Shifting to low GWP alternatives in commercial refrigeration

Trecerea la alternative cu GWP scăzut în refrigerarea comercială

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DOI: 10.37789/rjce.2024.15.3.17

Abstract
Adoption of the new regulation 2024/573 of the European Parliament and of the Council, due to the increase in global warming, commercial refrigeration adapts, together with the reduction of the possibility of using refrigerants with a GWP greater than 150 units starting from 2025. In this way, the transition to refrigerants with GWP less than 150 units becomes mandatory for manufacturers of stationary refrigeration equipment. Refrigerants with GWP below 150 units are from category A2L (slightly flammable refrigerants) and A3L (flammable refrigerants) and this implies greater safety measures in installation and service than in the case of refrigerants from category A1L (non-flammable refrigerants).

Key words: *commercial refrigeration, low GWP, A2L refrigerants, A3L refrigerants.*

1. Introduction

The refrigerants with GWP greater than 150 units that we know now are towards the end of their service life according to regulation 573/2024 of the European Parliament and the Council [1], but also the beginning of a new stage in the development of refrigerants and the equipment that uses them. At the same time, the technological advance allows us to use refrigerants with low GWP such as CO2 for a long time from now, but from an economic point of view it is known that it is not sustainable in all economies, so refrigerants in the A2L category (only slightly flammable) with GWP below 150 units represents a viable solution with immediate application in commercial refrigeration (Fig. 1) [2].

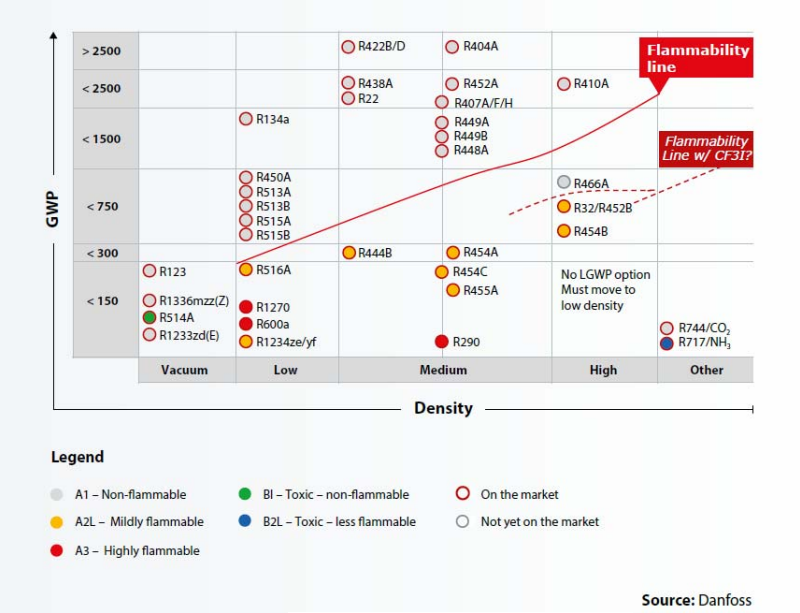

Fig.1. Main refrigerants in the market [2]

2. Case study

This study shows the differences between an installation using refrigerant R404A – A1L with GWP -AR4, 3922 units and an installation using refrigerant R455A -A2L with GWP -AR4, 148 units. Both of them are installed on the same type of cold room Fig.2 [3].

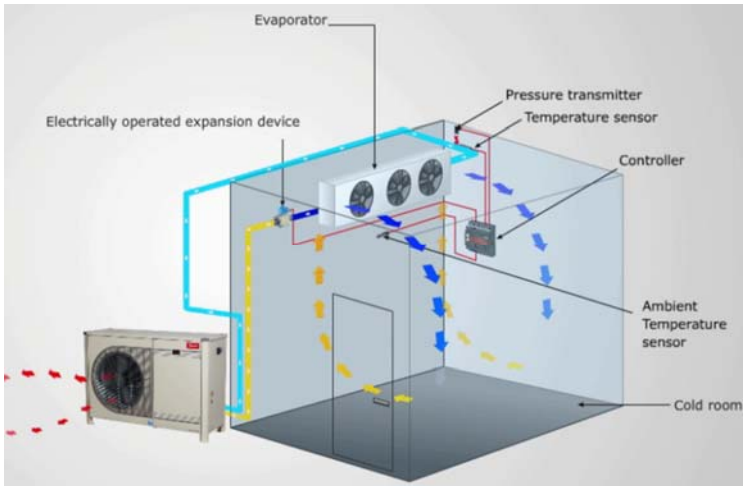

Fig.2. Cold storage room [3]

The cold room cooling capacity requirement calculation (Table 1) is done with Scelte Selection Software by ECO Modine [4]:

Table 1

Calculating cold requirements [4]

Scelte SELECTION SOFTWARE
Adrian Mihai

ECO heat transfer coolers
MODINE
Cold Room
3/24/2024

Internal length	m	5.000	Internal volume	m³	60.000
Internal width	m	4.000	Cold room position	Internal	
Internal height	m	3.000	Traffic	Medium	
	Insulation		**Thickness mm**	**Conductivity W/(m*°C)**	**Ext. T. wall? W/(m*°C)**
Wall A	Polyurethane foam 40 kg/ m3		100	0.020	30.0
Wall B	Polyurethane foam 40 kg/ m3		100	0.020	30.0
Wall C	Polyurethane foam 40 kg/ m3		100	0.020	30.0
Wall D	Polyurethane foam 40 kg/ m3		100	0.020	30.0
Ceiling	Polyurethane foam 40 kg/ m3		100	0.020	30.0
Floor	Concrete		200	1.512	16.0
Mean value					
Freezing point			°C	-1.2	
Water content			%	81	
Specific heat BEFORE freezing			kJ/(kg*°C)	3.54	
Latent heat for freezing			kJ/kg	258.20	
Specific heat ABOVE freezing			kJ/(kg*°C)	1.79	
Respiration heat			W/kg-24h	1.07	
Cold room : Preservation of fresh products					
Max room capacity by load 120 kg/ m³			kg	5040.000	
Products introduced daily			kg	504.000	
Temperatura aria esterna / Relative humidity			°C / %	30.0 / 80	
Room temperature / Relative humidity			°C / %	2.0 / 80	
Load temperature			°C	15.0	
Cooling time			h	18.0	
Number of personnel in room / Occupancy				1	
Hours of stay in room			h	1.0	
Lighting			W/m²	10.0	
Wall dispersion		24.00 h	kW	34.651	
Air changes		24.00 h	kW	13.243	
Ventilation		24.00 h	kW	3.346	
Product cooling		24.00 h	kW	8.589	
Respiration		24.00 h	kW	5.393	
Packaging		24.00 h	kW	0.000	
Personnel		24.00 h	kW	0.266	
Lighting		24.00 h	kW	0.200	
Other		24.00 h	kW	0.000	
TOTAL		**24.00 h**	**kW**	**65.687**	
Compressor running hours		24.00 h	h	12.00	
Hourly Plant Load		**24.00 h**	**kW**	**5.474**	

This old cold room is coolled by one condensig unit Tecumseh with piston compressor, model SILFH 4544 ZTX (Fig.3), which works with refrigerant R404A and having an evaporation temperature of -8°C and GWP = 3992. The performances of the SILFH4544-ZTX at the point of operation are presented in Table 2, and the mechanical and physical characteristics in Table 3 [5].

Fig. 3. Data sheet SILFH4544-ZTZ [5]

Table 2

Performance at specified operating point SILFH4544-ZTX data al 50 Hz [5]

Characteristics	Notation	U.M.	Value
Cooling Capacity	Q_C	kW	5.49
Total Power Input	P	kW	3.10
Coeficient de performanță	COP	W/W	1.77
Current at 400 V	I	A	6.16
Condensing Temperature	T_c	ºC	45.00
Subcooling	T_{SC}	K	4.67

Table 3

The characteristics for condensing unit Type SILFH4544-ZTX [5]

Characteristics	U.M.	Value
Mechanical and physical		
Diameter condenser fan/Speed	mm/rpm	450 / 830
Number of fans	pcs	1
Total Fan Power Input	W	95
Height	mm	837
Depth / Width	mm	654/1174
Suction Diameter	inch	7/8
Liquid Line	inch	½
Suction Type		Cu Type
Net Weight	kg	90.0
Sound		
Dew temp. for refrigeration applications (MT)	°C	-8.0

The second instalation according to the new regulation is condensig unit Tecumseh with piston compressor, model SILFH 4544P-TX (Fig.4), which works with refrigerant R455A and having an evaporation temperature of -8°C and GWP =148.

Fig. 4. Data sheet SILFH4544P-TX [5]

The performances of the SILFH4544P-TX at the point of operation are presented in Table 4, and the mechanical and physical characteristics in Table 5 [6].

Table 4

Performance at specified operating point SILFH4544P-TX data al 50 Hz [6]

Characteristics	Notation	U.M.	Value
Cooling Capacity	Q_C	kW	5.49
Total Power Input	P	kW	2.73
Coeficient de performanță	COP	W/W	2.01
Current at 400 V	I	A	5.73
Condensing Temperature	T_c	ºC	45.00
Subcooling	T_{SC}	K	4.67

Table 5

The characteristics for condensing unit Type SILFH4544P-TX [6]

Characteristics	U.M.	Value
Mechanical and physical		
Diameter condenser fan/Speed	mm/rpm	450 / 1100
Number of fans	pcs	1
Total Fan Power Input	W	185.0
Height	mm	710
Depth / Width	mm	652/1169
Suction Diameter	inch	7/8
Liquid Line	inch	½
Suction Type		Cu Type
Net Weight	kg	92.0
Sound		
Dew temp. for refrigeration applications (MT)	°C	-8.0

3. Comparative analysis

The investments costs presented in Fig 5. a), shows the differences betwen instalation with R404Aand instalation with R455A, this is showing that the new technology is more expensive than the old one.
When we talk about annual exploitation costs, the performances of the new equipments conparative with old one is better and the cost are much lower (Fig. 5 b).
Evaluating the GWP performances (Fig 5 c) the new instalation with R455A is much more safe from environment point of view .

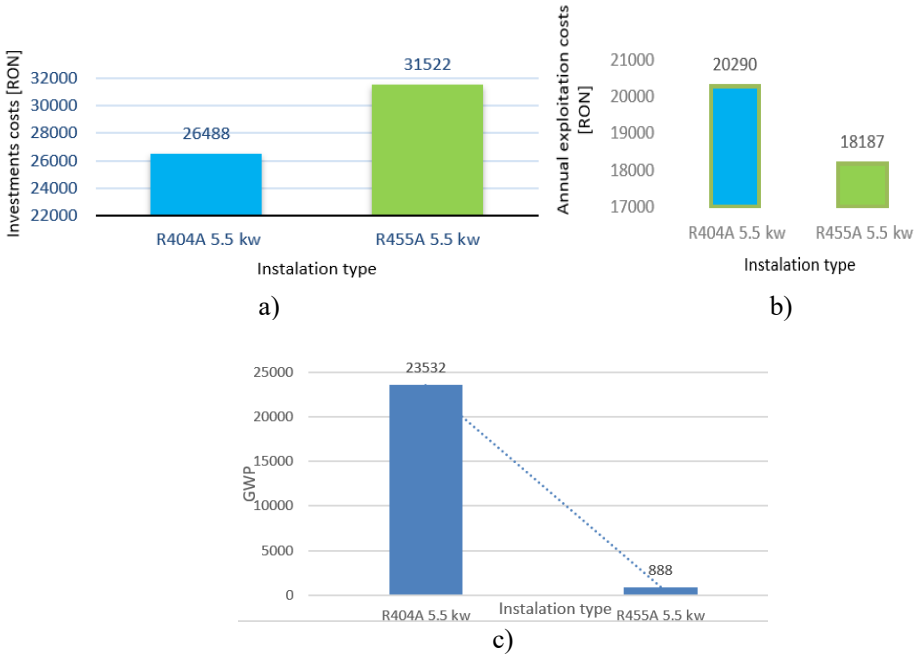

Fig 5. The investment and explitation costs exprimate in RON, respectively the GWP
a) Investments costs; b) Operating costs; c) GWP

6. Conclusions

Using R455A freon, we notice that from the point of view of the investment cost it is slightly higher, but at the same time the difference between the two technologies is relatively small compared to the total investment.

Being very similar technologies, the technicians do not require a high degree of technical training, only increased attention to the safety measures in assembly and service due to the A2L class of the refrigerant.

Analyzing from the point of view of the operating cost, it can be seen that thanks to the improved COP, we have a technology with lower energy consumption, which contributes a lot to the recovery of the investment.

At the same time, from the point of view of the environment, a drastic decrease in GWP is observed, so we can say that this refrigerant significantly helps to reduce the contamination of the atmosphere with greenhouse gases.

In accordance with the new European rules F-Gas 573/2024, manufacturers of refrigeration equipment are prepared to offer technical-economic solutions with low GWP, viable at affordable prices compared to those of the old solution with high GWP**.**

References

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