Chemisorption

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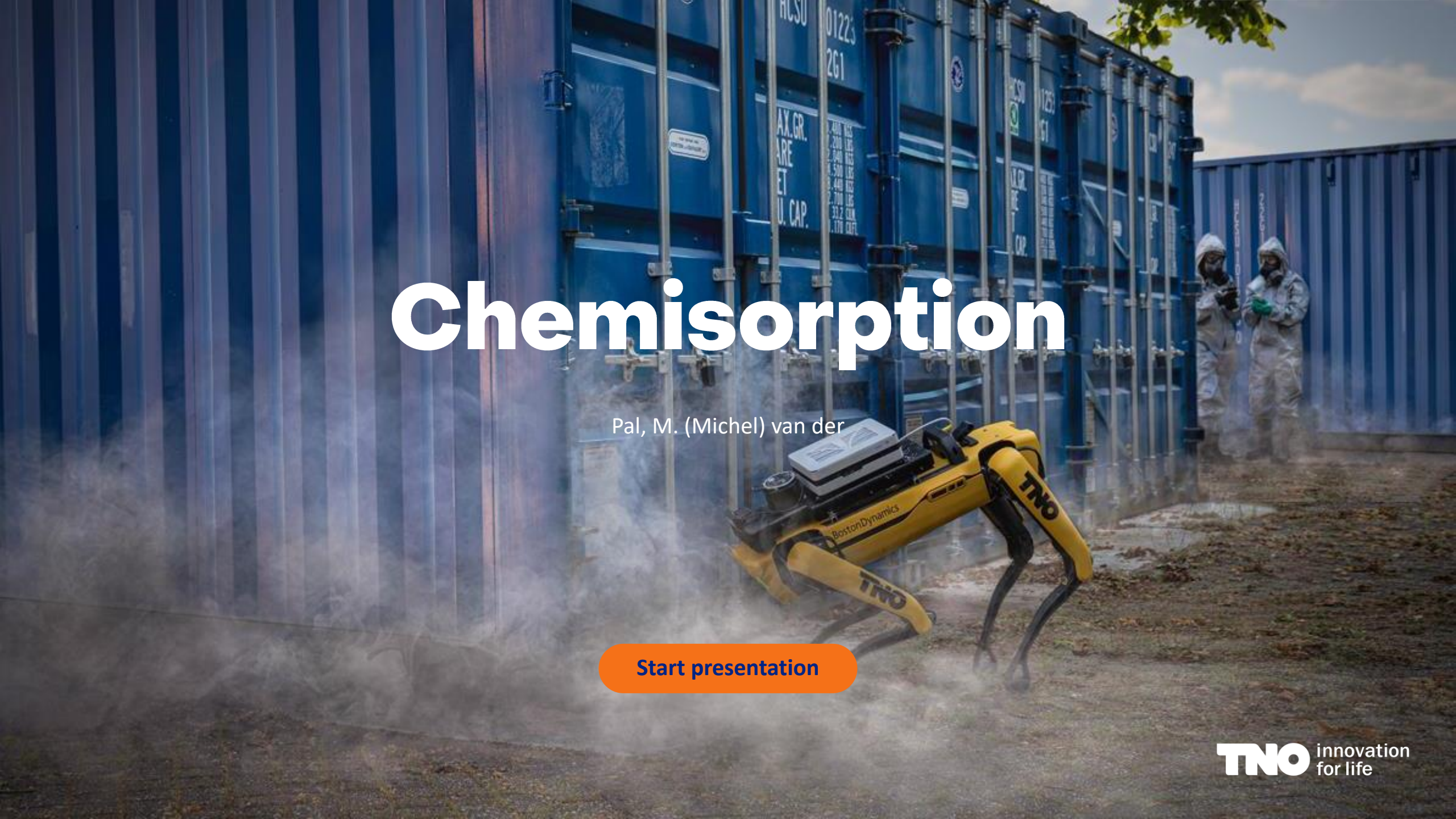
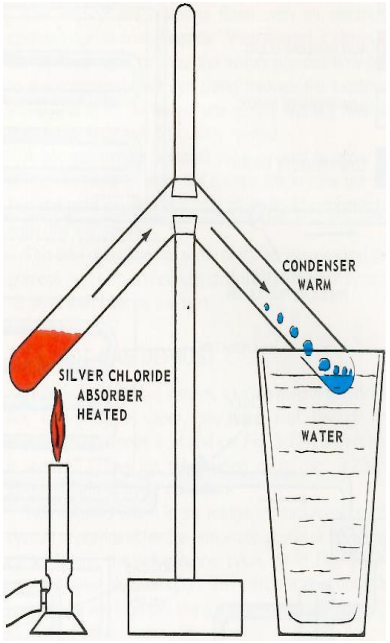


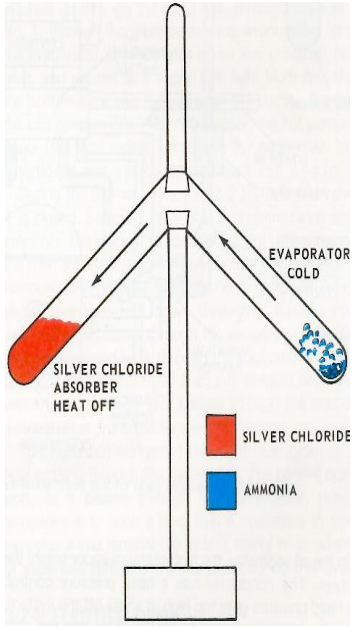
Start presentation

TNO innovation for life

In the beginning…

It started with Faraday in 1821…





sion to notice some years since with chloride of silver.* When dry chloride of silver is put into ammoniacal gas, as dry as it can be made, it absorbs a large quantity of it; 100 grains condensing above 130 cubical inches of the gas: but the compound thus formed is decomposed by a temperature of 100° F. or upwards. A portion of this compound was sealed up in a bent tube and heated in one leg, whilst the other was cooled by ice or water. The compound thus heated under pressure fused at a comparatively low temperature, and boiled up, giving off ammoniacal gas, which condensed at the opposite end into a liquid.

Liquid ammonia thus obtained was colourless, transparent, and very fluid. Its refractive power surpassed that of any other of the fluids described, and that also of water itself. From the way in which it was obtained, it was evidently as free from water as ammonia in any state could be. When the chloride of silver is allowed to cool, the ammonia immediately returns to it, combining with it, and producing the original compound. During this action a curious combination of effects takes place: as the chloride absorbs the ammonia, heat is produced, the temperature rising up nearly to 100°; whilst a few inches off, at the opposite end of the tube, considerable cold is produced by the evaporation of the fluid. When the whole is retained at the temperature of 60°, the ammonia boils till it is dissipated and re-combined. The pressure of the vapour of ammonia is equal to about 6.5 atmospheres at 50°. Its specific gravity was 0.76.

* Quarterly Journal of Science, vol. V. p. 74.

Contents

1) What is needed to make a functioning thermochemical heat pump?
2) A bucket full of problems
3) How to make sure we all benefit from the ideas/challenges

What is needed for a functioning TC heat pump?

Technical:

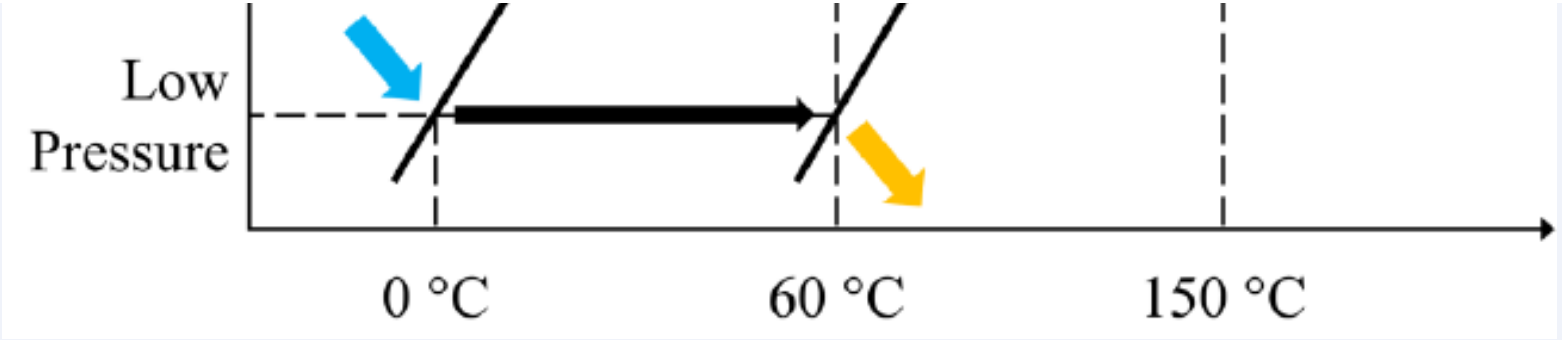
1) Accurate adsorption and desorption lines within application area
2) Sufficiently high power input/output, i.e. sufficient kinetics and heat&mass transfer rates
3) Low thermal mass (and/or high sensible heat recovery)

Economical:

1) Mass producible components
2) Cheap materials
3) Sufficiently compact/high power density

The ideal thermochemical heat pump cycle…

- Fewer heat exchangers
- No refrigerant control valves
- Easy ???!!!???

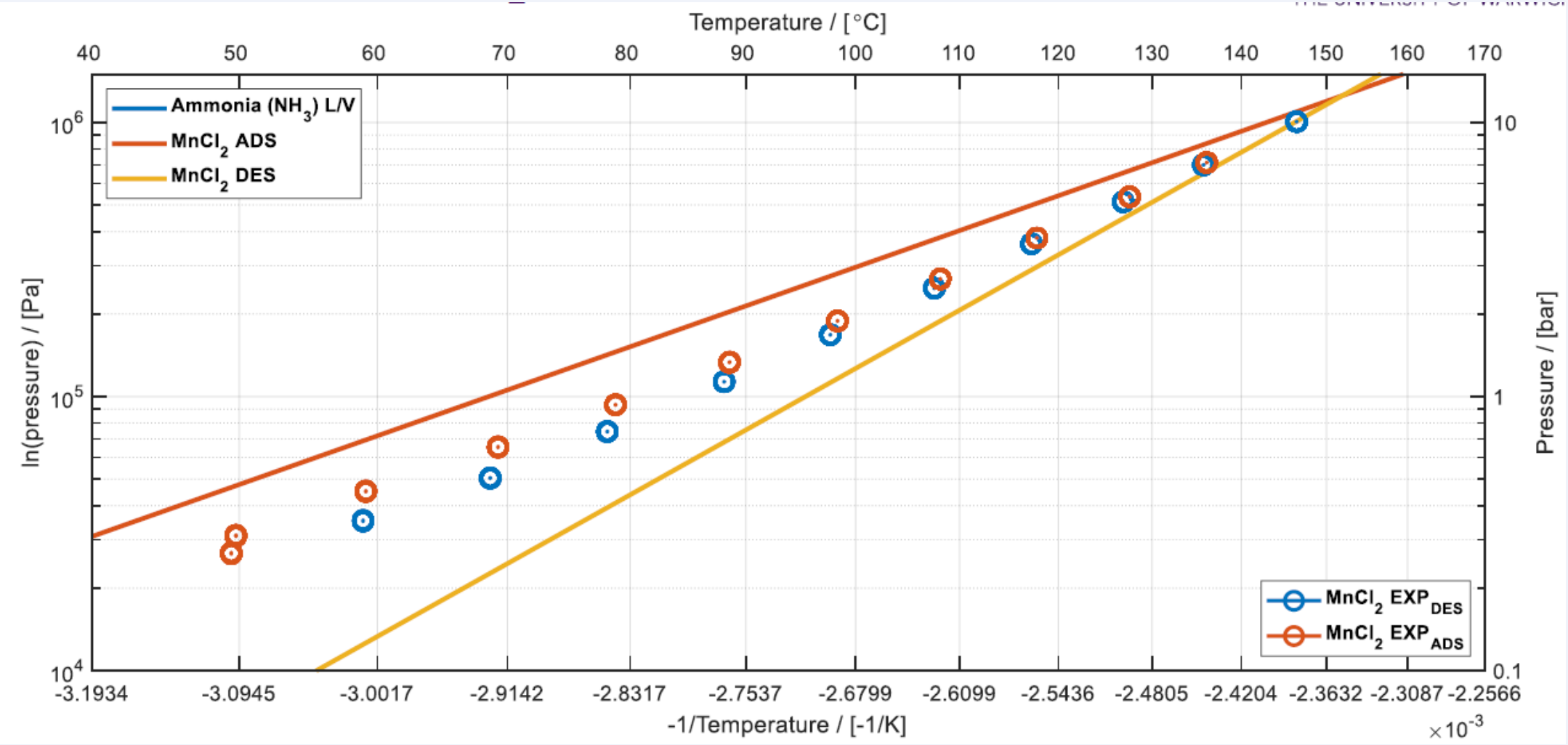


A bucket full of problems: part 1

Literature data incomplete, unreliable or simply wrong

A bucket full of problems: part 2

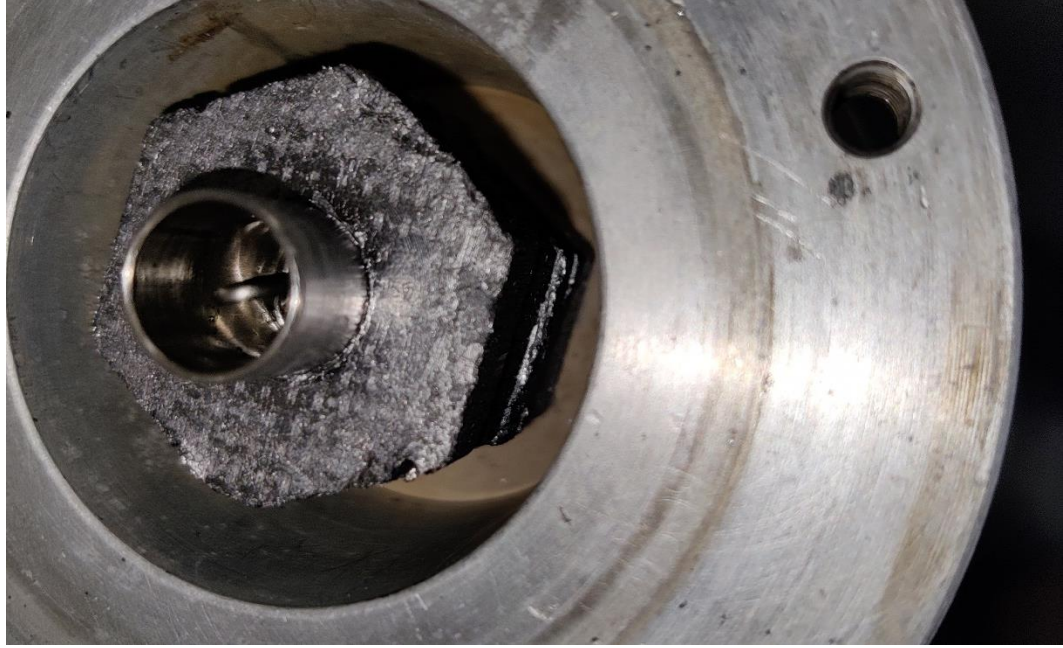
Hysteresis: truth or fiction?

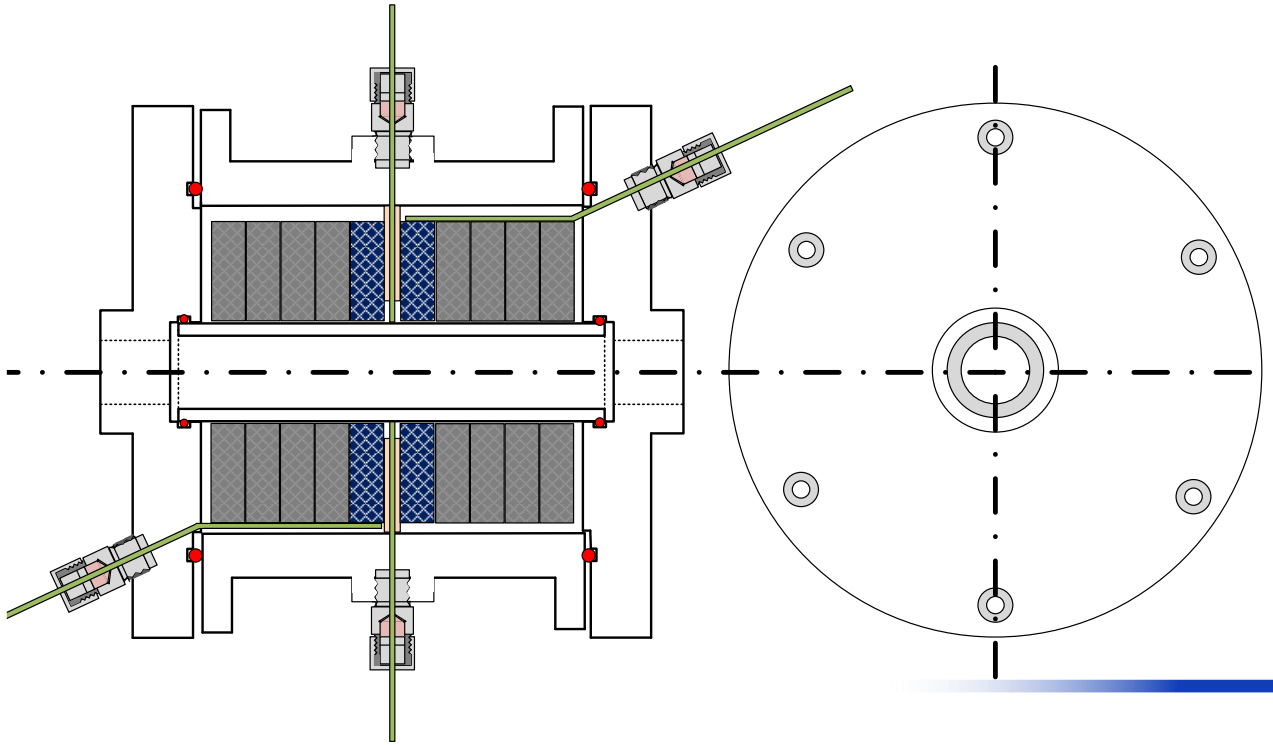


A bucket full of problems: part 3

Reaction kinetics: heat transfer limitations in disguise?

Shell Side LTJ





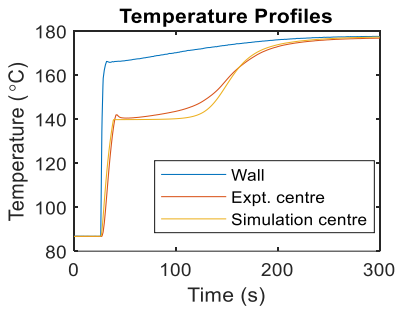
30-35mm disks/ hexagons

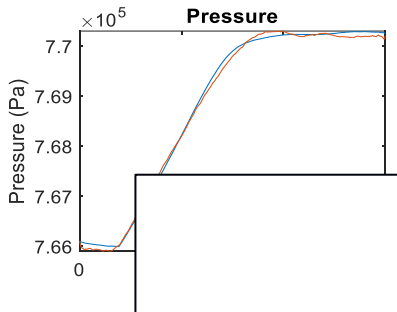
Similar to working machine

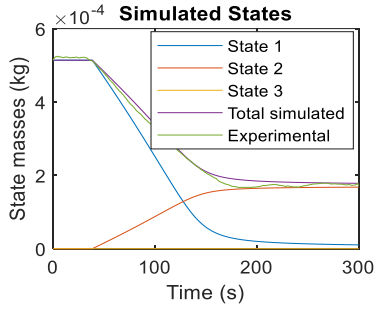
More scope for modelling and evidence

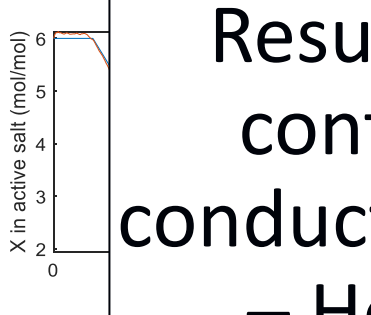
Simulating Results from LTJ

$$\frac{dx}{dt} = (1-x)^y A \frac{P_{eq} - P}{P}$$



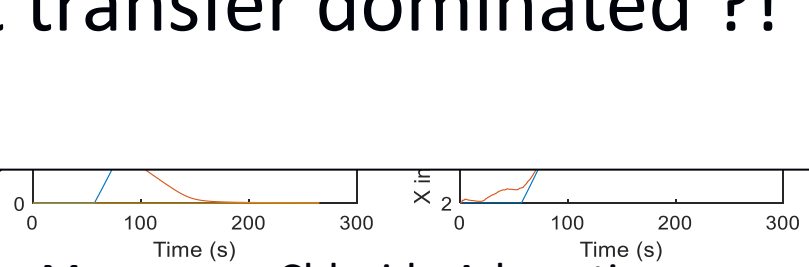




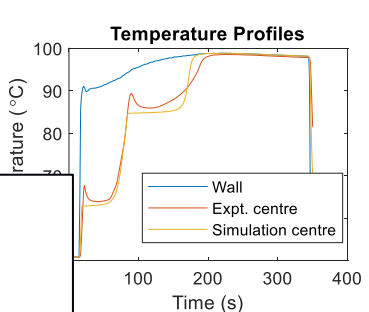


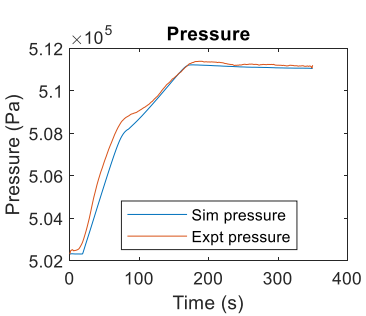
Manganese Chloride D

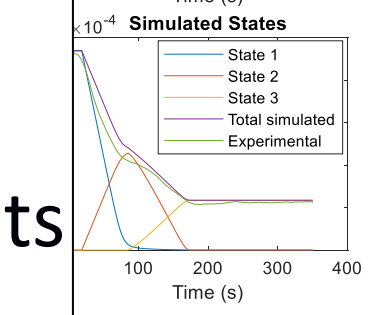
Results much more sensitive to contact resistance and matrix conductivity than reaction constants – Heat transfer dominated ?!

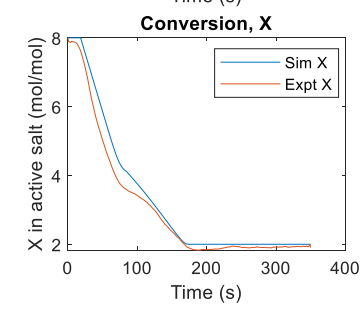


Manganese Chloride Adsorption









alcium Chloride Desorption 2
eactions

- *A* and *y* identified
- IJR paper: Modelling and analysis of ammonia sorption reactions in halide and other salts for heat pump and thermal transformation cycles. Parts 1 & 2

The way forward…

1. Literature data incomplete, unreliable or simply wrong: how to assure quality, which aspects should be reported that are missing now?

2. Hysteresis: truth or fiction?: how to deal with hysteresis – especially given you can find some many different numbers/lines, or is it not as important as we make it to be?

3. Reaction kinetics: heat transfer limitations in disguise?: separating reaction kinetics and heat (and mass) transfer limitations is highly desirable because the solutions to each problem are completely different. What would be the preferred method to do so? Also, any ideas on how to further improve thermal resistance between sorbent(matrix) and heat-transfer fluid?

4. All the other issues I have missed, please add your strange experiences with chemisorption here!