

Making Sense

Webinar Series

$$D = \frac{1.86 \cdot 10^{-3} T^{3/2} \sqrt{1/M_1 + 1/M_2}}{p \sigma_{12}^2 \Omega}$$



Making Sense Webinars

Emerson and Our Partners Giving Insight on the **Three Most Important Issues** in Refrigeration

We're Making Sense of the promising role of **new refrigerants**.

We're Making Sense of **energy reduction** technologies.

We're Making Sense of the application of electronics to improve **operational visibility**.



The widespread deployment of new, sustainable, energy-efficient refrigeration solutions using natural refrigerants is fast approaching.

Emerson Climate Technologies invites you to interact with some of the refrigeration industry's most trusted and respected thought leaders on the emerging world of new refrigerants, their benefits and challenges, and how to ensure that your refrigeration system is prepared for the future. This roundtable discussion will be moderated by Emerson's own experts, and you'll have the chance to ask questions and share your own experiences.

At AHR 2013, we're helping attendees MAKE SENSE of the issues that matter most. Check our website at www.emersonclimate.com/conferences for presentation schedules and topics. Bring this card with you to one of our presentations and you'll be entered for a chance to win an Apple iPad!

> See what makes sense at the AHR Expo, booth #1605.

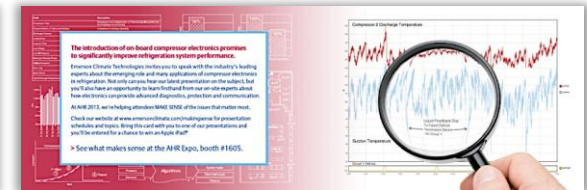


Emerson's energy reduction technologies are addressing the energy needs of today's industrial and equipment applications.

Emerson Climate Technologies is excited to network with the refrigeration industry's foremost innovators in energy reduction technologies. We will be having a presentation about how the improvements in equipment and system technologies are being utilized in today's refrigeration applications. The experts will be present throughout the event to answer any questions you have about these innovations — from the utilization of digital modulation and electronic expansion valves to the application of scroll and variable speed technologies.

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The introduction of on-board compressor electronics promises to significantly improve refrigeration system performance.

Emerson Climate Technologies invites you to spend with the industry's leading experts about the strategic use of many applications of compressor electronics in refrigeration. You'll get a chance to hear from our world's most innovative minds. And you'll also have an opportunity to hear firsthand from our own experts about how these new, comprehensive solutions improve efficiency, protection and communication.

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Making
Sense of the promising role of
new refrigerants.
Webinar Series

Seven Keys to Servicing CO₂ Systems

CO₂ Booster Systems From a Service Mechanic's Perspective

July 14, 2015

Presented By:

Andre Patenaude

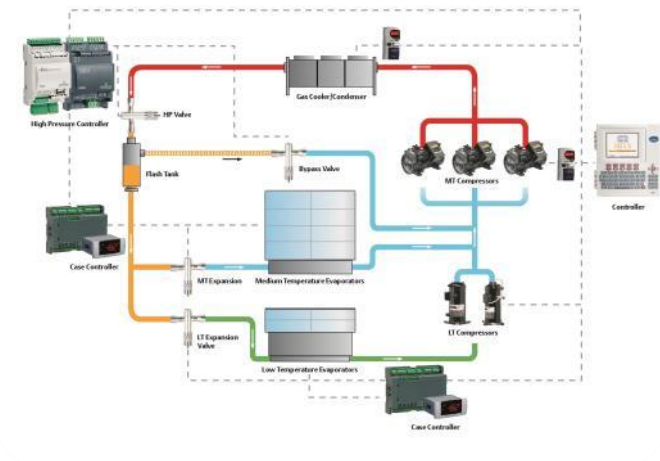
Director — CO₂ Business Development
Emerson Climate Technologies



What We'll Cover

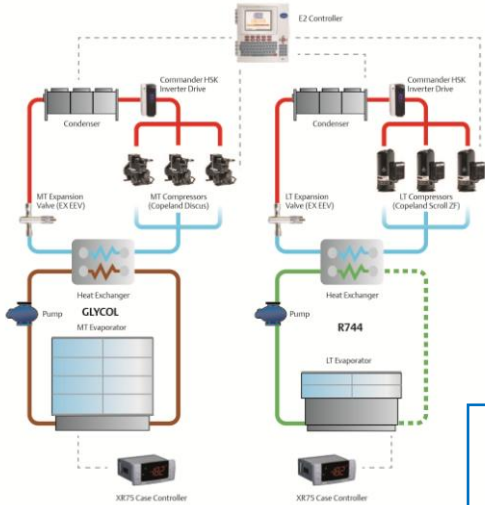
- **Three Basic System Architectures**
- **Transcritical Vs Subcritical Operation**
- **Three Main Differences Between HFC and R744 Systems**
 - Low Critical Point
 - High Triple Point
 - High Pressure
- **Dealing with Standstill Pressures**
 - Managing Pressure Reliefs
 - Managing Power Outages
 - How to Mitigate Risk
- **Peculiarities With R744**

Typical CO₂ Transcritical Booster System

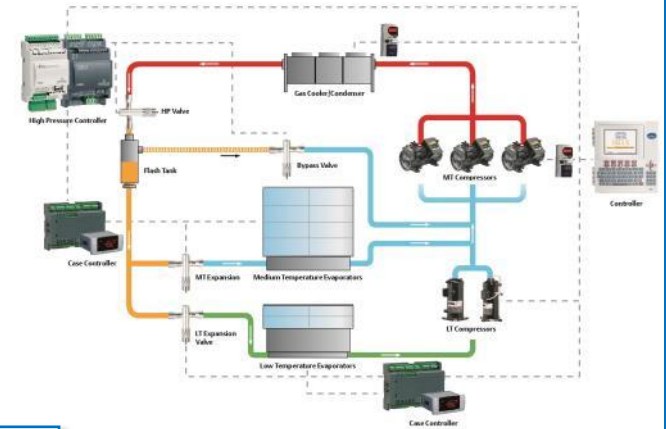


CO₂ Architectures

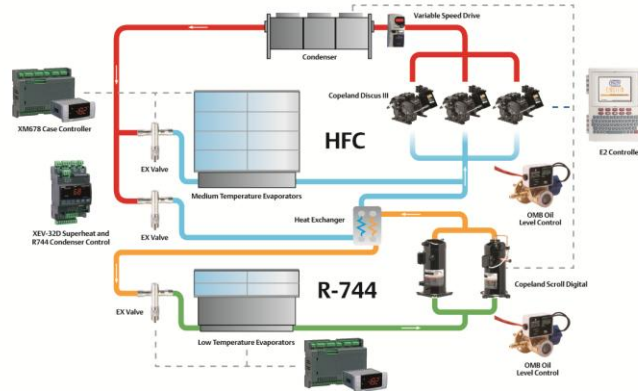
Typical Secondary System: MT Glycol, LT CO₂



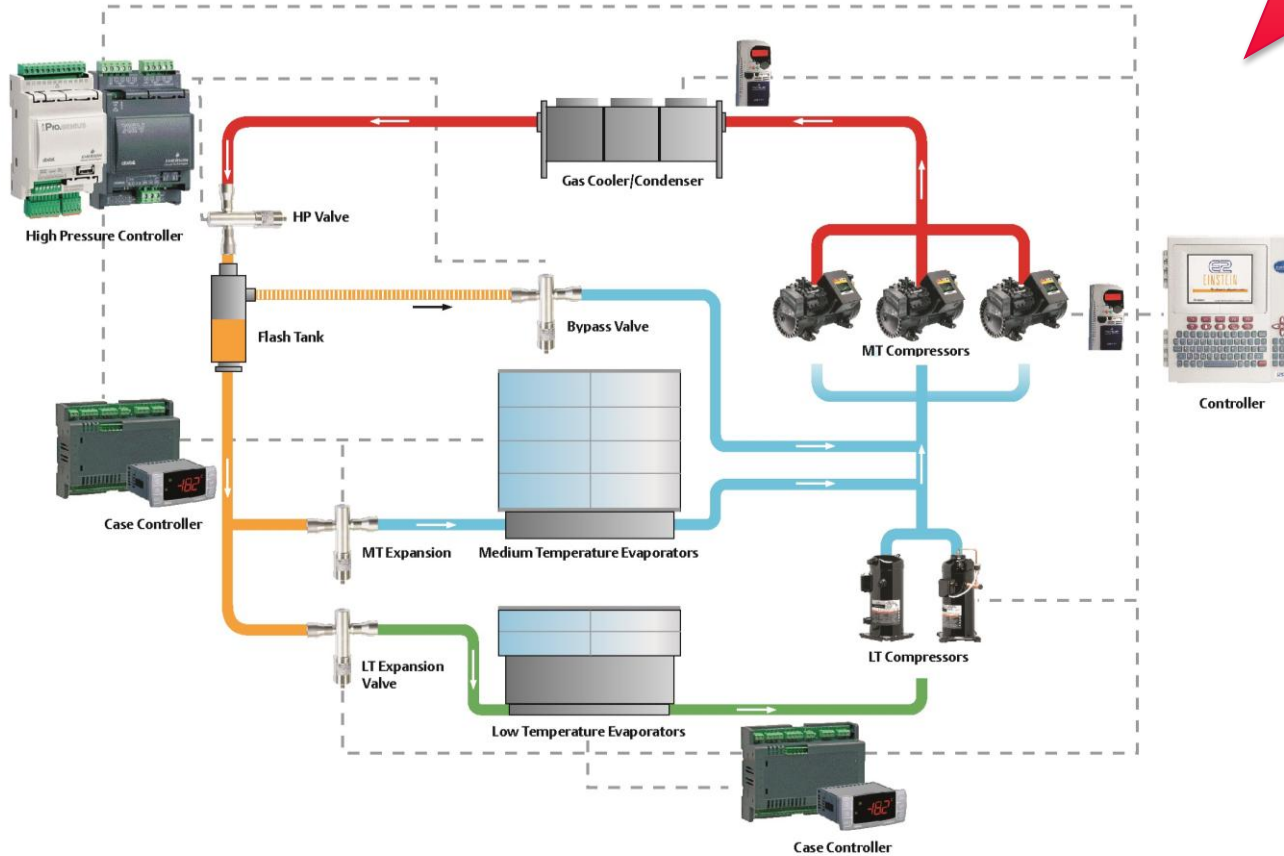
Typical CO₂ Transcritical Booster System



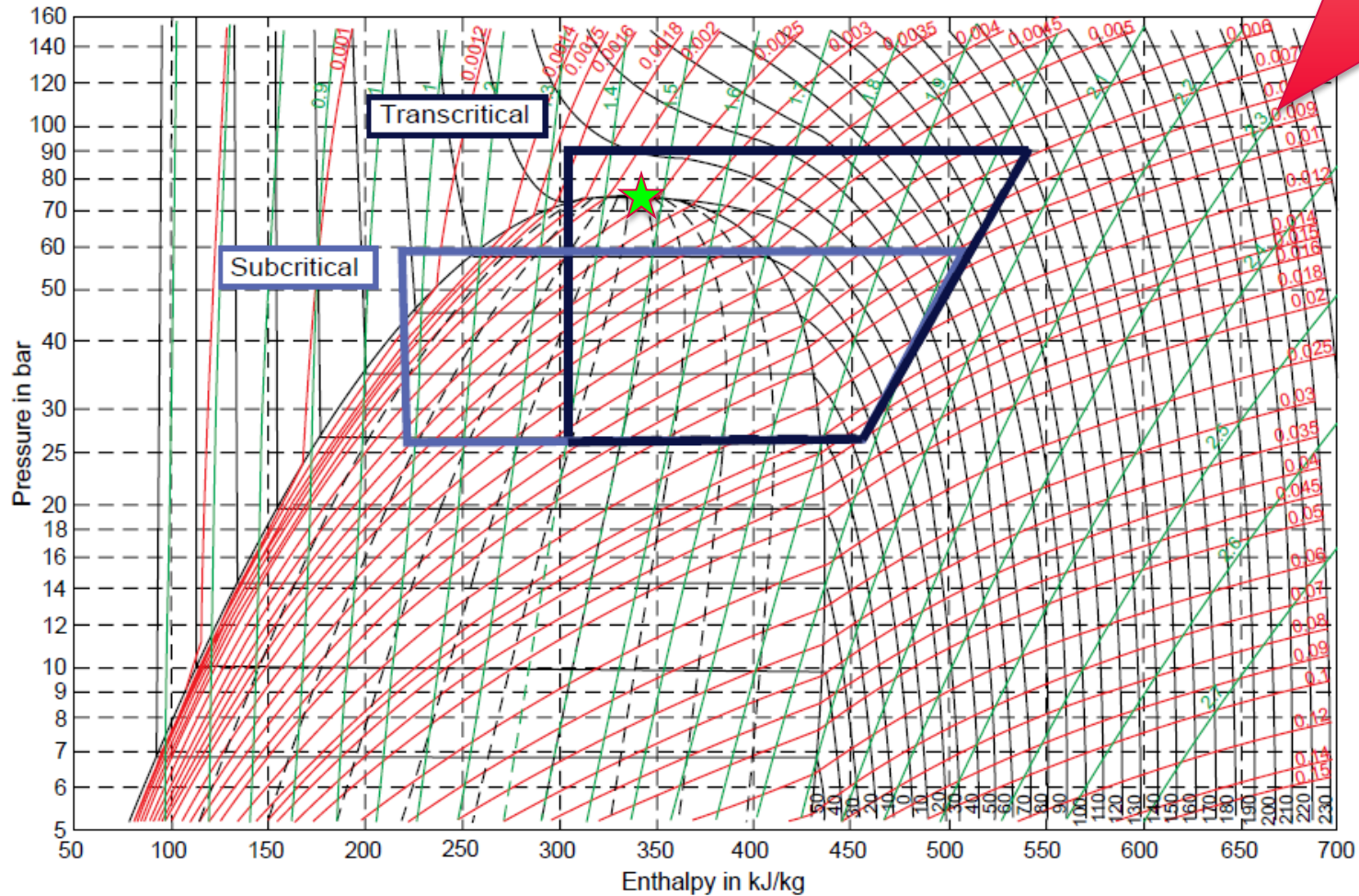
Typical CO₂ Hybrid Cascade System



CO₂ Booster Transcritical

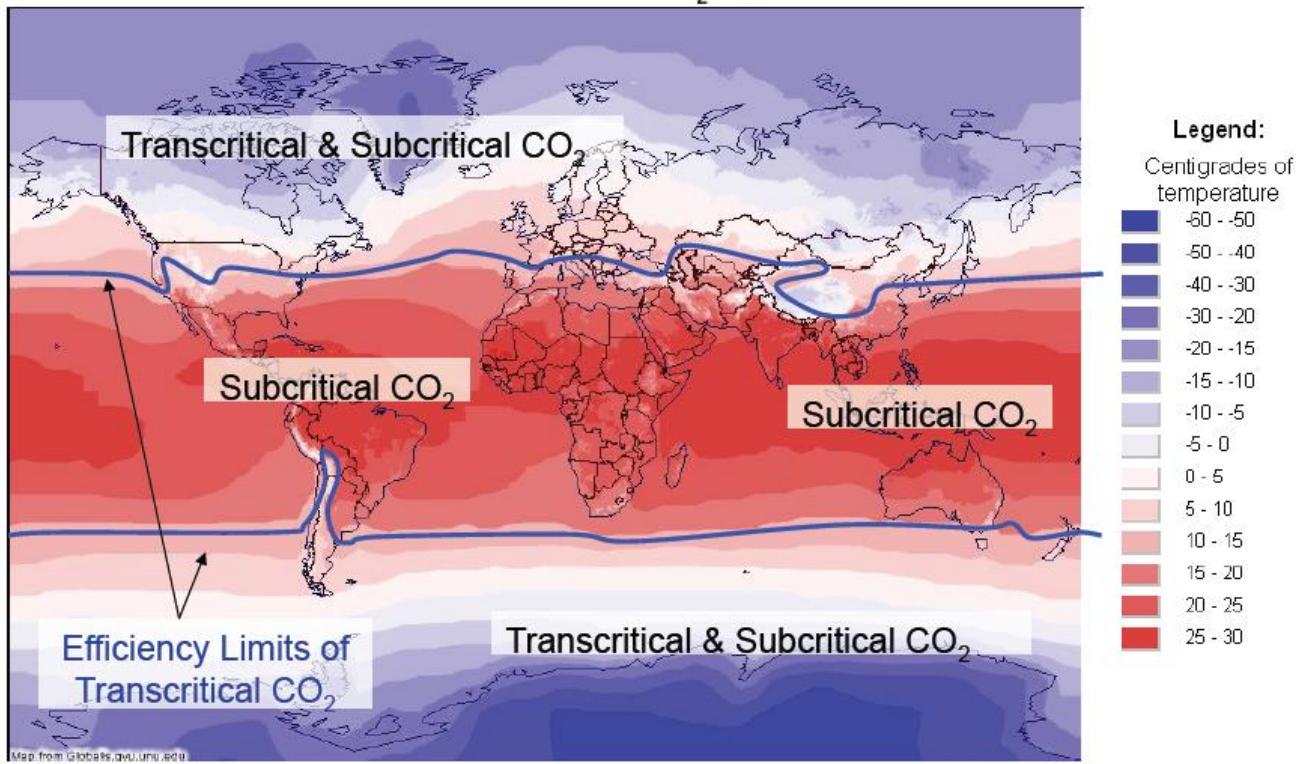


Subcritical vs. Transcritical Operation



Climatic Impact of CO₂ System Architectures

Fig. 1.2 Potential Global Distribution: CO₂-System Alternatives:



Global Supermarket / C-Store CO2 System Installations

Cumulative Total CO₂ Transcritical Systems

| <u>2013</u> | <u>2015</u> | <u>2018</u> |
|-------------|-------------|-------------|
| 3057 | 6103 | 13606 |

Cumulative Total CO₂ Cascade/Secondary Systems

| <u>2013</u> | <u>2015</u> | <u>2018</u> |
|-------------|-------------|-------------|
| 2060 | 5273 | 10275 |



| | <u>2013</u> | <u>2015</u> | <u>2018</u> |
|----|-------------|-------------|-------------|
| TC | 65 | 105 | 190 |
| C | 12 | 15 | 20 |

| | <u>2013</u> | <u>2015</u> | <u>2018</u> |
|----|-------------|-------------|-------------|
| TC | 2885 | 5110 | 11125 |
| C | 1638 | 4478 | 8990 |

| | <u>2013</u> | <u>2015</u> | <u>2018</u> |
|----|-------------|-------------|-------------|
| TC | 3 | 70 | 200 |
| C | 102 | 150 | 245 |

| | <u>2013</u> | <u>2015</u> | <u>2018</u> |
|----|-------------|-------------|-------------|
| TC | 100 | 800 | 2000 |
| C | 4 | 30 | 60 |

| | <u>2013</u> | <u>2015</u> | <u>2018</u> |
|----|-------------|-------------|-------------|
| TC | 1 | 3 | 6 |
| C | 46 | 100 | 210 |

| | <u>2013</u> | <u>2015</u> | <u>2018</u> |
|----|-------------|-------------|-------------|
| TC | 0 | 0 | 0 |
| C | 58 | 200 | 350 |

| | <u>2013</u> | <u>2015</u> | <u>2018</u> |
|----|-------------|-------------|-------------|
| TC | 3 | 15 | 85 |
| C | 200 | 300 | 400 |

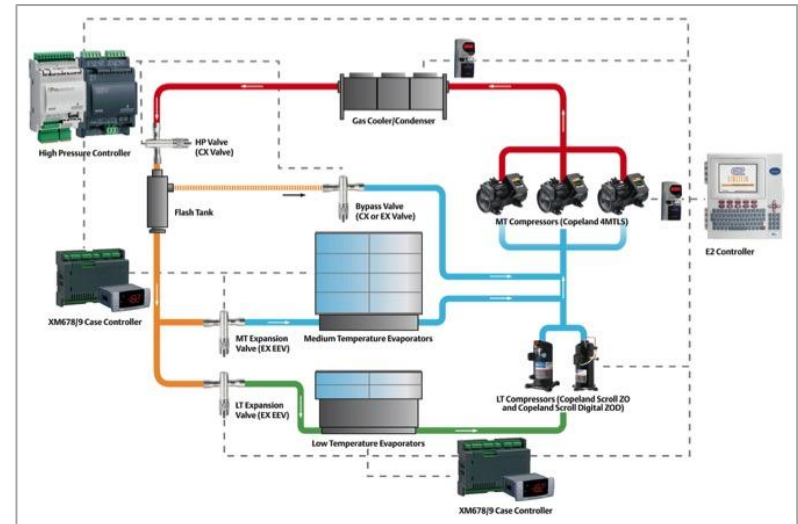
Question 1

What is your occupation?

- 1. HVAC/R Service Mechanic**
- 2. HVAC/R Service Manager**
- 3. HVAC/R Contracting Owner**
- 4. Engineer**
- 5. Wholesaler**
- 6. Sales**
- 7. Marketing**
- 8. Other**

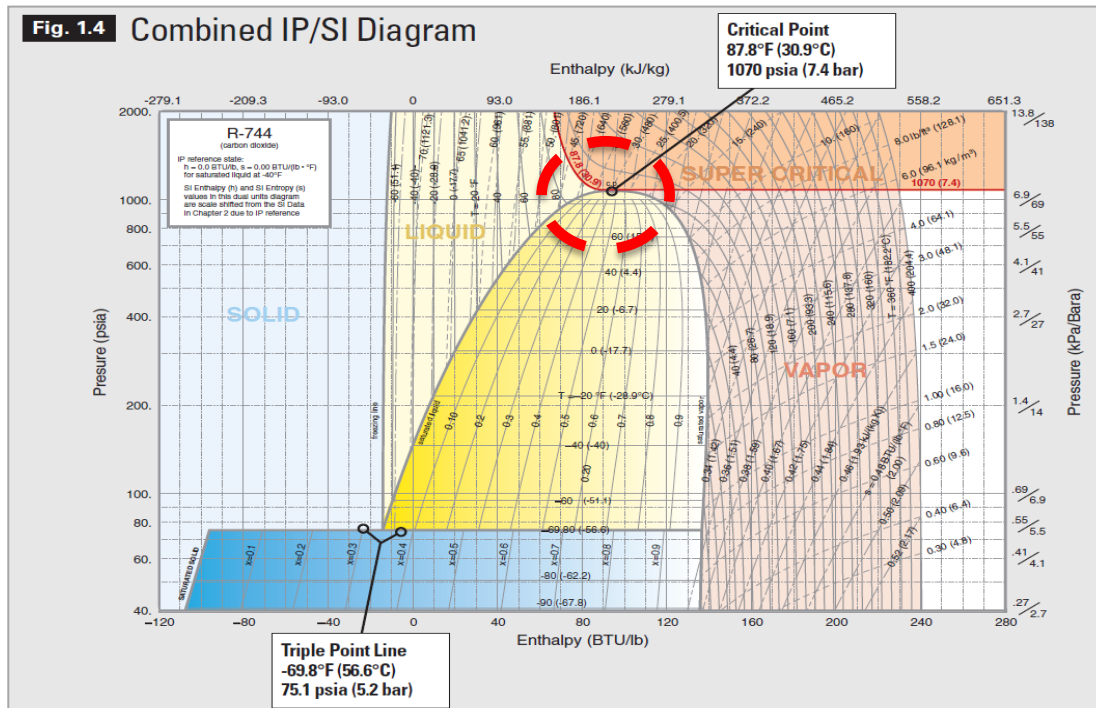
What We'll Cover

- Three Basic System Architecture
- Transcritical Vs Subcritical
- **Three Main Differences Between HFC and R744 Systems**
 - Low Critical Point
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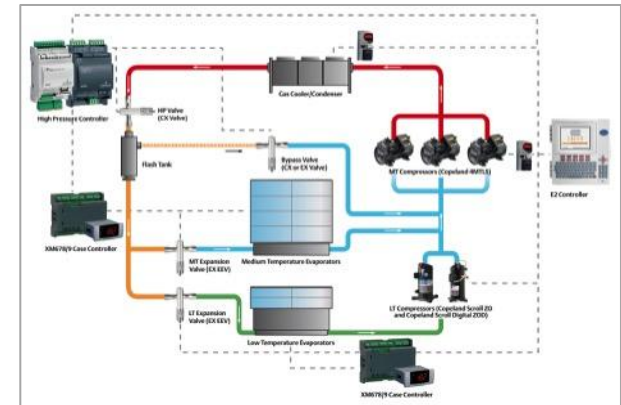


Three Main Differences Between HFC and R744 Systems

1. Low Critical Pressure (1055 psig, 87.8 °F)



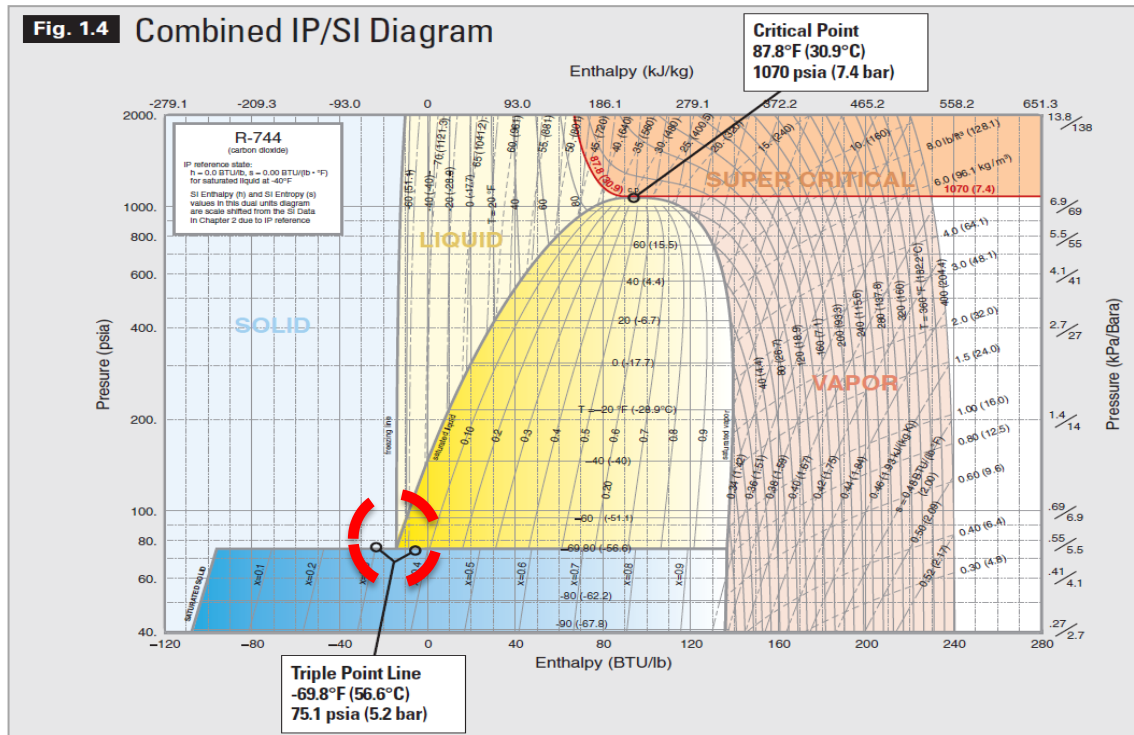
R744 Transcritical Booster System



<https://www.youtube.com/watch?v=GER3NxsPTOA> Video of Phase change of CO₂

Three Main Differences Between HFC and R744 Systems

2. High Triple Point (60.4 psig, -69.8 °F)

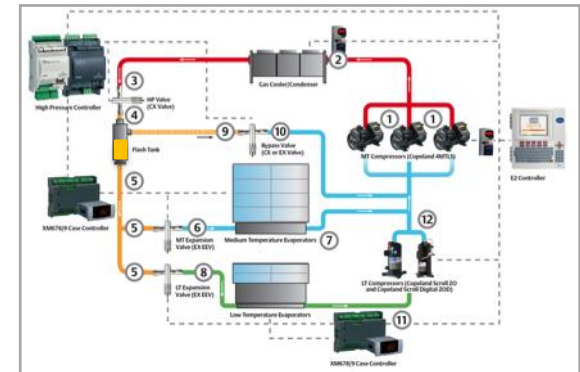
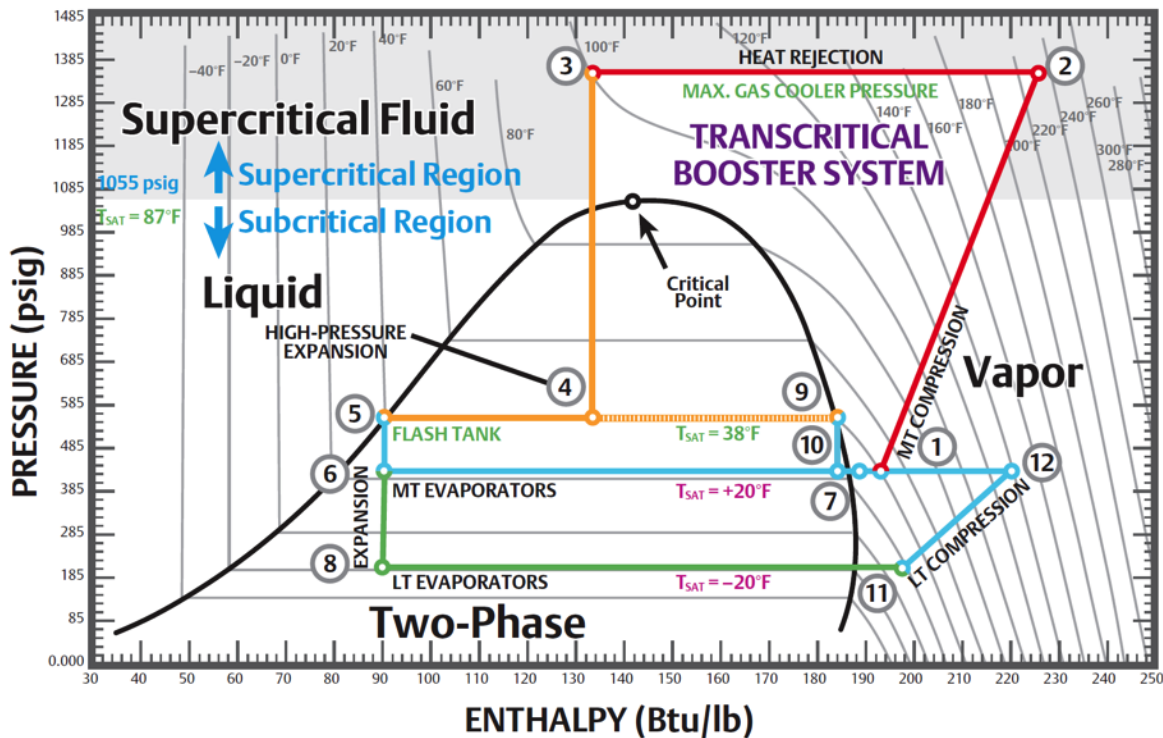


-109.3 °F Surface Temp of Dry Ice



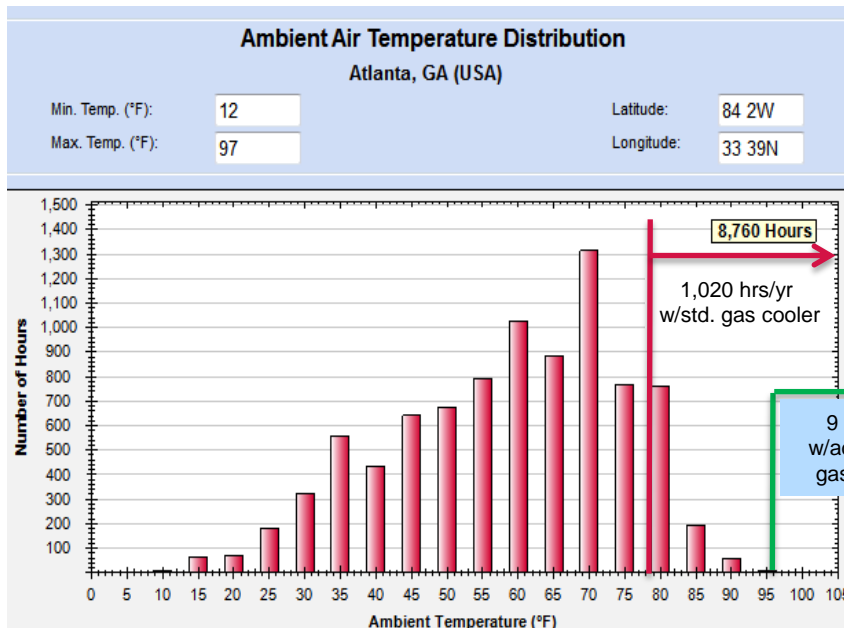
Three Main Differences Between HFC and R744 Systems

3. High Pressures — Operating

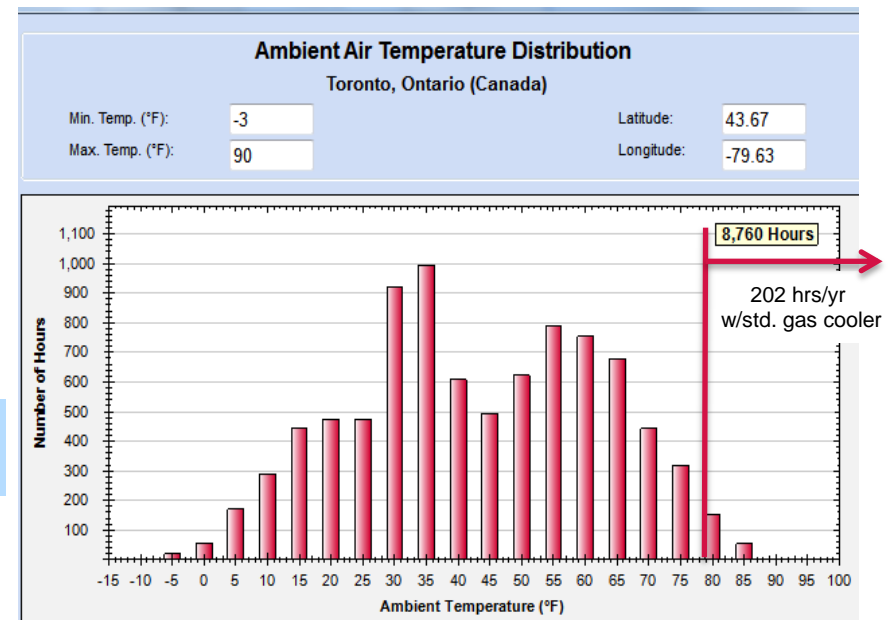


Time Spent in Transcritical

Atlanta, GA

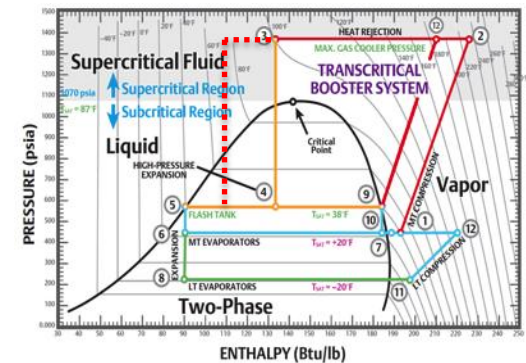
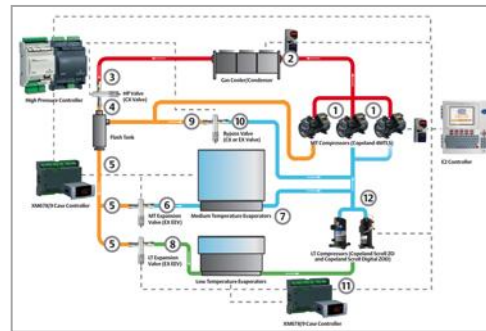
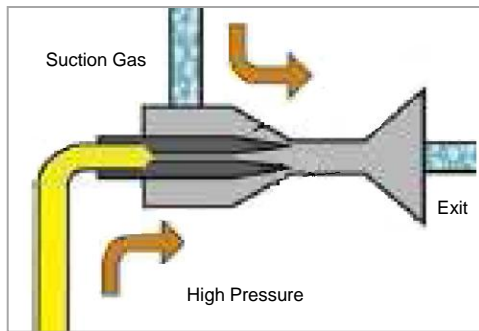
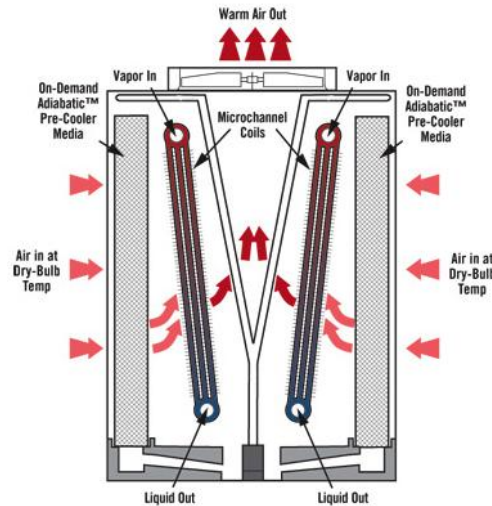


Toronto, ON



Five Ways of Improving Efficiencies in Warm Ambient Regions

- Spray Nozzles
- Adiabatic Gas Coolers
- Parallel Compression
- Sub-Cooling
- Ejectors



Question 2

- **Have you ever worked on a CO2 system?**
 - No
 - yes
 - If yes; which type of System?
 1. Secondary (Using R744 as a secondary fluid)
 2. Hybrid Cascade
 3. Booster Transcritical System

Managing Power Outages

How to Mitigate Risk of Blowing Pressure Reliefs

- **Generator and Standby Condensing Units**
- **Need a Refrigerant Plan**
 - Local Codes
 - Stock, Storage
 - Getting it to the Machine Room
- **Concerns With Resumption of Power**



Semi-Hermetic
Broken Reed

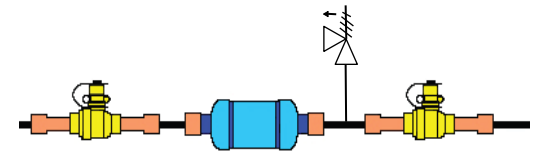


Scroll Thrust
Surface Galled

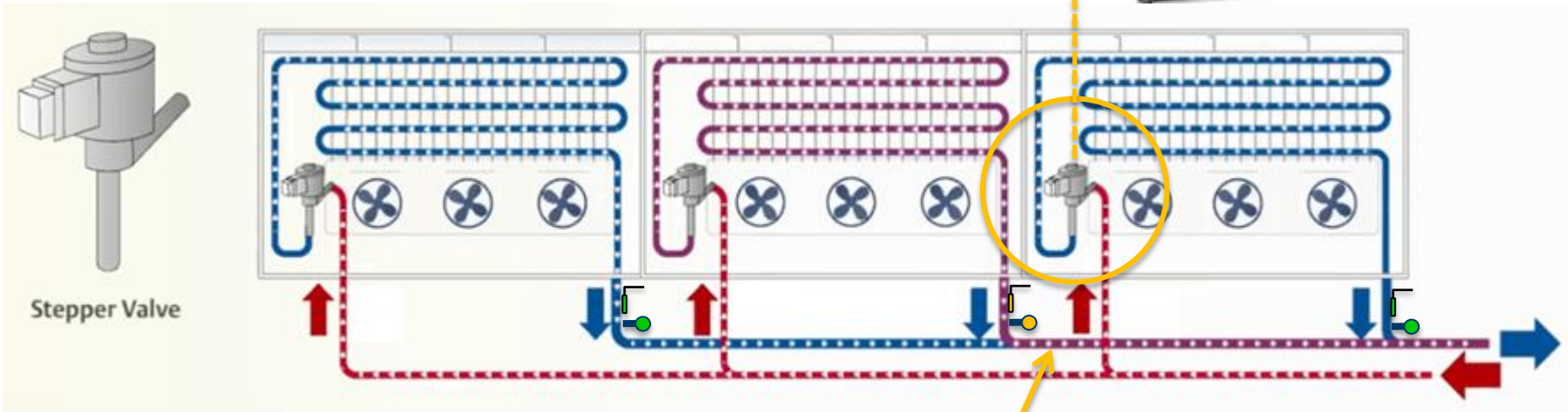


Service Peculiarities of R744

- Finding leaks is challenging
- Dedicated set of gauges, high-pressure hoses and miscellaneous parts at each store
- Preventative maintenance schedule is critical with R744
- Understand the consequences of trapping R744
- Training of service personnel is required
- Don't just call any “?? & Refrigeration Company” from the phone book for a quote on R744 systems



Evaporator Cooling With Closed EEV



Flood Back

Evaporator Cooling With Closed EEV

- Issue With Suction Piping Free
- Draining Down Into the Case



**Corrected Piping
NO Free Draining**



System Cleanliness / Dryness

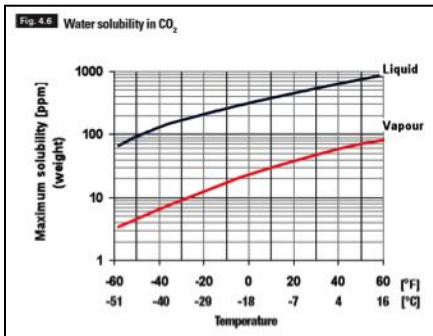
System Cleanliness



Oil Separator Filter Photo



System Dryness



| R744 CO ₂ Sensitivity (PPM) | | | | |
|--|-------|-------|-------|-------|
| Liquid Temperature | 14 °F | 32 °F | 41 °F | 68 °F |
| Very Dry | 8 | 11 | 13 | 20 |
| Dry/Caution | 14 | 19 | 22 | 34 |
| Caution/Wet | 29 | 39 | 46 | 72 |
| Wet | 46 | 63 | 75 | 116 |

Steel Pipe



Pipe corrosion caused by carbonic acid

R744 (CO₂) Cylinder From Linde



**Dip Tube Line
Designating
Liquid Tank**



Grade 4 = 99.99% Pure

Key Points to Take Away

- **R744 pressures are higher than HFCs but manageable**
- **Contractor must have strategy with “power off” conditions**
 - To deal with scheduled downtime
 - To deal with unscheduled downtime such as power outages
- **Understanding peculiarities of R744 will reduce maintenance cost and downtime**
- **System cleanliness, including dryness, is key to efficient operation**
- **Properly trained service company will ensure the lowest possible operating costs**

Contact

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andre.patenaude@emerson.com

Thank You!

Questions and Answers

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