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LESSON - Oil free compressor based high temperature heat pumps

Experimental validation of wet compressor model. Design of CRHP.

Project number	UH-30-07
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Partners	Atlas Copco, DOW, Frames, IBK, ISPT, TU Delft
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Incentive

Wet compression resorption heat pumps are promising but require two-phase compressors. Wet compression results in approximately isothermal conditions during compression and prevents extremely high discharge temperatures in high temperature heat pumps. Design of CRHP is needed to more accurately estimate its costs.

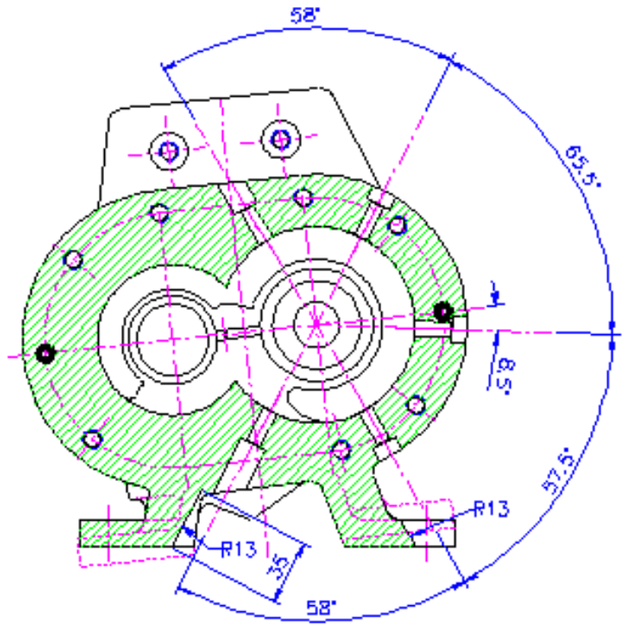
Objective

Extend the experimental program with the prototype developed in project UH-20-10 to identify the reasons for the deviation between compressor model predictions and experimental values and to use these results as the basis for the validation and improvement of the wet compression model developed in UH-20-10.

Design a CRHP and estimate its costs and performance.

Approach

Modify the experimental compressor set-up to solve the issues identified during project UH-20-10.



Implement these modifications at TU Delft set-up and perform experiments to derive experimental data.

Use validated model to come to a compressor design with higher isentropic efficiency. Design heat pump (on paper) which makes use of this compressor and predict its technical (COP) and economic performance (payback time).

Results

The system has been operated with an ammonia concentration of 30% in an ammonia water solution. Compressor inlet conditions around 60 °C (this corresponds to a heat source of about 65 °C) and vapour inlet qualities in the range 50 to 90 %.

The experimental data show clearly that larger amounts of liquid at the suction port (lower vapour quality) guarantees the sealing of the leakage paths and allow for higher pressure ratios.

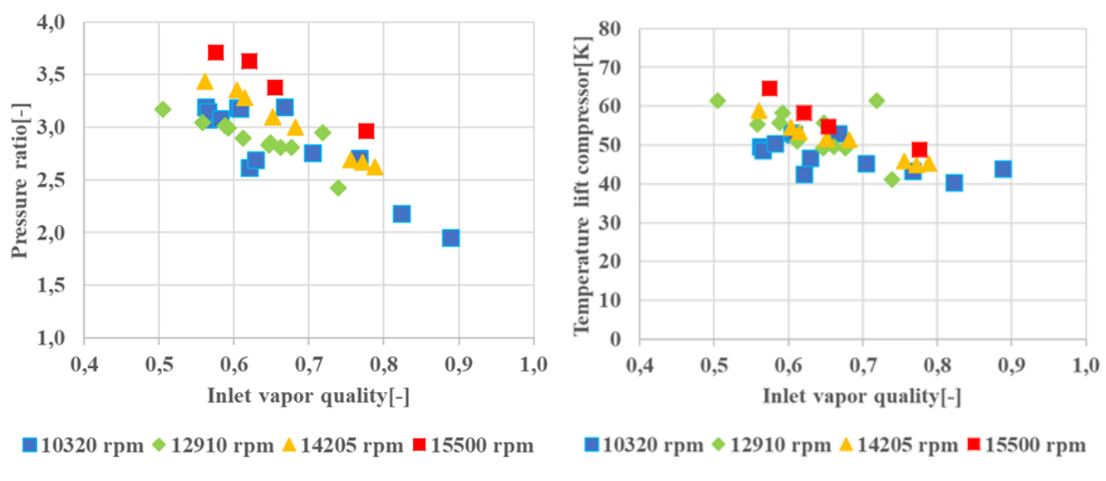


Figure: Left: Pressure ratio as function of compressor inlet quality; Right: temperature lift across the compressor. In both figures the rotational speed has been varied.

The figure on the right hand side shows how the vapour inlet quality affects the temperature rise as the working fluid passes the compressor. Discharge temperatures are up to 125 °C so that heat could be delivered to an application at 120 °C.

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