High temperature heat pumps demonstrated in energy intensive industries

Figure 1: *DryFiciency Heat Pump at AGRANA Starch production facility in Pischelsdorf, Austria*

Summary of demonstration case

In the H2020 project DryFiciency, high temperature heat pumps were developed and demonstrated to supply process heat with up to 160°C for industrial drying processes to increase energy efficiency and to lower CO_2 emissions. AGRANA is a global player in the segments of fruit, starch and sugar, specializing in the processing and refinement of high-quality agricultural raw materials. The DryFiciency heat pump was integrated in the wheat starch dryer, it uses warm water from a heat recovery cycle as the heat source and supplies approx. 10% of the heat demand of the dryer.

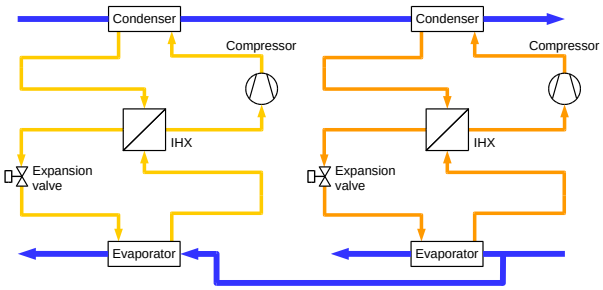

Figure 2: Layout of the DryFiciency heat pump

Norbert Harringer, CTO and Member of the Management Board of AGRANA Group:

"AGRANA is committed to CO2-neutral production. It is clear that this requires an action plan with ambitious but realistic milestones. Specifically, this means that AGRANA will invest around EUR 10 million annually through 2025 to save 25% of the greenhouse gas emissions caused by our production and to reduce them to net zero by 2040. The DryFiciency project is also a building block in our climate strategy for achieving our emissions targets."

It is a closed loop vapor compression heat pump, the development and demonstration work included:

- The use of the synthetic low GWP refrigerant R-1336mzz(Z) by Chemours
- Innovative screw compressors designed by BITZER adapted to high heat supply temperatures
- Fine-tuned, synthetic lubricant working stable with the refrigerant by Fuchs Schmierstoffe
- Refrigerant cycle designed as twin cycle for efficient operation over a wide range of operation conditions

Operating experiences

The DryFiciency heat pump was operated for more than 4000 h with a maximum heat output of 374 kW (design point at 138°C heat supply temperature). Compared to a natural gas burner providing the same amount of process heat, the DryFiciency heat pump reduces end energy consumption by 2400 MWh/a, primary energy consumption by 1700 MWh/a, CO_2 emission by 660 t/a, resulting in 42900 €/a energy cost savings. The internal heat recovery cycle is an efficient heat source allowing for valorisation of waste heat from other processes at the site.

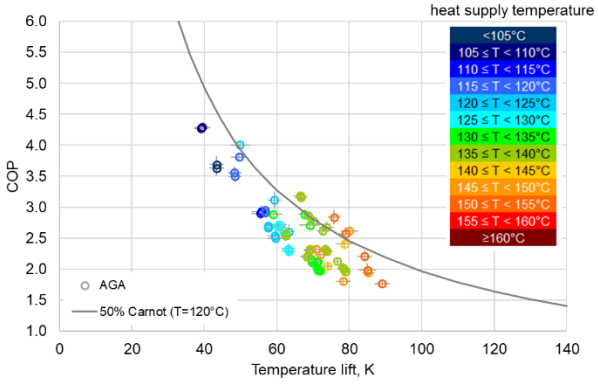

Figure 2: Measured COP of the DryFiciency heat pump at AGRANA

Special learnings

Challenges encountered during the development of the high temperature heat pumps included material compatibility (lubricant, refrigerant, sealing materials), mechanical design (vibrations), integration infrastructure (e.g. pressure maintenance, flow measurement) and in the process control (e.g. start up procedure, data transfer, measurement devices). DryFiciency demonstrated the successful component development for high temperature applications such as compressors, lubricant and refrigerant as well as the successful operation of the closed loop heat pumps in industrial environment.

Contact information

Thomas Laminger, Agrana Stärke GmbH
thomas.laminger@agrana.com
+43 676 892613343
Veronika Wilk, AIT Austrian Institute of Technology GmbH
Veronika.Wilk@ait.ac.at
+43 664 6207794

All information were provided by the Consortium without third-party validation. The infomation was provided as an indicative basis and may be different in final installations depending on application specific

FACTS ABOUT THE CASE

Installation year: 2020
Operating hours: over 4000 hours
Working fluid used: HFO-1336mzz(Z)
Compressor technology: screw compressors
System manufacturer: built by AMT Kältetechnik based on the design by AIT
Performance in design point:

- **Heat source: 76°C → 72°C, water**
- **Heat sink: 96°C → 138°C, water**
- **Heat supply capacity: 374 kW**
- **$COP_{Heating}$: 3.2**

Performance at 152°C heat supply temperature

- **Heat source: 81°C → 78°C, water**
- **Heat sink: 102°C → 152°C, water**
- **Heat supply capacity: 340 kW**
- **$COP_{Heating}$: 2.87**

Investment cost pilot installation: -
Savings: 42900 €/a at 138°C
Estimated annual CO_2 savings: 660 t/a at 138°C