OSTBAYERISCHE TECHNISCHE HOCHSCHULE REGENSBURG

LABORATORY OF SORPTION PROCESSES

# Research and development activities of adsorption heat transformation processes at OTH Regensburg

## - 4th MI-Meeting Workshop, June 3rd 2021 -

**Belal Dawoud**

**Laboratory of Sorption Processes (LSP)**

**OTH Regensburg Technical University,**

**Regensburg, Germany**

# Recent R&D Activities @ OTH Regensburg

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- Development of a **hydraulic system** for **integrating a seasonal adsorption TES-System** for **south**, **middle** and **northern European countries,**
- Development of the **vacuum valves for the storage modules,**
- Development of **plate heat exchangers** to act as an **adsorber/desorber**,
- Experimental and Analytical Investigation of **plate heat exchangers** as **evaporator/condenser**
- **Designing the whole demonstration STES unit.**

# Contents

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- Development of a **hydraulic system** for **integrating a seasonal adsorption TES-System** for **south, middle** and **northern European countries; Final Results,**
- Development of the **vacuum valves for the storage modules,**
- Development of **plate heat exchangers** to act as an **adsorber/desorber; 1st WP,**
- Experimental and Analytical Investigation of **plate heat exchangers** as **evaporator/condenser**
- **Designing the whole demonstration STES unit.**

# Best Ads-STES Configuration to be further developed

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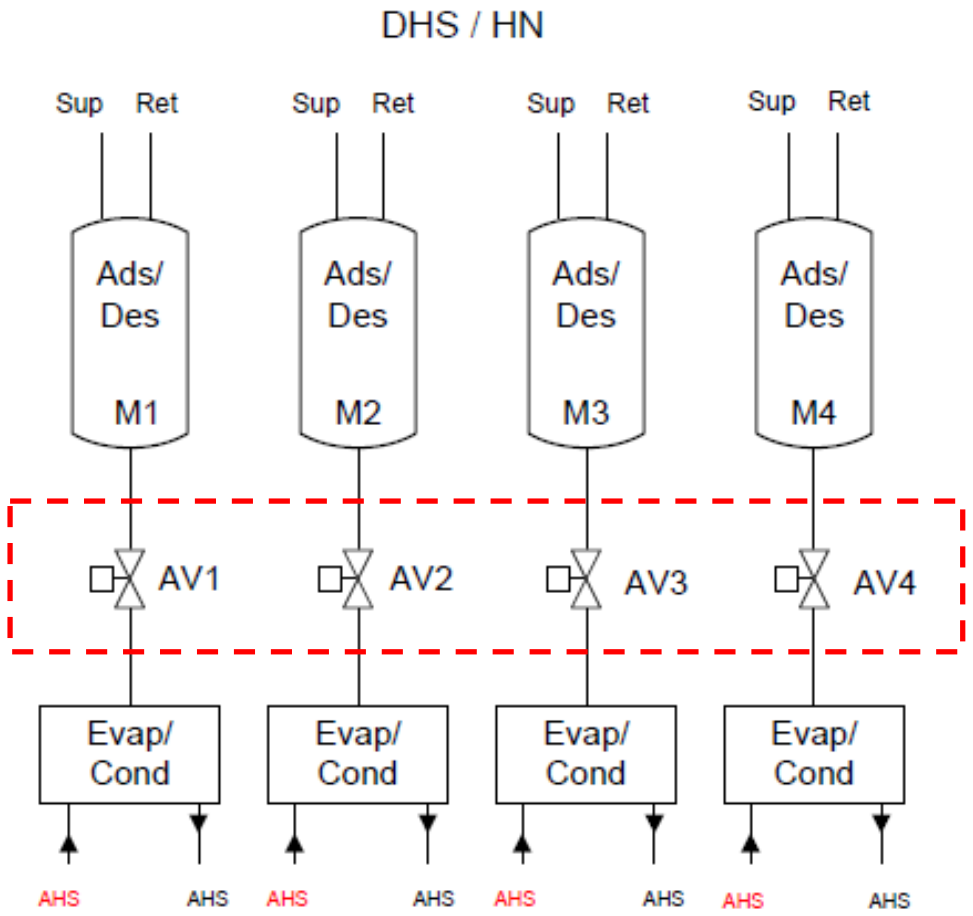


**Individually actuated vacuum valves**

# Ads-STES integrated in the generic heating system for South/Middle EU countries

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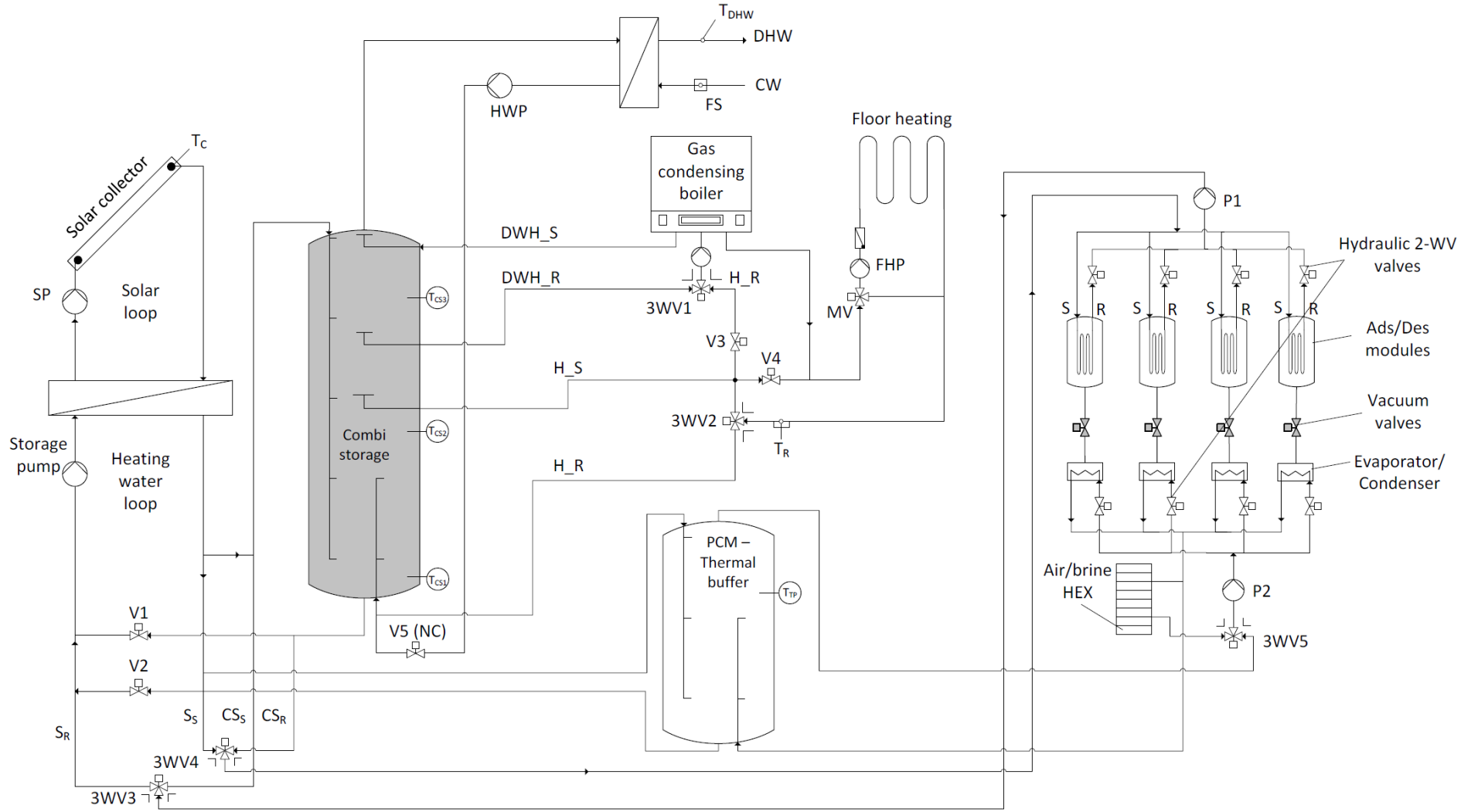

# Ads-STES integrated in the generic heating system for Middle/Northern EU countries

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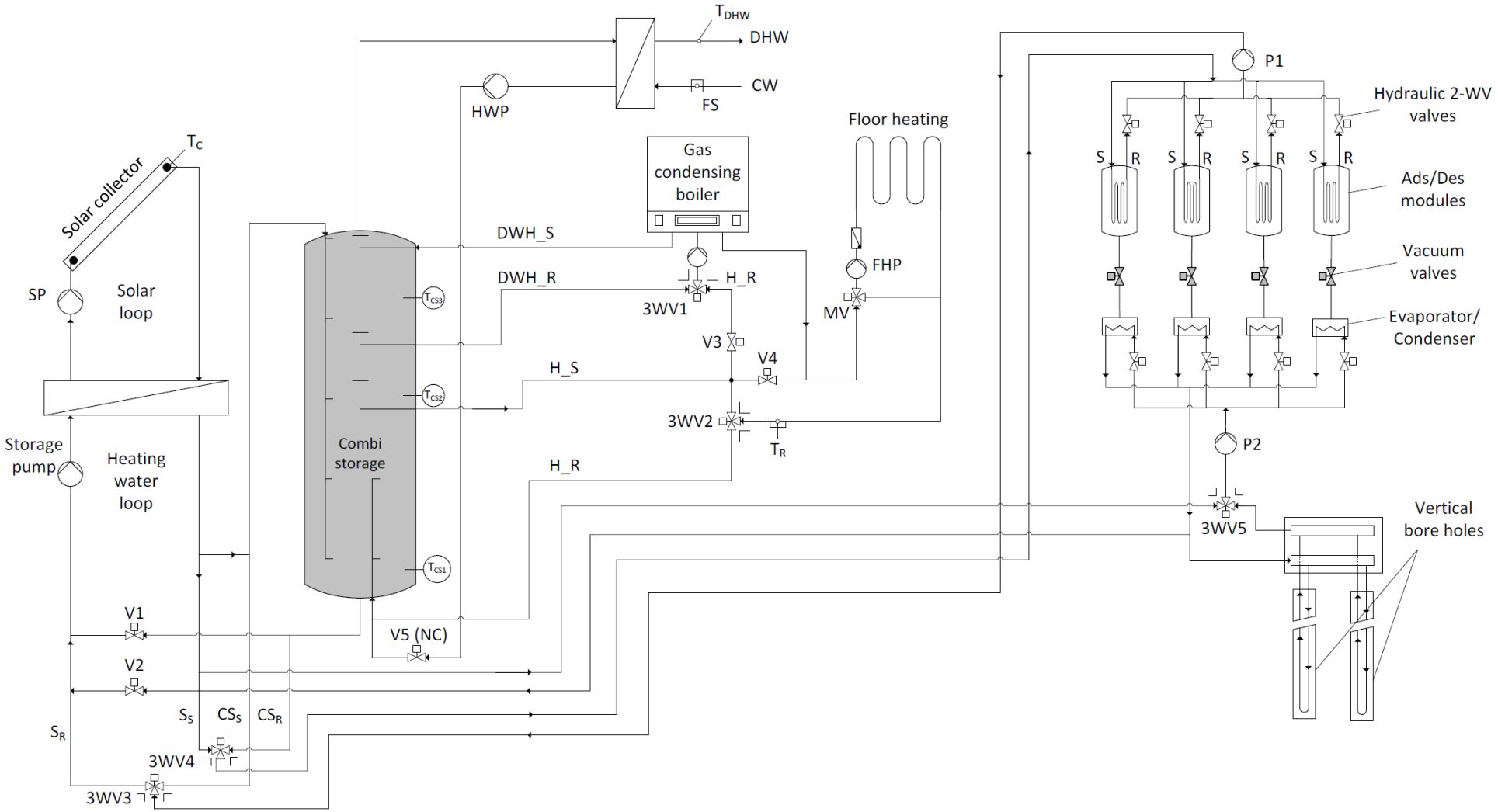

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# First Work Package: AIREC Cross-Flow Plate Heat Exchanger

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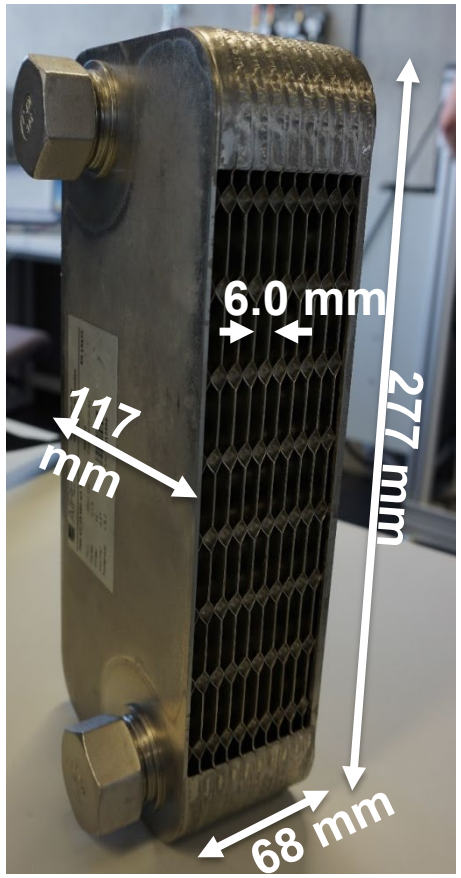
- A compact brazed plate heat exchanger consisting of stainless steel plates brazed either with copper or nickel.
- Designed to handle **asymmetric** volumes (Gas/Liquid domains) with high performance.
- **Open sides for gas entering and leaving**.

- **Some Technical Data**

  Volume of side "A" (**heat transfer fluid** side): **0.57 L**

  Volume of side "B" (**gas or here adsorbent** side): **1.14 L**

  Plate thickness: 0.35 mm




**AIREC's PHE**

# AIREC Cross heat Exchanger as an Adsorber HEX

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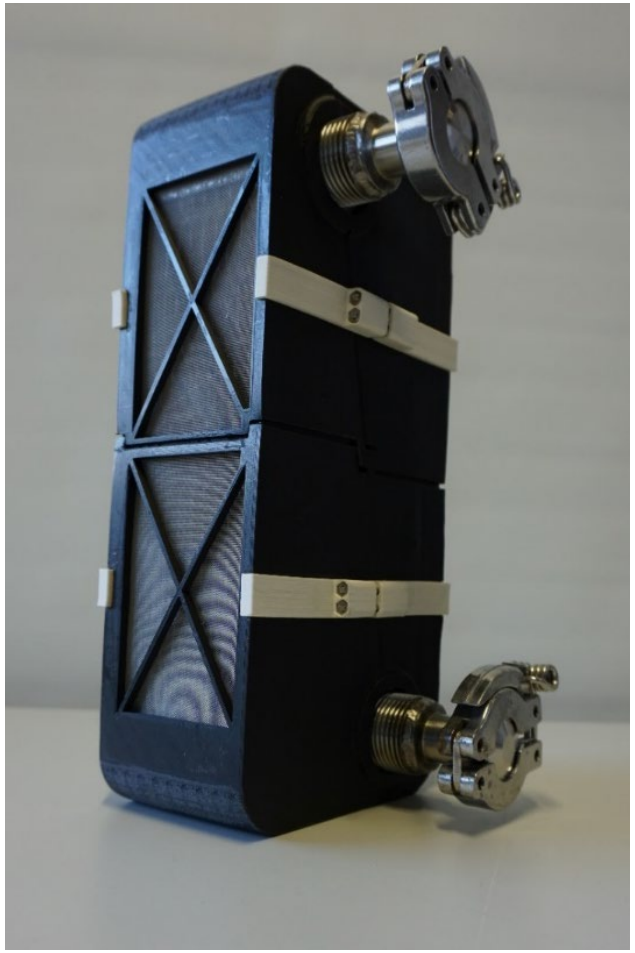
## a) Construction as an adsorber HEX

**Gas domain** is **filled in** with **818 g** of loose grains of **Siogel**

Metal sieves inside the two 3D-printed casing parts to prevent the grains from falling down

Casing parts are screwed together



# AIREC Cross heat Exchanger as an Adsorber HEX

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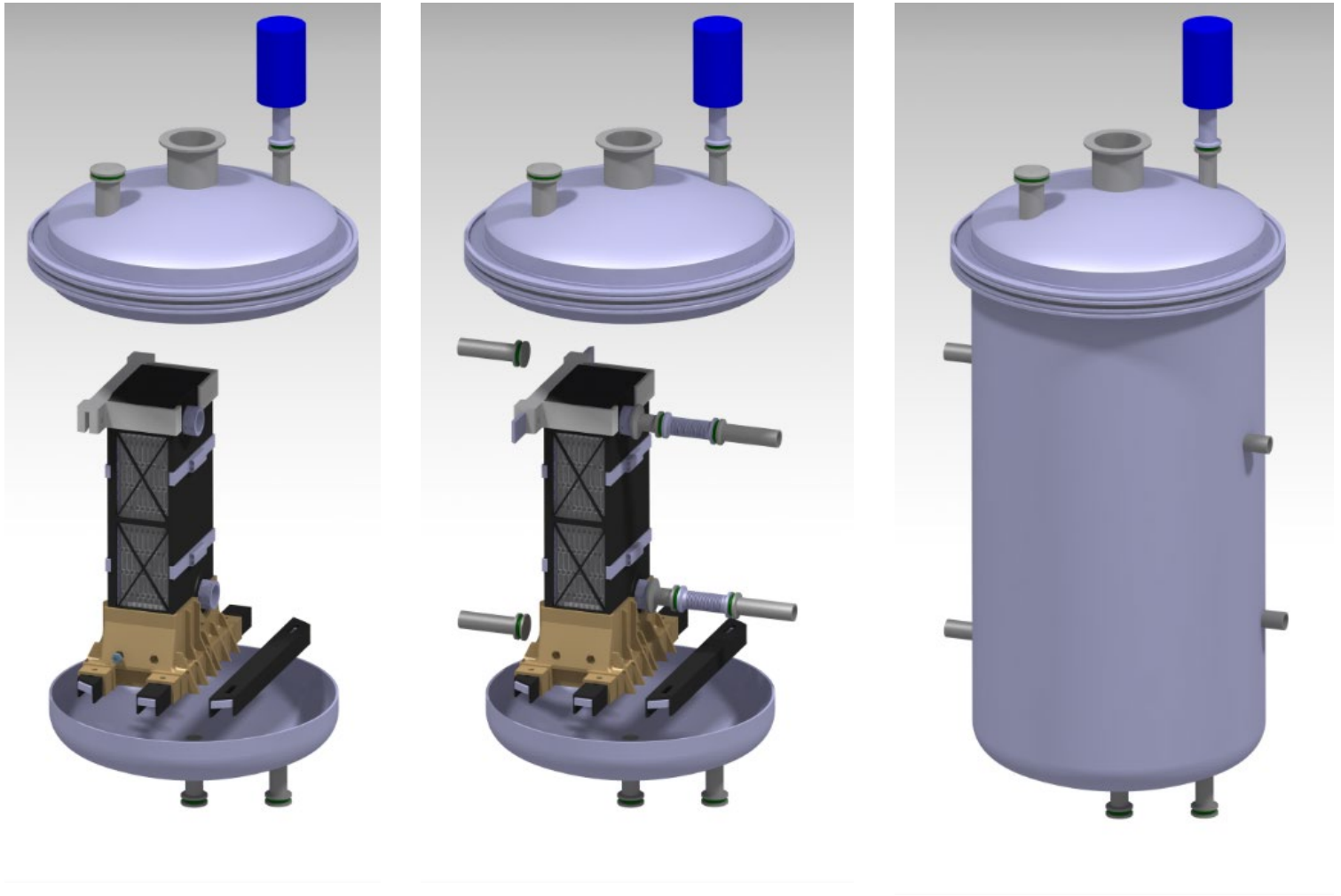
## b) Assembly inside a vacuum chamber



# AIREC Cross heat Exchanger as an Adsorber HEX

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## b) Assembly inside a vacuum chamber

# Utilized Falling-Film Evaporator/condenser

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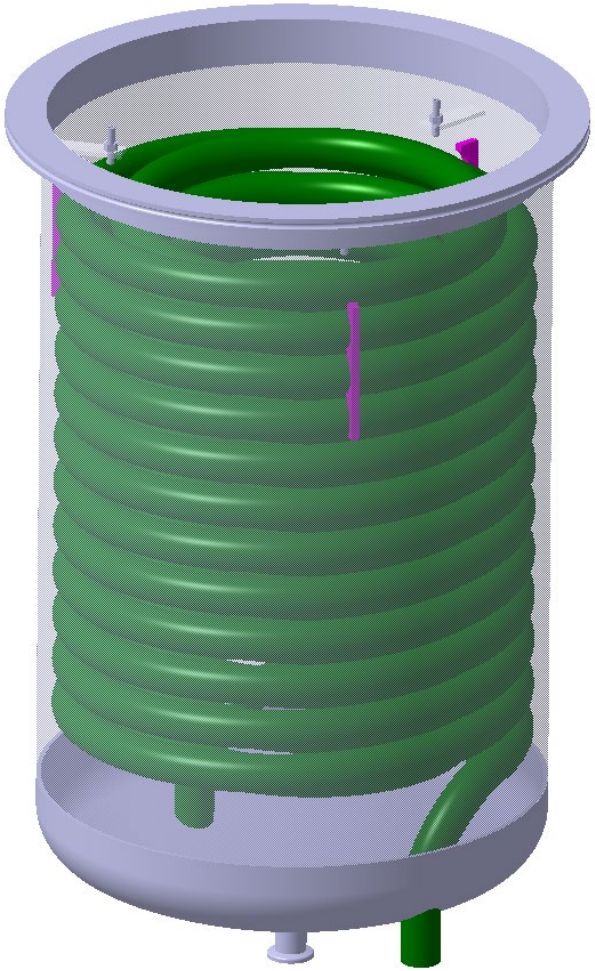

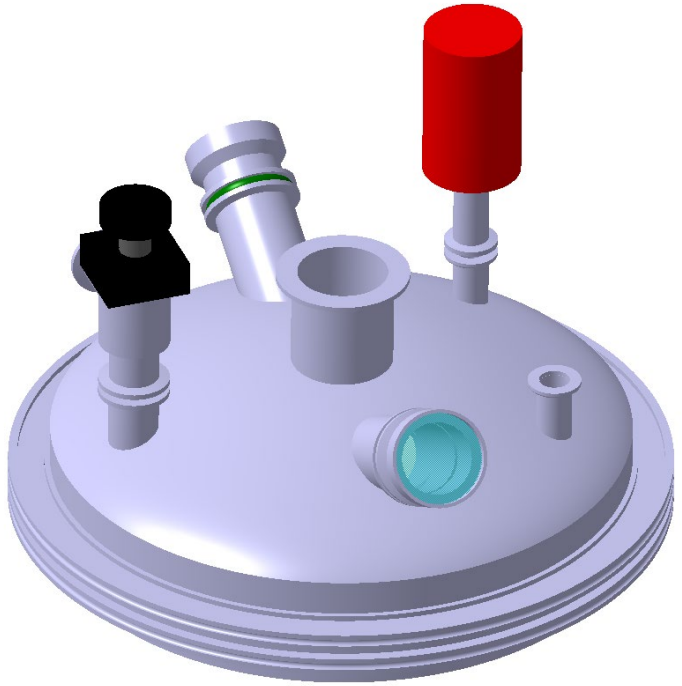

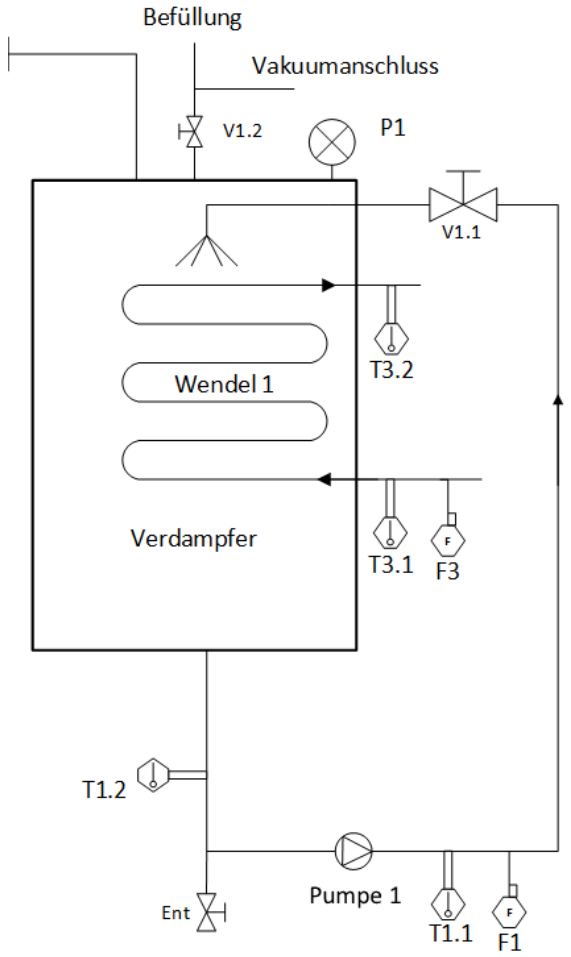

# Test Unit with AIREC Cross HEX as an Adsorber HEX against the falling-film evaporator

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# LabVIEW Control of the Sorption Test-Rig

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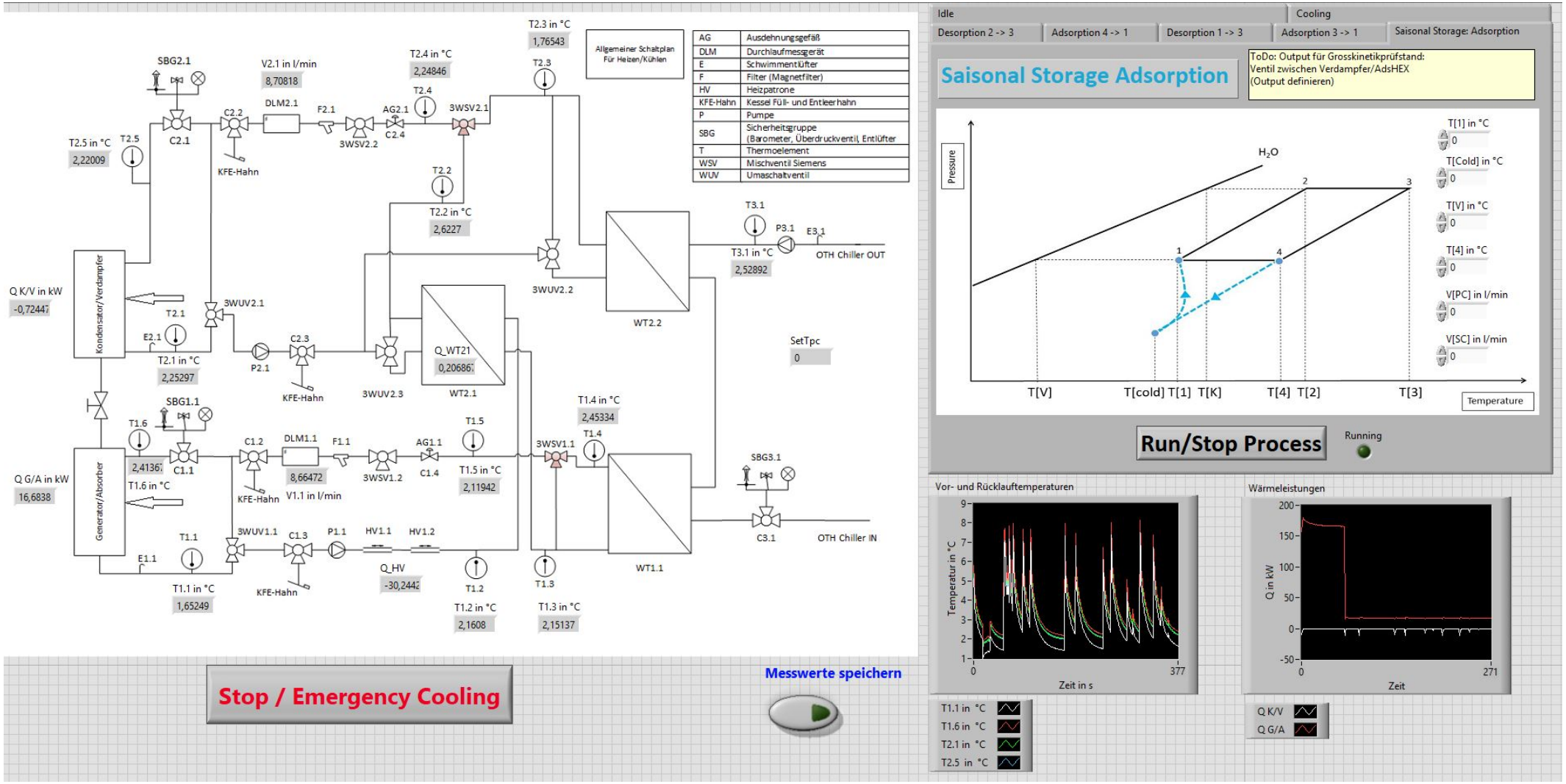

# Sorption Test-Rig and the Adsorption Unit including the AIREC PHE as an Adsorber/Desorber

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# Operating Conditions

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- LTJ-processes were performed at $T_{ev}$=10 & 15°C and $T_{cond}$= 30 & 35°C
- Desorption temperature 90 °C
- Adsorbent material: Siogel
- Adsorbent dry mass: 818 gram
- Grain size: 0.71 to 1 mm
- HTF flow in the Absorber PHE: 6 LPM
- Evaporator type: falling film
- Sprinkling flow rate inside the evaporator: 5LPM
- HTF flow rate in the evaporator HEX: 6 LPM

# Small-Scale Sample Design for the Sorption Kinetic Measurements

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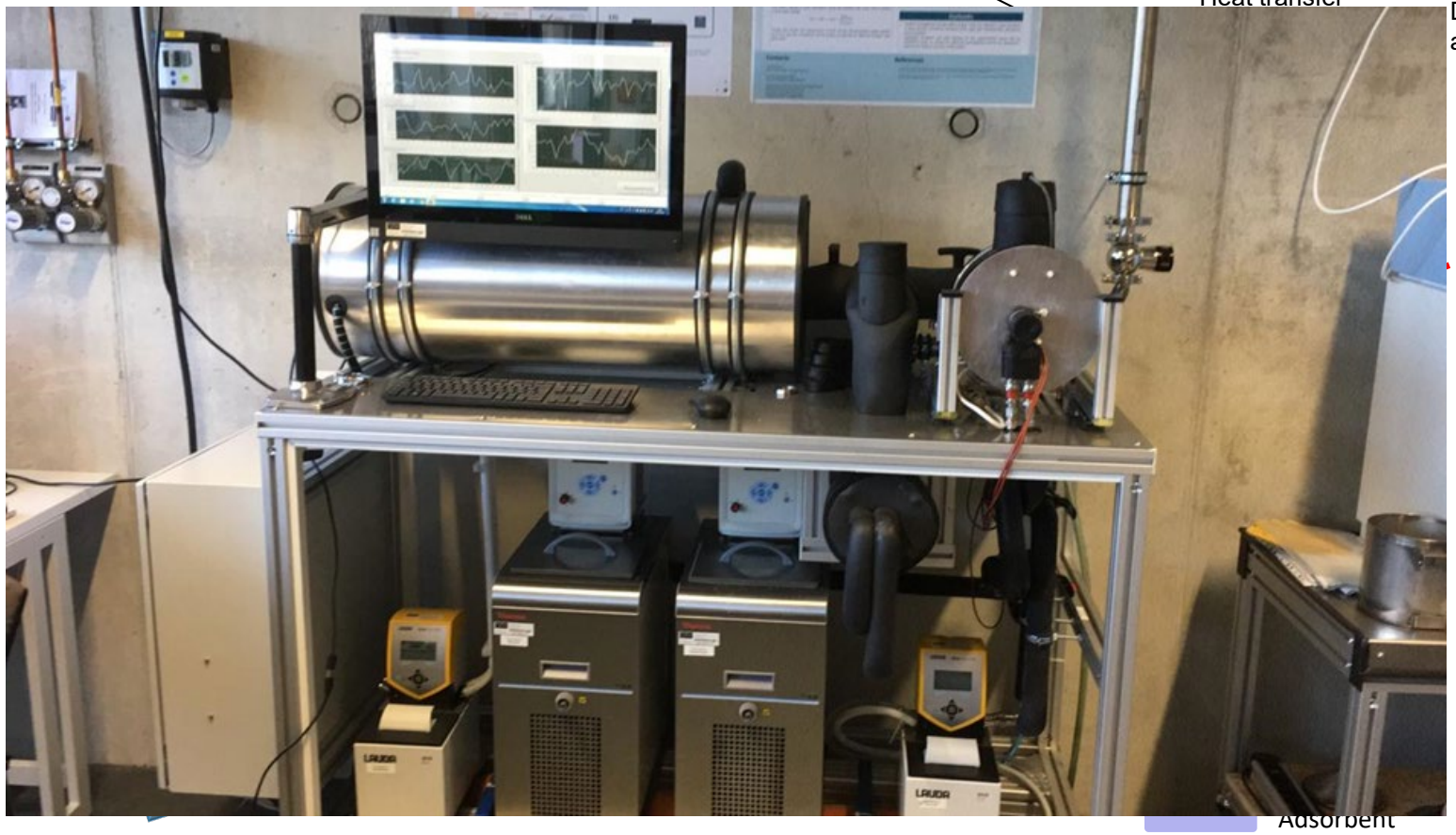


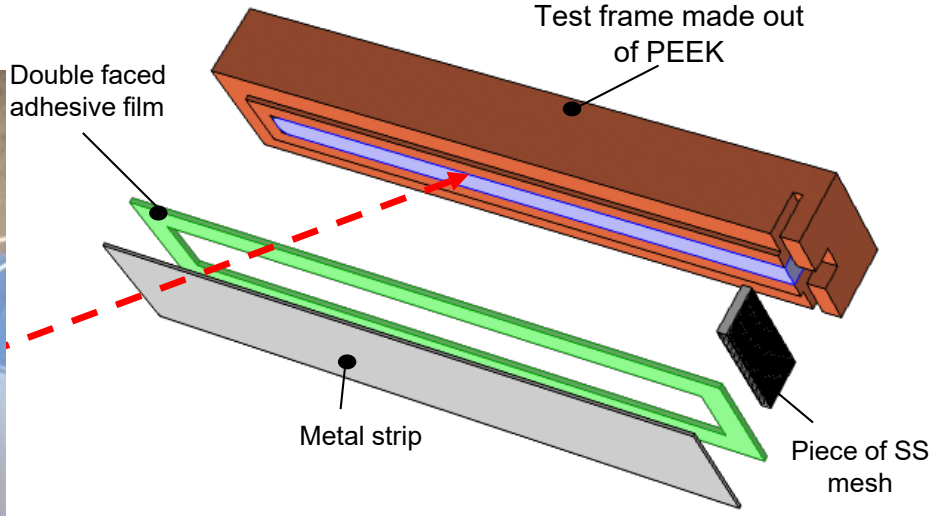


Test Frame placed on the tempered surface of the measuring cell

# Comparison between Full-scale and Small-scale Adsorption Kinetics

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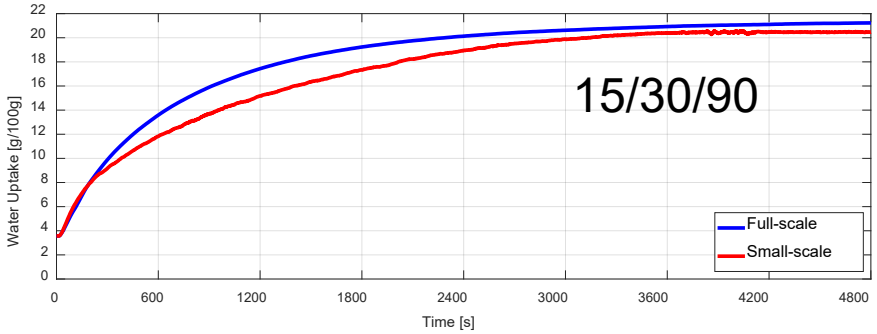
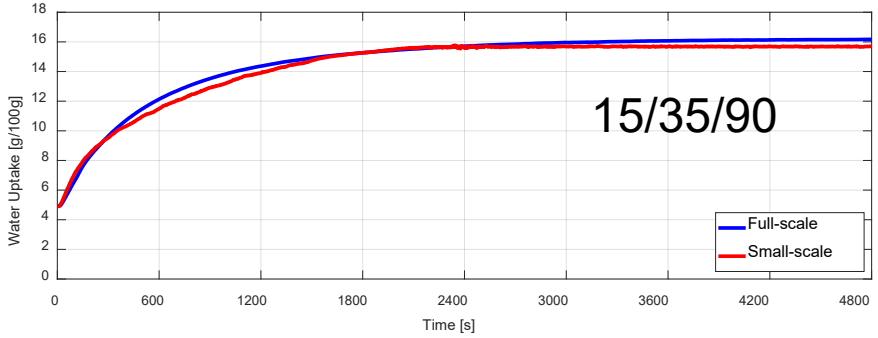
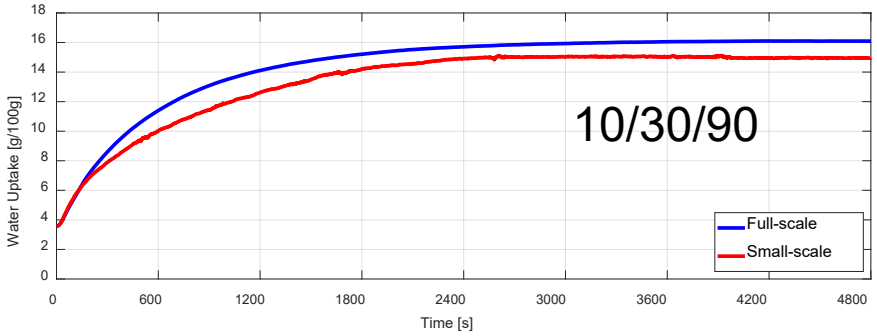
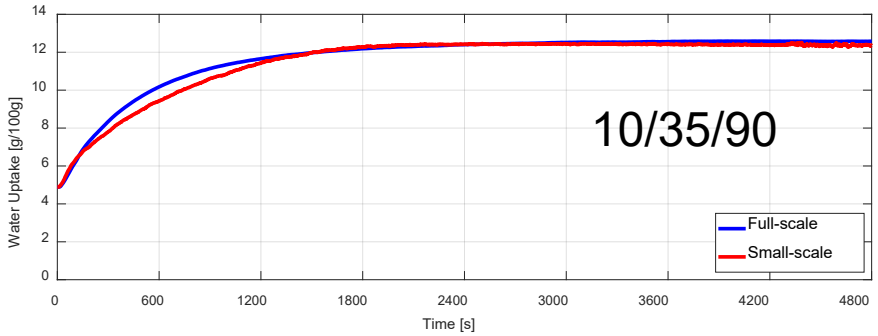
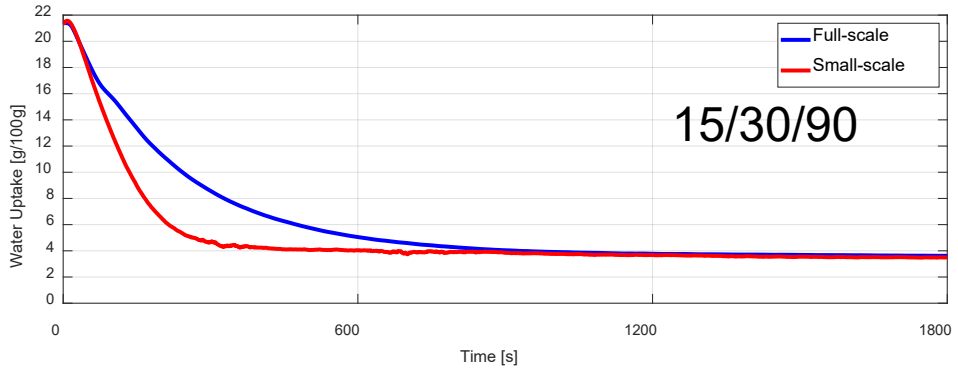


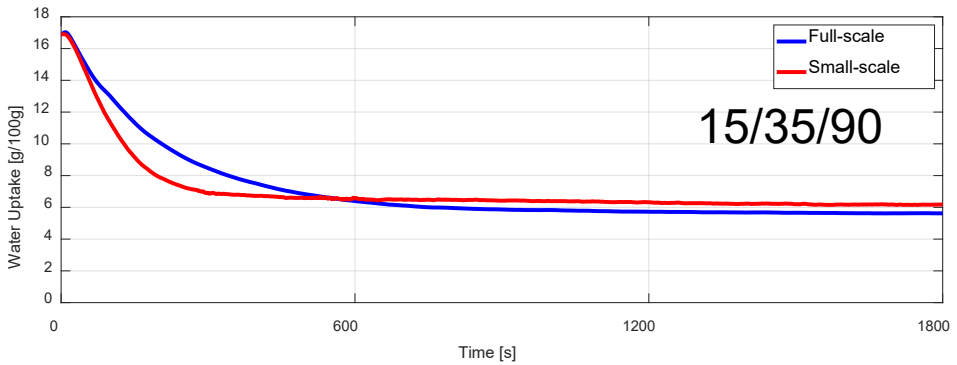



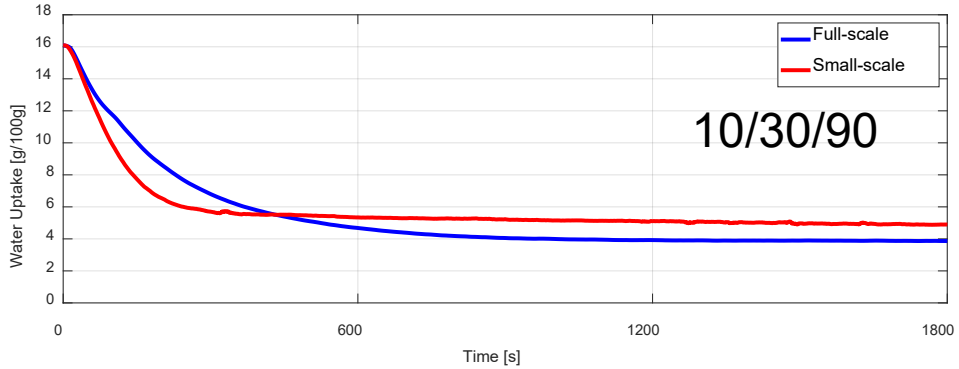



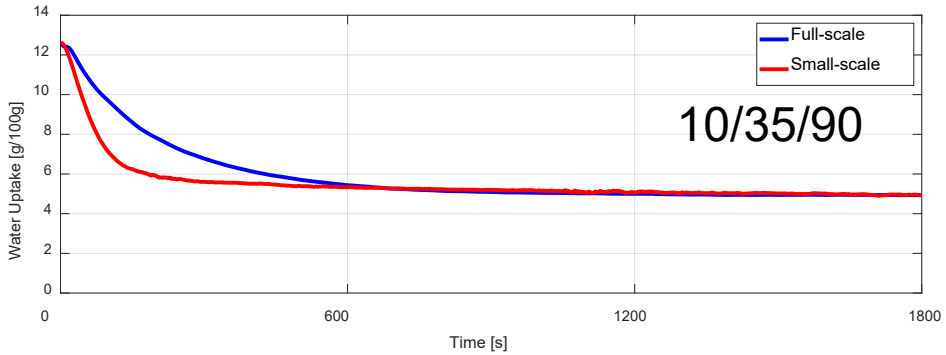



# Comparison between Full-scale and Small-scale Desorption Kinetics



# Summary

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- A **solar-assisted generic heating system** has been developed for **integrating a seasonal adsorption TES,**
- Open structured **cross flow plate heat exchangers** has been constructed and tested as an **adsorber/desorber** against a **falling film evaporator/condenser showing slow kinetics** but **a very promising potential** for further developments,
- **Slow kinetics** are attributed to the **long diffusion path inside the PHE (***See our paper in HPC21***)**,
- **Small scale test frame** has been carefully **designed to simulate the adsorbent domain** of the investigated **PHE** for **sorption kinetic measurements**,
- A **very good matching** between **small-scale** and **full scale results** pave the way to **optimize the design of adsorber plate heat exchangers** on a **small scale basis**,
- The results concerning the adsorber PHE is under preparation for publication in Energy.


**Thank you very much for your kind attention.**

**Questions are more than welcome!**