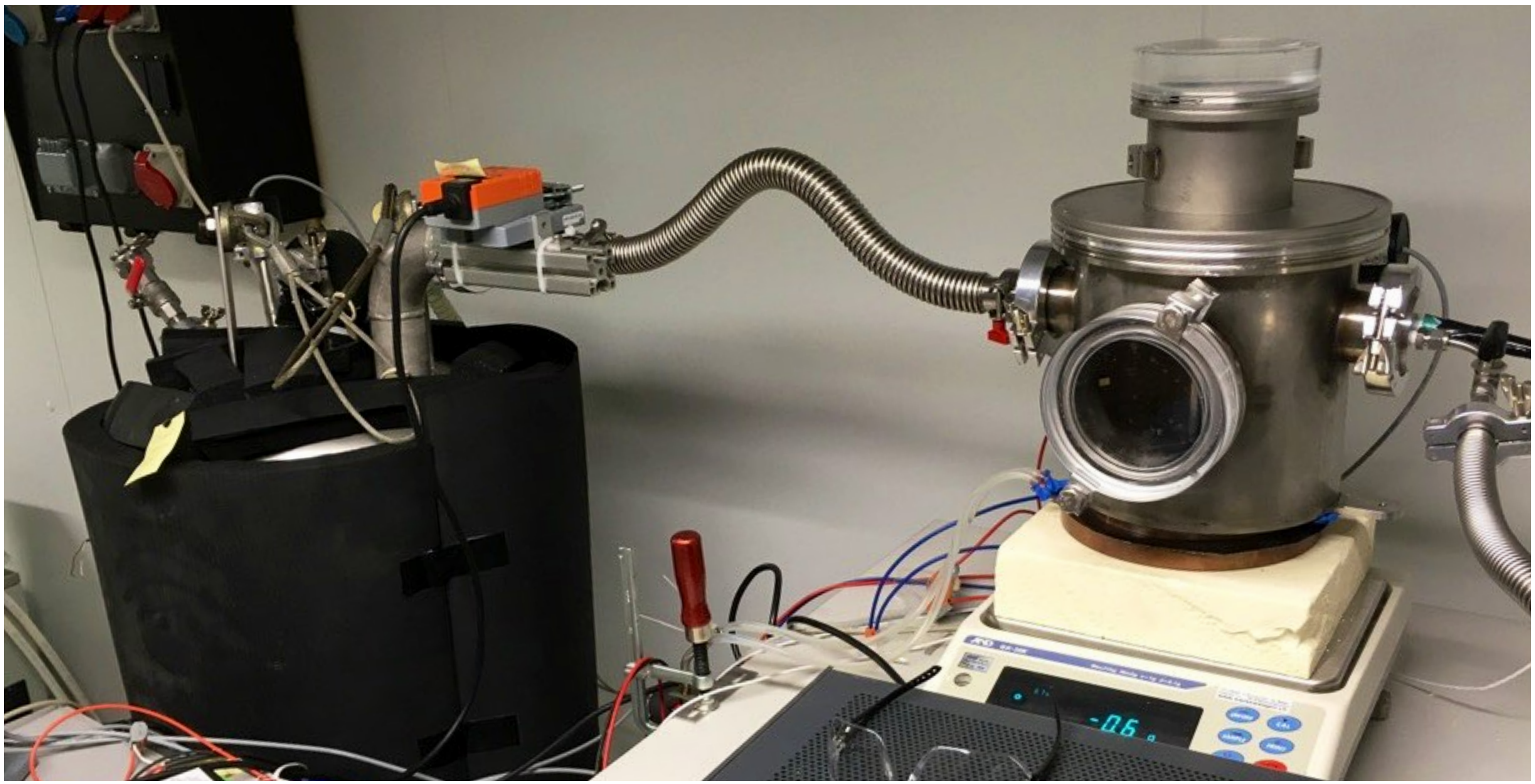
Bulk scale power investigation

Vapour connection



Evaporator / Condenser

Absorber / Desorber

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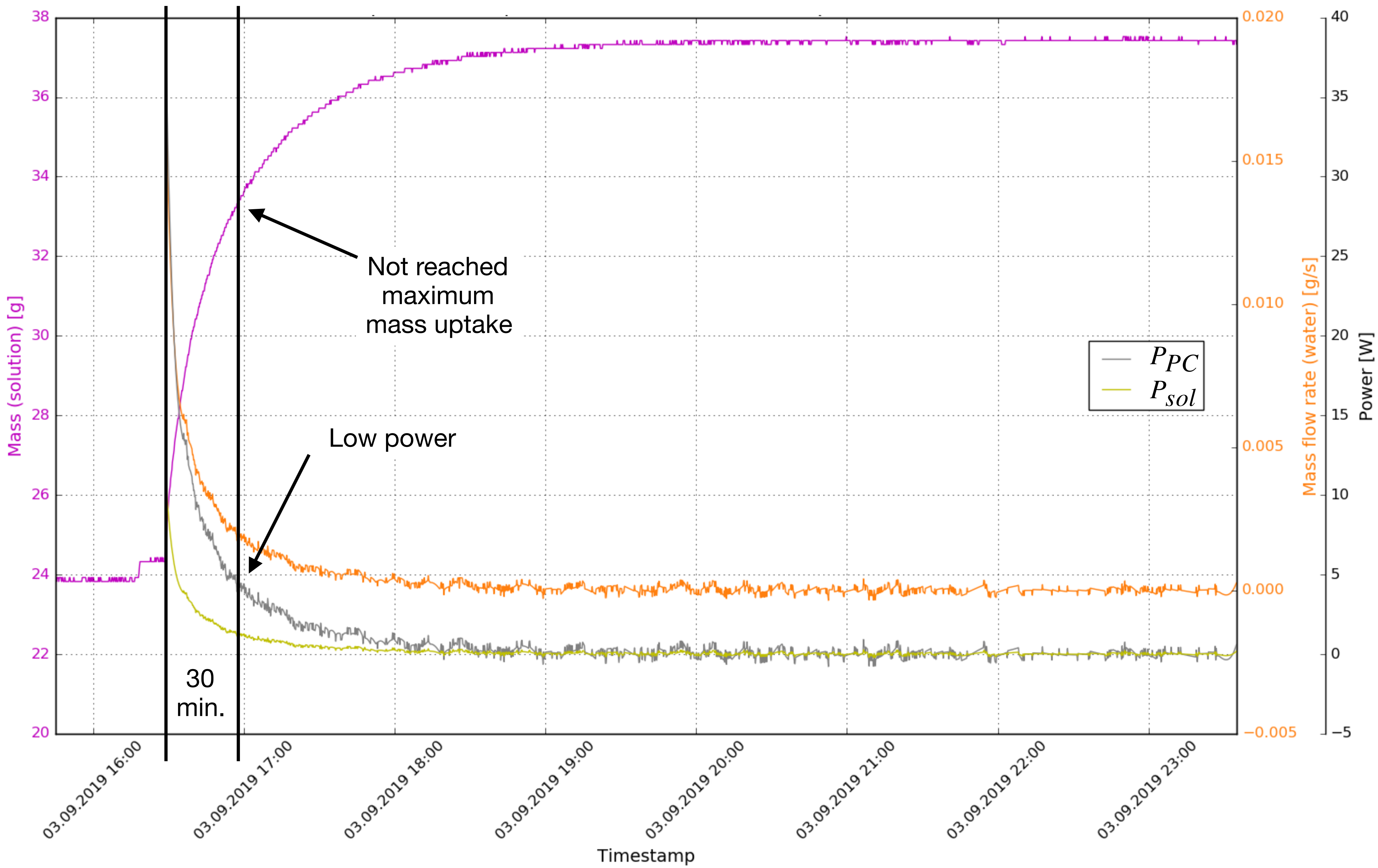
Bulk scale power



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Component design

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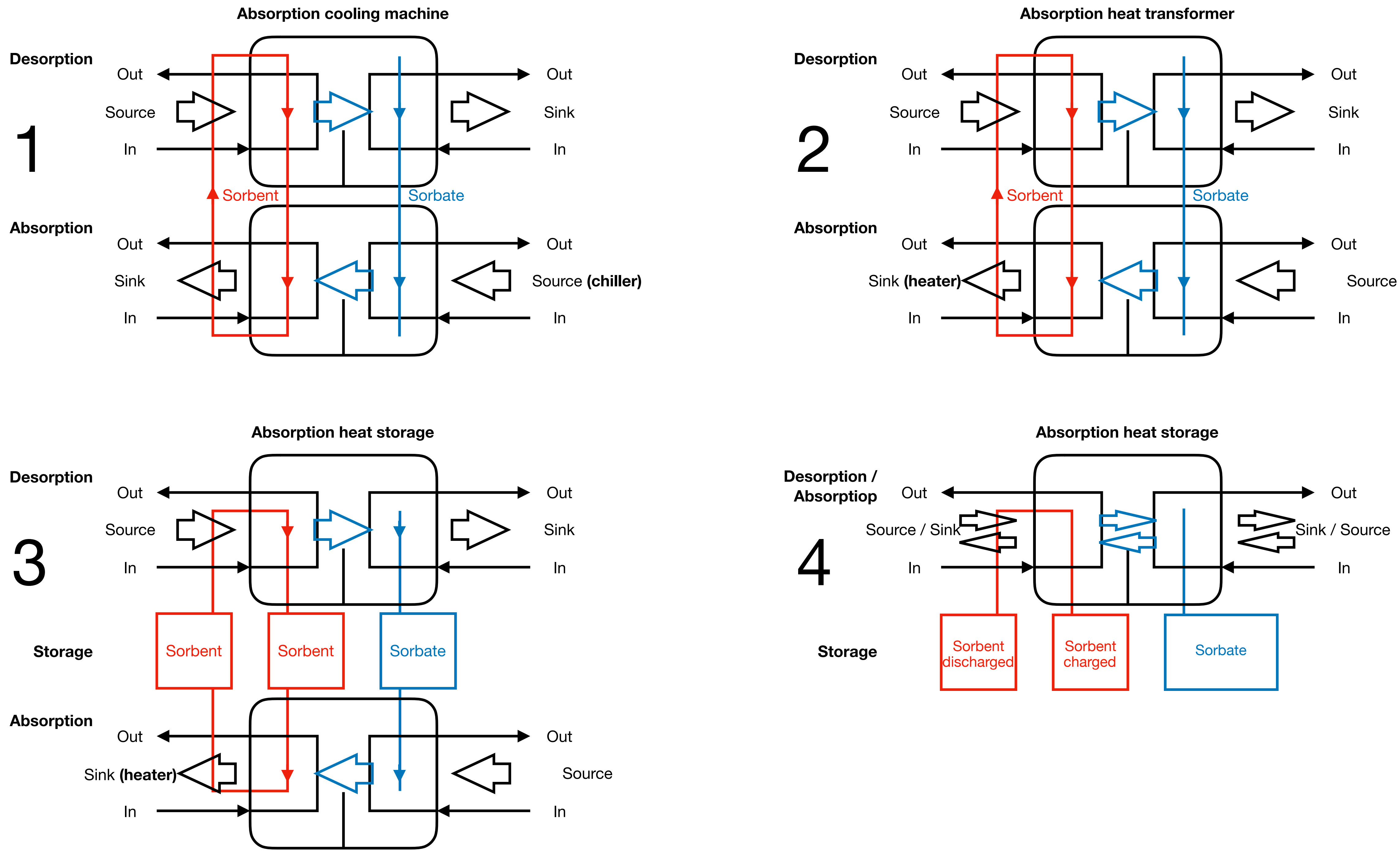
Absorption machine comparison



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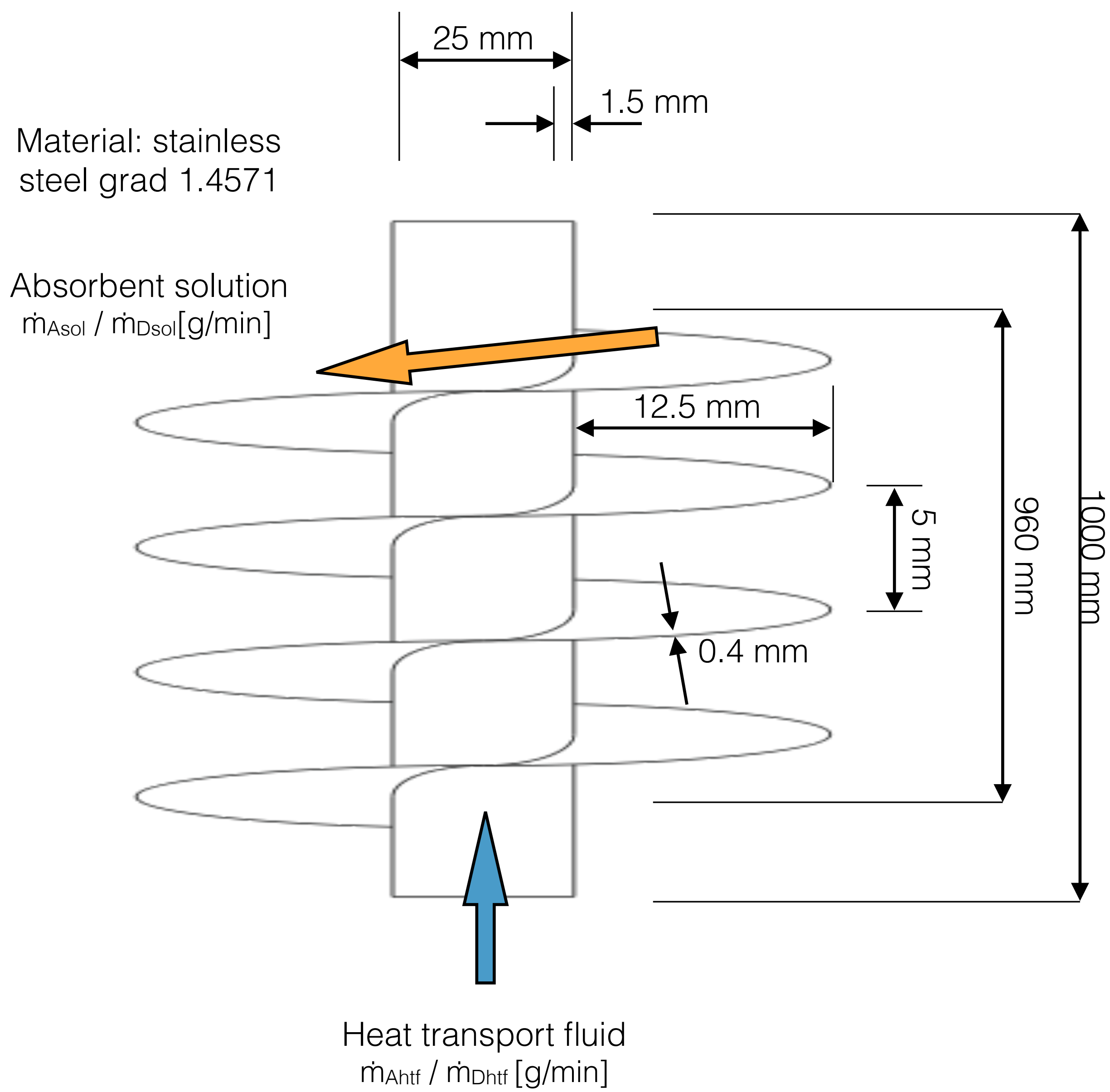
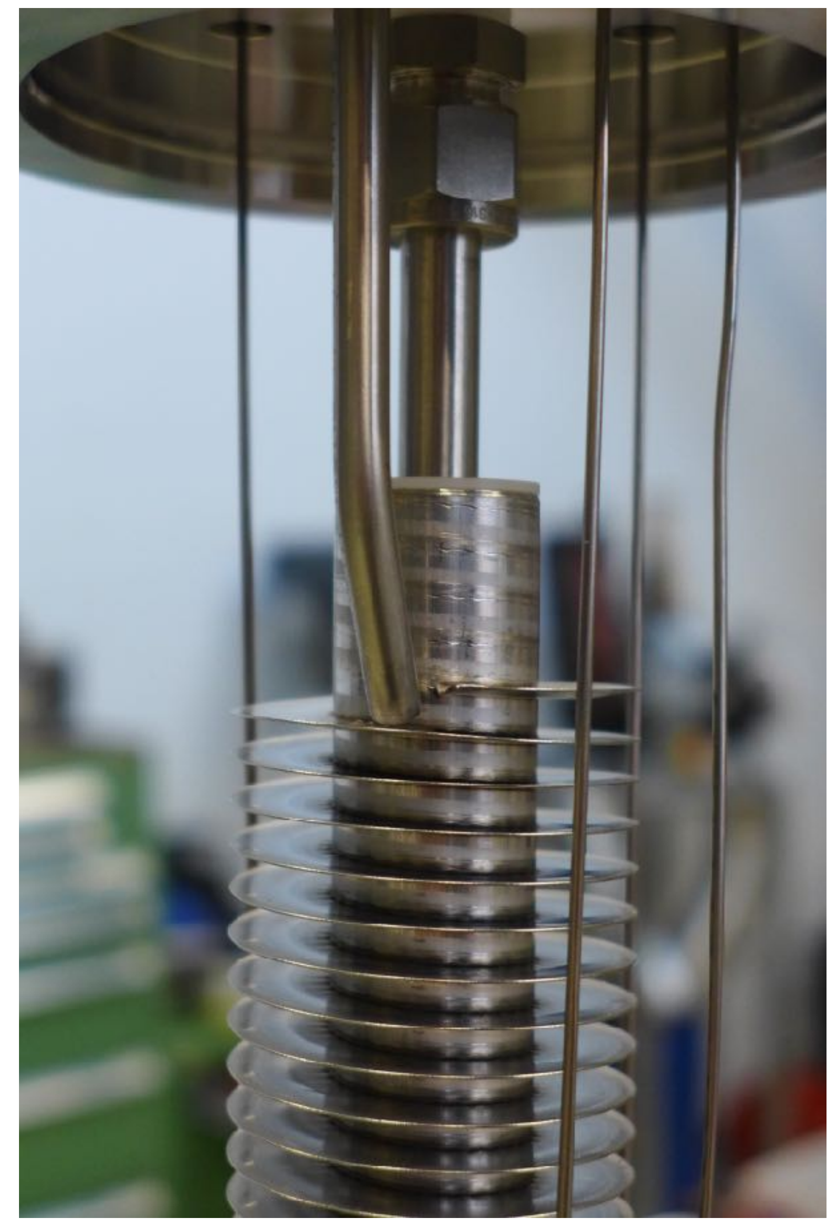
Heat and mass changer design for sorption heat storage





Fumey B, Weber R, Baldini L. Liquid sorption heat storage – a proof of concept based on lab measurements with a novel spiral finned heat and mass exchanger design. Appl Energy 2017;200:215–25.

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Lab scale HMX

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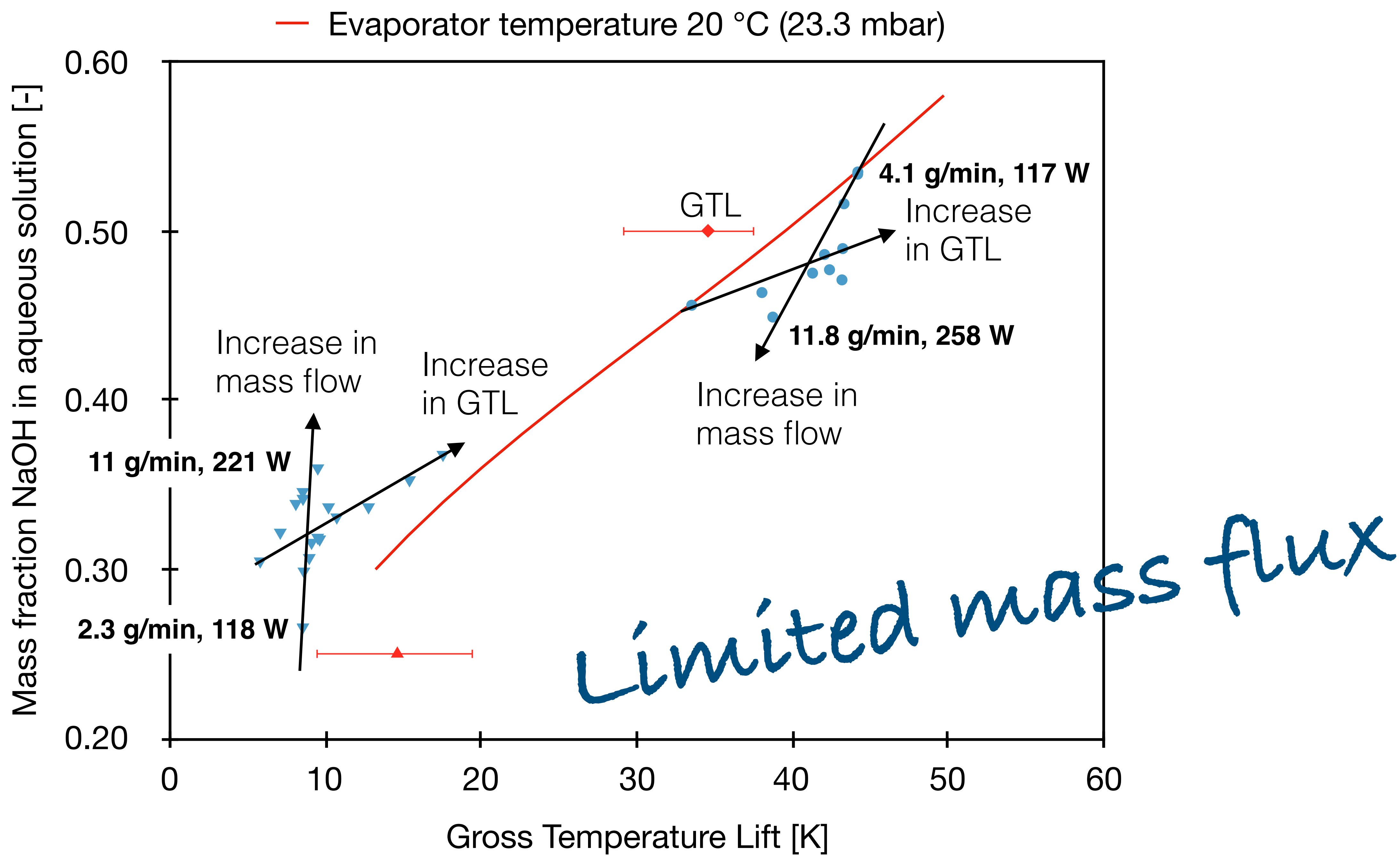
Performance evaluation



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Conclusion

- Choice of process affects performance.
- To compare sorption systems, uniform testing temperatures are essential.
- Sorption storage requires operation close to the vapour pressure, temperature and concentration equilibrium.

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