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VTech e-news

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Alternative Refrigerants in North America

This edition of VTech e-news focuses on Alternative Refrigerants and recent developments in the North American market. These changes are certainly going to affect every aspect of production, whether you are a component manufacturer interested in leak detection or a refrigeration OEM looking to charge products with these new refrigerants. We hope that you will find this information useful and please feel free to contact us with any questions. Thank you.

- The VTech Team

Alternative Refrigerants: What's it Going to Be?

While "alternative" or "natural" refrigerants have been used widely in Europe and elsewhere since the early 1990's, the subject of alternative refrigerants is just beginning moving to the forefront in North America. "Green" initiatives and growing competition in the global marketplace are the driving forces behind this change. The substitute refrigerants include R290 (propane) R600 (isobutane) and R744 (CO2) and even R1234yf, a replacement for R134a, for use in the Automotive Industry.

Naturally, Industry professionals want to know which one of these refrigerants is going to be the most widely accepted. The answer is, simply, all of them.

(Continued on page 2)

Change in Vending

Alternative Refrigerants: Rules & Regulations

Government Weighs in on Alternatives

Alternative Refrigerants have been approved for use by domestic manufacturers under the Significant New Alternatives Program (SNAP). Each of these gases has their own specific EPA Rulings. Some of the key bullet points are given below. Click on the links to read the full guidelines in the applicable Federal Register.

(Continued on page 3)

CO2 Refrigerant Charging

Controlling Pressure and Temperature

Traditional HFC and HCFC refrigerants are relatively simple to control. Raising the pressure in the tank, either with a pump or by applying heat, results in liquid refrigerant, ideal for high accuracy charging. CO2 poses some problems in that the gas behaves in the opposite manner- CO2 must be kept the temperature below its critical point of 31°C and maintain a pressure under 100 bar, which also avoids the gas turning into a solid. So, controlling the

(Continued on page 2)

VTech's 200-CO2 Automatic Refrigerant Charging System

What's it Going to Be? continued from page 1

While the industry in North America is still largely in the exploratory stage, based on the EPA's regulations, (an overview of which follows this section), each alternative refrigerant will be used in an application-specific manner, closely resembling this table:

Refrigerant	Industry	Application
R290	Commercial Refrigeration	Beverage Dispensing, Foodservice, Retail Refrigeration
R600	Domestic	Household Refrigerators
CO2	Commercial Refrigeration	Vending machines & Automotive
R1234yf	Automotive	Automotive

Some commercial refrigeration manufacturers have to consider producing both R290 and CO2 for units, due to the Hydrocarbon charge size limitations set by the EPA of 150 g (5.3 oz) of R290. CO2 does not have such a limit and therefore would be suitable for units that exceed this charge size.

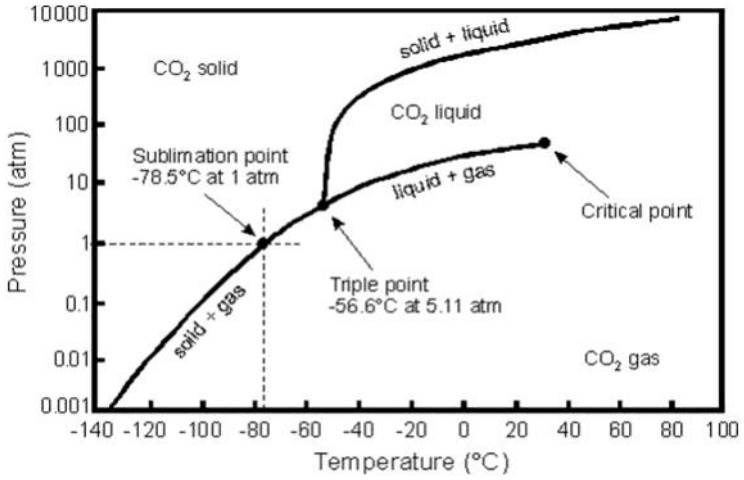
Environmental impact is the key driving force behind these changes, with the impetus for this change coming primarily from the customers of the commercial refrigeration manufacturers, specifically big players in fast-food restaurant chains and soft drinks (companies you may have heard of), appealing to the environmentally-conscious consumer by illustrating their desire to make "greener" choices.

Increased energy efficiency is another key selling point for using alternative refrigerants; the low boiling point and vapor pressures (with the exception of CO2) allow for smaller compressors that use less energy for an easier heat transfer cycle. Reportedly this can reduce energy consumption by up to two thirds. On page 3 is a table with applicable refrigerant data with HFC's R134a, R404a and R410a as a baseline comparison.

Controlling Temperature and Pressure continued from page 1

temperature and pressure is essential.

Temperature: In most non-climate controlled production environments the temperature can vary wildly from season to season, reaching well over a comfortable 20-25°C at which CO_2 remains a liquid. Once it surpasses 30°C it changes state to a gas and becomes much more difficult to charge, due to the fact that the refrigeration system is a fixed volume and when vapor is added to the system the required pressure to continue to charge the gas grows steadily until it surpasses the ability of the system to charge it. The larger the charge size, the higher the pressure will need to be. But, as we will see, increasing pressure is not the solution.



Pressure-Temperature phase diagram for CO_2.

Pressure: As the temperature rises so does the pressure; at 30°C (86°F) CO_2 is over 1,000 psig (68 atm/bar). A CO_2 System will run at around 100 bar. As the pressure approaches the fusion point, CO2 will turn into a solid. So, keeping the temperature low ensures the pressure does not rise too high.

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> **"There is nothing permanent but change."**
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> **- Heraclitus**

Rules and Regulations continued from page 1

Hydrocarbons	CO2 (MAC) CO2 (Refrigeration)	R1234yf
Hydrocarbons approved for Household Refrigerators, Freezers, and Combination Refrigerators and Freezers, Retail Food Refrigerators and Freezers (Stand-Alone Units Only). Acceptability does not apply to walk-in coolers or vending machines. ASHRAE categorizes hydrocarbons, as an A3 gas, which indicates higher flammability but lower toxicity. Refrigerant charge limited to 57g (2 oz.) of R600 in domestic refrigerators and 150g of R290 in commercial refrigeration. Domestic Refrigerators must meet UL Standard 250. OSHA Requirements 1910 must be followed including those at 29 CFR 1910.106 (flammable combustible liquids), 1910.110 (storage and handling of liquefied petroleum gases), 1910.157 (portable fire extinguishers) and 1910.1000 (toxic and hazardous substances). Proper ventilation should be maintained at all times during manufacture and storage (i.e. warehousing) of equipment with hydrocarbon refrigerants. If ¼ of the LFL is reached the space should be evacuated until safe levels return. Venting of these refrigerants is prohibited although there is a push to relieve this ban due to the scarcity of recovery equipment.	The use of CO2 in MVAC systems must adhere to the standard conditions identified in SAE Standard J639 (2011version) including: -Installation of a high pressure system warning label; -Installation of a compressor cut-off switch; -Use of unique fittings with sizes as indicated -Use of SAE Standards J1052, J2772 and J2773 -FMEA as per J1739 CO2 approved as a replacement for HFC-22, et al in new equipment including vending machines. CO2 exempt from venting prohibition. EPA recommends all users follow ASHRAE standard 15 and addendums. EPA recommends placing vending machines in well-ventilated spaces. Additional training for service personnel recommended. OSHA has established permissible exposure limits (PEL) of 5,000 ppm per 8 hr/day, 40 hr/ week and NIOSH has established a 15-minute recommended short-term exposure limit of 30,000 ppm.	R1234yf approved for use in Mobile Air Conditioning applications for passenger cars and light duty trucks. “Unique” Fittings required as per SAE Standard J2844 to avoid cross-contamination and venting and facilitate purity of recycled refrigerant. Follow SAE’s Standard J639 for compressed gases. Manufacturers must conduct Failure Mode and Effect Analysis as provided in SAE J1739 Cylinders range from 5 to 50 lbs. Requirements for handling, storage, and transportation of compressed gases apply to this refrigerant, such as regulations of the Occupational Safety and Health Administration at 29 CFR 1910.101 and the Department of Transportation’s requirements at 49 CFR 171–179. Additional training for service technicians recommended. Observe requirements of Significant New Use Rule at 40 CFR 721.10182.

Refrigerant Data continued from page 1

Refrigerant	Mole Weight	Liquid Density lb./cu. ft @ 86°F (30°C)	Boiling Point @ (14.7 psia/ 1 bar)	Vapor Pressure @21.1°C (70°F)	Global Warming Potential
R134a	102.03	74.13	-26°C (-15°F)	5.9 bar (85.8 psia)	1,300
R404a	97.6	63.71	-47.8°C (-54°F)	12.6 bar (182.9 psia)	3,300
R410a	72.6	64.92	-48.5°C (-55.4°F)	14.8 bar (215.3 psia)	1,725
R290	44.1	30.24	-42°C (-44°F)	8.5 bar (123.7 psia)	3
R600	58.12	33.98	-11.7°C (10.8°F)	3.15 (45.7 psia)	.001
CO2 (R744)	44.01	37.03	-78.5°C (-109.4°F)	58.8 bar (852.7 psia)	1