Resorption Heat Pump Updates

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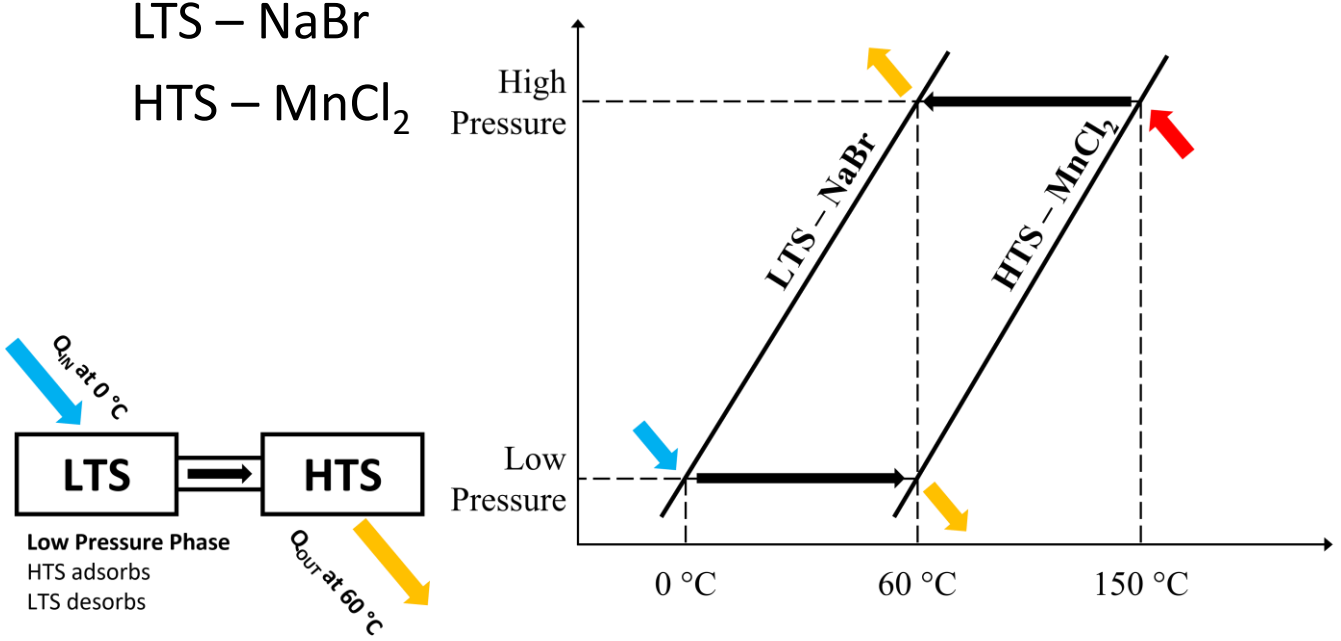
1. Resorption HP Operation

- Two salt **domestic heat pump** using ammonia-salt

LTS – NaBr

HTS – $MnCl_2$

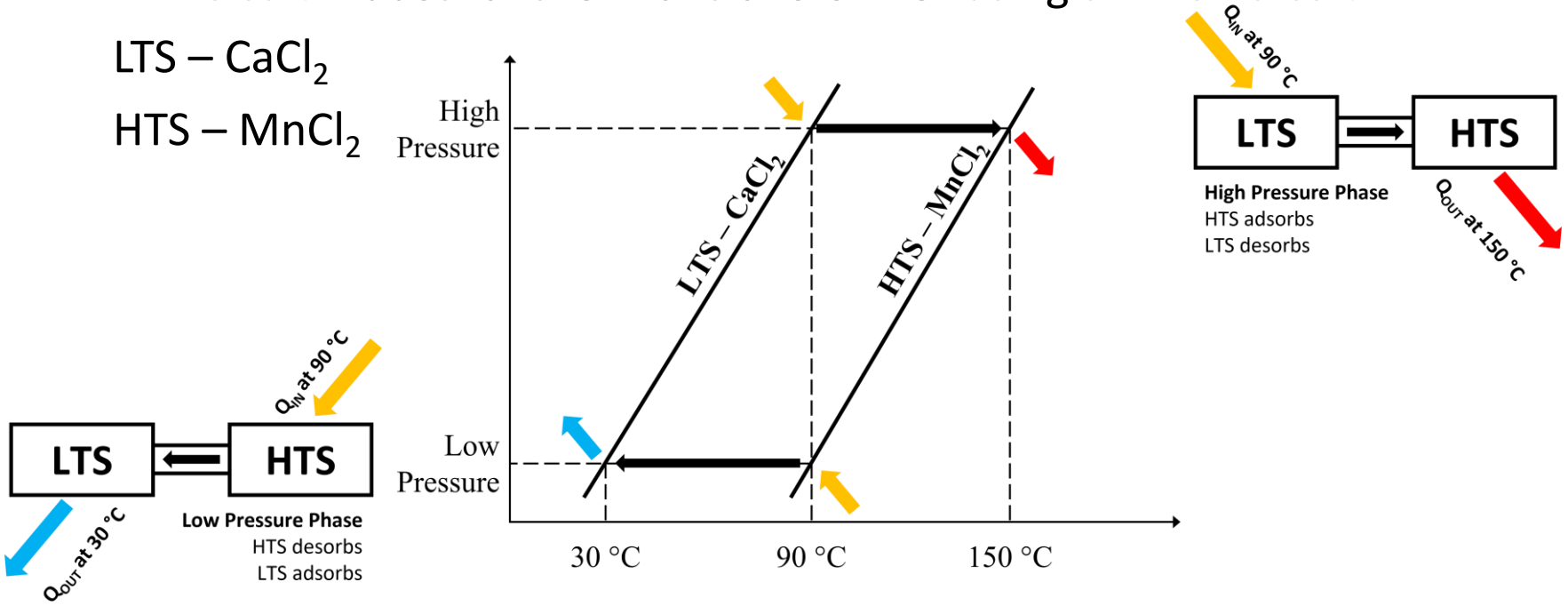


2. Resorption TT Operation

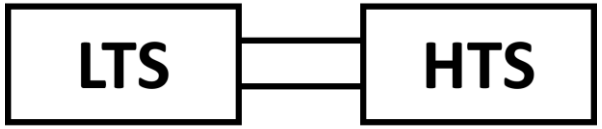
- Two salt **industrial thermal transformer** using ammonia-salt

LTS – $CaCl_2$

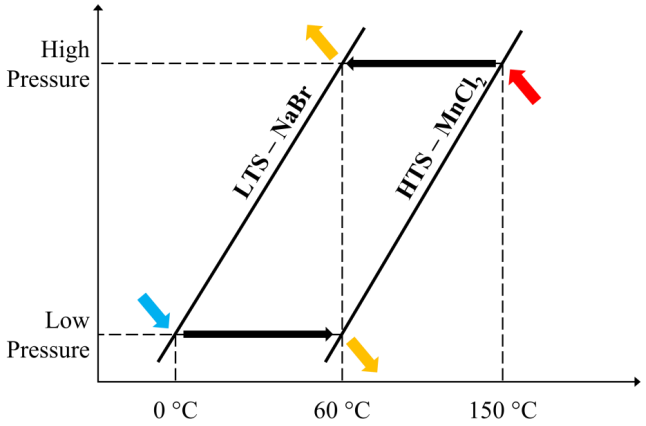
HTS – $MnCl_2$

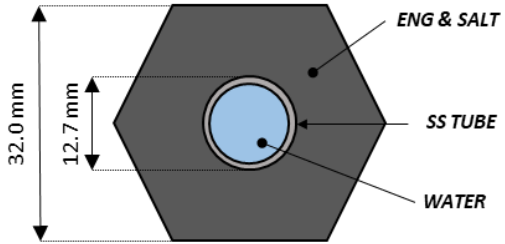


3.1 Resorption Design

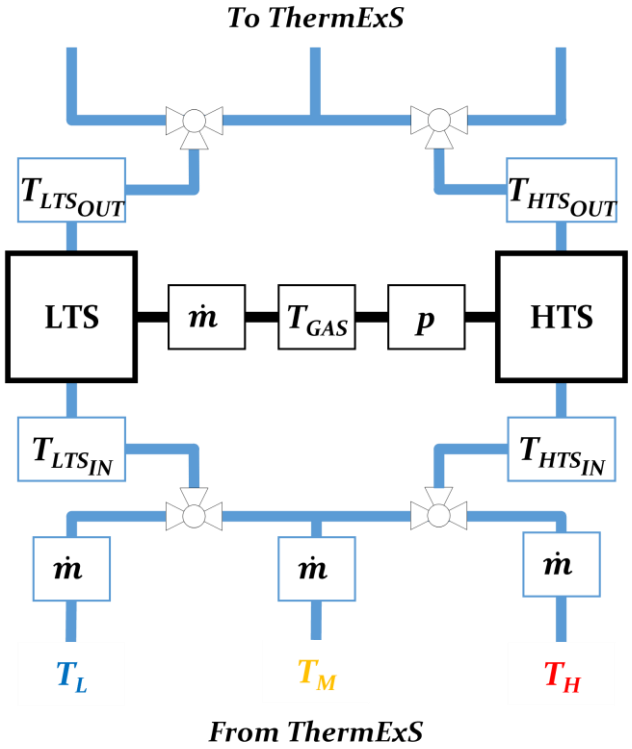


- Two reactors with salt, and an ammonia connection between them (+ some fluid flow to each reactor)



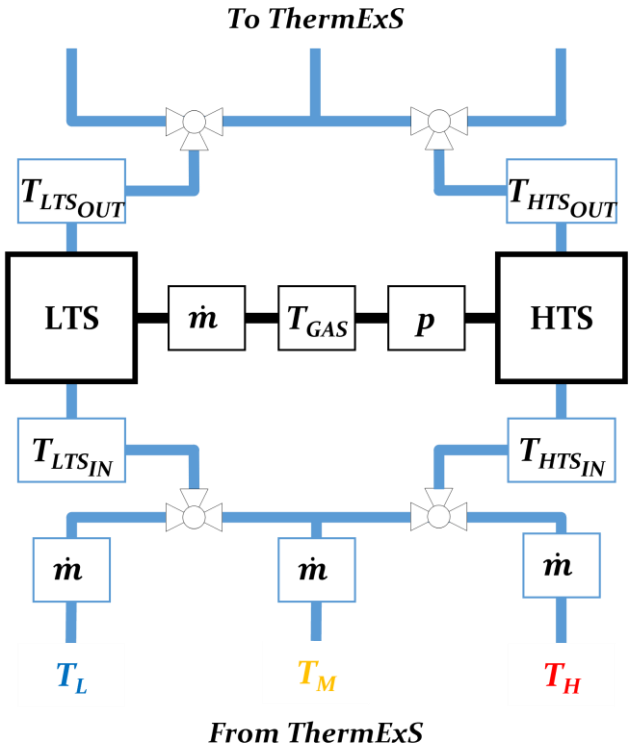


3.2 Resorption Design

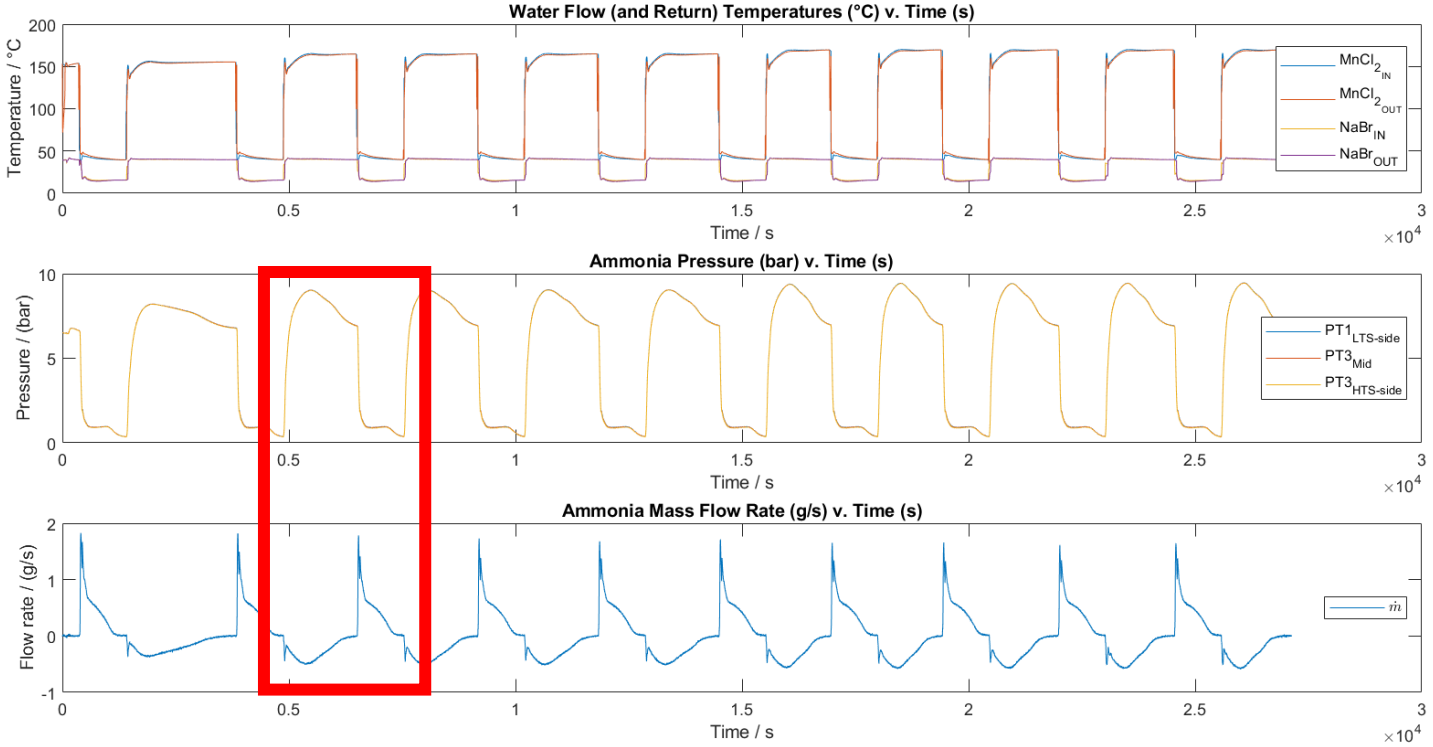


- Two reactors with salt, and an ammonia connection between them (+ some fluid flow to each reactor) = simple!
- For performance analysis we want:
  - Pressure, temperature, flow rates on fluid and ammonia sides
  - As well as flow control to each reactor

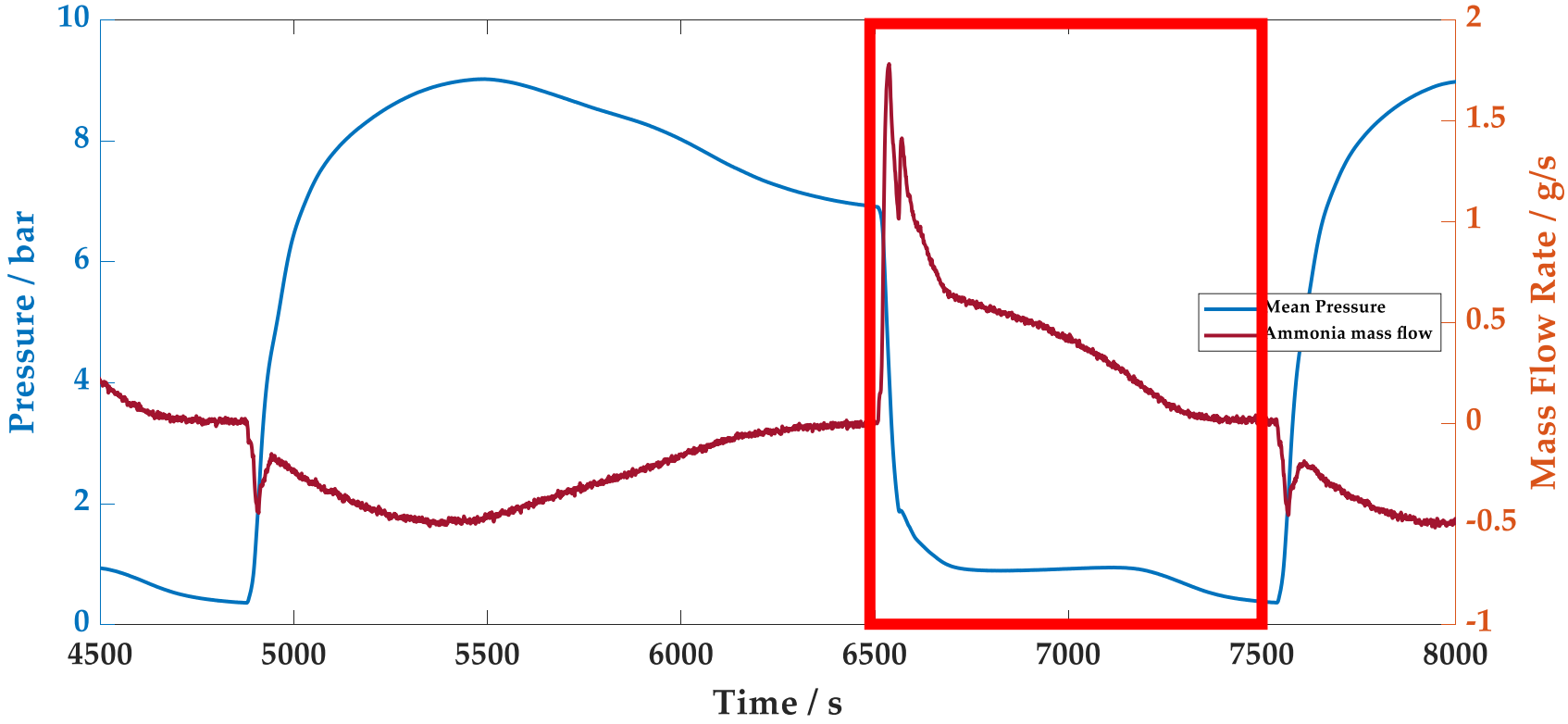
3.3 Construction



4.1 Results: Resorption Tests (HP)

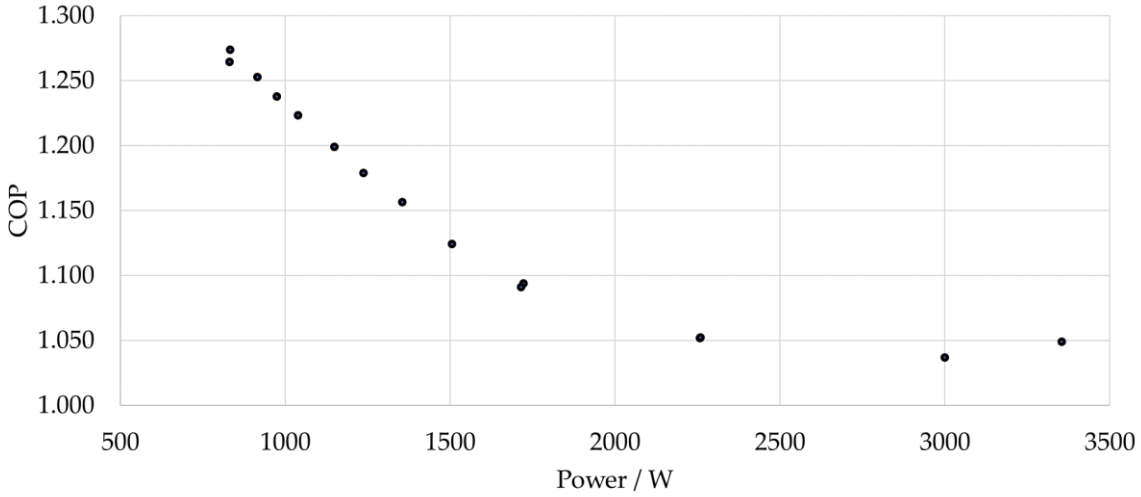


4.2 Results: Resorption Tests (HP)



4.4 Results: Summary

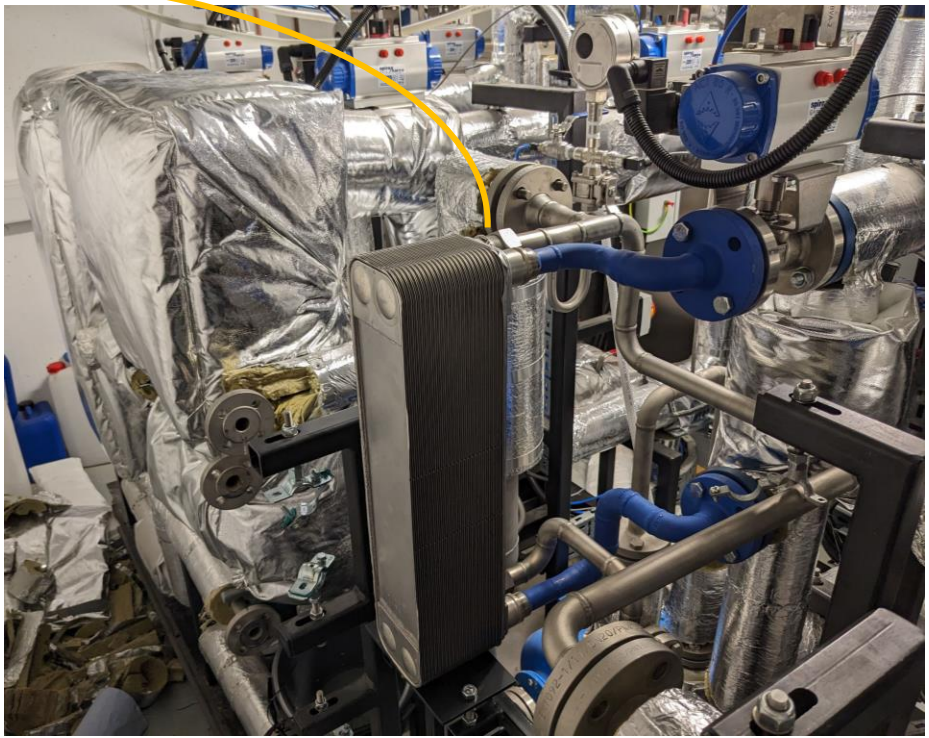
- COP = 1.27, P = 996 W (165°C), COP = 1.26, P = 1036 W (170°C)
- Lower than anticipated power output, but 100+ cycles now conducted with repeatable results
- COP vs. Avg. Power
  - Full to 95% clipped cycles (160/40/15°C)
- Swelling observed but no performance degradation on tests to-date
- But…



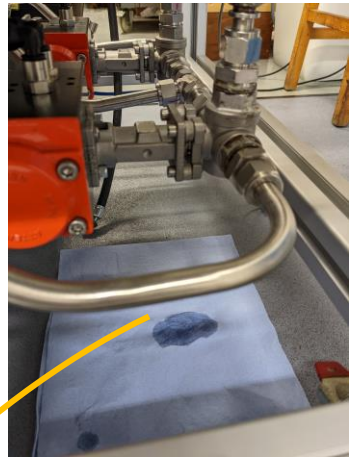
5.1 Operational Issues #1

- High pressure water leaked into the atmospheric silicone oil side

5.2 Solution #1

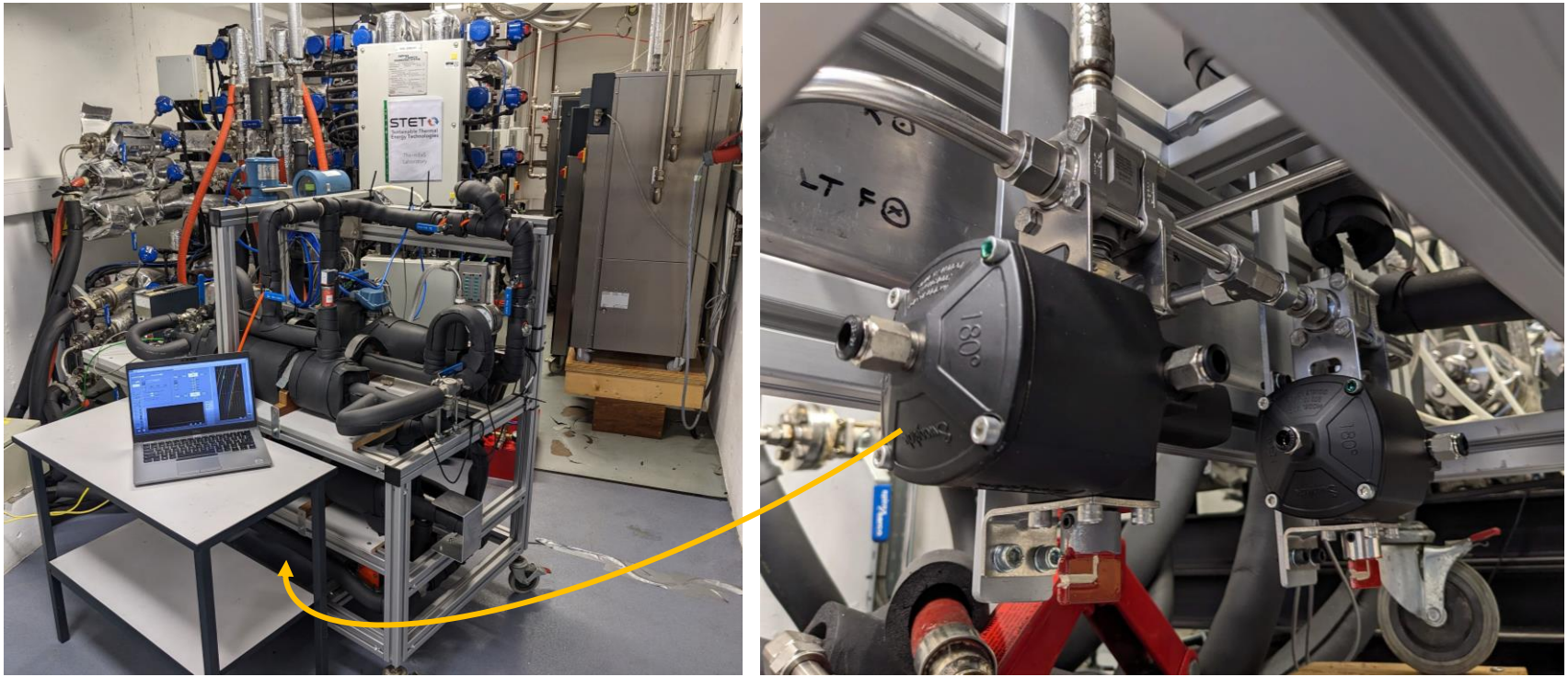


5.3 Operational Issues #2



- Swagelok valve replacement underway
- Reinforced PTFE seats designed to operate at temperatures > 200 °C
- Improved body construction

5.4 Solution #2



6.1 Plan: Resorption HP Testing

✓Finish writing the thesis summarising the findings to date.

- Future work 1. Continue resorption heat pump testing
  - Testing matrix for different temperatures
  - Clipping to shorten cycle times
- Future work 2. Investigate improvements in the tube side composite contact to enhance the heat transfer

T_L	15 / 10 / 5 °C			
$(T_H \setminus T_M)$ / °C	60	50	40	30
170		7	6	
160		2	1	3
150			4	5

6.2 Plan: Resorption HP Testing

- Future work 3. Geometry optimization
- Funding proposal for a four reactor system providing a continuous medium temperature heat output (compared to the pseudo-continuous output in a two reactor system)

T_L	15 / 10 / 5 °C			
(T_H \ T_M) / °C	60	50	40	30
170		7	6	
160		2	1	3
150			4	5

7. Conclusions

- A two-salt resorption test bench has been designed and manufactured.
- The system can be cycled in a repeatable manner and is providing useful insight into the nature of coupled ammonia-salt reactions.
- Initial results are promising having completed over 100 cycles with heat pump operation.
- Ongoing repairs to the heat exchanger and valve manifold before testing can start again.

THANK YOU FOR LISTENING

QUESTIONS?

George, Steve, Bob and Stan

Engineering and Physical Sciences Research Council

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