Nidec
Global Appliance

Ecological Sustainability
with Embraco VCC Compressors

2023

embraco
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Introduction

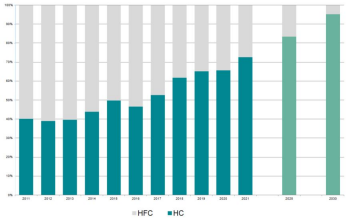
Transformations are a constant of humanity, but never before have they been so fast and rapidly accelerating, in many social and industrial fields, including the refrigeration sector.

What's affecting **Refrigeration**

High attention to the environment
Sustainable economy
More stringent regulations

→

Natural Refrigerants
Reduced direct and indirect emissions
High Efficiency Solutions
Supply Chain Governance



R290

Natural refrigerants: HCs in Europe almost totally cover self contained equipment and a consistent part of stationary equipment; in the rest of the world HCs are growing fast. R290's low GWP (0,02 - 6AR IPCC) practically nullifies the impact of direct emissions: in-use phase and supply chain's indirect emissions assume crucial focus as areas of improvement.

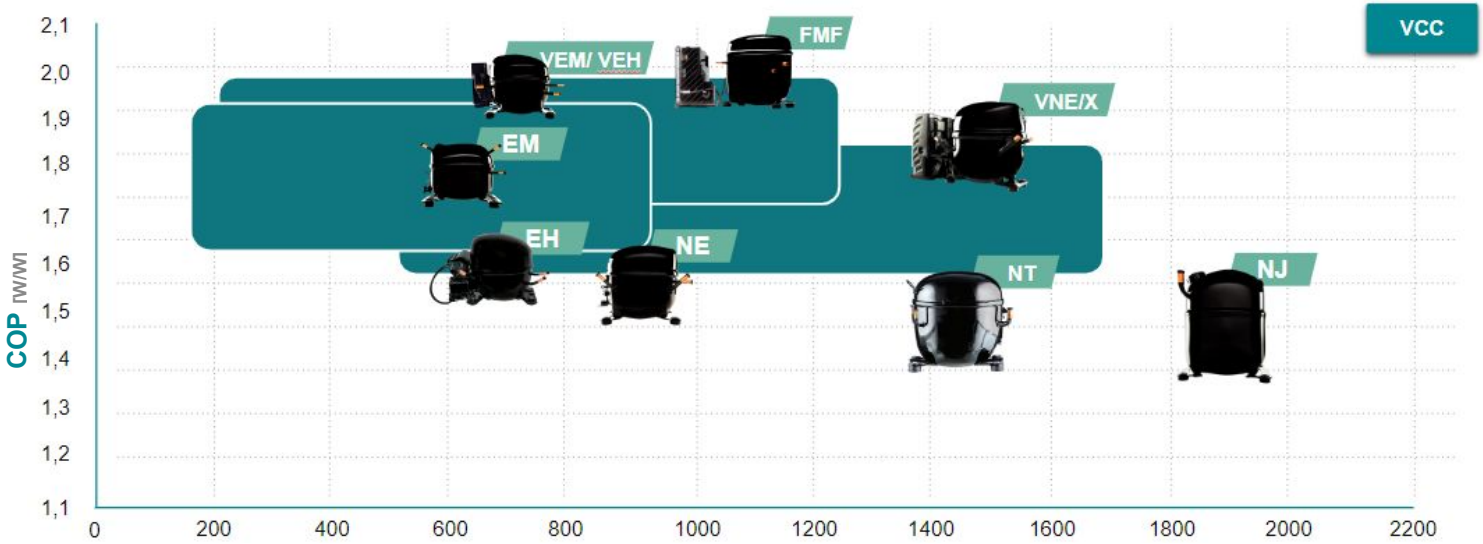
VCC

Among the various elements to increase the energy efficiency of the cabinets, **VCC compressors** produce the greatest effect, combined with a rapid return on investment

Compact frames

Supply chain emission reduction: the compact frames of the Embraco VCC compressors allow a reduction of emissions for the processing of raw materials and transport

A complete portfolio suitable to different needs



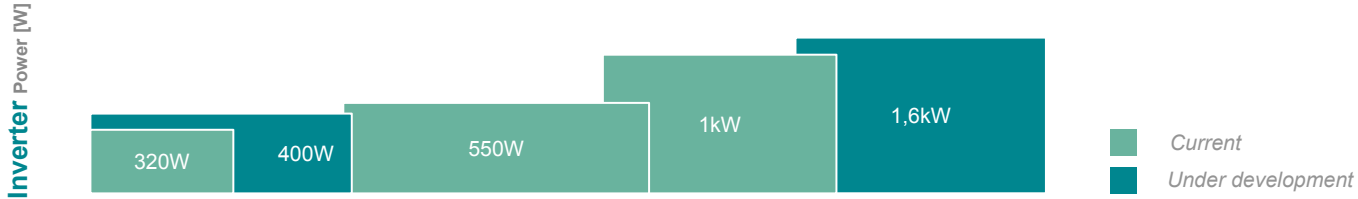
Naturally Efficient

Energy Efficient

Reliable

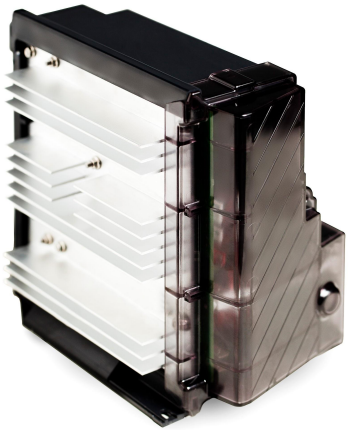
COOLING CAPACITY [W]

Test condition: Ashrae LBP 32



Adopting the Variable Speed Technology

The VCC brings **highest saving when running at low speed**. To achieve these conditions it is necessary to adjust the rotation steps (and possible stops) of the VCC: this is possible thanks to a **fine tune (*) of the control parameters**.



(*) the Embraco VCC have 3 control modes:

a- ***SDI (smart drop-in)**: the control algorithm is embedded into the inverter; the thermostat just turns on/off the compressor and the inverter adjusts its speed depending on the compressor load, without external sensors.*

b- ***Frequency control**: an external controller controls the inverter, which establishes the compressor's speed according to the input frequency*

c- ***Serial control**: the external controller adopts a serial communication protocol (RS-232); it is possible to define the compressor speed and check other parameters. This allows OEMs to develop their own control logic and obtain feedback on compressor operation.*

MAIN BENEFITS OF THE VCC TECHNOLOGY

- Low noise & vibration
- Temperature Control
- Variable Speed/Capacity
- Fast cooling and Freshness
- Wide Voltage Range
- Reduced Pull Down Time
- High Efficiency

Variable Speed vs On-Off Compressors

Scope:
Compare the energy consumption of **three typical plug-in commercial refrigeration equipments** when using on-off compressors and Embraco VCC compressors, with SDI logic or frequency control

Cabinet selection:
High efficiency cabinets, in mass production or new developments, using R290 and top efficiency on-off compressors

- Vertical Two-Doors freezer - VF2 (EN23953:2015)
- Vertical open cooler, 2,5m - VC2 (EN23953:2015)
- Monoblock for cold room - Daikin model BCVT K1 CC2 (EN 17432:2021)

Compressors:

- On-off compressors: NT (high efficiency) and NTX (top efficiency)
- VCC high efficiency, wide speed range:
    - VNEX (new development, under tests by OEMs)
    - FMFT (already largely used on CR appliances)

Methodology:
The first two cabinets were designed and optimized for the use with on-off compressors, and have been tested at the Embraco Labs at first in the original version, to set the baseline, and later replacing the on-off compressors with the with VCC ones, without modifications of the refrigeration circuits, only **optimizing the refrigerant charge** and **fine tuning the compressor's speed control parameters**.
The monoblock has been designed and optimized for variable speed.

Two-Doors Reach In Freezer

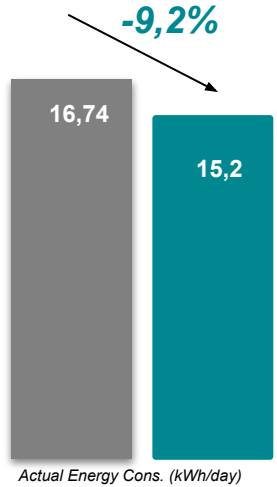
Case Study Parameters

	On-Off	VCC
Compressor	**NTX2211U**	**VNEX221U**
Type	**Fixed Speed**	**Variable Speed**
Nominal Voltage	220-240V 50Hz	208-240V 50/60 Hz
Refrigerant	R290	R290
Charge	180 g	150 g
Condenser	Finned-tube	Finned-tube
Evaporator	Finned-tube	Finned-tube
Defrost	Hot Gas	Hot Gas
Class	3-L1	3-L1
Climate Class	C	C
Energy Label	C	C

TDA (Total Display Area): 2,31 m²

Cabinet test conditions: EN-ISO-23953-2

Energy Consumption Reduction



9,25%
energy consumption reduction

1.287 kg CO_2/10 yrs
not emitted due to lower energy consumption
assuming 0,229 kg CO_2e / kWh*

101 €/year
savings in the energy bill
assuming 200€ / MWh electricity cost**

Results obtained by just switching the compressor and optimization of the speed control.
Fine tuning the control parameters, adjusting the rotation speed and the possible stops of the compressor, is key to minimize the energy consumption
Further savings can be achieved by optimizing the cooling circuit and increasing the refrigerant charge - simulations indicate that the saving can approach 15%,

* according to data from the European Environment Agency
** IBIS World Consulting Firm

Vertical Open Cooler

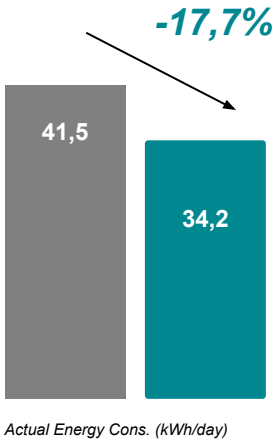
Case Study Parameters

	On-Off	VCC
Compressor	**2x NT6230U**	**2x VNEX621U**
Type	**Fixed Speed**	**Variable Speed**
Nominal Voltage	220-240V 50Hz	208-240V 50/60 Hz
Refrigerant	R290	R290
Charge	2x 150 g	2x 170 g
Condenser	Finned-tube	Finned-tube
Evaporator	Finned-tube	Finned-tube
Defrost	Natural	Natural
Climate Class	3	3
Class	H2	H2
Energy Label	F	E

TDA (Total Display Area): 5,2 m² - Length: 2,5m

Cabinet test conditions: EN-ISO-23953-2

Energy Consumption Reduction



Actual Energy Cons. (kWh/day)

17,7%
energy consumption reduction

6.102 kg CO_2/10 yrs
not emitted due to lower energy consumption
assuming 0,229 kg CO_2e / kWh*

533 €/year
savings in the energy bill
assuming 200€ / MWh electricity cost**

Fine tuning the control parameters, adjusting the rotation speed and the possible stops of the compressor, is key to minimize the energy consumption

* according to data from the European Environment Agency
** IBIS World Consulting Firm

Walk-in cold room monoblock – Daikin LMSEY

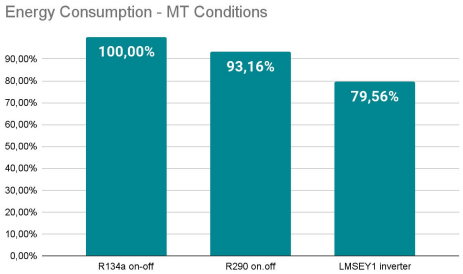
Cooling capacity [kW] MT (Tc 0°C - Ta 32°C)	1.28	2.45
Cooling capacity [kW] LT (Tc -20°C - Ta 32°C)	0.75	1.41

LMSEY1 has been compared, through EN 17432 tests (*), with similar capacity R134a (MT only), R452a (LT only) and R290 units available on the market and equipped with on-off compressors. *(Test carried out in Daikin Labs)*

LMSEY1 results show better EER both in MT and LT conditions.

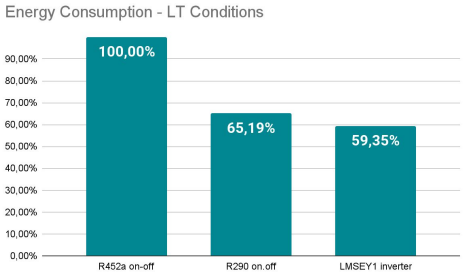
Better EER allowed by inverter technology translates into lower electrical energy consumption

MT conditions



MT conditions:
Exterior temperature at inlet 32 °C
Interior temperature at inlet 0 °C

LT conditions



LT conditions:
Exterior temperature at inlet 32 °C
Interior temperature at inlet -20 °C

(*) The results are more conservative than real situations, which show conditions such as:

- Door openings of the walk-in cold room
- Food perspiration
- Variable heat load due to foodstuff rotation
- Variable heat load due to outdoor conditions

Assuming negligible direct emission (hermetically sealed systems) and same reliability of the products, these diagrams represent also the TEWI and the annual cost of ownership.

Courtesy of Daikin

Conclusions

- Sustainable economy, environmental attention of the users, more stringent regulations (the imminent Fgas revision, the Ecodesign revision and the harmonization of the EN 60335-3-89:2022) stimulate a transformation process toward a rapid diffusion of natural refrigerants - in particular of HCs for self-contained and stationary equipment - and a strong demand for high-efficiency solutions, also minimizing the use of raw materials

- The large adoption of HCs and their low GWP practically nullified the direct CO_2 emission and focus the attention on in-use energy saving and supply chain indirect emissions.

- Embraco R290 VCCs – high efficiency in compact frames compressors - represent a valid solution to these needs.

- The energy saving and CO_2 indirect emissions highlighted in the case studies on 3 representative solutions of self-contained refrigerating equipment evidence the substantial energy saving even vs on-off high efficiency solutions

- The VCC compressors, already widely used on cabinets for retailers, are growing strongly also in the Ho.Re.CA. professional and merchandisers segments: their diffusion contribute to the ecological transformation targeted by the EU Green Deal and REPower EU.