

WEBINAR ON HIGH TEMPERATURE HEAT PUMPS

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Case study Cremo: Integration concept and status

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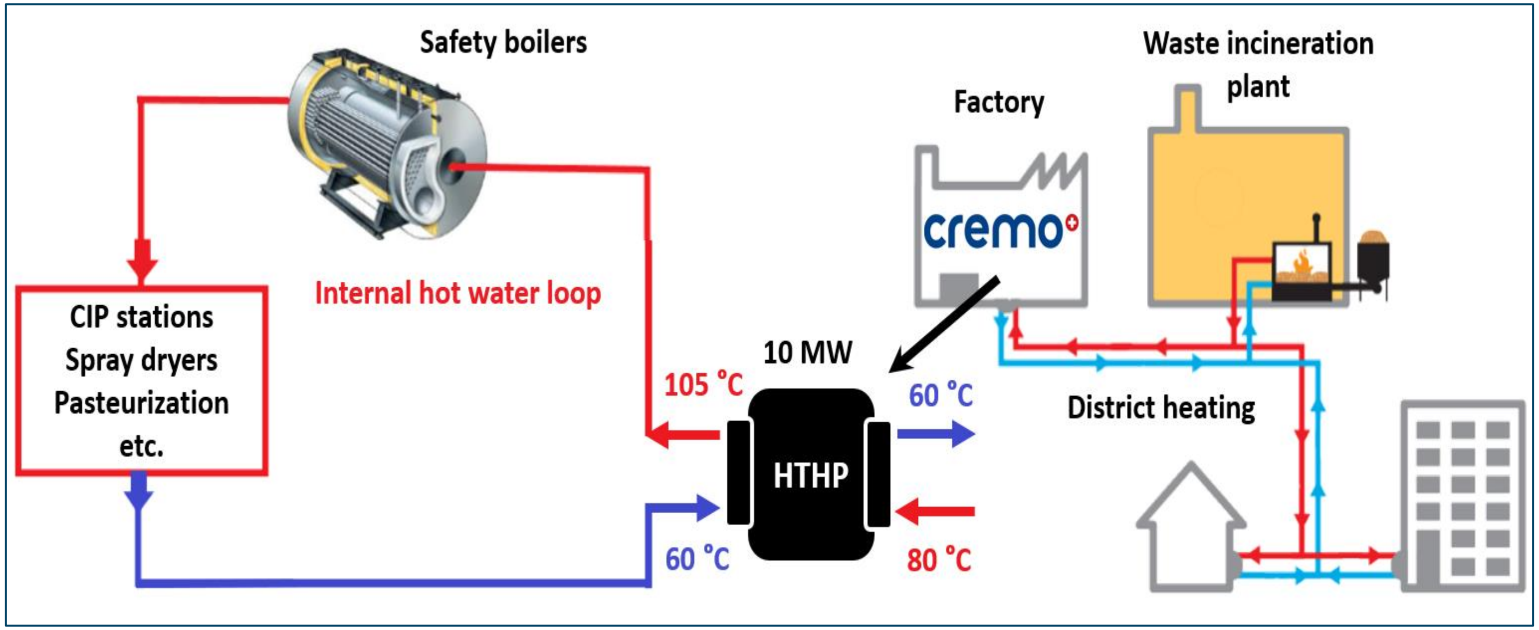
Company presentation

- Among largest milk processing companies in Switzerland (est. 1927) owned at 90% by milk producers
- 8 production sites in Switzerland
- Villars-sur-Glâne factory processes 240’000 t/yr of milk to produce
  - Cheese and butter
  - Skim milk, whey and milk permeate powder

cremo

Potential opportunities for HTHP

- Steam for milk permeate powder drying plant
- Boost district heating network distribution temperature
- Upgrade heat recovered in the factory to a hot water loop

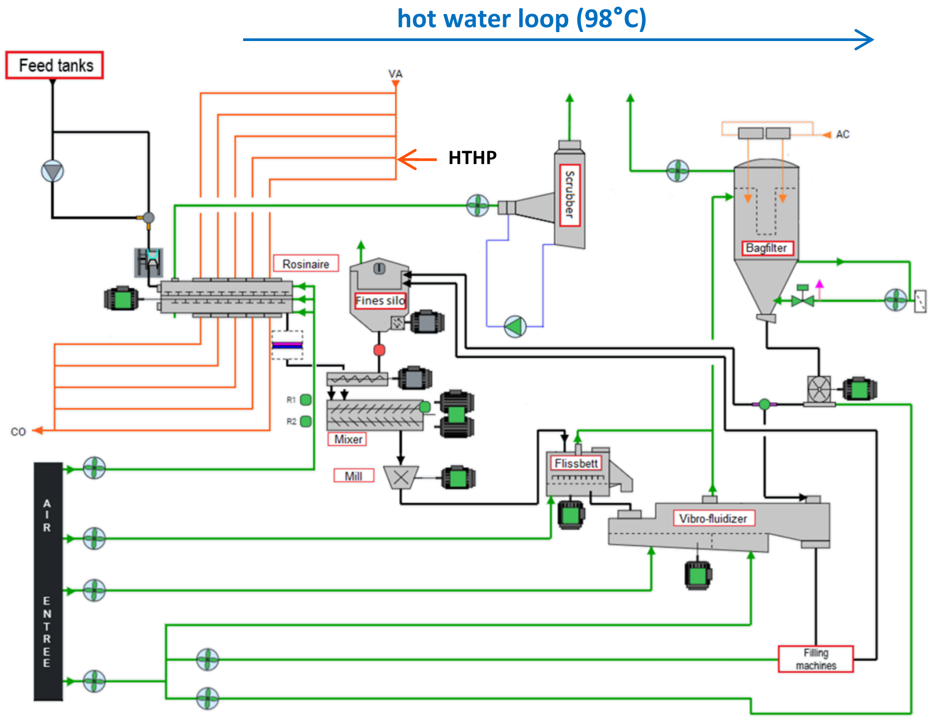


Selected case study for HTHP

- Supply steam to the milk permeate powder drying process
  - Low pressure steam needed
  - 15% of factory steam consumption (from gas boiler)
  - Simultaneity and proximity of sources & sinks (semi-continuous process)
  - Potential waste heat to be recovered

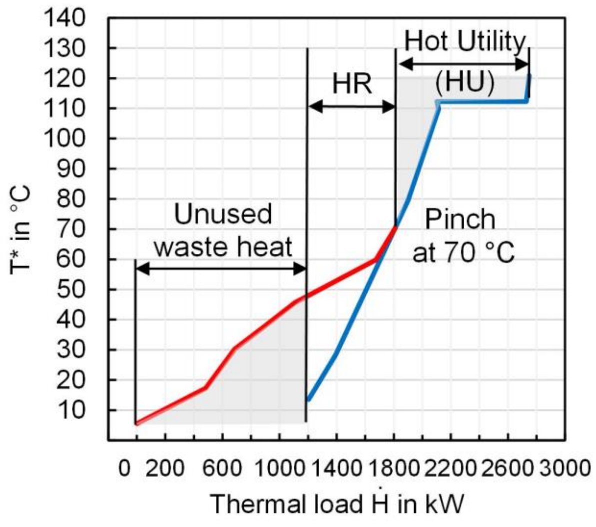
Characterisation of the streams

- Measurement campaign : fundamental needs vs current heat supply?
  - Sinks :
    - Steam for paddle dryer (1.8 bara steam)
    - Air heaters for paddle dryer, static & fluidized bed (between 75°C - 117°C)
  - Sources :
    - Exhaust air from paddle dryer and from static & fluidized bed (66°C)
    - Hot water loop (98°C)

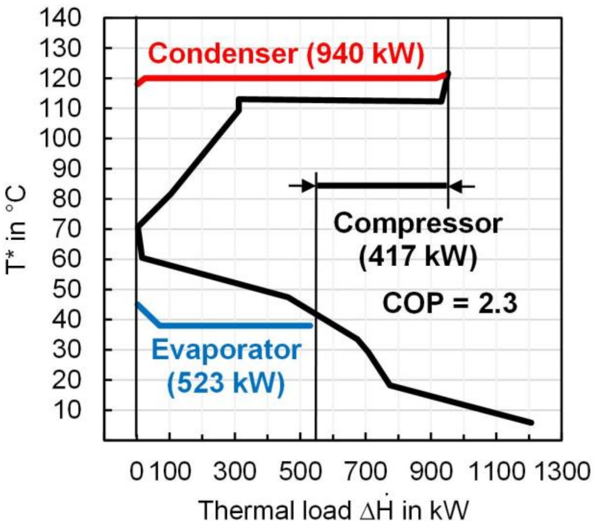


Pinch Analysis of case study

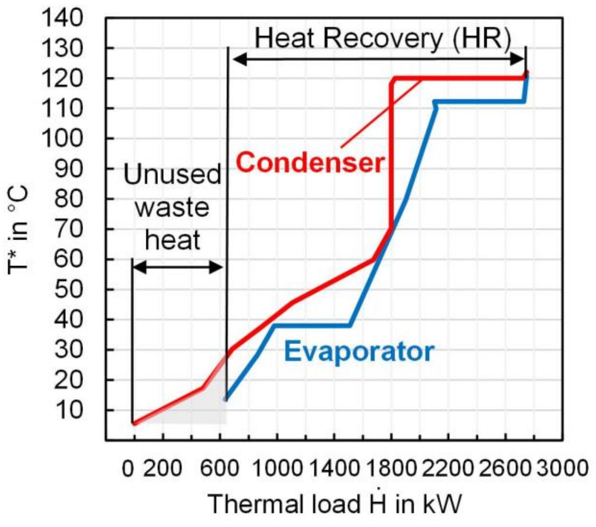
- Heat recovery potential through direct heat transfer of about 600 kW between air flows
- HTHP integration identified providing low-pressure steam at 110 °C using humid exhaust air as a heat source
  - HTHP : evaporation at 38 °C, condensation at 120 °C → low expected COP of 2.3
  - Constrains : existing heat recovery on exhaust air streams / very little space in air heating room for modifications



Composite curves (CC)



Grand composite curves (GCC)



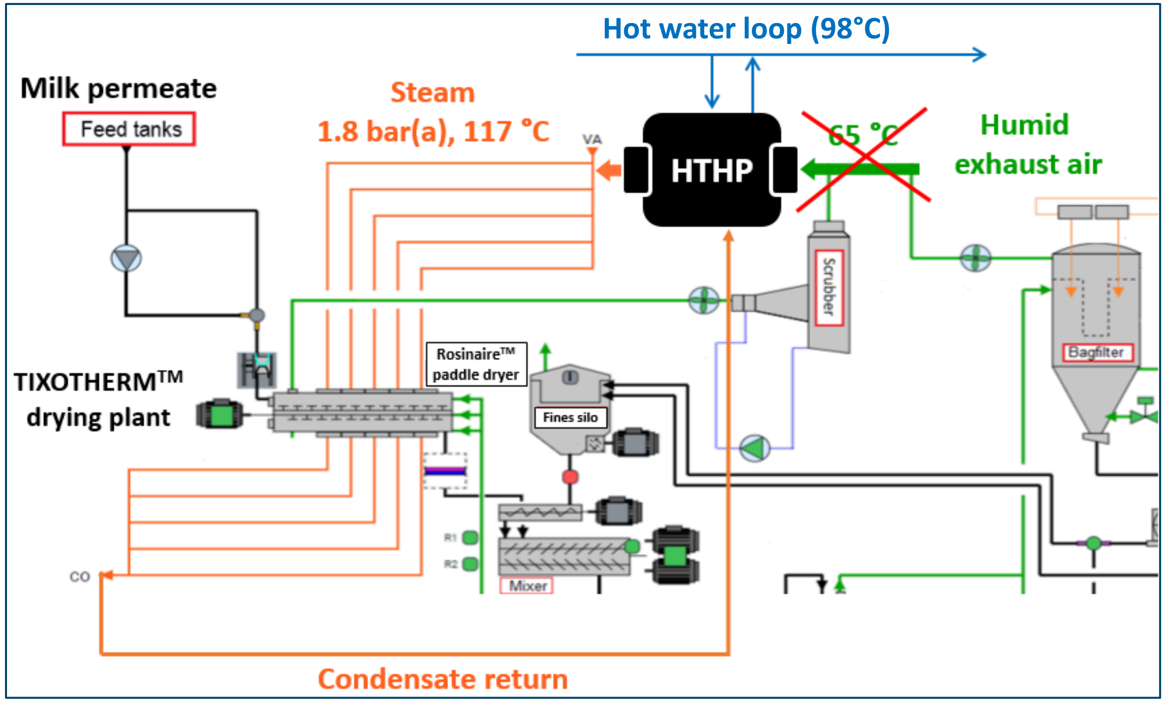
Composite curves with HP integration

Integration concepts

- *Optimal integration from Pinch analysis*
  - *Heavy modifications required to existing heat recovery system*
  - *Spatial restrictions*

- **Considered concept**
  - **Sink : 810 kg/h steam at 1.8 bar(a) for the paddle dryer**
  - **Source : 98°C water loop**

- *Alternative concept tried*
  - *Sink : 1'300 kg/h at 4 bar(a) for paddle dryer + air heaters*
  - *Source : 98°C water loop*
  - *Proved to be a technical no-go with MVR*



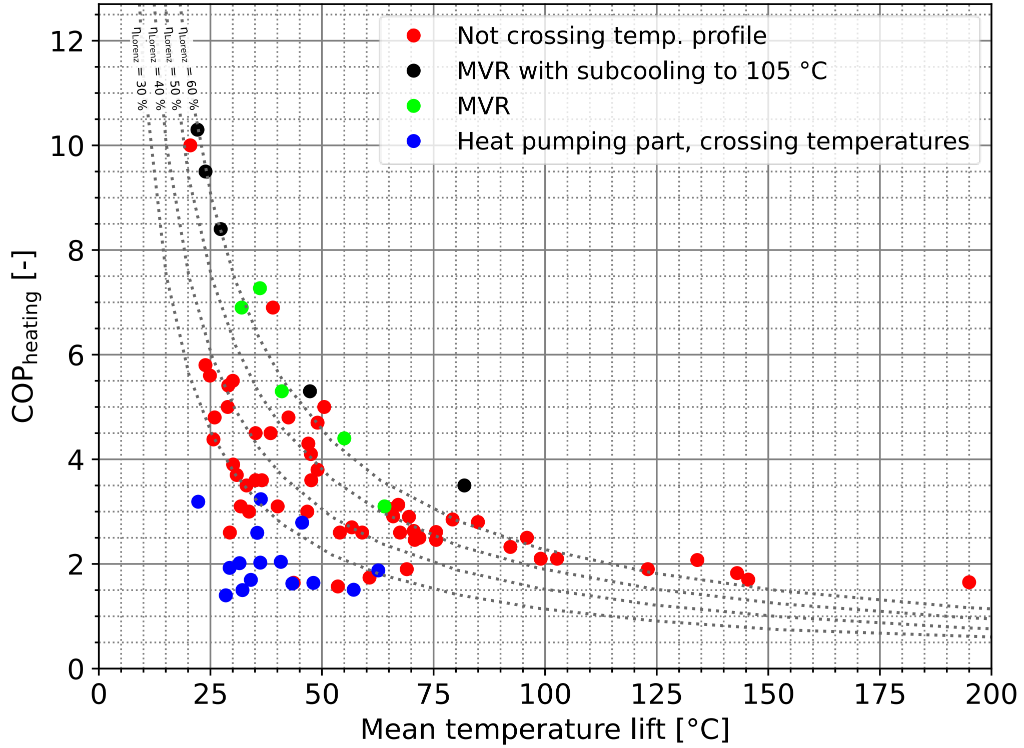
Integration considerations

- Points to be checked
  - Simultaneity sink-source?
  - Heat storage needed?
  - Space available?
  - Supporting structure sufficient?
  - Electrical power reinforcement needed?
  - Compliance to hygienic conditions for all equipment?
  - Introduction of equipment?
  - Redundancy?

Preliminary evaluation

- Initial data and hypothesis
  - 1.8 bar(a) / 500 kW steam produced
  - MVR heat pump with COP of 9
  - Annual operating time 2700h/yr
  - Specific HTHP cost 450 CHF/kW
  - Subsidies from myclimate & SFOE

- First result estimates
  - Annual energy saving : 15%
  - Annual CO_2 emissions reduction : 94%
  - Payback of 4 years

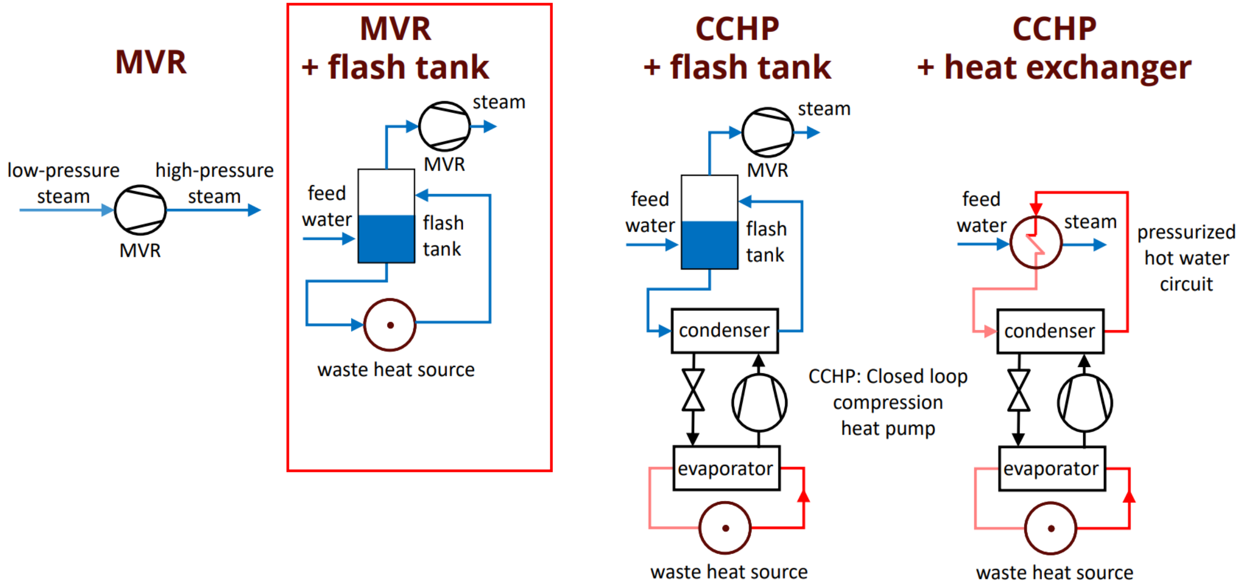


[IEA Annex 58 Task 1, based on manufacturer data]

Heat pump type selection

- Various steam-generating HP technologies available

- MVR technology chosen
  - Mature and reliable technology
  - Good efficiency
  - Contains no refrigerant fluid
  - Sub-atmospheric evaporation

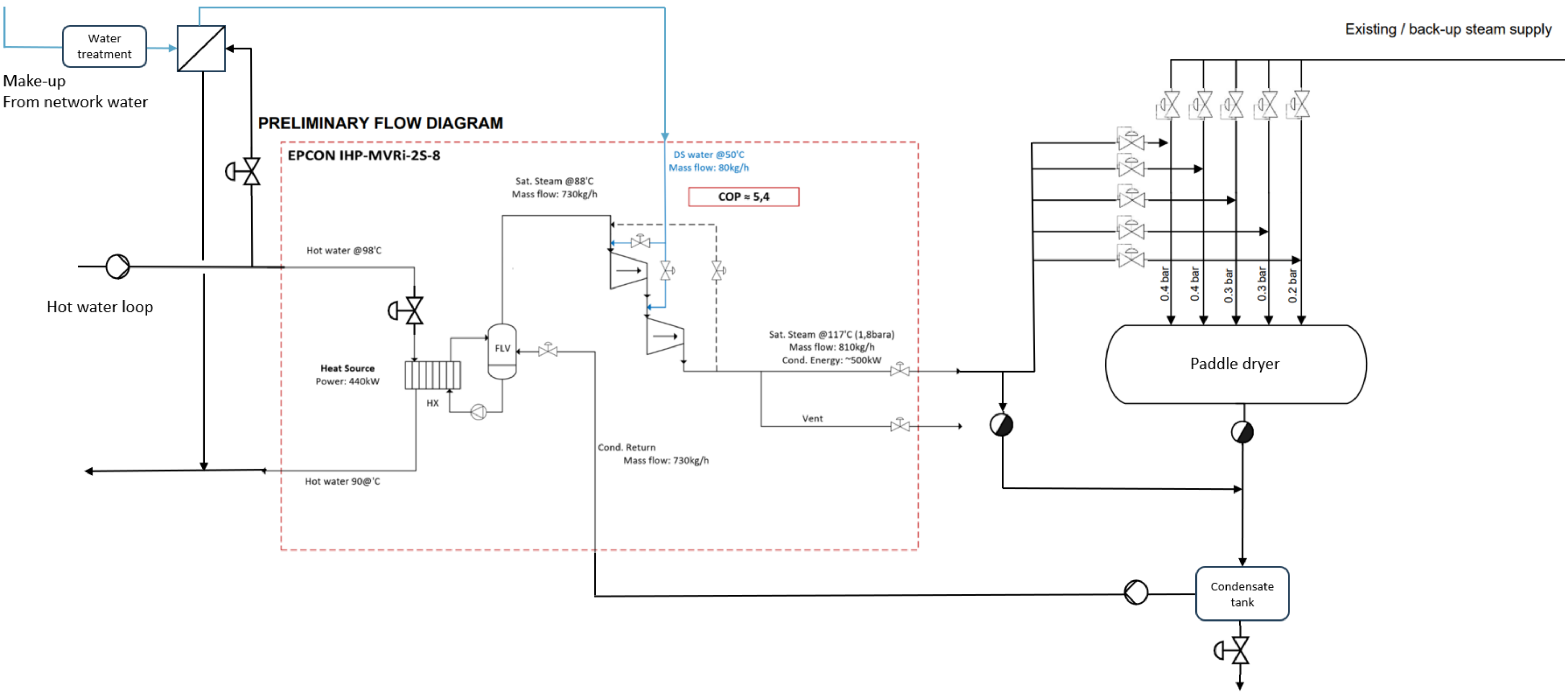


Source : IEA Annex 58

- Challenges faced
  - Small capacity out of the specification for various suppliers
  - Introduction to 5th floor by the freight lift (→ setup on 2 skids)

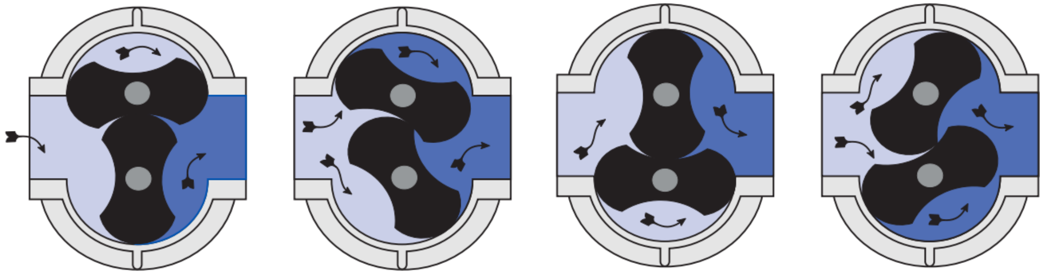
Integration scheme

- EPCON MVR-HTHP integration concept at Cremo factory : technically feasible

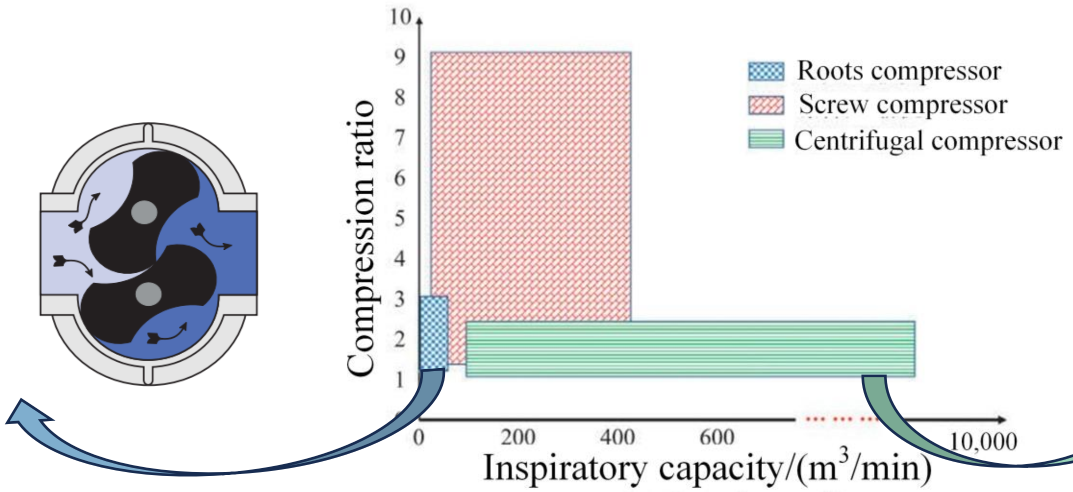


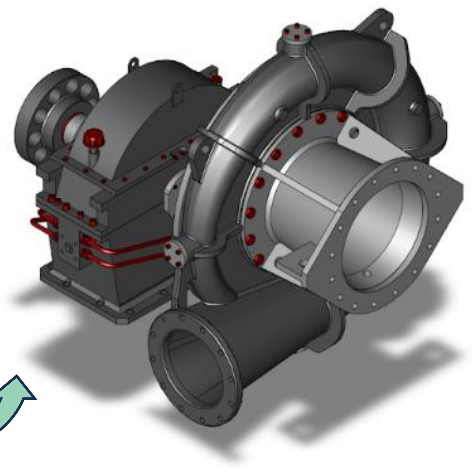
Performance gap

- Expected COP = 9 for MVR-HP → COP = 5.4 effective value
- Low steam flowrate
  - Compression technology affected
  - 40-60% isentropic efficiency of roots compressor vs 70-90% of centrifugal blower
- Better efficiency for large scale compressors in general



Roots compressor





Centrifugal compressor

Project results

- Total cost of the project (CAPEX)
  - CHF 1’570’700.-
- Specific cost
  - 3’140 CHF/kW installed
- Cost efficiency
  - OPEX overcost : 72 CHF/tCO_2 avoided
  - No profitability
    - 22yrs payback if 200CHF/tCO_2 conceded for avoided emissions
    - Heat source not free
    - High specific cost of HTHP
    - Lower COP than expected
    - Moderate operating time
    - Not eligible to myclimate subsidies, to be confirmed for SwissEnergy program (included here)

Project costs breakdown	
Source side	4.5 %
MVR HTHP incl. delivery & installation	85.0%
Secondary side	6.5 %
Other	4.0%

Environmental benefits	
Annual energy saving	15%
Annual CO_2 emissions reduction	98%

Cost efficiency improvement

- Alternative heat source, broaden the search out of particular process
  - Waste heat (under study)
  - Even better if cooling utility avoided by HTHP integration

- Larger heat pump
  - Lower specific cost
  - Increased efficiency

- Increased operating time

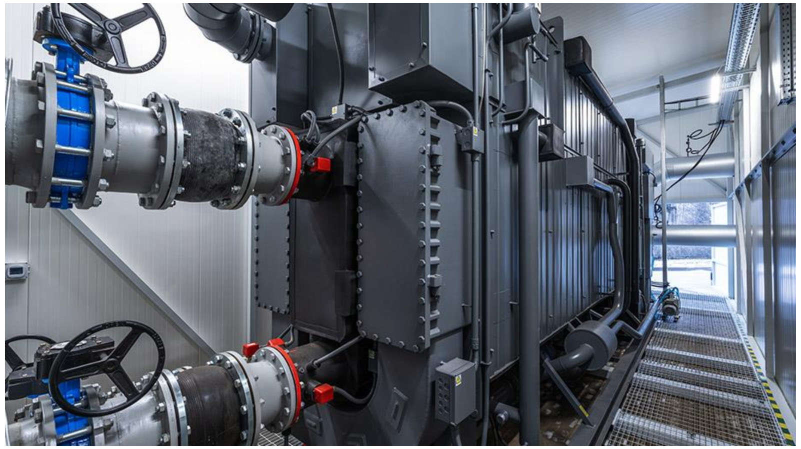
- Higher cost for gas

Subsidy programs

- HP for process heat – SwissEnergy/SFOE
  - Subsidy of max. 40% of over-cost for industrial heat HP project

- Industrial HP - Myclimate
  - Subsidy
    - Global amount of 18 ct/kWh (average over last 3 years consumption)
    - Yearly payment of CHF 160.-/tCO_2 up to subsidy amount is reached
    - Subsidy agreement until end of 2030

- Check the eligibility conditions

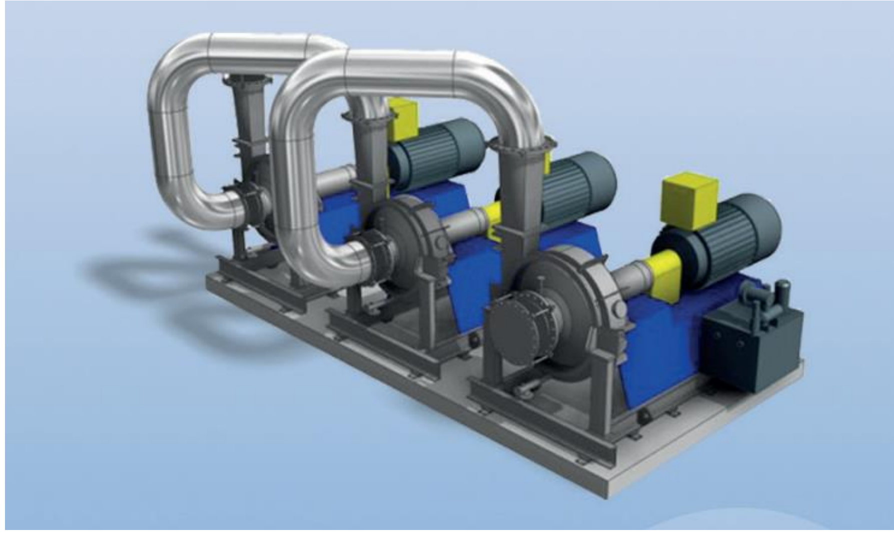


Conclusions

- Technically feasible solution found

- Benefits
  - Environmental : 98% annual CO_2 emissions reduction for the paddle dryer steam supply
  - Considered MVR-HP contains no refrigerant fluid
  - Installation close to the process unit keeps integration costs down
  - Efficiency : production as close as possible to the fundamental heating needs
  - Source : hot water loop availability

- Challenges
  - Profitability to replace fossil steam production
  - Low steam flow rate for MVR technology
    - Performance gap with larger machines
    - Increased price CHF/kWh for HTHP
  - Lack of data to find sufficient waste heat at interesting temperature
  - Semi-continuous production with moderate operating time
  - Factory building : access to the 5th floor for HP introduction



- Further information on HTHP : https://heatpumpingtechnologies.org/annex58