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Natural technologies for sustainability: accelerating implementation

Francesco Mastrapasqua
Institutional Affairs Manager, Epta

The Life-C4R project of the Epta group has been concluded and will be key in accelerating the implementation of very high-efficiency CO₂ commercial refrigeration systems in the European market. FTE2.0 (Full Transcritical Efficiency) and ETE (Extreme Temperature Efficiency) technologies proved their capability to combat climate change by replacing HFC (hydrofluorocarbons) greenhouse refrigerants with CO₂ refrigerant additionally providing a substantial energy saving in any country, with any external temperature and further maintenance cost savings, all in a very simple system design.

Context and objectives of the project

The HFC refrigerants in commercial refrigerators, air conditioners and heat pumps contribute to the current climate crisis.

Considering that the Paris Agreement, which engages 200 countries, aims at maintaining the temperature increase within 2°C while pursuing efforts to limit it to 1.5°C (compared to pre-industrial levels), it is clear that the 0.5°C temperature reduction possible simply by

eliminating the use of HFCs represents an important contribution to the global mitigation efforts.

The European Union aims to reduce greenhouse gas emissions from HFCs by 80 per cent by 2030 and tracks the progress towards this goal.

Rapidly reducing greenhouse gas emissions in the refrigeration sector is today more than ever considered the epochal challenge that, on the other hand, offers important opportunities for sustainable technologies that effectively act to fight climate change.

Technical actions

The Life-C4R project was created to accelerate the deployment of high-efficiency refrigeration systems based on R744/CO₂ refrigerant, a natural non toxic and non-flammable refrigerant, ensuring energy savings of more than 10 per cent in any country and with any climate, and reduced installation and maintenance costs by up to 30 per cent.

The Life-C4R started with a preliminary phase of industrial design and development of the refrigeration technologies based on performance tests and fine-tuning

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performed by Epta in its laboratories in Limana (BL) in Italy.

The Life-C4R technologies are:

- **FTE2.0 (Full Transcritical Efficiency)**
A device that allows elimination of the superheat, thus increasing the evaporation temperature in the MI cabinets evaporators (fresh food products), obtaining a considerable reduction in the energy consumption of the cooling power rack.
- **ETE (Extreme Temperature Efficiency)**
A sub-cooler using natural refrigerant CO₂ integrated into the refrigeration system, extending the range of use of the CO₂ system in the hot climates and with temperatures above 40°C.

The Life C4R technologies have been implemented in seven food retail stores in Italy, Romania and Spain.

These pilot installations were important in proving the reliability, performance and energy consumption of the C4R system in different conditions:

- Store surface, from 1000 to 6000 sqm
- Climatic conditions, from mild to extremely hot temperatures
- Different countries and with different habits, knowledge, skills, etc.

Data and results

The pilot projects were observed over more than a full year and aimed to verify the reliability and measure performance operation and consumption in all seasons. The pilots clearly show that the Life-C4R technologies guarantee a reduction in energy consumption ranging from 15 per cent to 23 per cent on an annual basis—much higher than initially expected.

The key outcome of the pilot store trials is that the Life-C4R technologies using CO₂ natural refrigerant always guarantee very efficient operation regardless of the outside temperature. The data acquired from the seven pilot stores allowed to build a model to predict the behaviour of the FTE2.0

Figure 1: Transcritical CO₂ power rack for medium-large stores with incorporated FTE2.0 and ETE.

Figure 2: Food retail stores equipped with the C4R technologies in the LIFE-C4R project.

and ETE systems in any other condition. A computational analysis tool has been created to give precise estimations to be used in sales and marketing activities.

The LCCP analysis

To monitor and evaluate the global carbon footprint of these innovative CO₂ solutions, Epta performed a full life cycle analysis of the greenhouse gas emissions of Life-C4R technologies according to the standards of LCCP (Life Cycle Climate Performance).

LCCP is a method that allows precise calculation of the overall carbon footprint of the system during its entire useful life "from cradle to grave" considering:

- a) direct emissions deriving from the loss of refrigerants into the atmosphere during the operation and disposal of the equipment;
- b) indirect emissions of greenhouse gases in relation to the production of electricity that powers the equipment;
- c) incorporated emissions, related to the processes of production, transport and end-of-life disposal of all materials, the equipment and the refrigerant.

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