



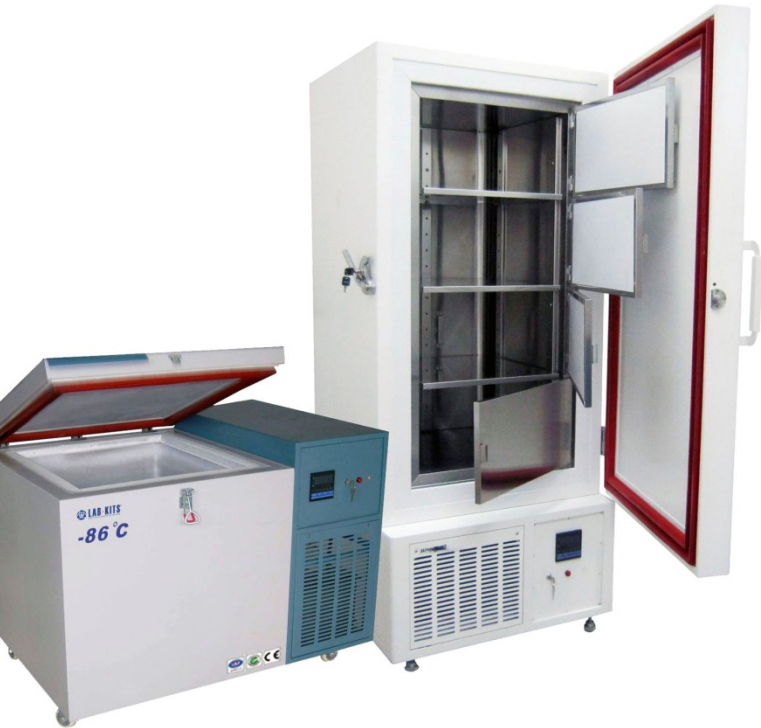
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16-17 March 2015 in Brussels

# Low Global Warming Alternatives for Ultralow Cascade Applications

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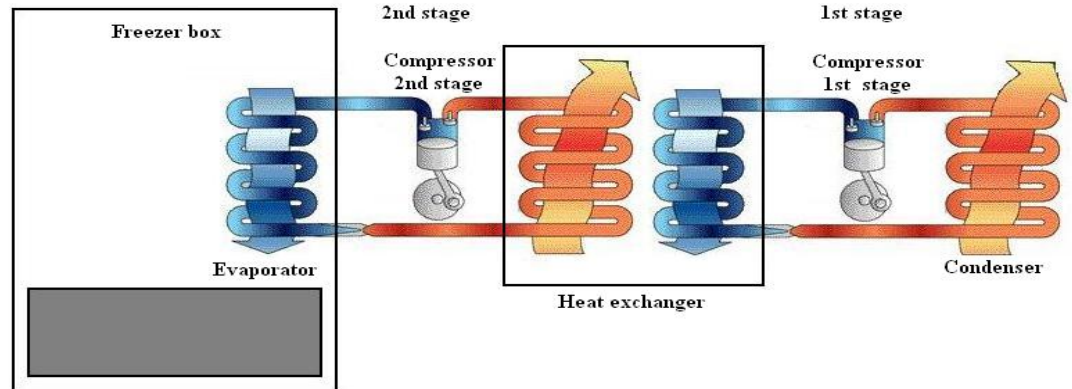
# Ultralow Refrigeration Systems



Ultra low refrigeration systems using cascade are used mainly for:

- **Biomedical**
- **Chemical**
- **Other laboratory purposes**

Those systems are able to provide very low storage temperature (from  $-70^{\circ}$  to  $-90^{\circ}\text{C}$ )



# Main Ultralow Cascade Producers



Embraco is present on cascade systems market since many years

# EU F-Gas Regulation

10. Domestic refrigerators and freezers that contain HFCs [...] with GWP of 150 or more		1 January 2015
11. Refrigerators and freezers [...] for commercial use (hermetically sealed systems)	that contain HFCs with GWP of 2500 or more	1 January 2020
	that contain HFCs with GWP of 150 or more	1 January 2022
11a. Stationary refrigeration equipment, that contains, or that relies upon for its functioning HFCs with GWP of 2500 or more <u>except equipment intended for application designed to cool products to temperatures below -50°C</u>		1 January 2020

**Recent EU F-Gas Regulation Exempted  
Ultralow Application From HFC Ban**

**WHY??**

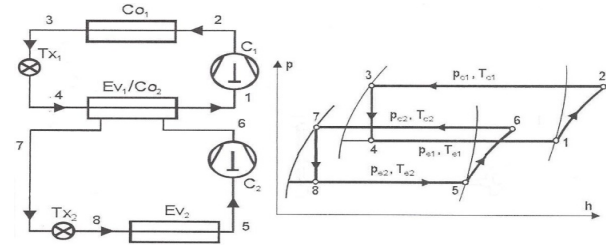
**Natural Refrigerant Solution is Ready!**

# Theoretical Simulation – Cascade System HC vs HFC

Condensing temperature - 1st stage	40°C
Evaporating temperature - 1st stage	-35°C
Condensing temperature - 2nd stage	-25°C
Evaporating temperature - 2nd stage	-90°C
Thermal load	1kW
Power of compressor - 1st stage	<b>0,88 kW</b>
Power of compressor - 2nd stage	<b>0,55 kW</b>
System COP (W/W)	<b>0,70</b>

**HFC  
R404A/R508B**

**HC  
R290/R170**



**System COP - comparison**

**+17%**

**Hydrocarbons offers potential efficiency gains**

**Second stage compressor requires 30 – 40% less power than first stage compressor.**


**Today all system are using the same model in both stages.**

**System optimization is possible.**

# Case Study

## Drop-in Conversion 800 lt. Upright ULT Freezers

	<b>HFC R404A/R508B</b>	<b>HC R290/R170</b>
Condensing temperature - 1st stage	41,7°C	39,6°C
Evaporating temperature - 1st stage	-36,2°C	-36,4°C
Condensing temperature - 2nd stage	-25,7°C	-26,6°C
Evaporating temperature - 2nd stage	-86,4°C	-91°C
Voltage	230V/50Hz	230V/50Hz
Power	1341W	1233W
Energy consumption per 24h	32,09 kWh	28,83 kWh
<b>GWP</b>	<b>3780/11950</b>	<b>3/3</b>
<b>TEWI</b>	<b>42.185</b>	<b>35.672</b>

 **-15%**

Environmental Impact of Cascade System w/ HCs is Significantly Reduced

# New Embraco Special Compressor Series For Ultralow Cascade System (R170)



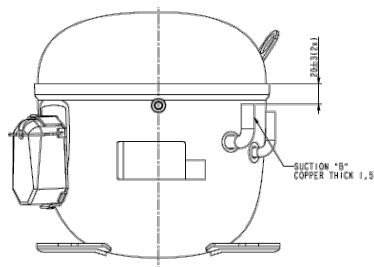
Model	Displ. cc	Voltage & Freq.	CAP W	COP W/W	Status
NT2178ULT	17,4	220-240V/50Hz	<b>402</b>	1,22	under dev
		115V/60Hz	<b>471</b>	1,22	production
		208-230V/60Hz	<b>470</b>		under dev
NT2192ULT	22,4	220-240V/50Hz	<b>516</b>	1,24	production
		208-230V/60Hz	<b>595</b>	1,21	production
		115V/60Hz	<b>600</b>		future dev
NT2212ULT	27,8	220-240V/50Hz	<b>650</b>		under dev
		208-230V/60Hz	<b>760</b>		future dev
		115V/60Hz	<b>760</b>		future dev

## Main Product Features:

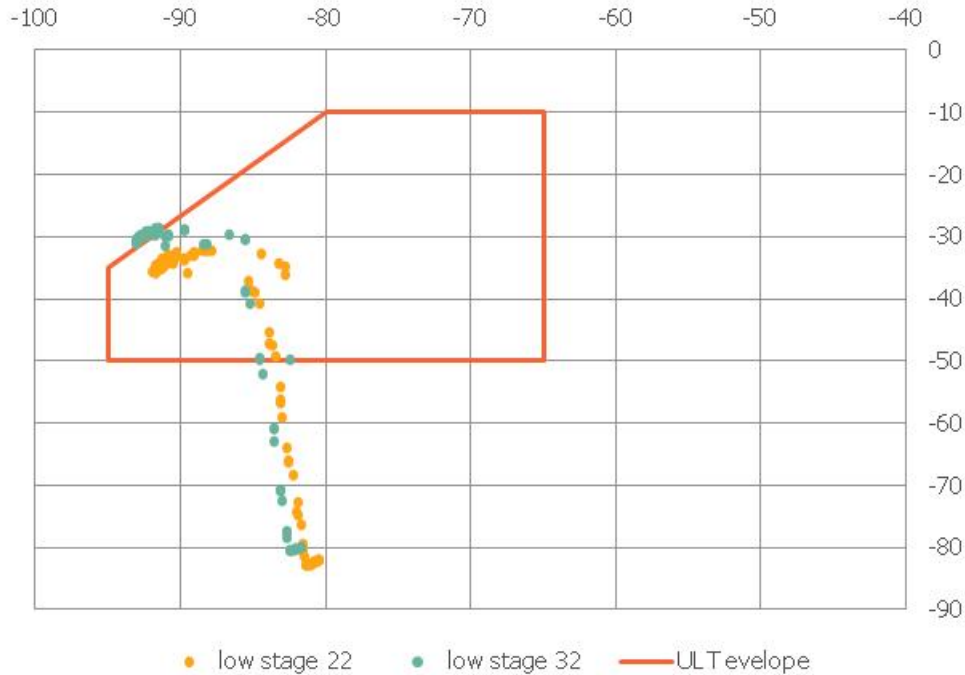
- Optimized Valving System
- Optimized Torque Electric Motor
- Low Residual Moisture Level
- Reduced Internal Volume (noPED)

### Nominal Point

T. Evap	-85°C
T. Cond	-30°C
T. Return	0°C
Subcooling	0K
T. Ambient	25°C



# Typical Low Stage Cycle Graph and Ultralow Approved Envelope



## Special Life Test Rigs





# Conclusions

- Ultralow cascade systems with hydrocarbon refrigerants is already market reality. There are no reason to exclude this kind of appliances from High GWP refrigerants ban.
- Efficiency improvement is intrinsic benefit of conversion of Cascade System into Hydrocarbon option.
- Considering both direct and indirect effect when using R290 and R170 in place of HFC's environmental impact of Ultralow Systems can be significantly reduced.
- United States have already proposed a protocol for Energy consumption test of Ultralow applications. What about Ecodesign?
- **Embraco is the first manufacturer offering special optimized compressor series (NT...ULT) to use in Second Stage of Cascade Applications.**



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**Thank you very much!**