

COMMERCIAL REFRIGERATION

APPLICATION : SUPERMARKETS AND HYPERMARKETS



POSSIBLE SOLUTIONS

DESIGN OF THE SYSTEM (ACCORDING TO EN 378 GUIDANCE)

R-454C / R-455A

R-1234yf

R-1234ze(E)

Class III

In technical room or open range (Full cooling piping)

Class II

Compressor in technical room or open range (indoor evaporator)

Class I

Indoor (Full cooling piping)

Medium temperature	Chiller	Chiller	Chiller
Low temperature	Chiller		
Medium temperature	<ul style="list-style-type: none"> Centralized or semi-centralized installation Condensing unit 	Condensing unit	Condensing unit
Low temperature	<ul style="list-style-type: none"> Centralized or semi-centralized installation Condensing unit 		
Medium temperature	Plugin unit (air or waterloop condensation)	Plugin unit (air or waterloop condensation)	Plugin unit (air or waterloop condensation)
Low temperature	Plugin unit (air or waterloop condensation)		

R-290

R-744 (CO₂)

Class III

In technical room or open range (Full cooling piping)

Class II

Compressor in technical room or open range (indoor evaporator)

Class I

Indoor (Full cooling piping)

Medium temperature	Chiller	Chiller
Low temperature	Chiller	
Medium temperature		<ul style="list-style-type: none"> Centralized transcritical installation Small CO₂ skid
Low temperature		<ul style="list-style-type: none"> Centralized transcritical installation (100% CO₂ booster or LP cascade with HFC/HFO or HC loop) Small CO₂ skid
Medium temperature	Plugin unit (air or waterloop condensation)	
Low temperature	Plugin unit (air or waterloop condensation)	

R-454C / R-455A R-1234yf R-1234ze(E) R-290 R-744 (CO₂)

Refrigerant type (HFC/HFO/HC/Inorganic)	HFC/HFO	HFO	HFO	HC	Inorganic
GWP (according to F-Gas UE/2024/573)	146	0.5	1.37	0.02	1
Safety classification Lower Flammability Level LFL	R-454C: A2L - 0.293 kg/m ³ R-455A: A2L - 0.431 kg/m ³	A2L - 0.289 kg/m ³	A2L - 0.303 kg/m ³	A3 - 0.038 kg/m ³	A1
Classification (according to Pressure Equipment Directive PED)	1	1	2	1	2
F-gas quotas	Applicable	Non-applicable	Non-applicable	Non-applicable	Non-applicable
Specific regulatory constraints	++	++	++	+++	++
Maintenance complexity (training, safety, tooling, Personal Protection Equipment PPE ..)	Training is mandatory Specific tooling PPE	Training is mandatory Specific tooling PPE	Training is mandatory Specific tooling PPE	Training is mandatory Specific tooling PPE	Training is mandatory Specific tooling PPE
Coefficient of Performance COP (theoretical) - Medium temperature ¹	3.8	3.8	3.9	3.9	2.9
Coefficient of Performance COP (theoretical) - Low temperature ²	Single stage : 2.2	Not applicable	Not applicable	Single stage : 2.2	R-455A / R-744 cascade : 2.3 Transcritical CO ₂ : 1.8
Technology readiness (prototyping, field test, availability)	Available	Available	Available	Available	Available

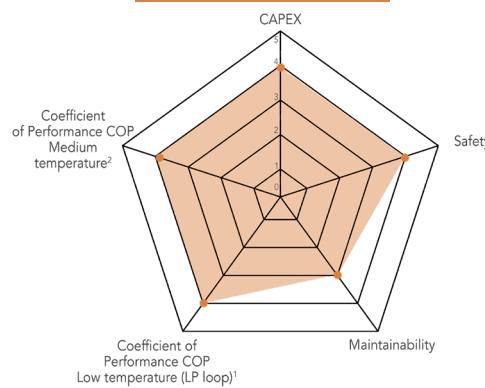
¹ HFC/HFO / HFO / HC : Tk = 45°C - To = -10°C - SC = 5K - SR = 10K - Isentropic efficiency = 100%

CO₂ : gas-cooler inlet pressure = 95barA - Gas-cooler outlet temperature = 37°C - To = -10°C - SC = 5K - Isentropic efficiency = 100% - Transcritical CO₂ with ejector

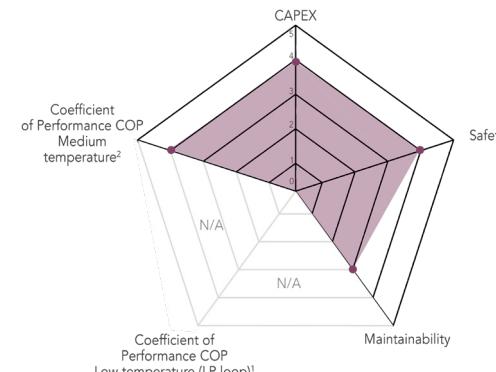
² CO₂ cascade layout, with R-455A HP loop : Tk = 45°C - To = -5°C - SC and SR = 5K - Isentropic efficiency = 100%

Transcritical CO₂ with ejector : Gas-cooler inlet pressure = 95barA - Gas-cooler outlet temperature = 37°C - To = -30°C - SC = 5K - Isentropic efficiency = 100%

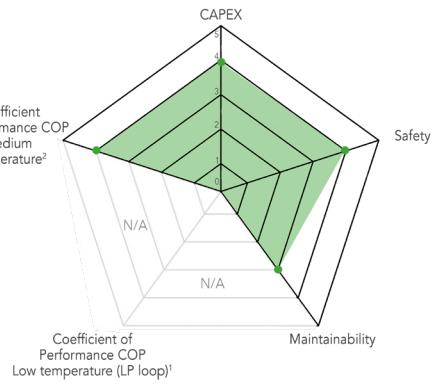
R-454C / R-455A



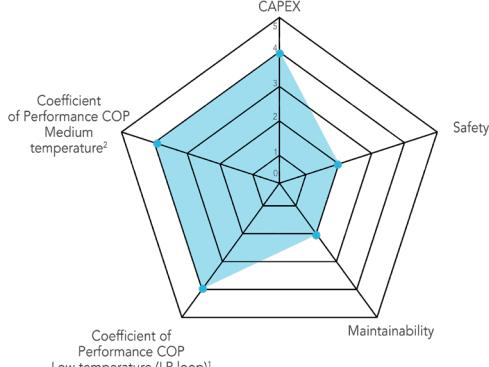
R-1234yf



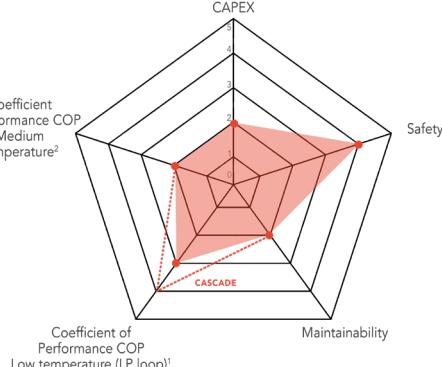
R-1234ze



R-290



R-744 (CO₂)



CONCLUSION

Class I : R-290 is the main solution for plugin units, with about 80% of newly-installed units.

Class II : CO₂ units are commonly used, as installers have heavily invested in training and specific tooling. CO₂ technology has nevertheless improved in the way of addressing high ambient temperature challenge. Semi-centralized A2L installations can meet maximum refrigerant charge regulatory requirements.

Class III : A2L and A3 with GWP<150 are available. R-290 chillers are currently spreading.