MVR-400 - Compact open-loop high-temperature heat pump Tocircle Industries

Figure 1: Tocircle's high temperature open-loop heat pump MVR-400 (MVR: Mechanical Vapor Recompression)

Summary of technology

Tocircle's MVR-400 system has the capability to compress steam directly, up to **12 bar(a) / 188°C**. It can effectively harness input steam, e.g. waste/surplus steam from industrial processes, with temperatures as low as 90°C, and additionally, when paired with a bottom cycle, it can recover heat from sources with even lower temperatures.

This versatile system is designed to manage wet and contaminated steam, making it particularly well-suited for applications involving low-quality waste steam.

It is supplied as a ready-to-use, plug-and-play unit that can be conveniently installed on site. It can also be fully covered and insulated to accommodate both outdoor/indoor installation.

Dimensions (mm):	5000/2000/2300 (L/W/H)
Weight:	8,000kg

SV-400 COMPRESSOR

Tocircle's MVR-400 is centered around the SV-400 compressor, a **rotary positive displacement machine** built on the **rolling piston principle.**

This compressor serves as the core component and offers a combination of simplicity and robustness. It excels at achieving **high-pressure ratios**, making it often sufficient for most industrial applications with just one compression stage to reach substantial pressure lift.

The SV-400 can handle a significant liquid content in the working fluid, eliminating the need for costly pre-treatment systems to address liquid droplets in the feed stream.

This remarkable **2-phase capability** enables direct injection of liquified working fluid into the compression chamber, maintaining it within the two-phase region during compression. The discharged steam is typically **saturated** or slightly superheated as required. This approach is notably more efficient than dry compression, which subjects the compressor and downstream system to high temperatures.

APPLICATIONS/INDUSTRIES

Tocircle's proprietary MVR-400 represents a breakthrough waste heat recovery solution,

tailored to industrial processes requiring temperatures exceeding 150°C.
Industries such as food and beverage, petrochemicals, waste management, and metal production, which rely on significant energy consumption, can greatly benefit from this technology.

DEVELOPMENT STATUS

Thorough testing at Tocircle's facilities, as well as a success full-scale pilot project involving a major industrial player in Norway, have been completed. As a result, the MVR-400 is now ready for market release.

TRANSPORT MEDIA

There are no constraints on the choice of transport media for both the sink and source. To facilitate heat transfer to a selected medium at the heat sink, the MVR-400 can be paired with a condenser.

FACTS ABOUT THE TECHNOLOGY

Delivered steam mass flow: 500 – 850 kg/h pr. Unit, saturated or superheated. The total capacity can be increased by operating several compressor units in parallel.

Steam discharge pressure: 1 - 12 bar(a)

Steam discharge temperature: 100 - 188°C. The compressor is designed to handle max. 20 bara, which means a temperature of 212˚C for saturated steam.

Heating capacity for the full-scale pilot at client's facilities was approximately 450 kW.

Working fluid: Water (R718)

TRL level: TRL 7-8

Additionally, when combined with a bottom cycle, it offers the flexibility to accommodate various transport media on the heat source side.

PERFORMANCE OF THE MVR-400 (OCT. 2023)

Location	T source, in	T source, out	T sink, in	T sink, out	COP
	[°C]	[°C]	[°C]	[°C]	
Client's facilities (NO)	100	N/A	N/A	153	2.3
Tocircle's facilities	100	N/A	N/A	152	3.4
Tocircle's facilities	115	N/A	N/A	153	4.2
Tocircle's facilities	117	N/A	N/A	170	2.5
Tocircle's facilities	120	N/A	N/A	180	2

Project example

WASTE HEAT RECOVERY FROM SUPERHEATED STEAM DRYERS

In 2022, Tocircle's MVR-400 was successfully installed and put into operation at a bio-waste management plant to increase energy efficiency during the drying process. The MVR harnessed moisture evaporating from the waste while drying, in the form of atmospheric steam and efficiently compressed it 5.1 bara/153°C. This compressed steam was subsequently reintroduced into the dryer and the MVR became the only heat source, replacing the diesel-fired steam generator.

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