ThermBooster

SPH Sustainable Process Heat GmbH

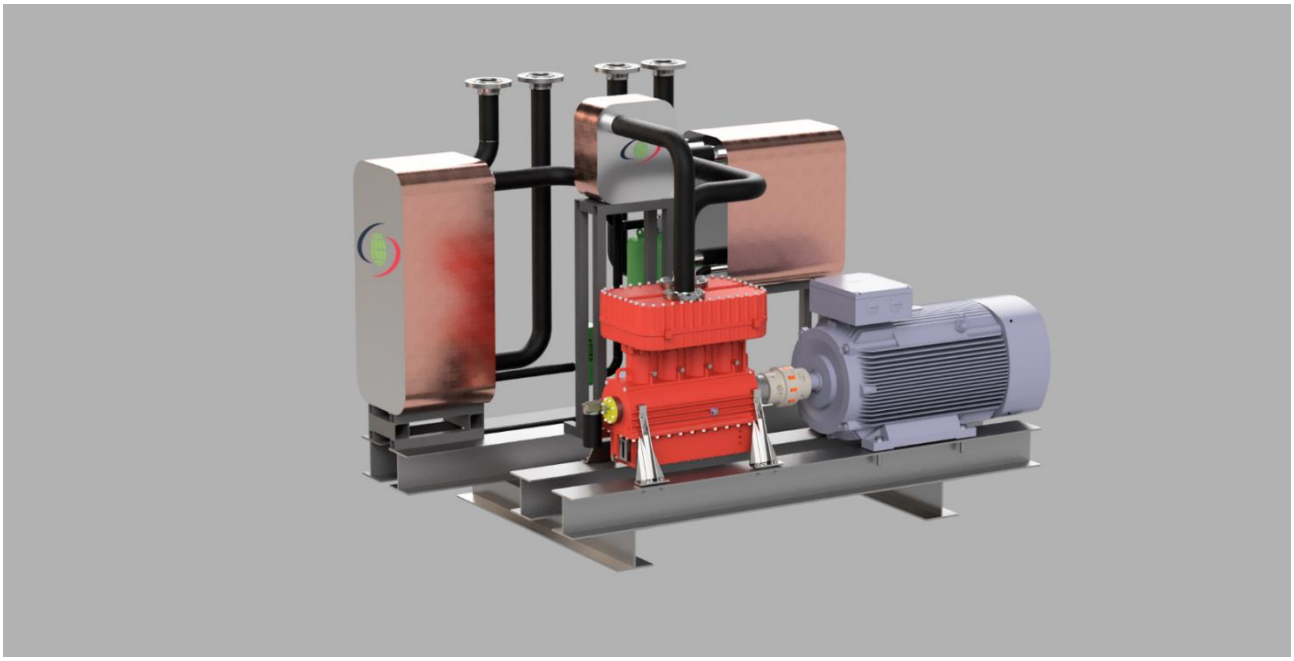

Figure 1: ThermBooster Water-Water configuration.

Summary of technology

The ThermBooster is a closed loop compression type heat pump. It runs with different types of low GWP A1 HFO refrigerants like R1233zd or R1336mzz-Z to reach temperatures up to 165 °C and a thermal power output of about 500-1000 kW per used compressor. The compressor is a 4-cylinder piston compressor, especially designed for the use of HFO in high temperature applications. The piston compressor is an open type with a shaft sealing, driven by an electrical IE4 performance motor. The valve system is optimized for HFO fluids and reduces the pressure losses by up to 30 % compared to standard piston compressors. The compressor has an integrated oil conditioning for heating and cooling of the oil. The used oil type depends on the refrigerant. The hardware itself is designed for temperatures above 250 °C, which can be reached by using natural HCs as working fluid.

The system can be built as water–water or water-steam type. The steam version uses a direct combined condenser/steam evaporator to produce the steam. The system is available as 1-stage system for temperature lifts up to about 60 K and as 2-stage system for lifts up to about 140 K. If starting from low temperature sources, a standard screw compressor is used for the low temperature stage. The stages are coupled by a combined condenser/evaporator heat exchanger. By combining multiple compressors in a parallel configuration higher thermal power output can be reached, also multi-cycle configurations are possible.

The compressor is inverter driven and hence the thermal power can be adjusted very fast in a range between 33 % and 100 %. By choosing a different working fluid and lubricant, the hardware can be adapted to a different temperature level.

The first systems will be deployed into industrial applications in the first half of 2022. The compressor and systems are developed by former Viking Heat Engines Germany developers, with years of experience in the field of piston machines development and ORC/High temperature heat pump systems.

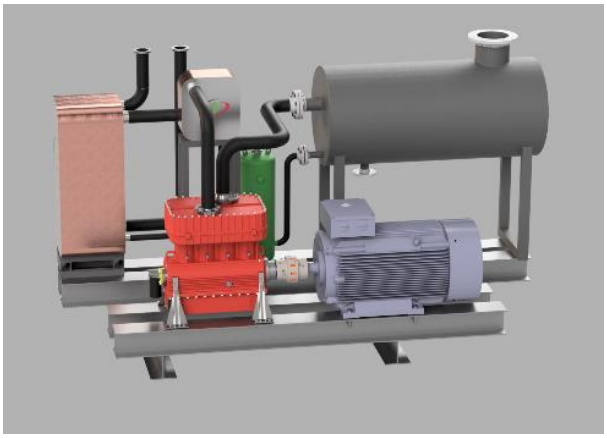

Figure 2: ThermBooster direct steam production.

Table 1: Performance.

$T_{source,in}$ [°C]	$T_{source,out}$ [°C]	$T_{sink,in}$ [°C]	$T_{sink,out}$ [°C]	$COP_{heating}$ [-]
85	78	90	134 (3 bar sat. steam)	3.9 calculated
50	40	90	140 Hot water	2.9 calculated
95	90	95	159 (6 bar sat. steam)	3.0 calculated

Project example

One of the first customer installations will be to produce 2.7 bar saturated steam for a plastic processing company. Target for the company is to reduce the CO_2 foot print of their products. As heat source the cooling water loop of a large CHP engine is used. In this case the ThermBooster is used to cool the CHP engine and uses this low temperature heat to produce steam at the same level as it is done directly with the energy in the exhaust gas. The combination of CHP engine together with the ThermBooster guarantees a use of more than 80% of the total fuel energy of the CHP system, which is prepared for H_2 use in the future to further reduce the CO_2 foot print. The COP in this application is calculated to 3.9 and the payback time is less than 4 years without the consideration of any incentives for investment. The first step will be one CHP in combination with one ThermBooster, after one year the extension to two CHPs, thus reaching a total of three ThermBoosters, is planned.

FACTS ABOUT THE TECHNOLOGY

Heat supply capacity: 300 kW – 5 MW

Temperature range:
Heat source: 20 °C – 120 °C (up to 150 °C planned)
Heat sink: 80 °C to 165 °C (up to above 200 °C planned)
Spread between 5 °C and up to 70 °C or more

Working fluid:
R1234ze, R1233zd, R1224yd, R1336mzz-E, R1336mzz-Z (natural HCs planned for higher temperatures)

Compressor technology: Piston

Specific investment cost for installed system without integration:
150 €/kW for low lift 1-stage systems to 1000 €/kW for high lift 2-stage systems

TRL level:
Former smaller systems TRL 7-8, current larger system TRL 6

Expected lifetime: System service lifetime up to 20 years, compressor lifetime before major overhauling 40,000 – 60,000 h

Size: Single stage, one compressor water-water system 3 x 2 m, 4 tons

Contact information

SPH Sustainable Process Heat GmbH
info@spheat.de
+49 2204 7061490

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