ENOUGH
EUROPEAN FOOD CHAIN SUPPLY
TO REDUCE GHG EMISSIONS BY 2050

Factsheet 8
May 2023

Smart CO_2 (R744) refrigeration and heat pumping systems

This paper presents applications for refrigeration systems using CO_2 (R744) as a working fluid. Key advantages to encourage a widespread utilization are also identified.

Main results: Commercial refrigeration has many successful market introductions globally with high growth rates. Cold Thermal Energy Storage using the solid-liquid phase change of CO_2 can support existing large scale freezing plants to support load shift (el. power demand) for industrial freezing plants.

Mobile AC systems, bus, train, truck, trailer, container

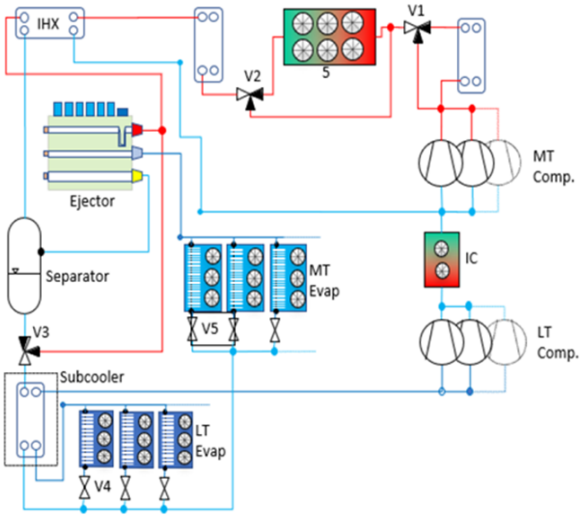
- For trucks and trailers, Ecooltec 2022 developed roof-mounted refrigeration units using propene (R1270) and CO_2. The air inside the cargo compartment is either heated or cooled by CO_2. Propene is applied inside the active outdoor refrigeration loop, heating or cooling the CO_2. This way, CO_2 is applied and circulation without any pump or compressor unit.

Commercial refrigeration

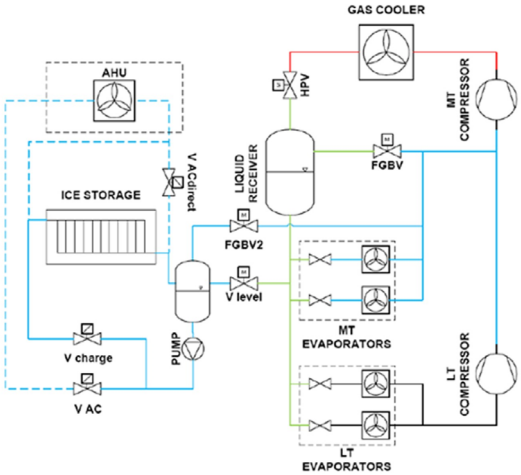
- For warm climate locations, the high-pressure control valve is replaced with ejectors enabling for expansion work recovery. Additional heat exchangers are used for heat recovery if required by the end-user site.
- Low ambient temperatures operation can be challenging for ejector CO_2 booster systems. Pardiñas Á.Á. 2022 proposed an approach continuing with the idea of partly bypassing the ejectors. The ejector is active if there is sufficient expansion work available. In this active mode, the ejector acts as a MT 'booster device' and pre-compresses the entire MT vapour flow rate towards the suction port of the MT compressor.

Cold Thermal Energy Storage (CTES)

- For AC support of a supermarket, Selvnes 2023 described a CTES unit integrated into a standard booster system. Water is the stationary CTES fluid. The phase change between liquid and solid state is used to store cooling capacity, by recondensing CO_2 which evaporates while cooling air inside the air handling unit (AHU).
- For storage and freezing around – 50°C, Mastrani 2022 proposed using the solid-liquid phase change of CO_2 for low-temperature thermal energy storage in pillow plate heat exchangers. The concept requires to let CO_2 swing between the saturated solid and saturated liquid state and avoid going beyond the liquid region. Applicable to implement peak load shifting in industrial freezing plants.



Energy efficient, simple ejector supported R744 commercial refrigeration unit (Pardiñas Á.Á. 2022)



Simplified system circuit for supplying AC by CTES unit based on water/ice as the natural storage medium. The system is shown in charging mode (Selvnes 2023)

Find more about this study from the original publication:10.18462/iir.nh3-co2.2023.0002 .

ENOUGH webpage: https://enough-emissions.eu/
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This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement N° 101036588