Investigation of industrial high temperature heat pumps for simultaneous heating and cooling

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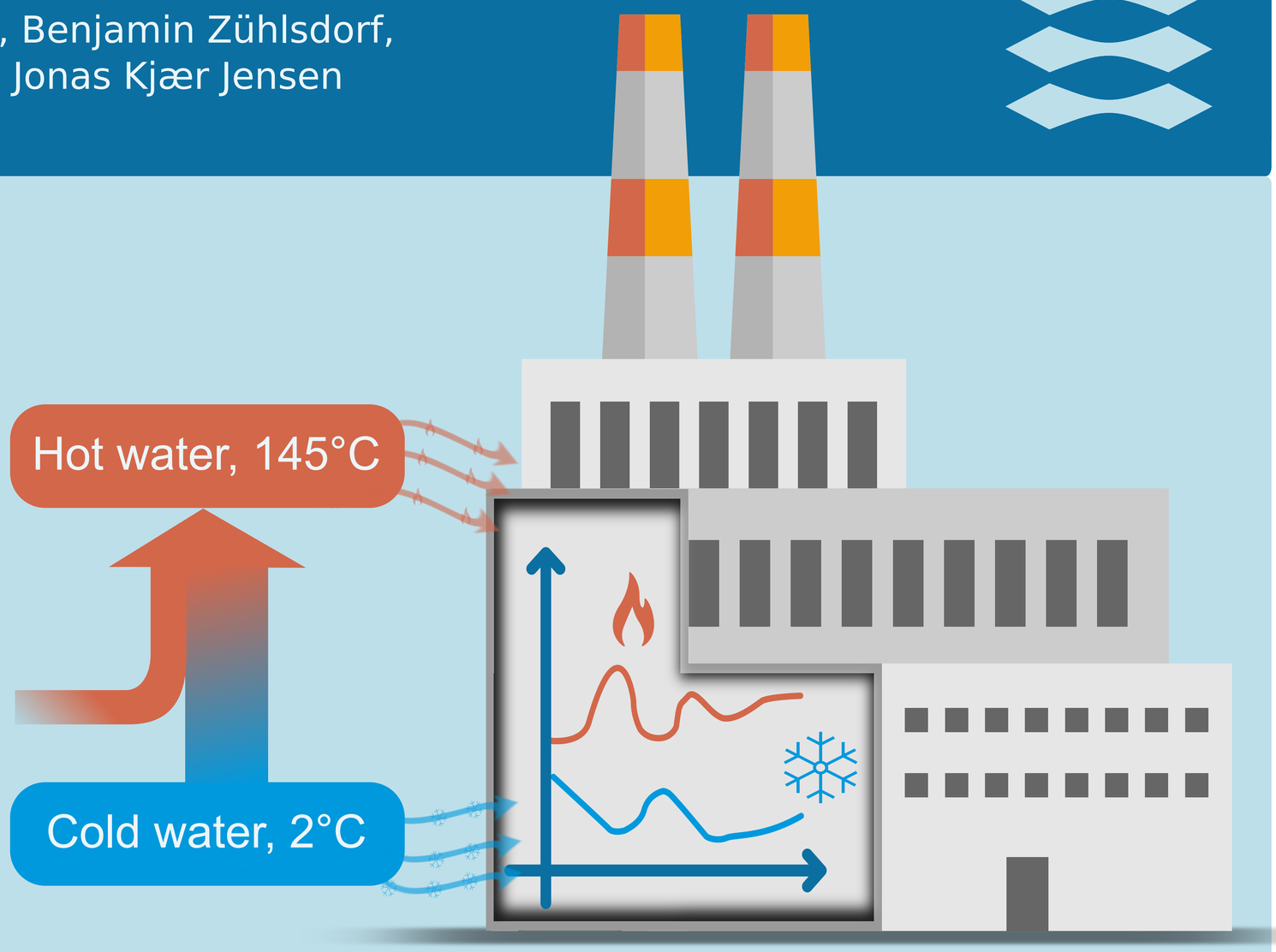
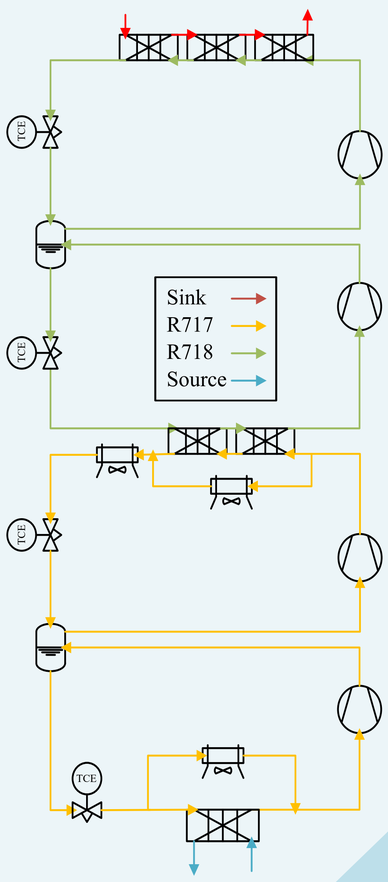
1 Background

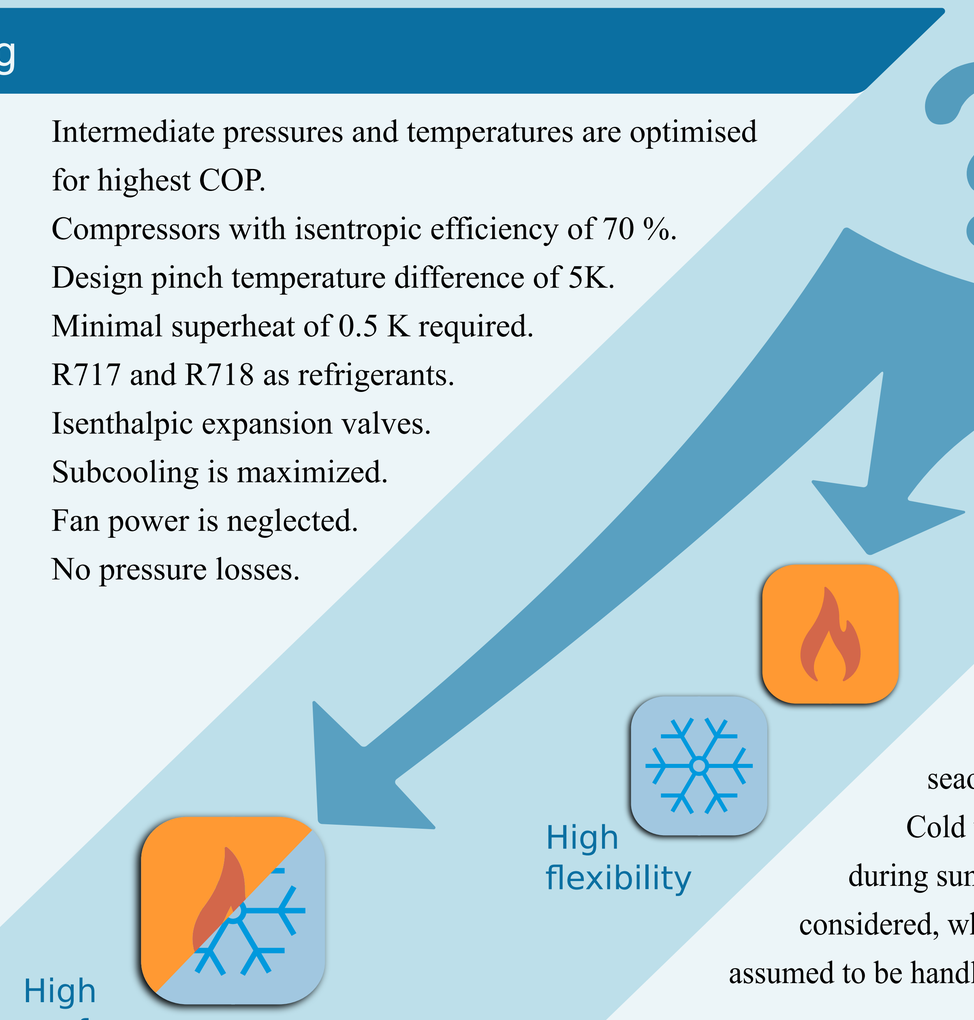
- Process industries are responsible for a large portion of the world's energy demand.
- Introducing high-temperature heat pumps (HTHPs) and electric boilers to supply heat is necessary for the total electrification of the industry.
- Combining the refrigeration system and the HTHP improves the overall efficiency. However, the integration is challenging as the heating and cooling demand is coupled.
- A case study of supplying simultaneous heating and cooling for a year is evaluated for a Danish brewery and compared to two separate heating and cooling utilities.



2 System modelling



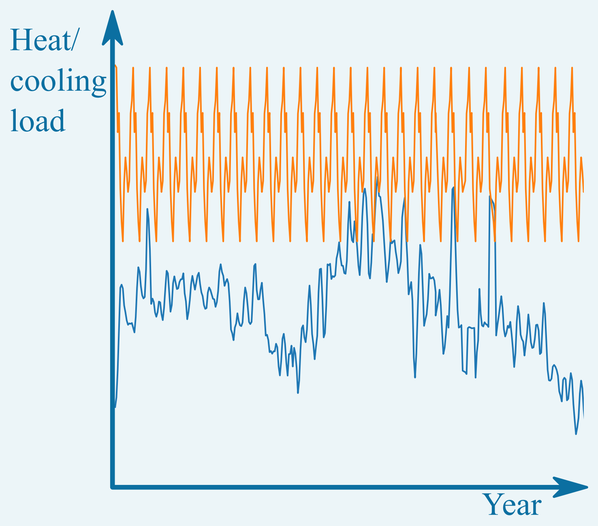
Intermediate pressures and temperatures are optimised for highest COP.
Compressors with isentropic efficiency of 70 %.
Design pinch temperature difference of 5K.
Minimal superheat of 0.5 K required.
R717 and R718 as refrigerants.
Isenthalpic expansion valves.
Subcooling is maximized.
Fan power is neglected.
No pressure losses.



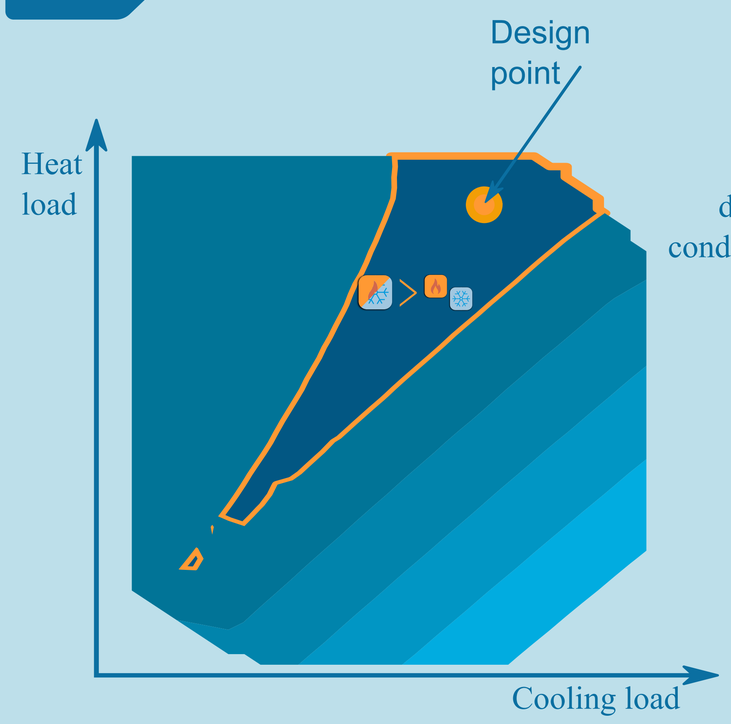
3 Case study

Design Conditions	
Hot supply	2230 kW
Cold supply	1380 kW
Hot water temperature	145°C
Hot return temperature	120°C
Cold water temperature	2°C
Cold return temperature	8°C

Hot water and cold water production. Bi-weekly trends for hot water consumption and seaonal trends for the cold water. Cold water consumption is largest during summer. The daily averages are considered, while short-term variations are assumed to be handled by buffer tanks or boilers.



4 Results



5 Conclusion

- The electricity consumption of the combined system is 9.8 % smaller at design conditions.
- Separate systems perform better for heating and cooling ratio demands differing from design.
- The ambient temperature shows neglectable effect on the combined system while seperate utilities vary by 10% in COP.
- The yearly electricity consumption is 2% lower for the combined system indicating negligible benefits in terms of operational costs.
- The size of the combined was greatly reduced, potentially yielding lower initial investment costs.

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This work has been conducted in collaboration with the project partners SuPrHeat