UNIVERSITY OF CAMBRIDGE

Low temperature sensible PTES with Kalina cycles

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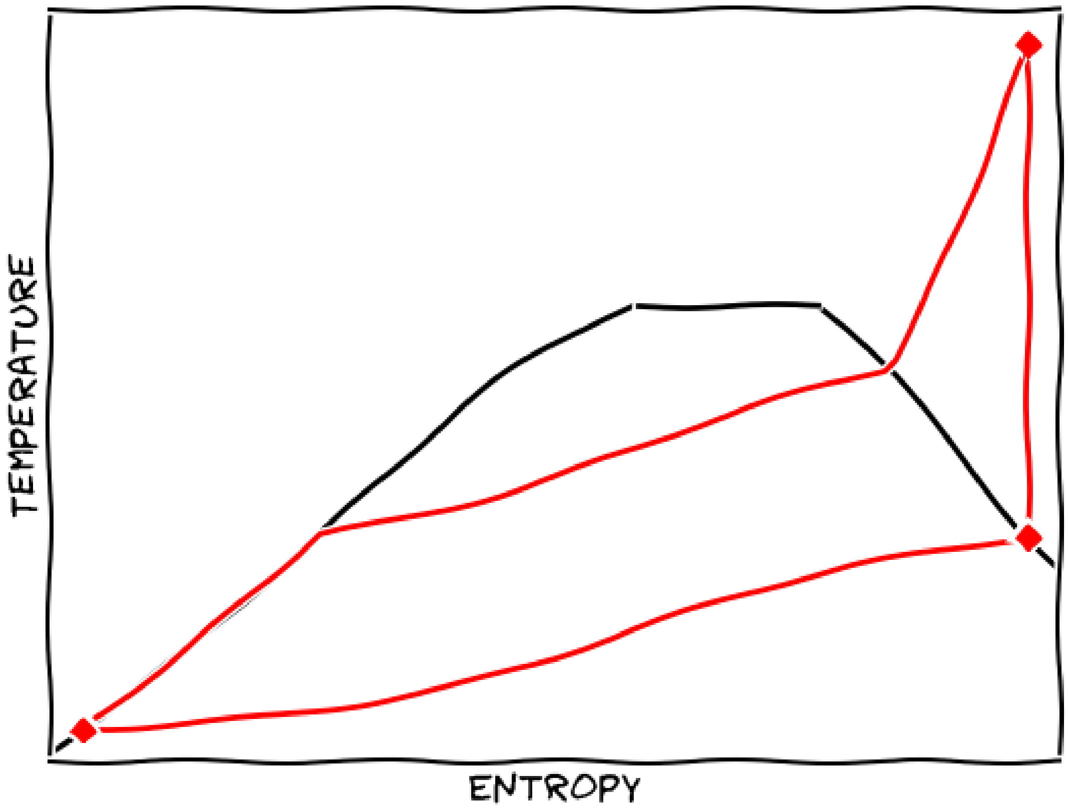
Outline

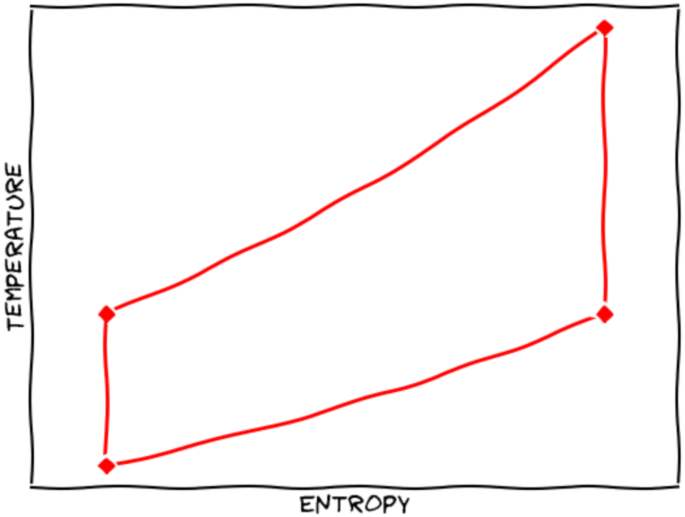
- Kalina and other cycles
- "c_p" problem and mixture optimization
- Setup and performance
- Conclusions

Kalina cycle

Working fluid = mixture

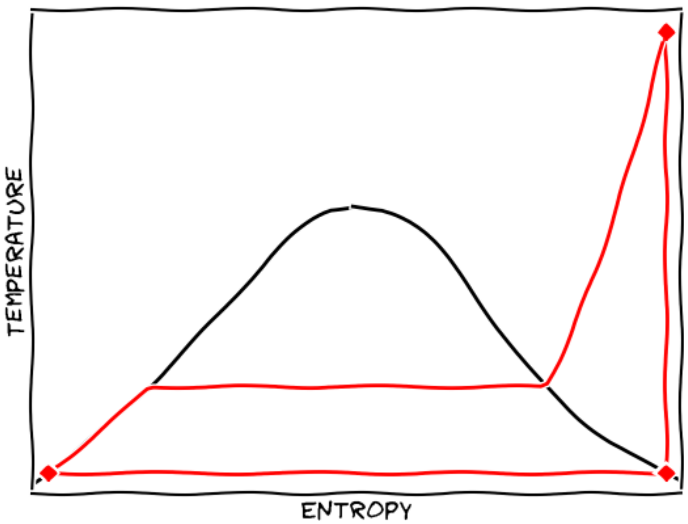


Different Carnot battery cycles



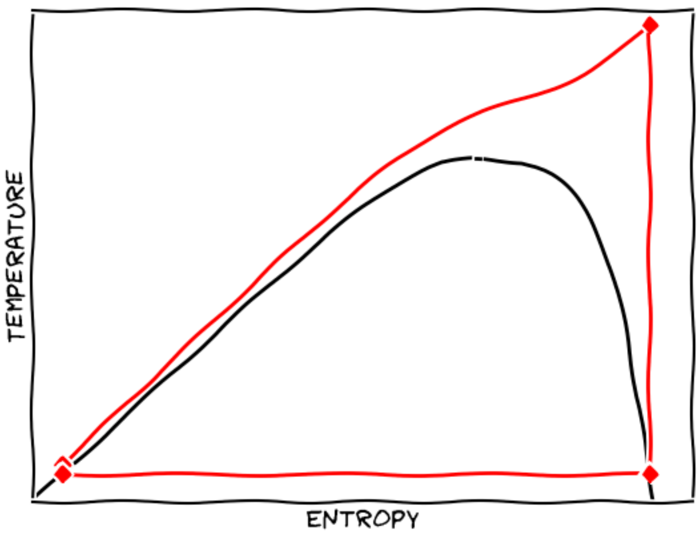
Cycle	Work ratio	Heat transfer
Brayton	Low	Sensible
Rankine		
Transcritical		
Kalina		

Different Carnot battery cycles



Cycle	Work ratio	Heat transfer
Brayton	Low	Sensible
Rankine	High	Latent (mostly) Pinch point problems
Transcritical		
Kalina		

Different Carnot battery cycles



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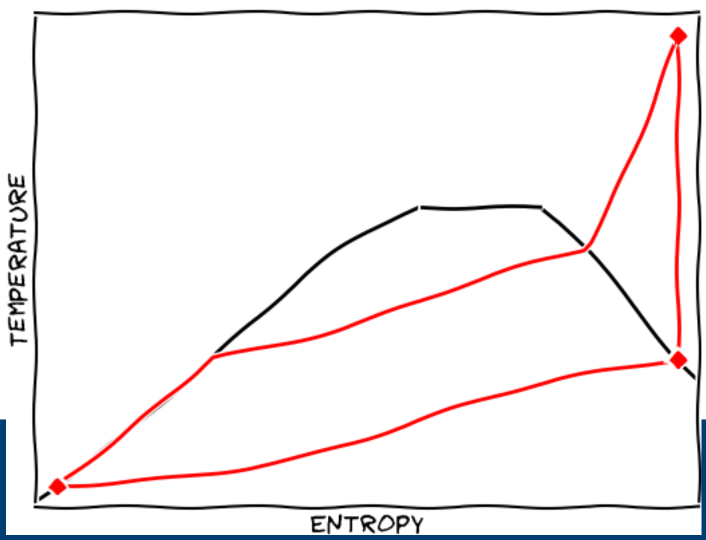
Kalina		

Different Carnot battery cycles



Cycle	Work ratio	Heat transfer
Brayton	Low	Sensible
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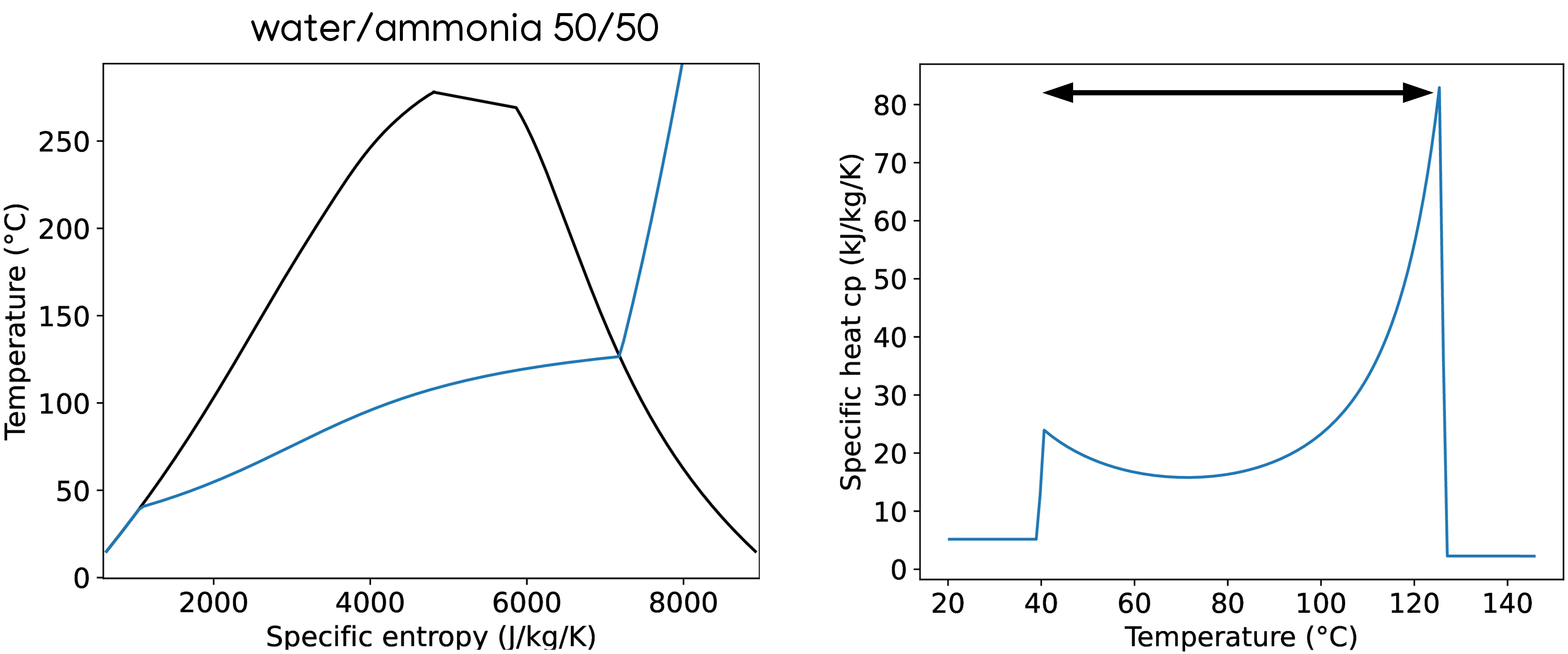
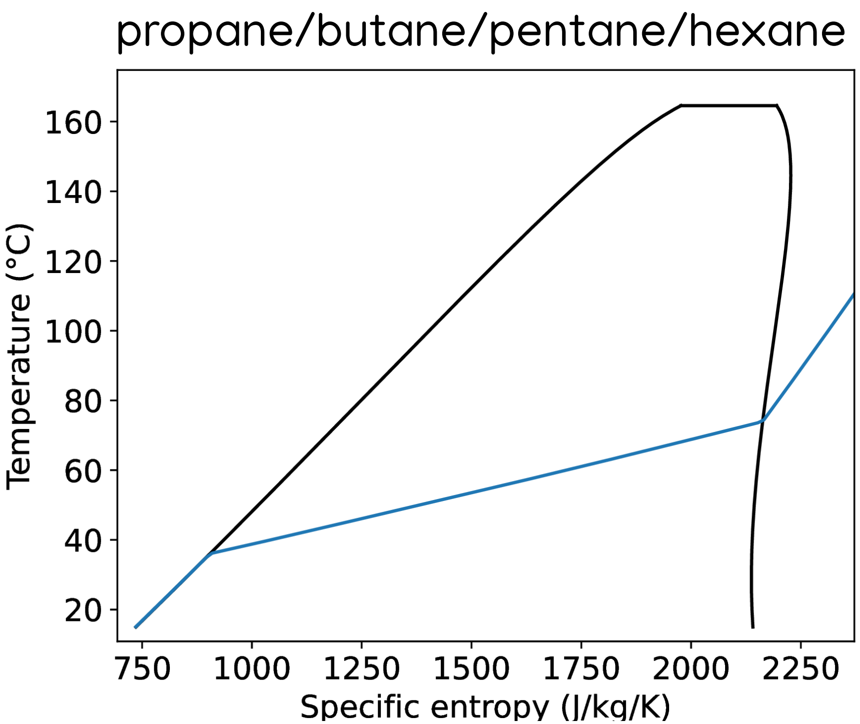
Kalina	High	Sensible

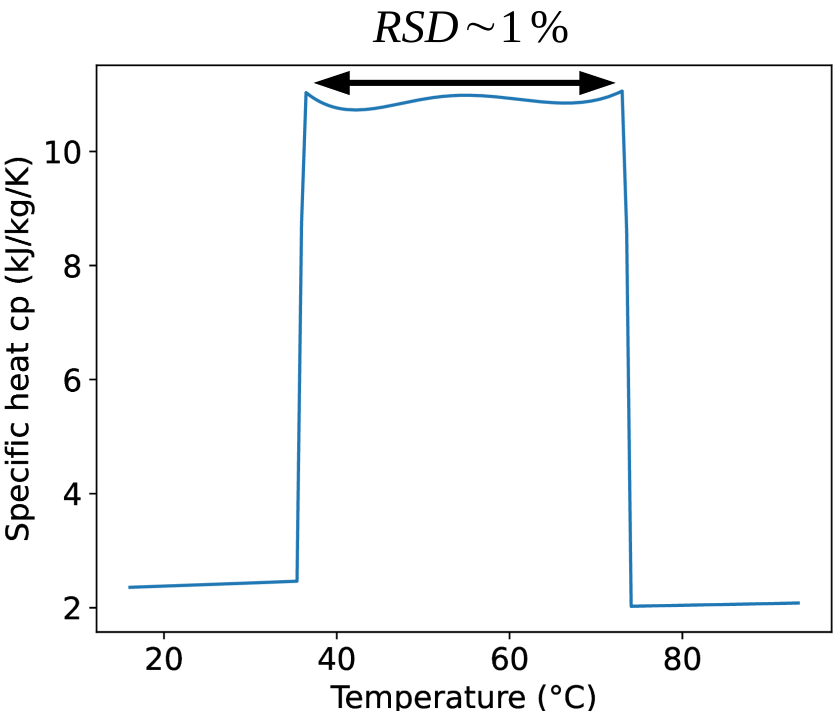
Effective heat capacity variation



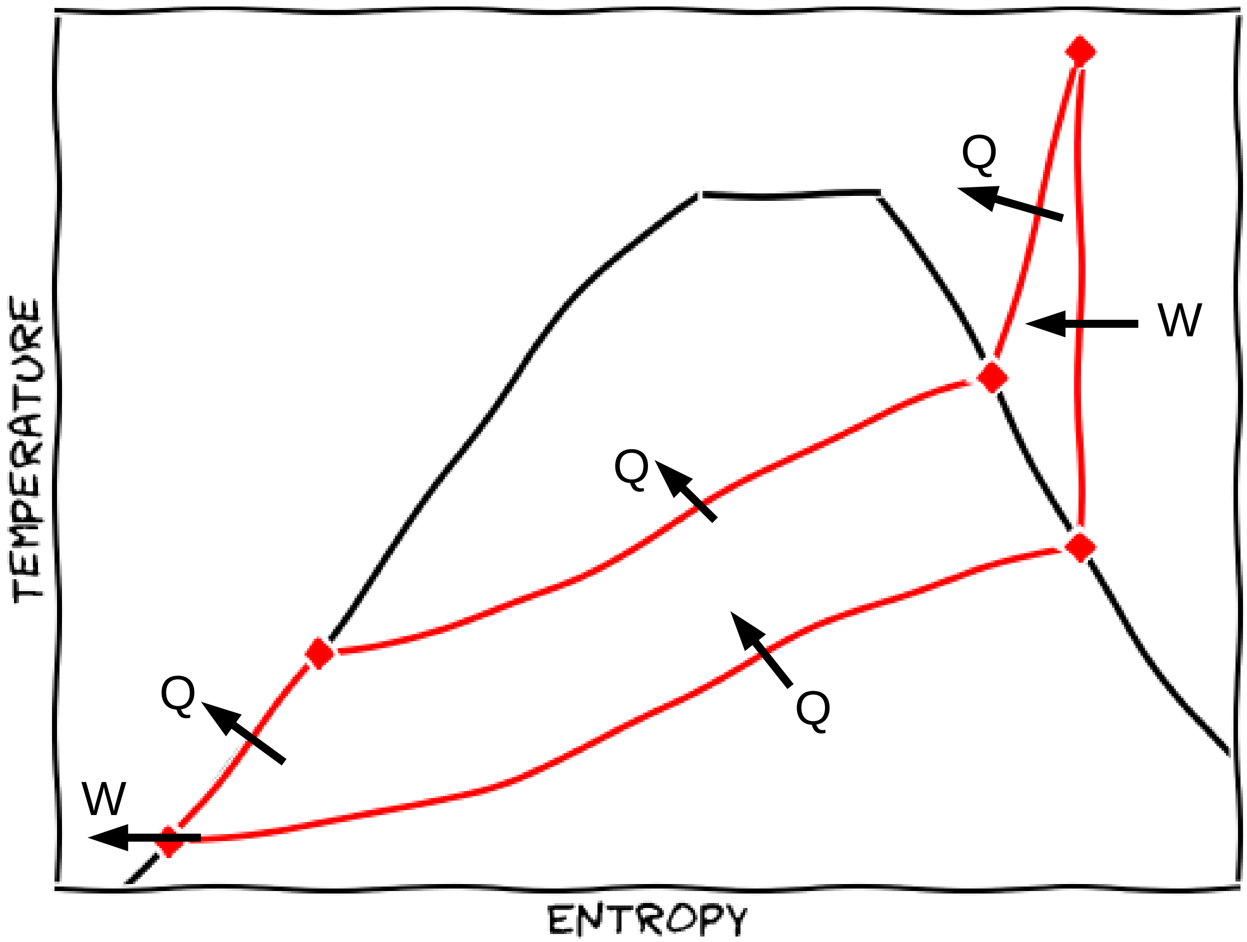
Mixture optimisation

Minimise relative standard deviation over isobars

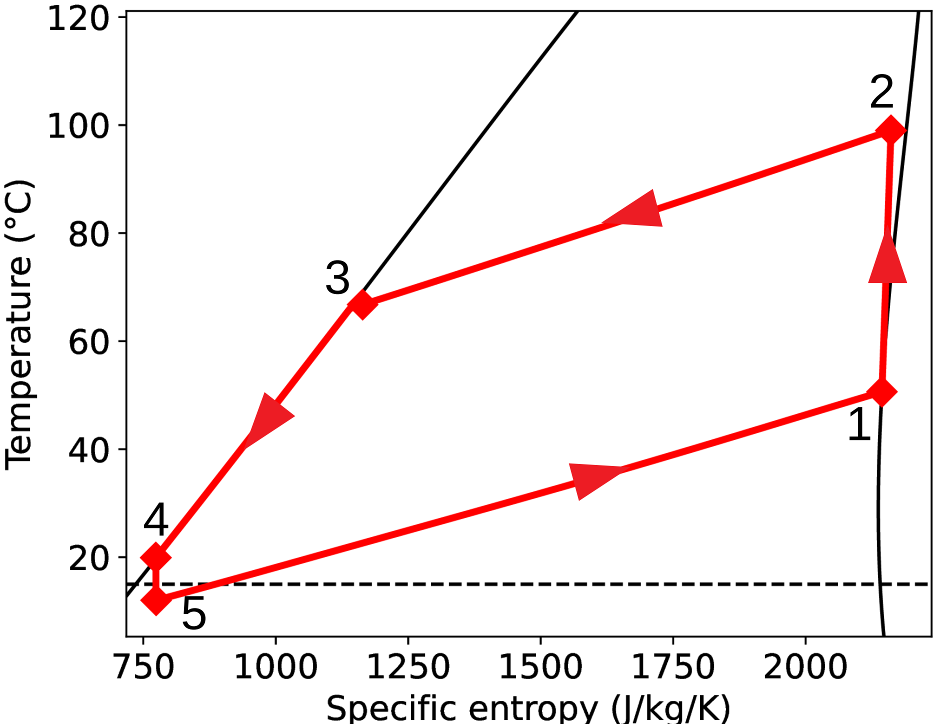


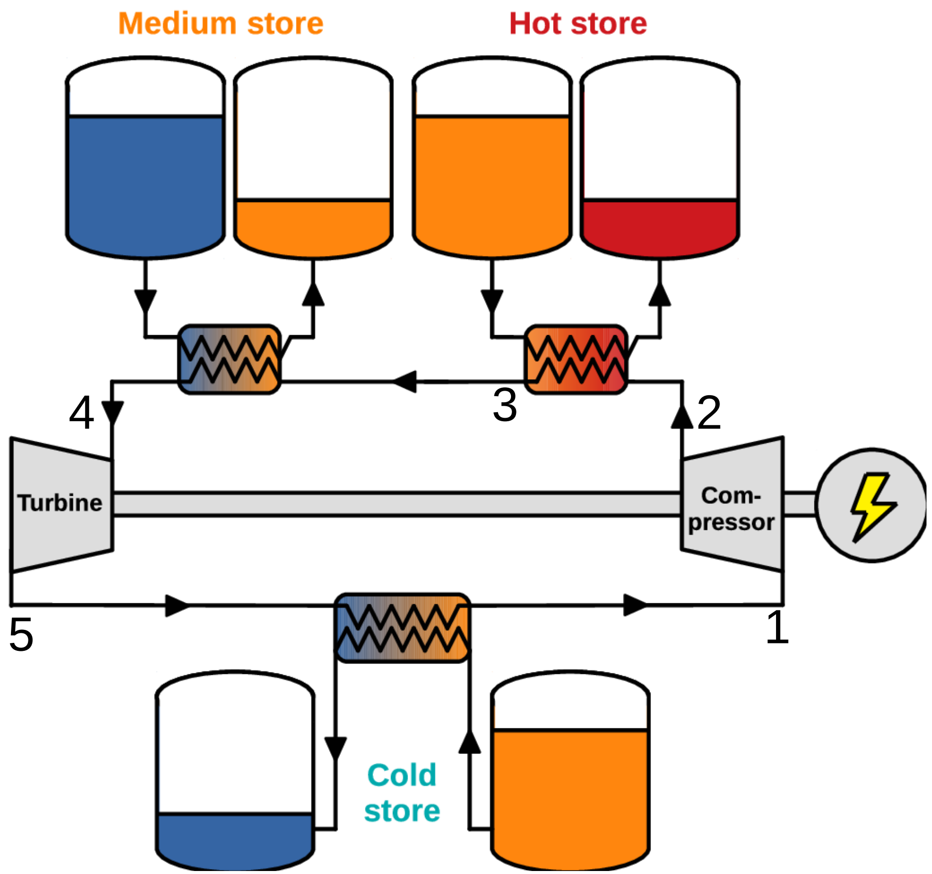


Setup



Multi-tank configuration





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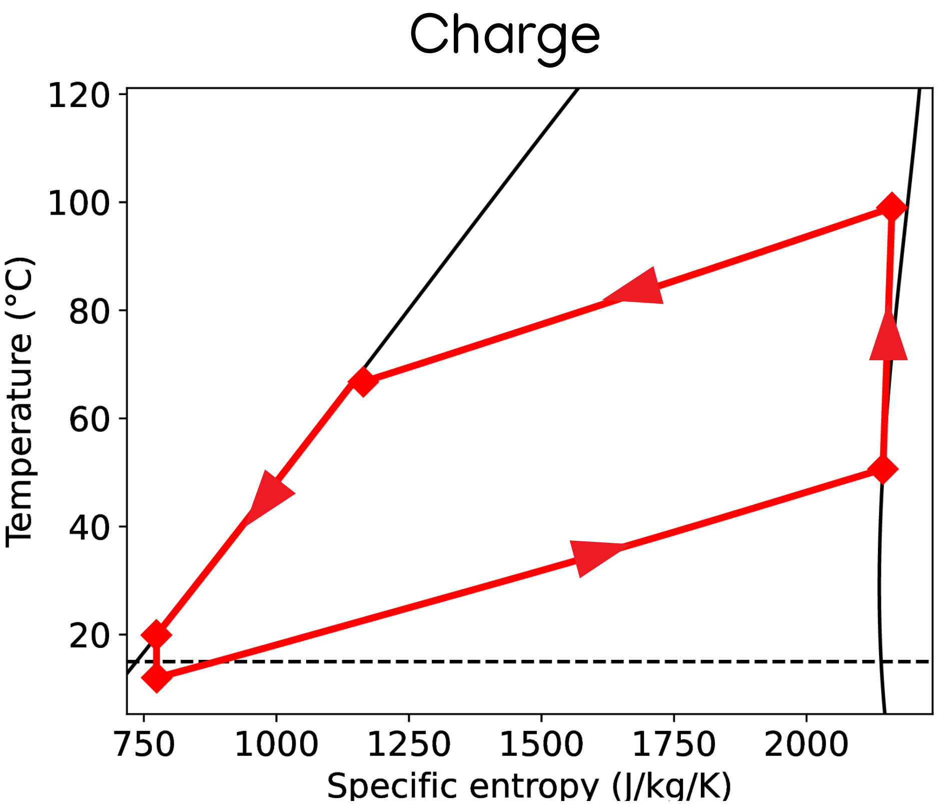
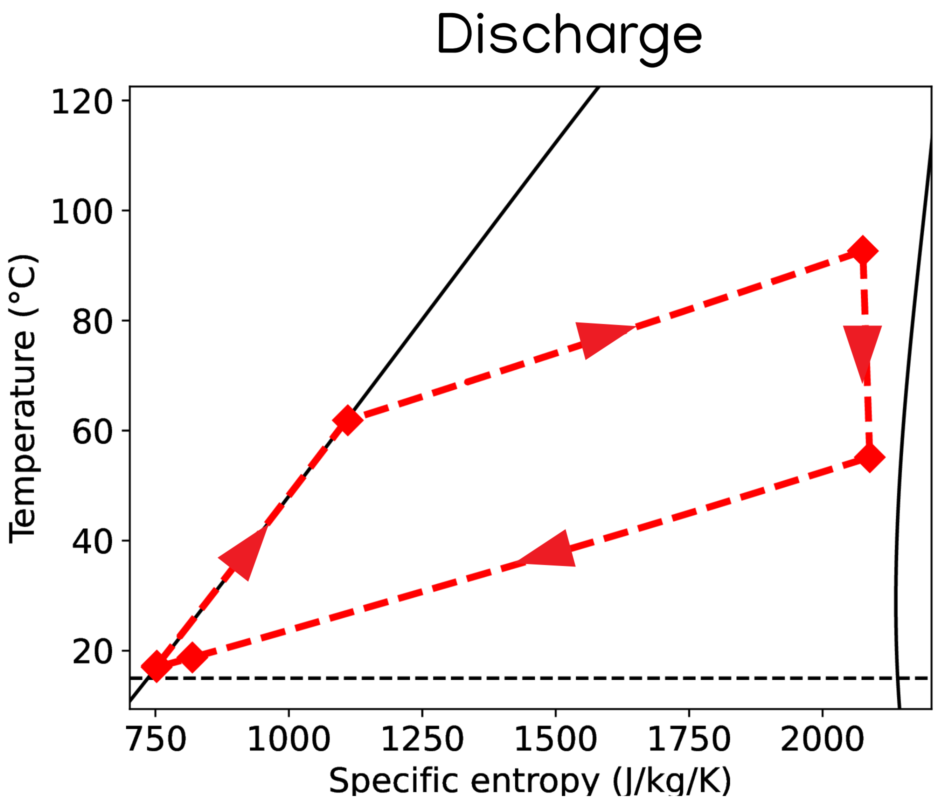
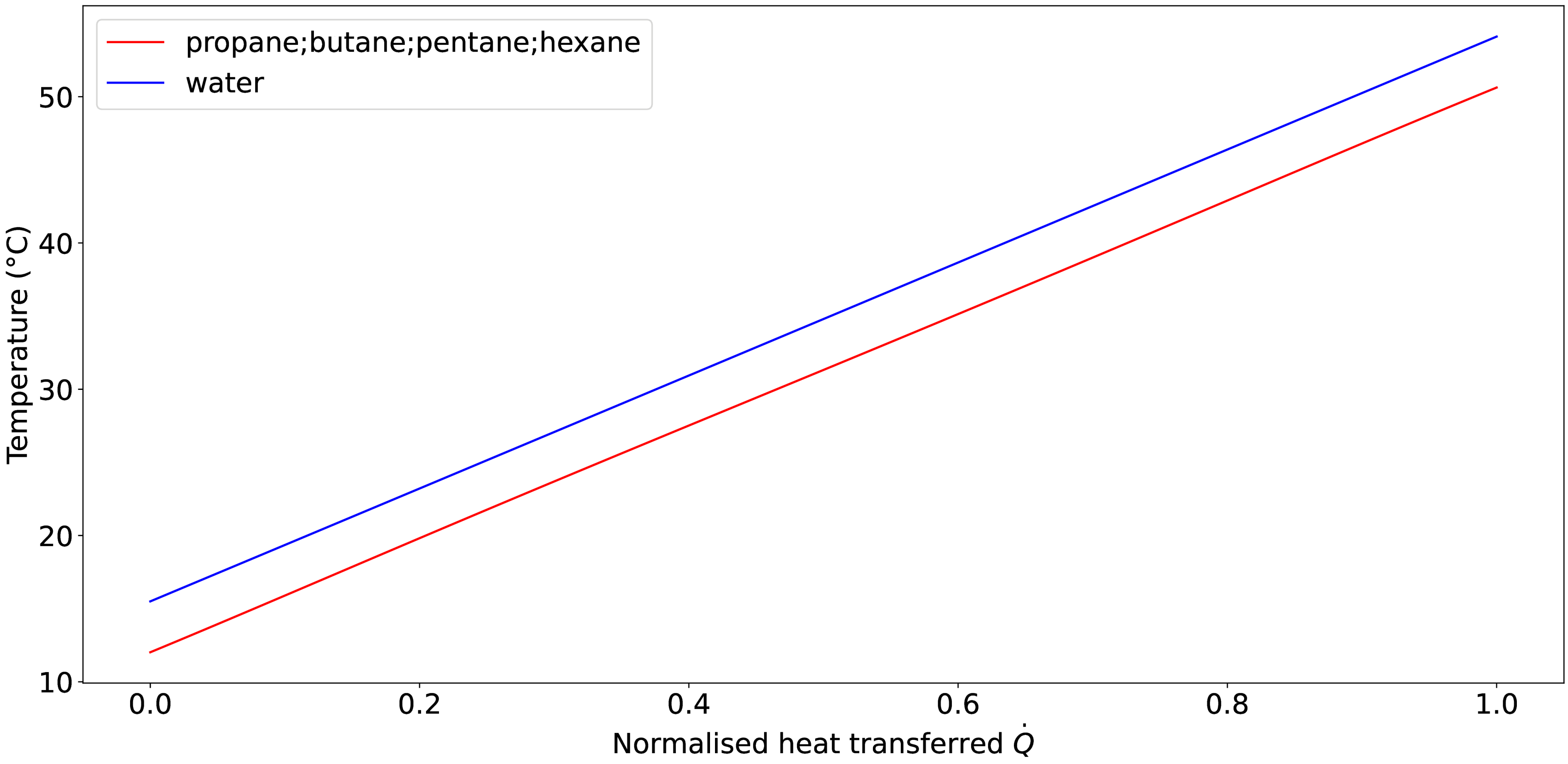




+ heat rejection to ambient during discharge

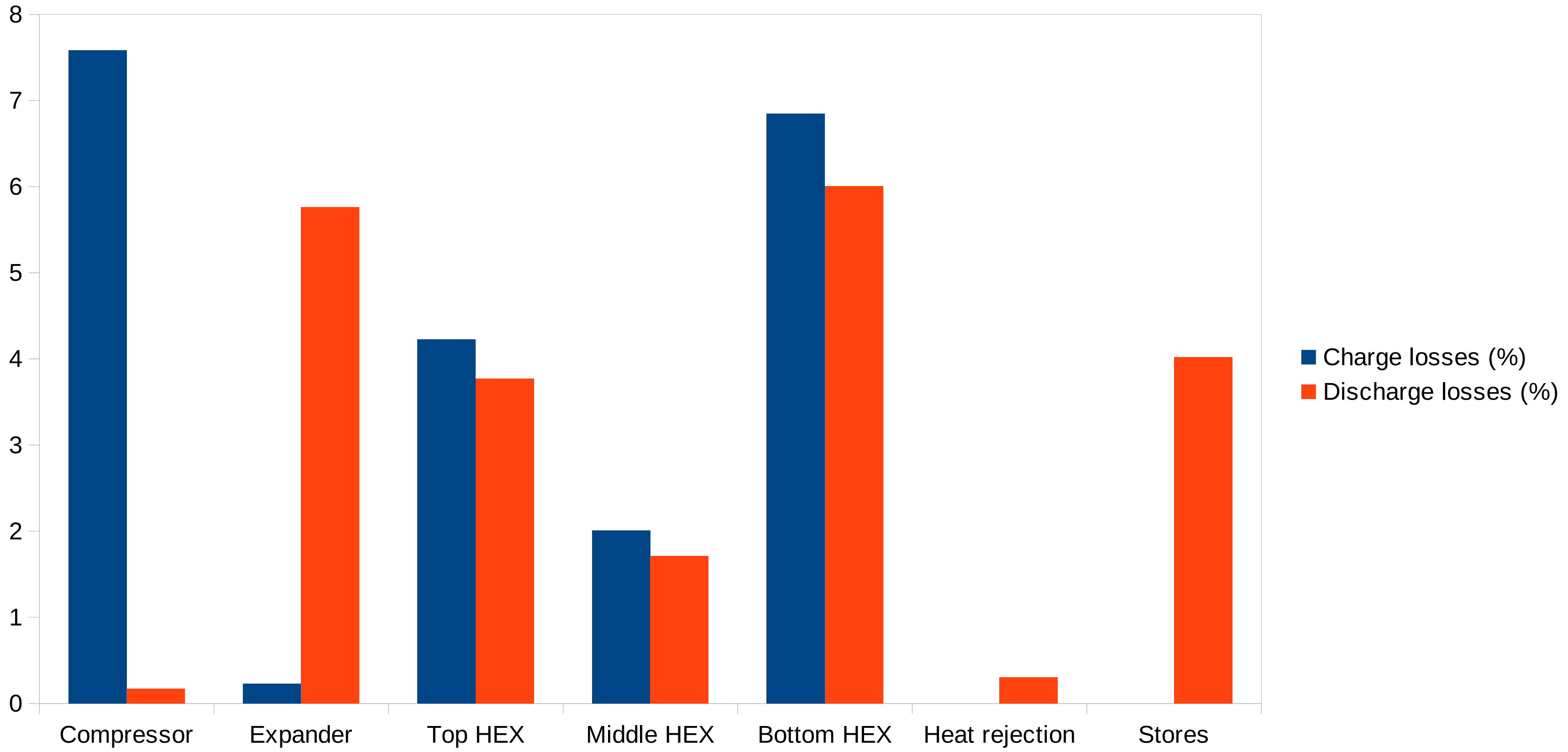
Multi-tank configuration



Thermodynamic performance

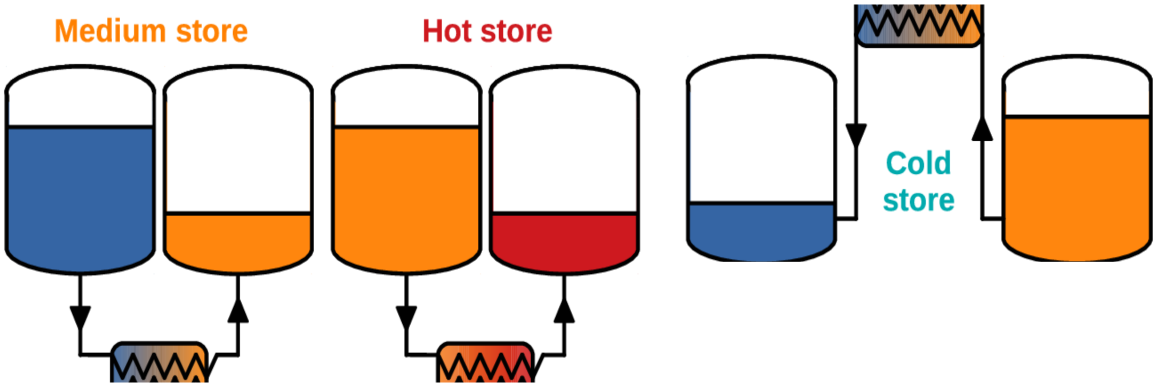
Assuming:
η = 90%
ε = 95%

Round-trip efficiency = 57%
(excluding mechanical losses)



Performance

Store	Medium	Hot	"Cold"	Total (weighted by $\dot{m}$)
Exergy density kWh/m^3	4.4	7.5	−2.8	**2.4**



Conclusions and outlook

- High work ratio
- Decent roundtrip efficiency
- Cheaper material requirements due to low temperatures

- Low exergy density
- Narrow temperature ranges
- Two-phase compressions/expansions

Outlook: widen temperature range for higher exergy density

Thank you for your attention!

Any questions?