Technical session topic: Energy-efficient heating and cooling systems for buildings **ICR0111**
Subtopic: Natural refrigerants in heat pump systems

Carbon dioxide as refrigerant for tap water heat pumps: a comparison with the traditional solution.

Luca Cecchinato, Marco Corradi, Ezio Fornasieri*, Lorenzo Zamboni
Dipartimento di Fisica Tecnica – Università degli Studi di Padova
Via Venezia, 1 – I-35131, Padova, Italy
Fax +39 049 8276896
e-mail addresses: vanna.casson@unipd.it, ceck@unipd.it, marco.corradi@unipd.it, ezio.fornasieri@unipd.it, lorenzo.zamboni@unipd.it, claudio.zilio@unipd.it

Carbon dioxide as operating fluid in compression refrigerating cycles takes advantage of its inherently large temperature glide in the heat rejection process, if the application requires heating of a relatively small flow rate of fluid with a large temperature difference from inlet to outlet. This would be the case in heating tap water, but the current technology of heat pumps is thought for the traditional refrigerants and therefore uses large flow rate and small temperature difference since a storage tank, where water is mixed, is generally employed.
To exploit the potential for energy saving arising from the transcritical cycle of CO_2 there is a need to promote water stratification inside the tank, so that the heat pump draws water from the bottom and raises its temperature up the same value of the top of the tank, where it is delivered.
A comparison is made, in terms of energy efficiency and swept volume, between such a heat pump and a traditional one, operating on R134a; the CO_2 system performs better than the competitor, provided that stratification is effective, but, in the case of mixing, R134a displays better efficiency.
This analysis is accomplished by means of an advanced simulation model of a refrigerating circuit where the condenser/gas cooler is a tube in tube heat exchanger and the evaporator is a traditional finned coil with tubes of 7 mm diameter. For the sake of comparison the heat exchangers are of the same area and, as possible, of the same design, except that they are optimised as for the configuration of the circuits, refrigerant side; CO_2 in fact needs higher mass velocity to attain the best trade-off between heat transfer coefficient and pressure drop.

* *Corresponding author* (tel. +39 049 8276878)

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