Real scale demonstration of a High-Temperature Heap Pump for industrial waste heat valorisation in a paper mill

Figure 1: Outdoor installation of two-stage HP system embedded in a container solution

Summary of demonstration case

Felix Schoeller GmbH & Co.KG is one the of the largest manufacturer in Europe dedicated to the production of technical and specialty paper. Headquartered in Osnabrueck, Felix Schoeller is a globally active family-owned company founded in 1895. Felix Schoeller develops, produces and markets specialty papers for photographic applications, for digital printing systems, for the packaging market, for self-adhesive applications and for the furniture, wood-based panel and wallpaper industries.

The main energy demand for the production and processing of paper is process heat (steam at different pressure levels between 2 bara and 8 bara). A combined heat and power plant on site and based on natural gas is supplying the industrial complex with process heat and electricity. The paper factory has a yearly demand for natural gas of 400 GWh.

A two-stage High-Temperature Heat Pump at full-scale by SPH Sustainable Process Heat GmbH is designed to upgrade of surplus waste heat and supply steam directly into the paper production process at Felix Schoeller.

The waste heat that will be used in the project is part of the exhaust heat from the paper machine dryer air hood system. This exhaust heat is currently recovered by means of a heat recovery system developed by the company VOITH, as an integral part of the efficient papermaking technology used by the demo site. The heat recovery system recovers the excess heat of the air used for drying purposes of the paper by means of air to water-glycol heat exchangers.

The Heat Upgrade System with a capacity of 1.2 MW_{th} is expected to reach a COP of 2.3 at design conditions.

"The main idea here is to harvest waste heat [...] and replace process heat that conventionally is supplied through the combustion of fossil fuels."

Paitazoglou Fraunhofer IEG

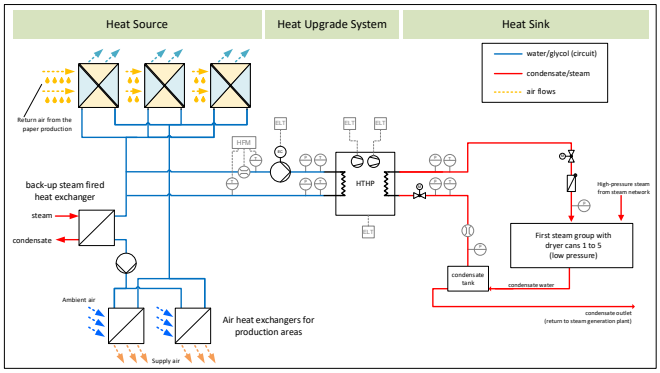

Figure 2: Simplified PID scheme of the two-stage HP integration (reference: Paitazoglou et al, IEG, PUSH2HEAT, High-Temperature Heat Pump Symposium 2024).

Operating experiences

After successful delivery of the container solution with the double stage High-Temperature Heat Pump by SPH the integration works finished shorty after.

Commissioning is in the last phase and is expected to be finished within 2025. Main operation is expected to take place from April to October when sufficient waste heat is available. The amount of hours with an excess heat that can be used as a heat source for the HTHP account to 4800 hours per year.

The HTHP system is designed for coping with flexible operating conditions in the heat source circuit, where temperature and flow rate vary strongly due to factors such as ambient air conditions, varying temperature demands of additional end-users and the type of paper being produced.

FACTS ABOUT THE CASE

Installation year: 2024

Operating hours: 4000h/a (expected)

Working fluid used: R515B (low-temperature stage) and R1233zd (high-temperature stage)

Compressor technology: screw (low-temperature stage) and piston (high-temperature stage)

System manufacturer: SPH

Sector: pulp & paper

Performance in design point:

- **Heat source:** 46 °C → 41 °C water
- **Heat sink:** 90 °C → 123 °C steam
- **Heat supply capacity:** 1.2 MW
- **$COP_{Heating}$:** 2.3 (design point)
- **Investment cost:** Not available

Savings: 108000 €/a

Estimated annual CO_2 savings: 231 t/a

Link to webpage or report: https://push2heat.eu/wp-content/uploads/2023/12/PUSH2HEAT_D3.1_System-design_STC_PU_final.pdf

Contact information

Reuven Paitazoglou, Fraunhofer IEG

reuven.paitazoglou@ieg.fraunhofer.de

+49 151 20157042

Tor Hodne, SPH Sustainable Process Heat GmbH

tor.hodne@spheat.de

+47 957 67 170