

Case study

Refosteel – Efficient Cryogenic Hardening for Precision Tool Manufacturing

Reliable -120°C steel hardening with 70% less energy consumption and only air as refrigerant



Photo credit: Refolution Industriekälte GmbH

Key information

Client: Rudolf Rieker GmbH, Germany

Supplier: Refolution Industriekälte GmbH, Germany

Type of facility: Cryogenic hardening chamber for steel tool components

Refrigerant: Air

System start-up: 2024

Requirements

Rieker is a specialist in induction hardening, a process that creates a very hard surface layer on low- or high-strength workpieces. Usually, the workpiece is hardened selectively in a specific area, using an induction coil to heat the surface to the hardening temperature. A special quenching medium is then sprayed onto the workpiece, producing a martensitic structure in the hardened layer. In its pursuit of more sustainable production methods, the company sought alternative solutions to the commonly used liquid nitrogen systems and chose air as a refrigerant in the cooling process. The new system was required to meet several key criteria:

- Achieve precise and repeatable martensite transformation at -120°C
- Eliminate the need for furnace re-tempering between cycles to minimize downtime
- Avoid the risks and logistical challenges associated with liquid nitrogen (LN_2)
- Ensure environmentally sustainable operations with a lower CO_2 footprint
- Ensure flexibility and compliance with future refrigerant regulations

Solution

The innovative Refosteel system features dual insulated chambers enabling thermal energy recirculation between loads. When one batch cools down, its cold air is reused to pre-cool the following batch—a design that delivers up to 70% energy savings and significantly improves thermal efficiency.

Temperature control spans from -40°C to -140°C , with continuous operation thanks to Mirai Intex's turbo-compressed air-cycle refrigeration, avoiding the need for periodic furnace re-tempering. The system includes oil-free compressors, mobile chassis, robust insulation panels, and Siemens PLC with LED status indicators to ensure easy operation and low maintenance

Open air cycle machine:

The open air cycle machine uses the air inside of the chamber as a refrigerant. No additional refrigerant is needed. The air is sucked by the machine and compressed in a turbo compressor. At a maximum pressure of 1,2 bar, the air is cooled in an air cooler. The turbine reduces the pressure of the cooled air, resulting in lower temperatures at the outlet of the turbine. The cold air then enters the room again.

Key benefits and features

The Refosteel system delivers:

- **Efficient Energy Recovery:** Dual-chamber thermal recirculation eliminates furnace re-tempering cycles, cutting energy use by up to 70%.

- **Continuous Hardening Process:** No downtime for temperature stabilization or chamber reconditioning between loads.
- **Sustainable and Safe Refrigeration Technology:** Uses only ambient air, eliminating synthetic refrigerants, LN₂ logistics, and related regulatory burdens.
- **Low CO₂ Footprint:** Natural refrigerant ensures future-proof compliance and reduced environmental impact.
- **Robust, Low-Maintenance Design:** Mirai Intex's oil-free turbo compressors run smoothly, while thick insulation and sturdy panels ensure long-term reliability.

Technical data

Cooling capacity: 10 kW at -80°C & 5 kW at -120°C

Refrigerant charge: only ambient air

Heat source temperature: -120°C

Condensing temperature: +6°C

Main components:

- Mirai Intex air-cycle chiller MC22 O/W
- Dual-chamber insulated hardening cell

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