EFFECTS OF A R744 COOLING UNIT DESIGN ON THE OVER-ALL ENERGY PERFORMANCE OF A REFRIGERATED VEHICLE

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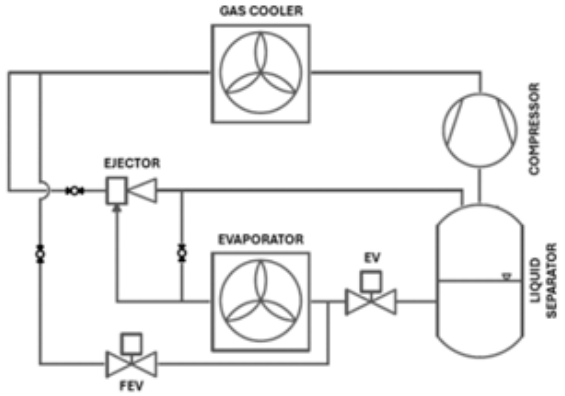
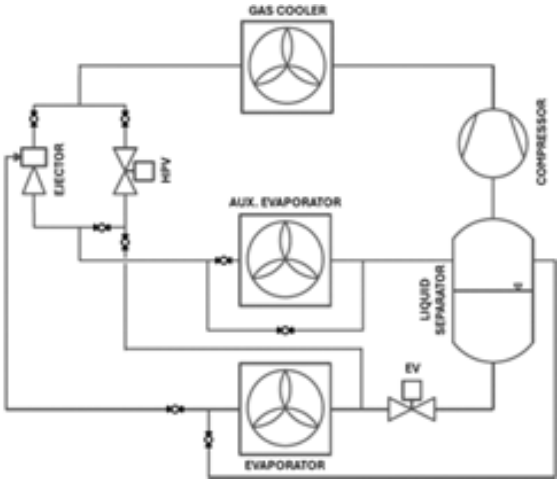
ENOUGH
EUROPEAN FOOD CHAIN SUPPLY TO REDUCE GHG EMISSIONS BY 2050

The objective of this study is the design and performance evaluation of a R744 refrigeration system employed on a small vehicle used for last mile delivery of chilled goods (4-5 kW at 0°C) in urban environment. Different R744 unit configurations were numerically evaluated, to identify the best trade-off between COP and unit weight, with the overall goal of minimizing the global carbon footprint.

Cooling unit layouts

The effects of different layouts, controls and components were numerically evaluated, firstly focusing on the thermodynamic performance of each solution, and then considering the trade-off between performance improvement and weight reduction, to reduce the overall carbon footprint of the transport refrigeration unit.

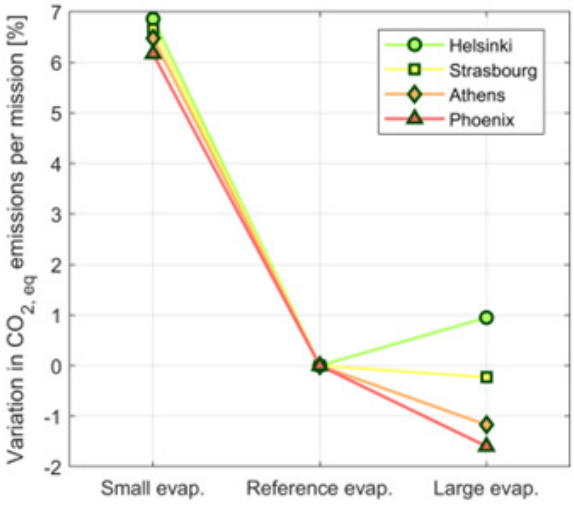




Cooling unit performance

A quasi-steady-state numerical approach was used to evaluate the CO2eq emissions associated with the cooling unit operating on a refrigerated van in a short-range multi-drop delivery mission. The carbon footprint was evaluated in four climatic conditions: Helsinki (cold European climate), Strasbourg (mild European climate), Athens (hot European climate) and Phoenix (hot desert climate).

- The fixed orifice (FO) unit layout with variable-speed compressor for high pressure control outperforms the modulated orifice layout with fixed-speed semi-hermetic compressor and HPV control, leading to a reduction in carbon emissions between -15.5% and -30.0% depending on climatic conditions.
- The scroll compressor used in the FO unit presents the double advantage of increasing the unit COP and at the same time reducing the weight of the unit.
- The use of an ejector can reduce the carbon emissions from -6.0% to -17.5% compared to a simple expansion valve cycle.



Find more about this study from the original publication: http://dx.doi.org/10.18462/iir.gl2024.1233

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Authors: Francesco FABRIS, Wasim SHAH, Sergio MARINETTI, Silvia MINETTO, Antonio ROSSETTI.
Corresponding author: fabris@itc.cnr.it

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