High Temperature Heat Pump + Thermal Energy Storage
Pars Makina Ltd.

Summary of technology

Our product is composed by a 100% electric high temperature heat pump based on a closed cycle charging a thermal energy storage tank. The technology is very suitable for homes and schools heating as well as process industry having waste heat for upgrade. We offer a low-cost decarbonization solution for revalorization low-grade heat such as:

- Heat from micro-size concentrated solar blocks (up to 100 °C)
- Underground and geothermal heat sources (up to 100 °C)
- Excess electrical power heaters fed from roof-top PVs. Electrical power is stored as heat inside HTHP evaporator.

Standard power rating of 15kW, 30kW, and 60 kW allow modular capacity installations up to 480 kW, combining 8 compressors in series per HTHP unit. This technology is highly flexible for different industrial operations and heat needs.

Working fluid is R-1233zd(E) and it is harmless, non-flammable, and non-toxic with an ODP of 0 and GWP < 5. The compressor technology is a patented double hinged arc vane rolling piston and its lubrication is POE-SL-68.

The Heat Transfer Fluid (HTF) on the sink and source sides is mineral-based Renotherm 320 with high thermal stability up to 320 °C. Refrigerant-to-HTF heat transfer in the evaporator and condenser are achieved through 13.05 m² of heat transfer surfaces and 29 m of finned copper piping. Hot oil circulation pumps move 100 liters of HTF within the condenser to the Thermal Energy Storage (TES).

μTES is made up of 100 kWh modules and are installed according to customer requirement. TES has a charge and discharge time of 6 hours. TES comes in three different configurations:

- Up to 120 °C: μTES-PCM contains PCM encapsulated tubes.
- Up to 150 °C: μTES-HTF contains heat transfer fluid (HTF).
- Up to 150 °C: Concrete filled μTES-C.

Integration of the heat pump and storage is optimized as operating temperatures and pressure ratios are specifically chosen for the highest operational efficiency. The calculated COP is around 9.67.

Advanced control allows for flexible operation and will follow plant heat load demand.

HTHP pilot plant is at TRL6 as the technology is being demonstrated in a relevant industrial environment.
Project example

HTHP-15 is demonstrated at full scale in the context of InnoSolPower (CSP ERA-NET grant agreement No. 838311). Performance tests are scheduled to end December 2023. Tested operating temperatures are between 100 °C and 130 °C and pressures are between 12.4 bar and 19.6 bar.

Results are presented to InnoSolPower Advisory Group Members.

Key Performance Indicators (KPIs) are: high density, high latent heat of fusion, high specific heat, melting point near the required operational temperature (120 °C), high thermal conductivity, low vapor pressure, high thermal stability, high chemical stability, low cost, high market availability, and small tank size.

HTHP technology extensions that we are working on are with transcritical and supercritical CO₂.

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### Table 1: Calculated performance.

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### FACTS ABOUT THE TECHNOLOGY

**Heat supply capacity:** Modules of 15 kW-30 kW-60 kW, combined units up to 480 kW

**Temperature range:** Maximum supply temperatures 150 °C. Maximum temperature lift is 50 °C. Maximum temperature glide at the source is 20 °C and at the sink is 40 °C.

**Working fluid:** R-1233zd(E)

**Compressor technology:** Patented rotary doubled hinged arc vane rolling piston

**The specific investment cost for the installed system without integration:** Combined HTHP-15 (15 kW unit) + µTES-PCM cost: 1500 €/kW

**TRL level:** TRL 6

**Expected lifetime:** 25 years with regular yearly maintenance

**Size:**

- HTHP alone: weight 250 kg and footprint 1 m²
- HTHP + TES: weight 2500 kg and footprint 8 m²

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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.