MAN Energy Solutions
Future in the making

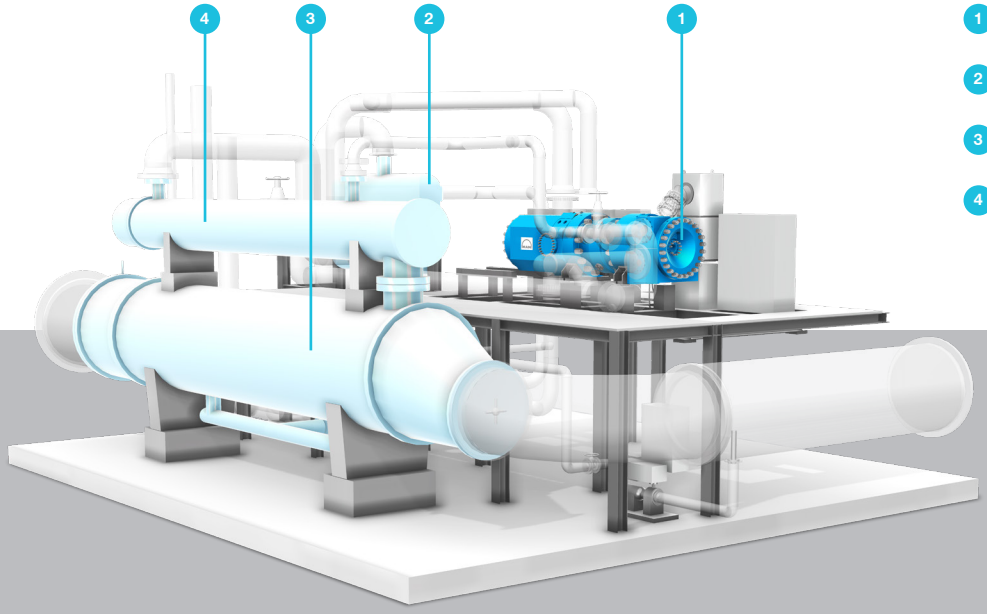
MAN heat pumps

Transcritical compression cycle (TCC)

The emission-free MAN heat pump solution makes efficient use of the special properties that CO_2 offers as working fluid. Operating with an optimized transcritical heat pump cycle, this high temperature industrial heat pump is able to generate temperatures from 0 °C (32 °F) up to 150 °C (302 °F) and up to 50 MW (170.61 MMBtu/h) of heating load and 30 MW (8530 tons of refrigeration) of cooling load with just one single heat pump unit.

Benefits at a glance

- All inclusive electric solution for low maintenance and remote operation
- Environmentally friendly refrigerant
- Large scale supply of heating and/or cooling
- High supply temperatures
- Fast start-up, shut down and load change reaction time
- Participation in the primary and secondary balancing market (FCR, aFRR)
- Flexible adaptation of supply and return temperatures under operation
- High power density



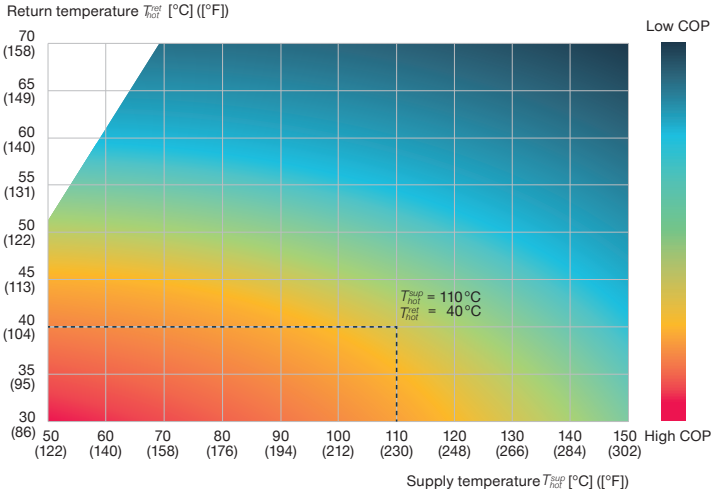
1. HOFIM® compressor
2. Heat sink HEX
3. Evaporator
4. Recuperator

Energy & storage systems

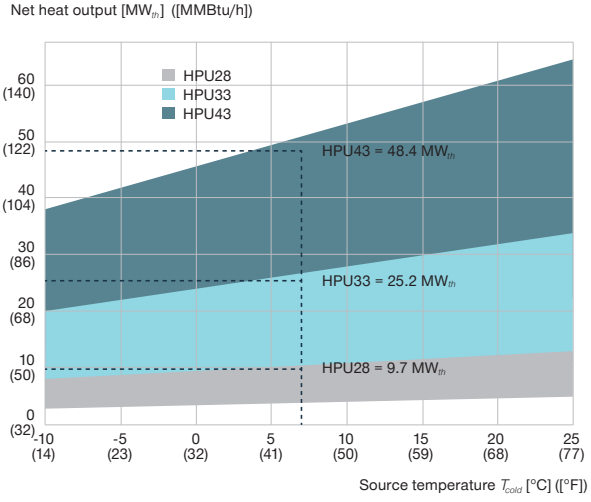
Nominal Conditions

	Unit	MAN HPU28	MAN HPU33	MAN HPU43
No. compressors	Pcs.	1	1	1
Variable speed drive (VSD)	–	Yes	Yes	Yes
Max. thermal turndown	%	50	50	50
Refrigerant charge (CO_2)	kg (lbs)	9'000 (19'841)	13'750 (30'313)	20'000 (44'092)
Electrical supply voltage	kV	min. 4.16	min. 6	Min. 6
Heating capacity	kW_{th} (MMBtu/h)	9'670 (33)	25'230 (86)	48'400 (165)
Cooling capacity	kW_{th} (tons)	6'270 (1783)	16'730 (4757)	32'500 (9241)
Motor input power	kW_{el}	3'400	8'500	15'900
COP (Hot)	–	2.84	2.97	3.04
COP (Cold)	–	1.84	1.97	2.04
COP (total excl. pumps)	–	4.68	4.94	5.08
Dimensions (L/W/H)	m (ft)	12/8/8 (40/26/26)	16/8/8 (52/26/26)	19/10/8 (62/33/26)
Floor load	kN/m² (psf)	10 (209)		
Connections at heat sink	–	DN200 (4")	DN300 (12")	DN400 (16")
Connections at heat source	–	DN500 (20")	DN900 (36")	DN1400 (56")
Design pressure	Barg (psig)	180 (2610)		
Design temperature	°C (°F)	200 (392)		
Controller type	–	Programmable logic controller (PLC)		
Communication protocol	–	MODBUS/PROFINET/Ethernet		

Nominal reference conditions: Heat sink supply/return temp.: 110 °C/40 °C (230 °F/104°F); Heat source temp.: 10 °C (50 °F)



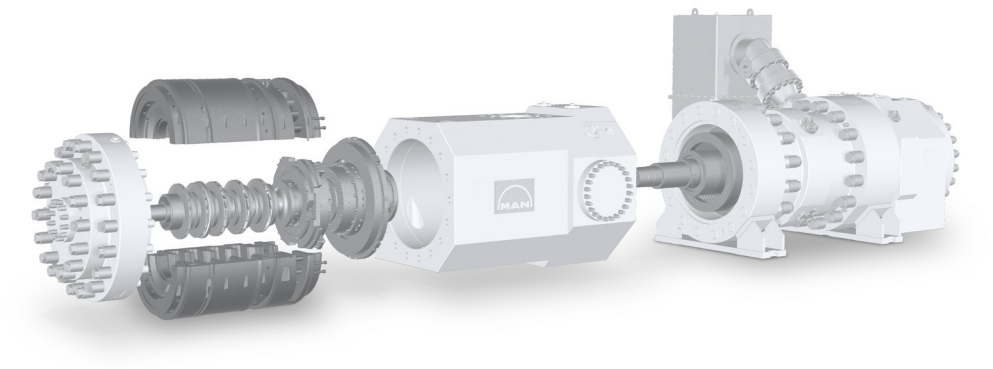
COP operating range as function of heat sink supply and return temperature for a constant source temperature



Net heat output as function of the source temperature (Heat sink temp. 110°C / 40°C (230°F / 104°F))

Advantages of using CO_2 as a refrigerant

- Carbon dioxide is a naturally available gas which is available in large quantities and inexpensive compared to synthetic refrigerants
- Carbon dioxide is an environmentally friendly, low GWP, non-toxic and non-explosive medium
- Carbon dioxide is a very dense refrigerant with a high volumetric heating capacity; this allows the piping sizes and equipment volume to be much smaller than an equivalent HFC system
- Transcritical CO_2 heat pump cycle systems provide a high discharge temperature, therefore removing the need for cascade heat pump systems or additional heating devices
- There is no impending legislation phasing out carbon dioxide; hence it can be considered as a safe refrigerant, matching the clients long-term carbon footprint reduction strategies
- Transcritical CO_2 MAN heat pump is remarkably suited for significant heat sink temperature differential



Dismantled HOFIM® Heat Pump core unit

Key components

HOFIM®
- Integrated machinery concept comprising of a centrifugal compressor, a high speed electric motor and power recovery turbine stage
- Hermetically sealed design preventing gas leakages to the environment
- Modular concept for maximum process design flexibility
- The active magnetic bearing system ensures a broad operating range, the highest reliability and availability as well as a quick start-up and shutdown; without a lubrication oil system and complex auxiliaries
- Designed for full remote operation, thanks to the comprehensive electric design
- Optimized installation and commissioning as well as lower maintenance since no external cooling medium, no lube oil neither sealing gas is required

Heat sink HEX
- Printed circuit heat exchanger (PCHE) design
- Very compact and robust design
- Suitable for efficient gas to liquid heat transfer with narrow approach temperatures

Evaporator
- Different types available based on heat source media (Shell & Tube, PCHE, Plate Fin)

Recuperator
- Heat exchanger used to optimize the system and reduce system losses
- Different types available based on heat source media (Shell & Tube, PCHE, Plate Fin)

Expansion
- Turbine stage for recuperation of the usable kinetic energy of the refrigerant in the expansion process
- Expansion valve for the expansion into the two-phase region until evaporation pressure

Control system
- Process control system for control and operation of the complete heat pump unit
- Advanced digital services for remote operation, real time monitoring and predictive maintenance availably

Other available options
- CO_2 to air evaporators
- CO_2 detection system for machinery room and in the water systems
- Heat exchanger online cleaning systems (on water side)
- Additional CO_2 storage vessel for maintenance purposes
- A wide range of after sales

Selected applications

Scalable and modular, MAN mega heat pumps are suitable for mid- to large-scale thermal consumers in the range of 25 – 50 MW per unit and larger.

District heating, municipal, urban and large facilities

With the MAN mega heat pumps, you can decarbonize the complete energy supply for district heating networks, urban quarters, small towns and large facilities like airports, universities or shopping malls.

Process industries

MAN heat pumps provide cost-efficient carbon-neutral heating or cooling for all kinds of industrial processes with intensive heating and/or cooling demands, especially in the food, beverage and chemical industries.

Data centers

Data center operators can reduce their CO_2 emissions and electricity costs with a direct supply of cooling energy. An additional revenue stream can be created by participating in the power markets and exporting thermal energy, e.g. for district heating.

MAN Energy Solutions Schweiz AG
Hardstrasse 319
8005 Zurich, Switzerland
P + 41 44 287-2211
info-ZUR@man-es.com
www.man-es.com

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