High-efficiency high-temperature heat pumps with temperature glide

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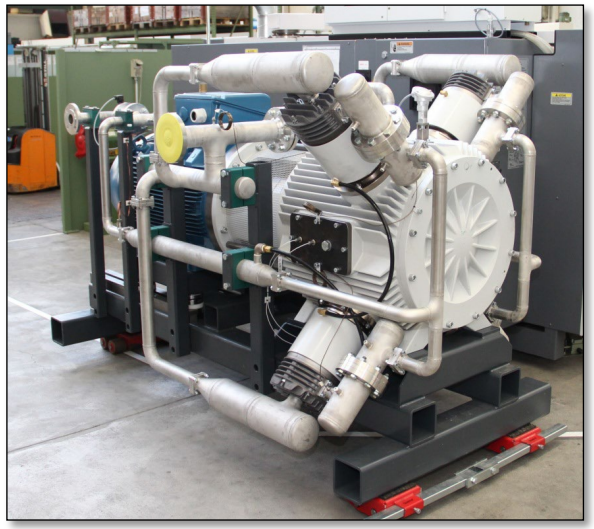
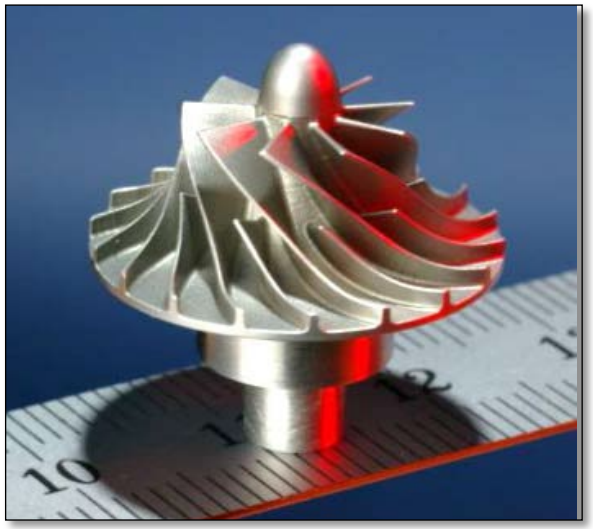
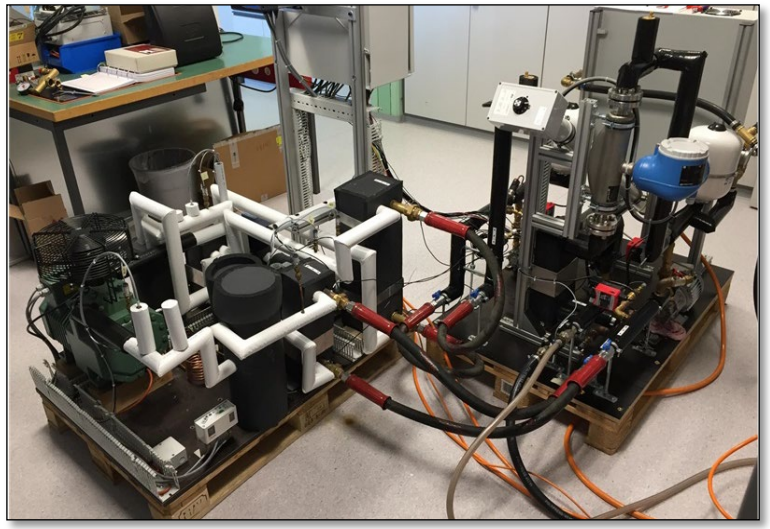
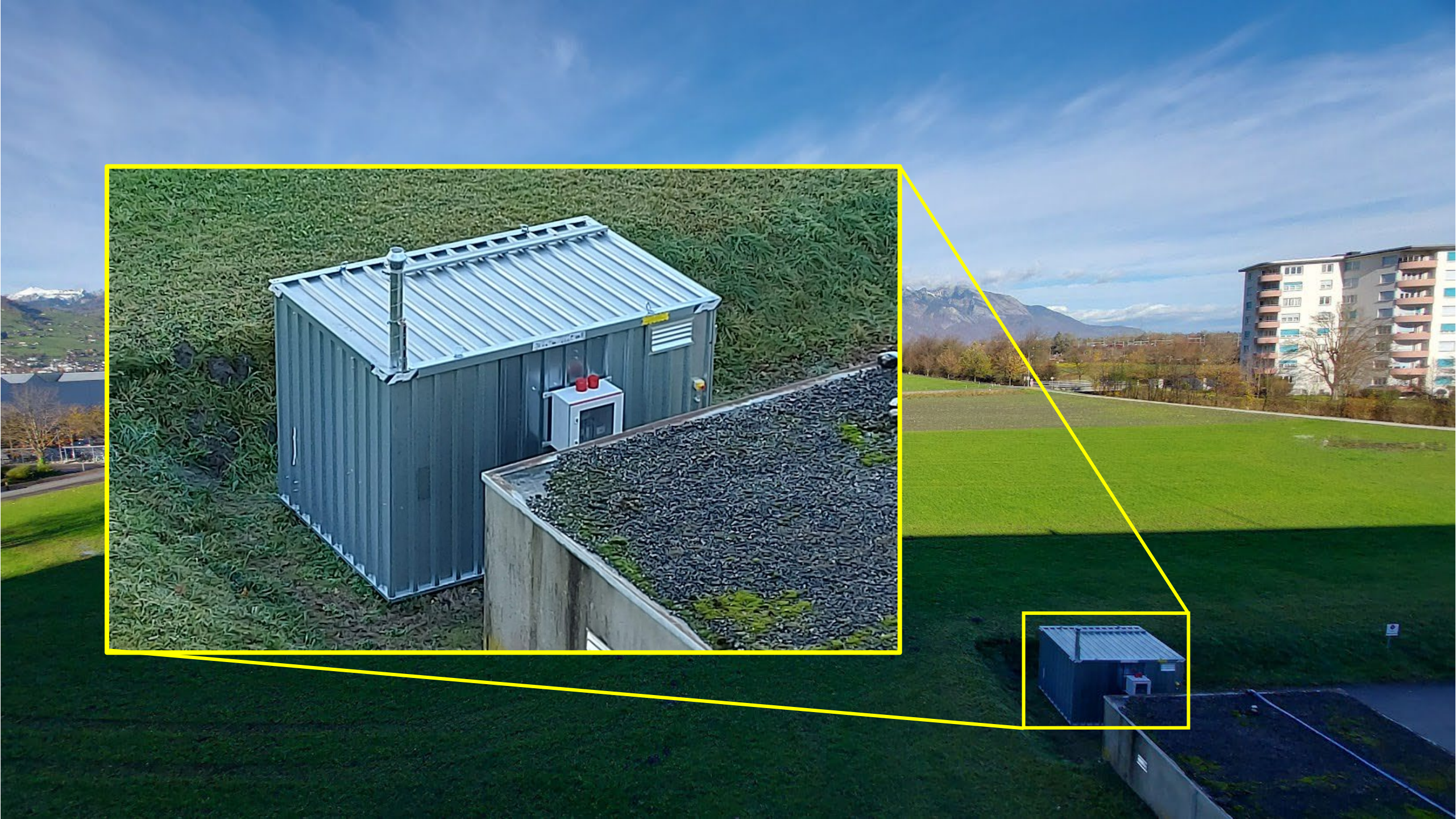
Sweet PATHFNDR and DeCarbCH Lunchtalk, 06 February 2024

Experimental part









High-glide mixtures!

We started out with lots of doubts…

COP improvement

Composition shift

Composition determination

Thermophysical properties of mixures

Charging of mixtures

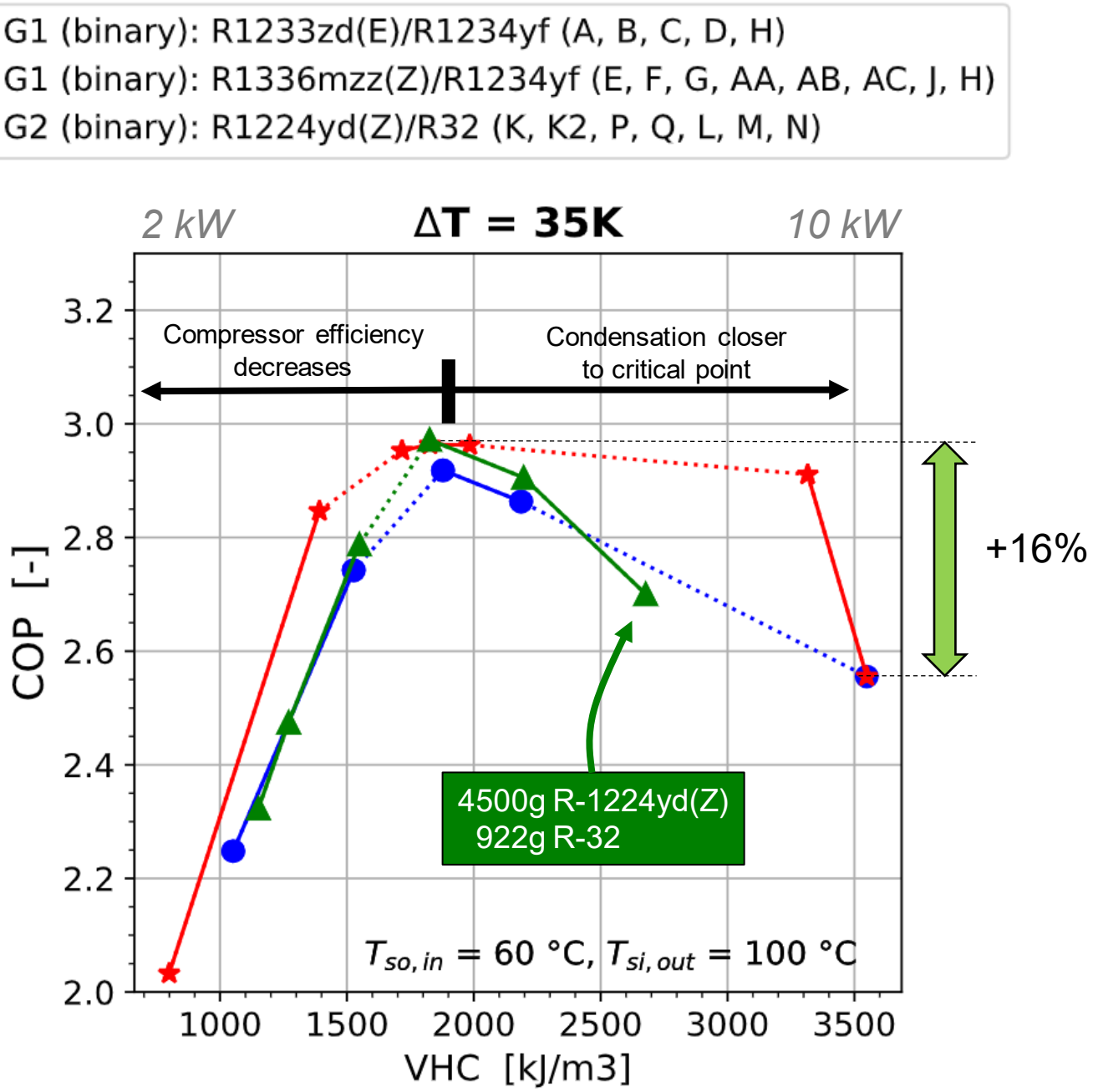
Solubility of mixture in oil

Degraded heat transfer coefficient

Compressor durability at high temperatures

COP improvements

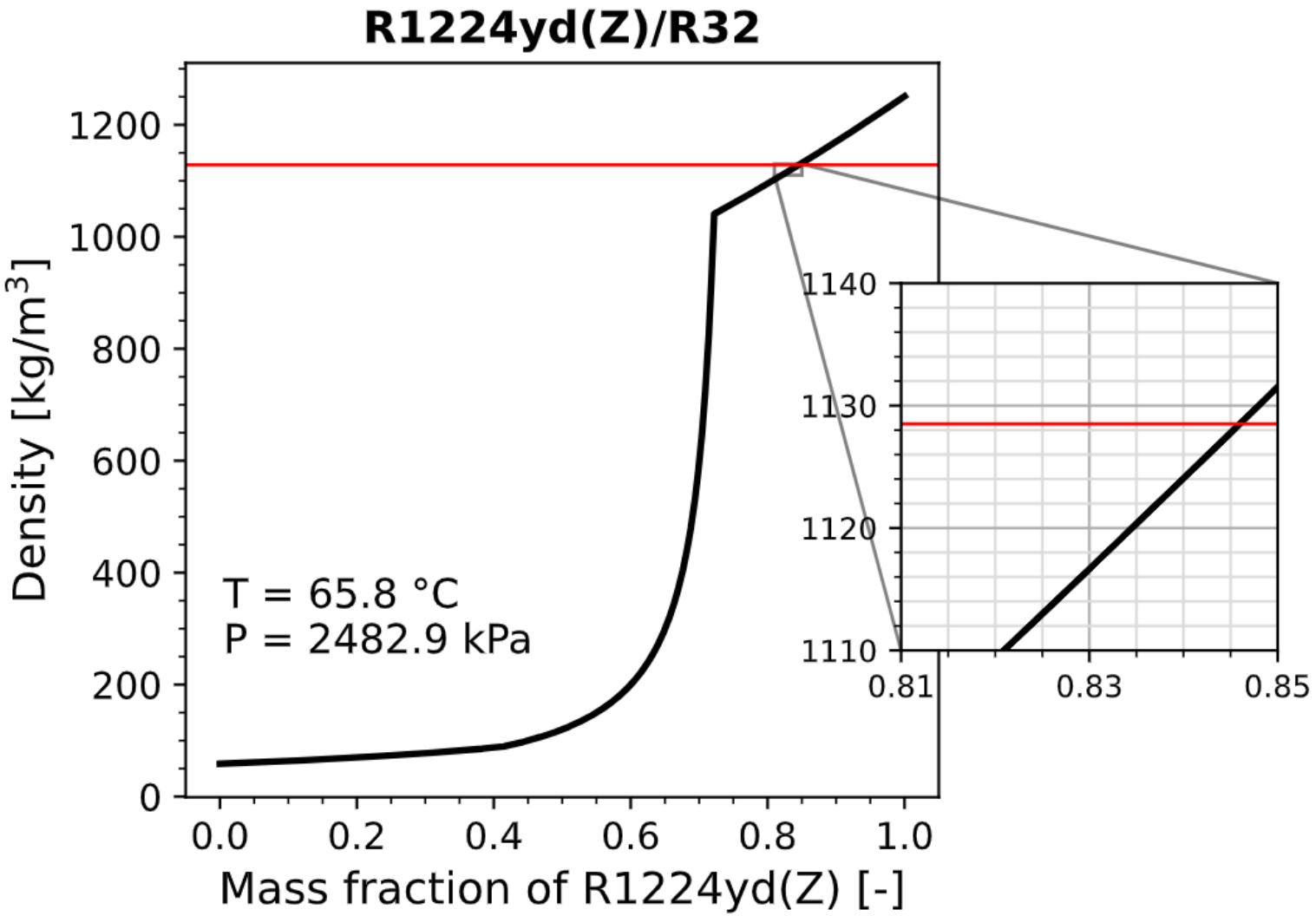
- 16% COP improvement using mixture over pure fluids
- Optimum occurs for different fluids at same volumetric heating capacity
- Shape of dome and compressor efficiency dictate COP trade-offs



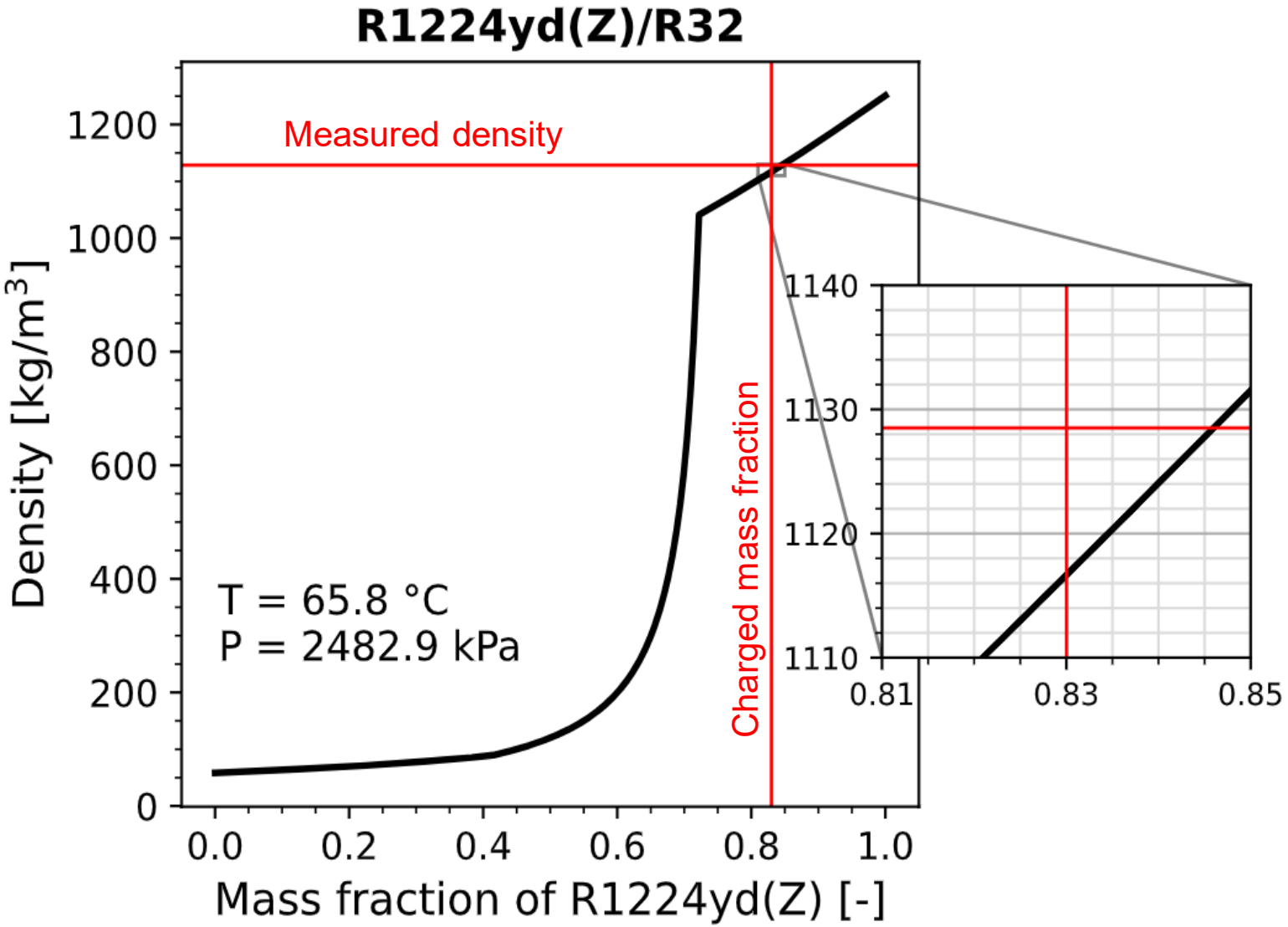
Operating conditions:

$$T_{so,in} = 60\ °C, T_{si,out} = 100\ °C$$
$$\Delta T_{so} = 35\ K, \Delta T_{si} = 35\ K$$
$$f_{comp} = 50\ Hz$$

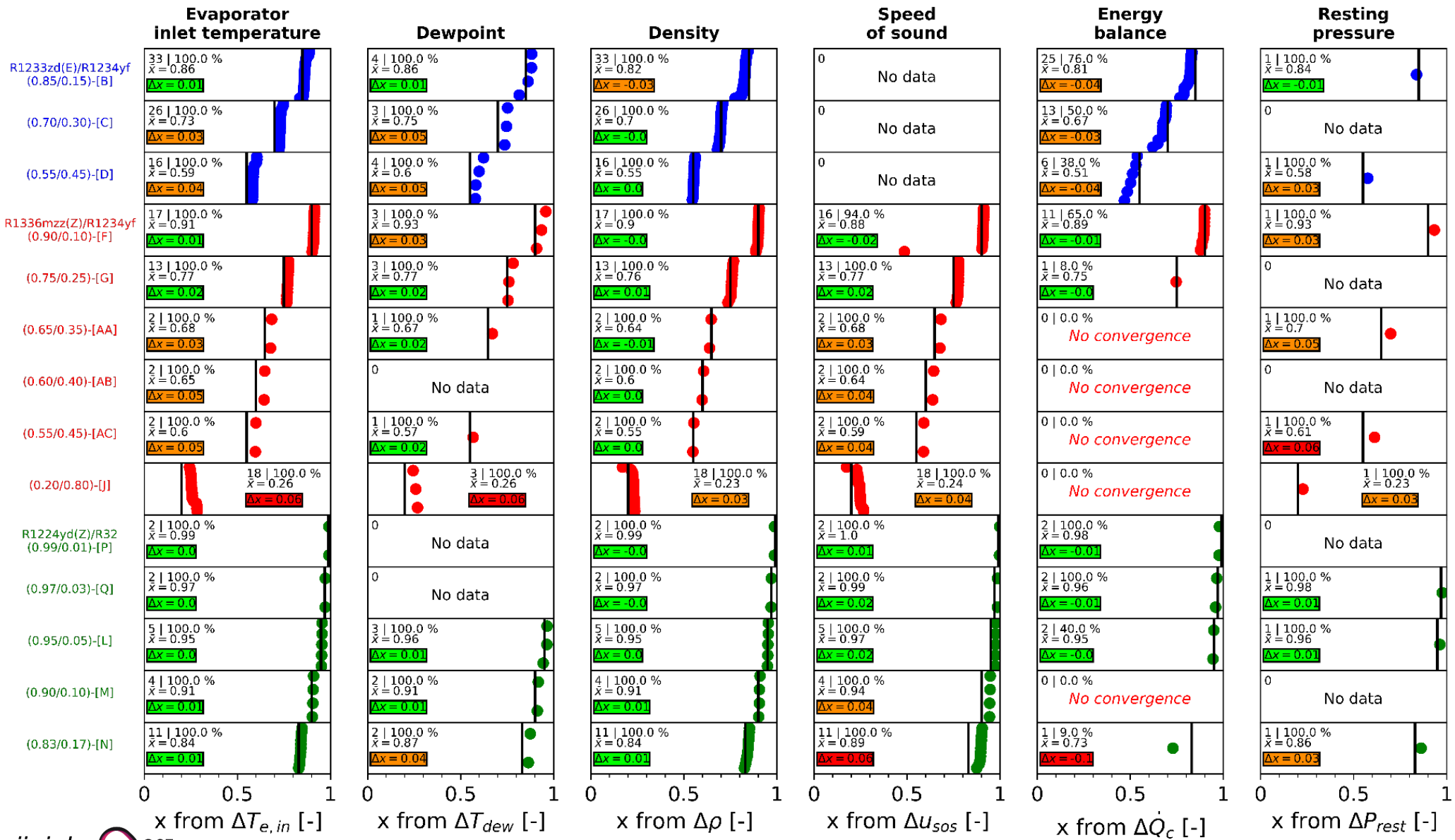
Composition determination



Composition determination



Composition determination



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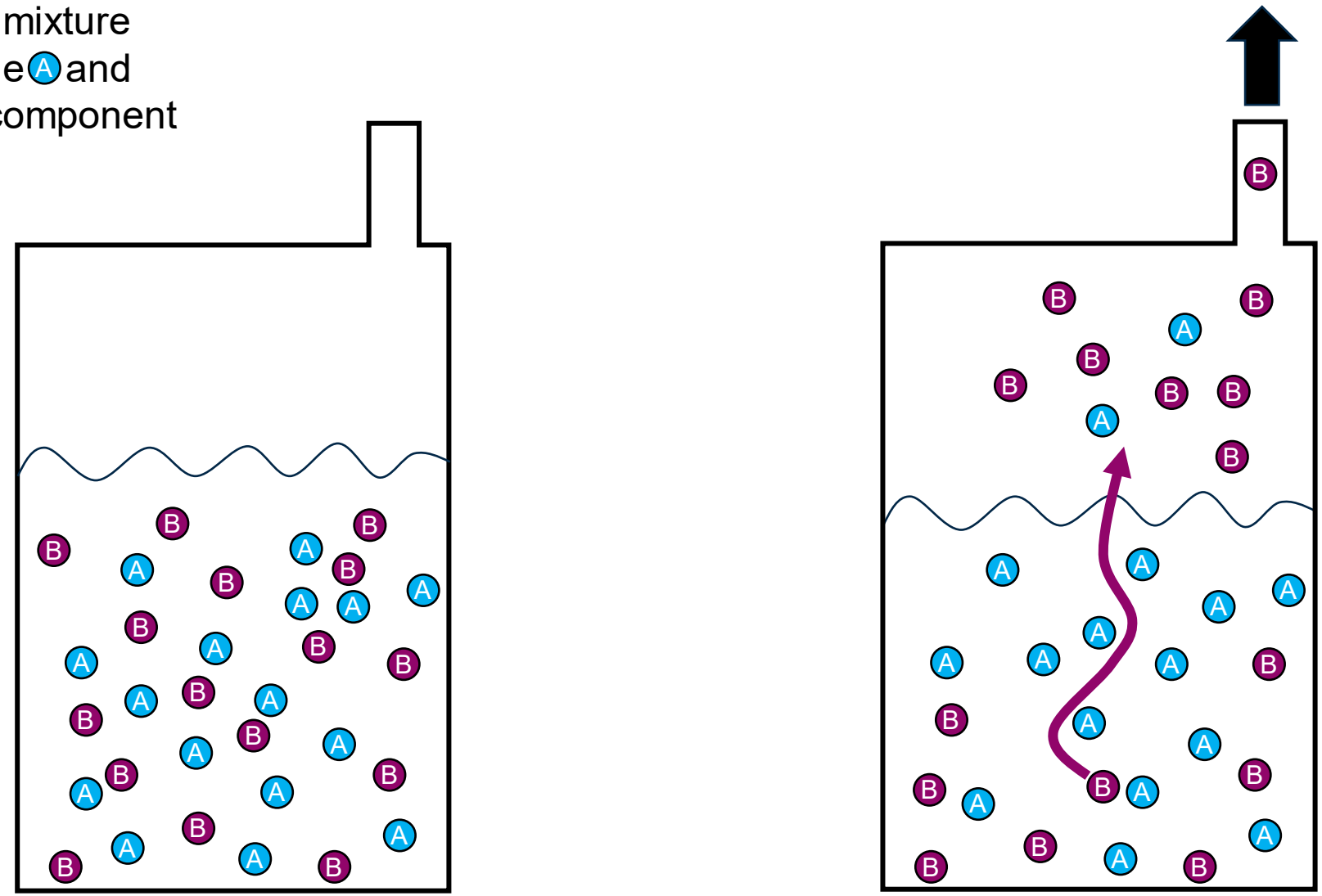
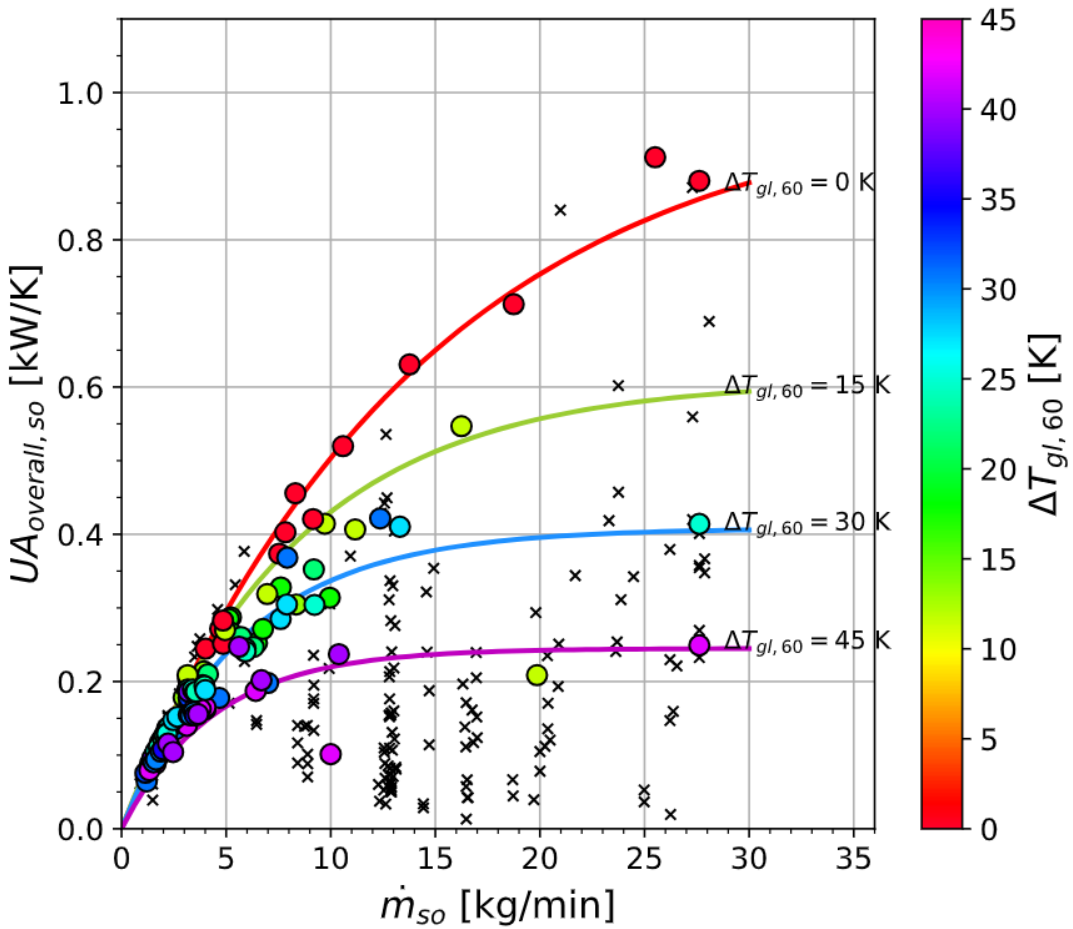
Heat transfer degradation

Evaporation of a mixture with a less volatile (A) and more volatile (B) component

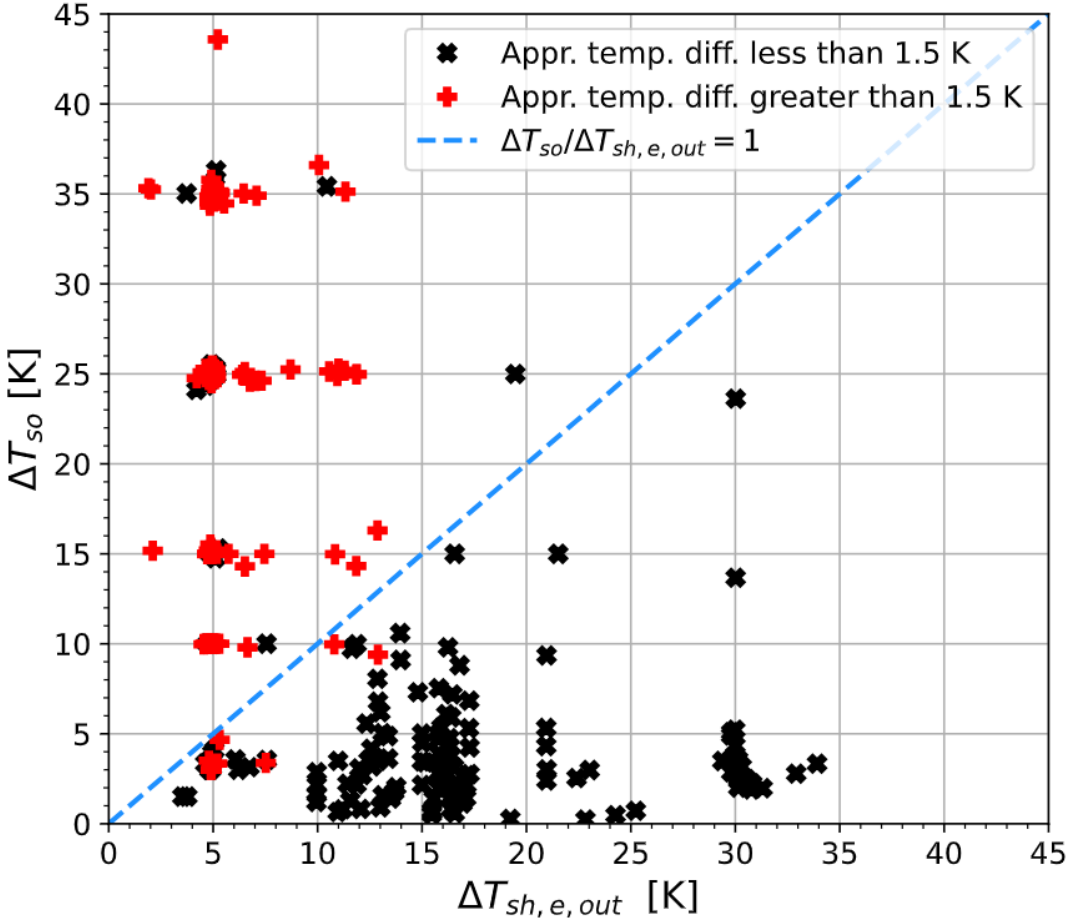


Heat transfer degradation

Fit for data with $\Delta T_{so}/\Delta T_{sh,e,out} > 1$



Separation of data



For remaining data, an approach temperature difference of 1 K is assigned.

Conclusions

1. COP improvements of 16% using high-glide mixtures
2. Composition determination successful with several different methods
3. Heat transfer correlation capturing effect of glide
4. Compressor examination after 1000 hours of operation with little wear and tear

Thank You!