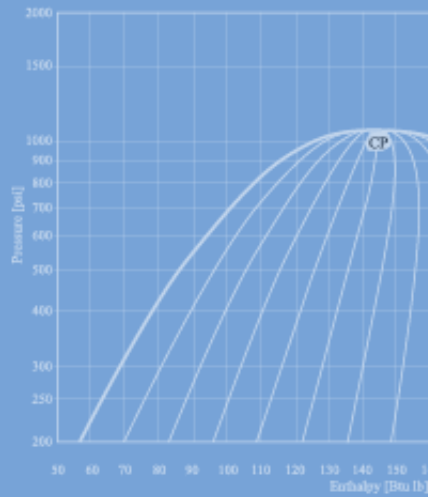


$$\text{COP} \equiv \frac{T_m}{T_m - T_o}$$



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 cost-effective, 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 use of these groundbreaking natural and alternative refrigerants. Gain insight on their properties, applications and environmental benefits. Don't miss out through providing your contact information today.

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.

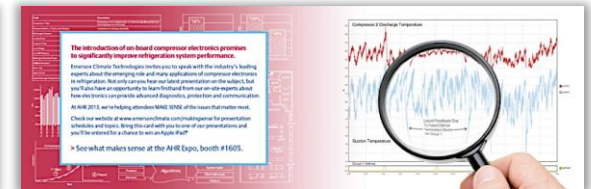


Advanced energy reduction technologies are enabling us to create a new era of system and equipment optimization.

Emerson Climate Technologies partners 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 through 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.

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.



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 and many applications of compressor electronics in refrigeration. Get the latest information from our world-renowned experts. Don't miss this opportunity to learn firsthand from our on-site experts about how the latest compressor advanced diagnostics, protection and communication.

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.

Mass flow rate (g/h)

$V_s = V_a \sqrt{P_a / P_s}$

Making Sense

of innovations in **energy-reduction technologies.**

$F_B = \frac{\pi}{4} (P_H - P_L) (d_2^2)$



Implementation of Low Condensing Refrigeration

August 20, 2013

Mike Saunders

Director of End User Technical Sales and Support
Emerson Climate Technologies

Mitch Knapke

Food Retail Market Manager
Emerson Climate Technologies

Andre Patenaude

Director of Marketing
Emerson Climate Technologies Canada

Agenda

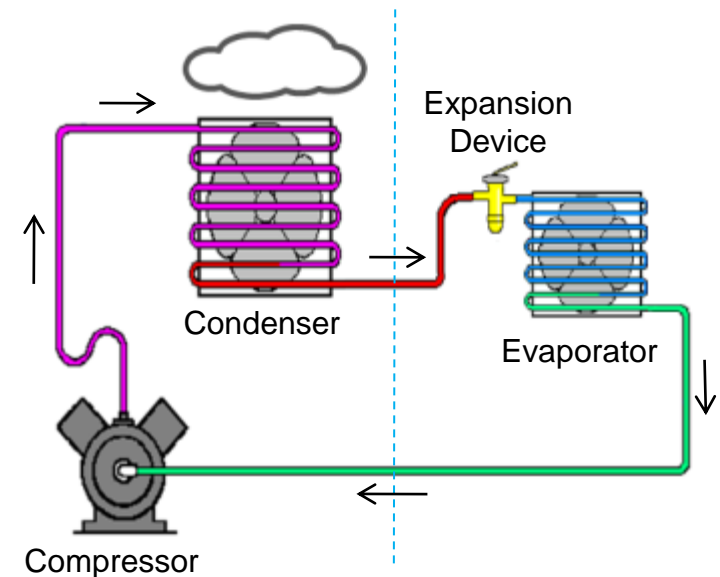
- **Basics of Low Condensing**
 - Definition
 - Benefits
- **Challenges Associated with Low Condensing**
- **Implementation**
 - Component Selection
- **Applications/Case Studies**

DISCLAIMER

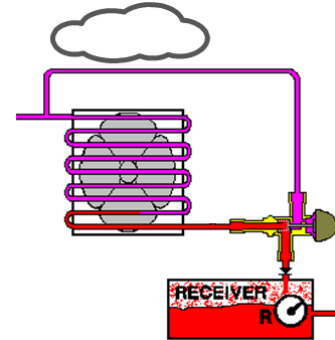
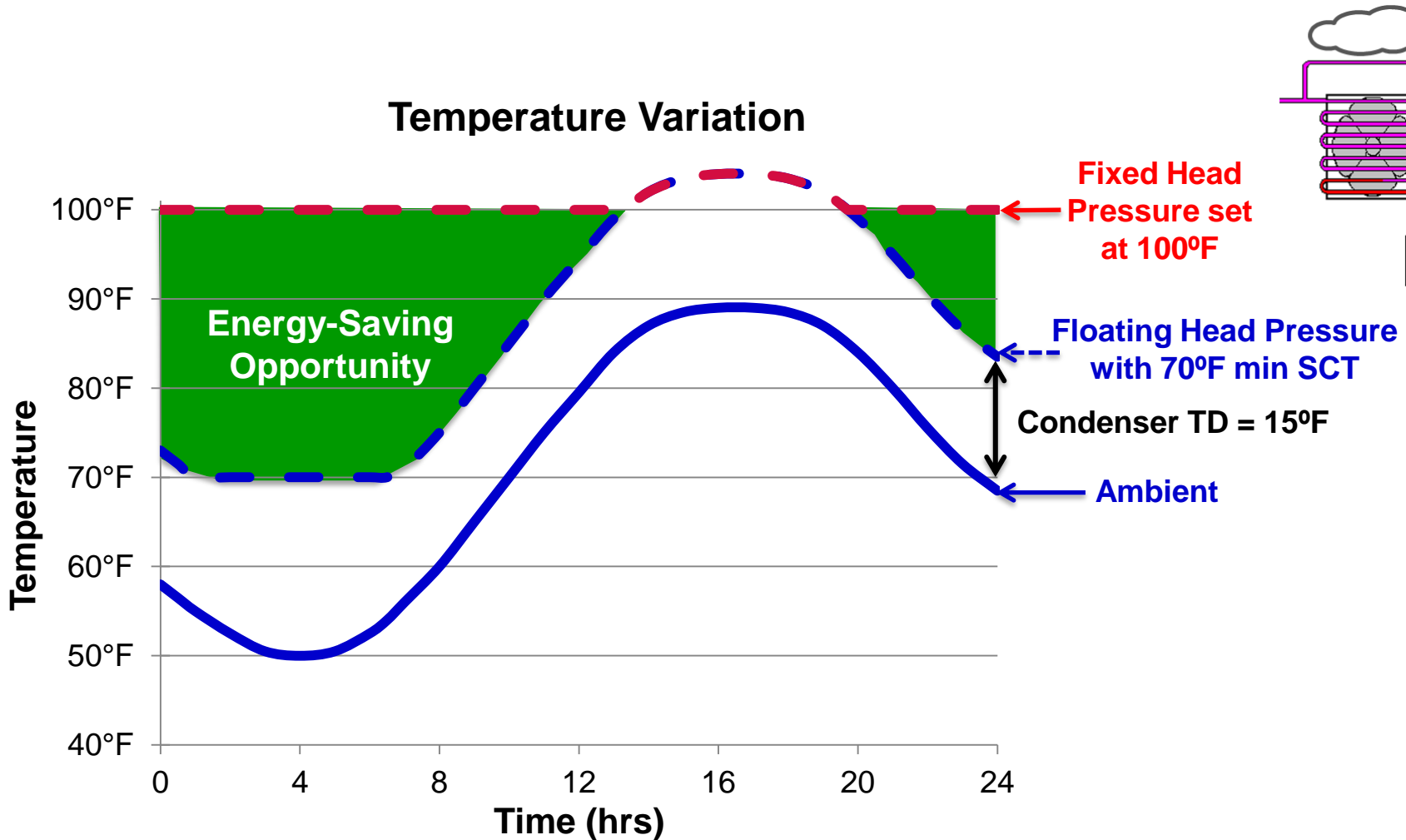
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Definitions

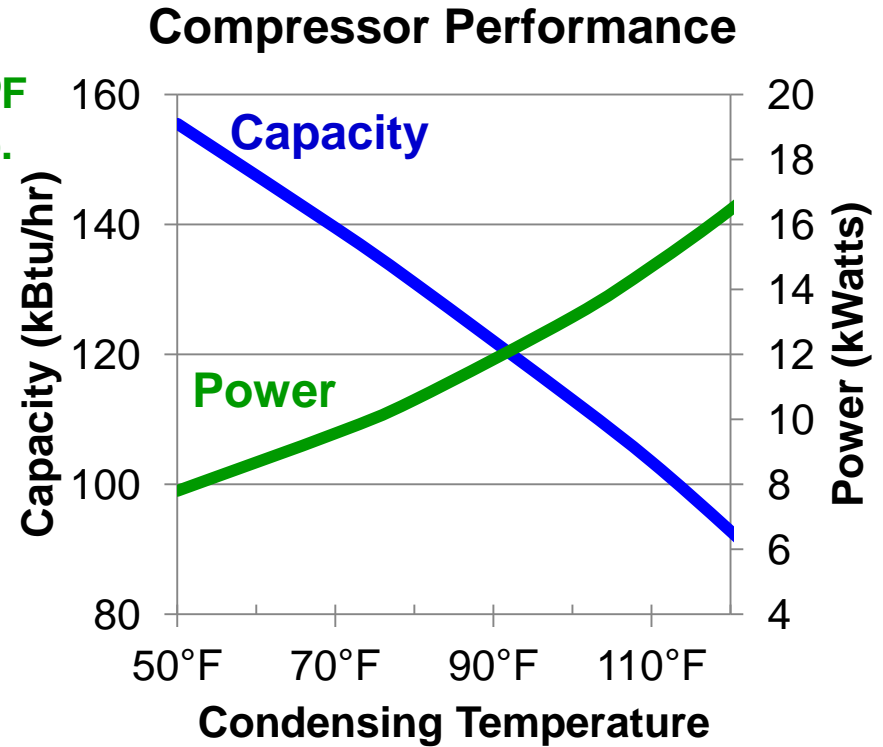
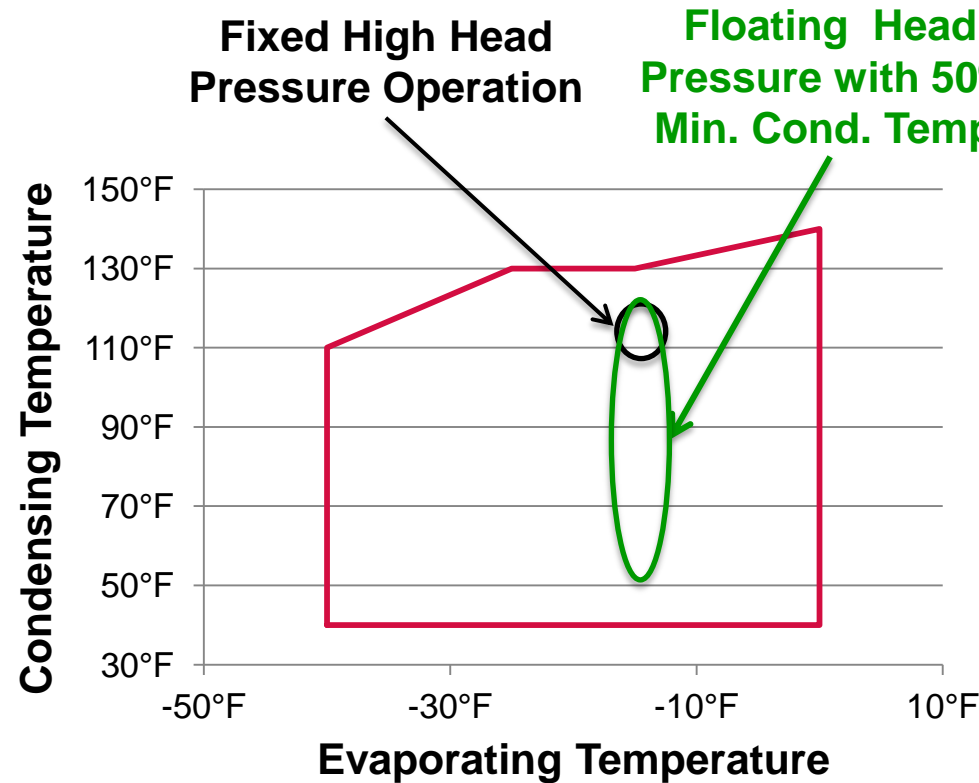
- **Fixed Head Pressure**: Condensing pressure is held above 105°F, typically by a head pressure control valve or fan cycling.
- **Floating Head Pressure (Ambient Following)**: Condensing pressure is a function of ambient temperature (typically 10-20°F above ambient). Head pressure is controlled by cycling or varying the speed of condensing fans.
- **Minimum Condensing Temperature**: The minimum saturated condensing temperature that the system will be permitted to operate.
- **Condenser TD**: The temperature difference between ambient and the saturated condensing temperature of the refrigerant.
- **Floating Suction**: Evaporating control that allows the suction pressure setpoint of the system to raise if case temperatures are being satisfied. (Another energy saving method, but NOT the topic of this webinar).



Low Condensing Introduction

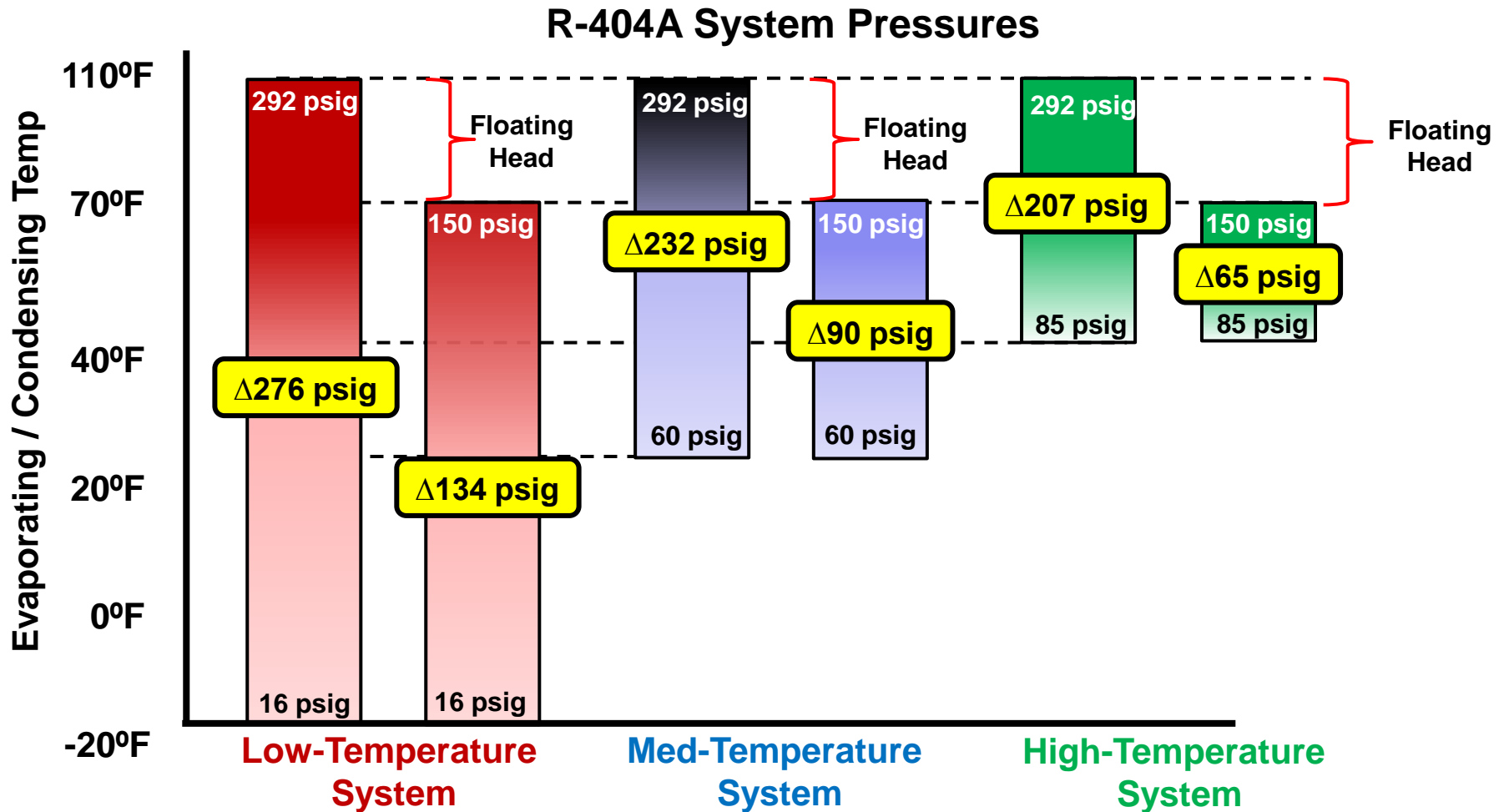


Low Condensing Operation

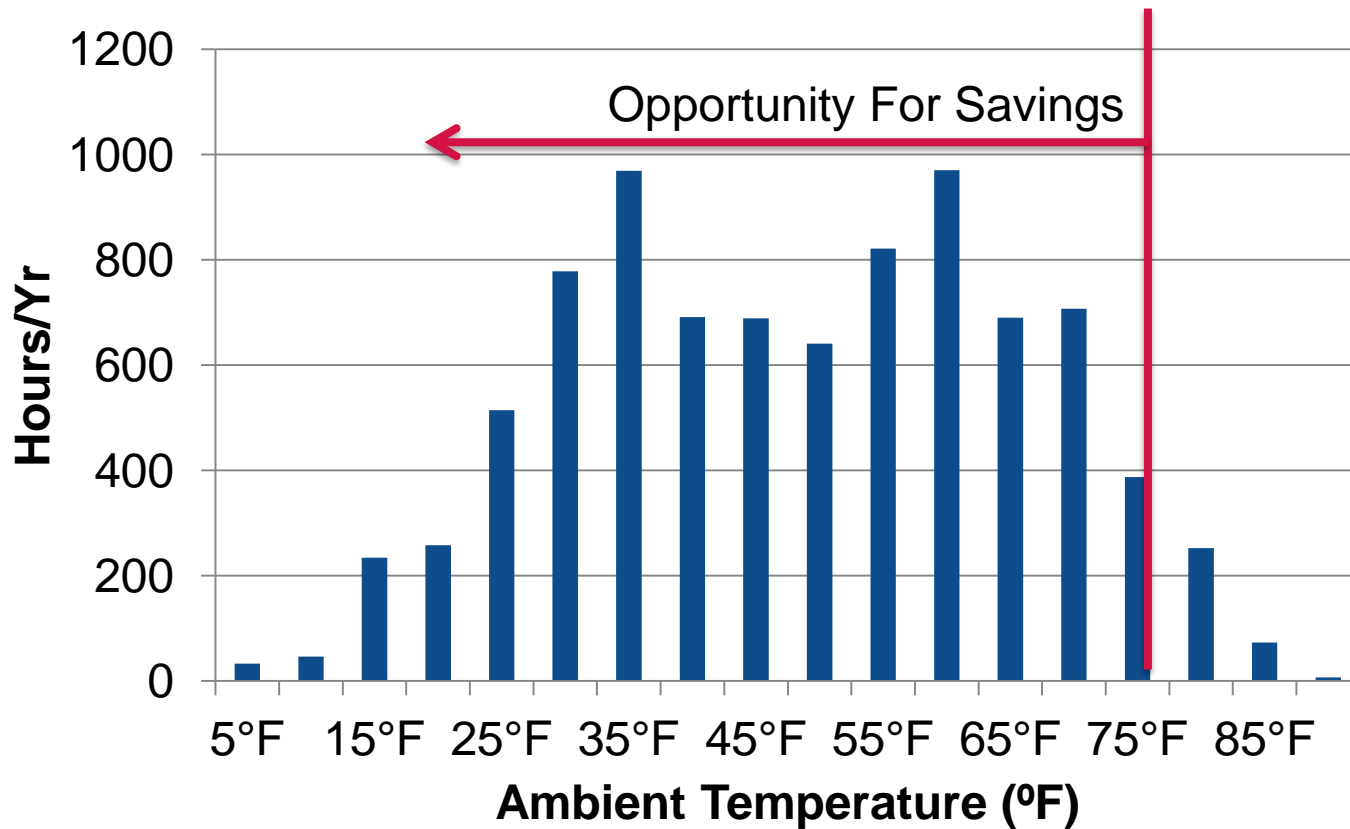


≈20% Increase In Compressor Efficiency for a 10° Drop in Condensing Temperature

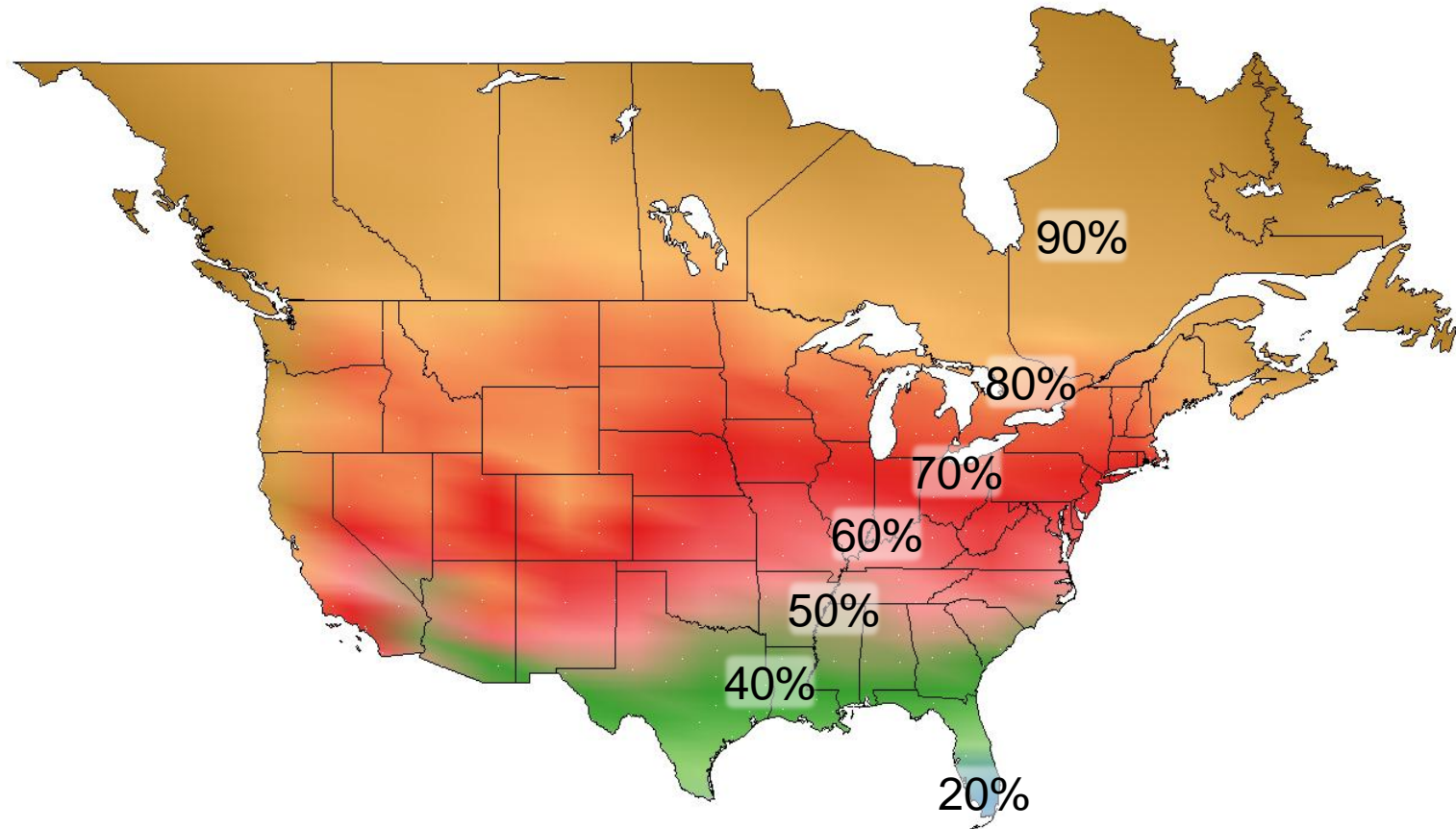
Greater Capacity, Less Power Achieved by Reducing Compression Ratio



Annual Temperatures – Boston



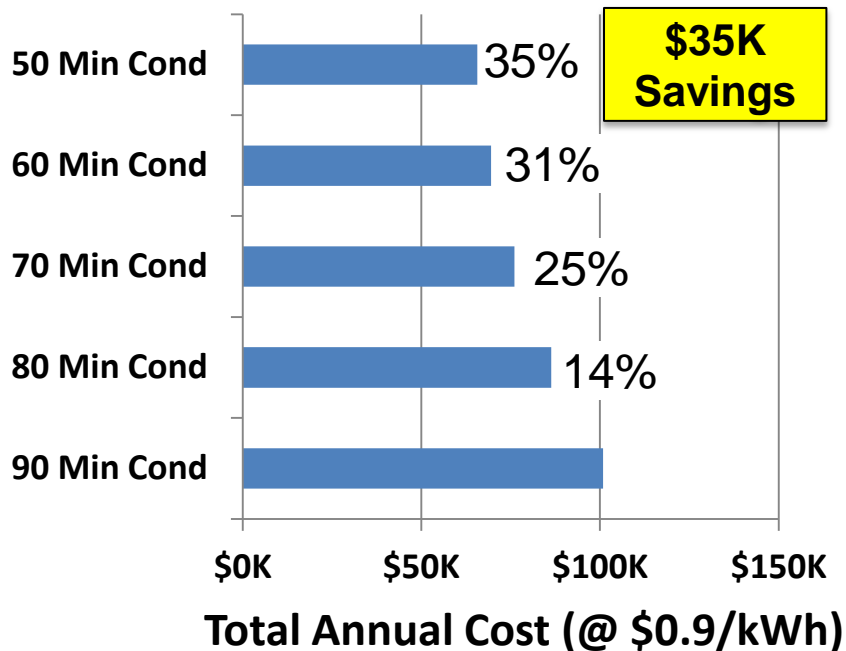
Percentage of Time Spent Below 60°F



Significant Opportunity for Savings

Annual Energy Savings

Typical Supermarket



*Based on Boston Installation, 750MBU MT, 235MBU LT

20 HP Condensing Unit

	Min. Cond. Temp	Annual Energy (kWhr)	Annual Energy Cost	Annual Savings
Low Temp	100°	113	\$8,450	Base
	70°	82	\$6,170	\$2,280
	50°	77	\$5,794	\$2,656
Medium Temp	100°	142	\$10,618	Base
	70°	100	\$7,461	\$3,158
	50°	91	\$6,798	\$3,820
Savings Multiplied with Additional Load/Systems				

*Based on St. Louis Installation



Perform Your Own Analysis With **Emerson's Product Selection Software**
Available for Download at www.EmersonClimate.com

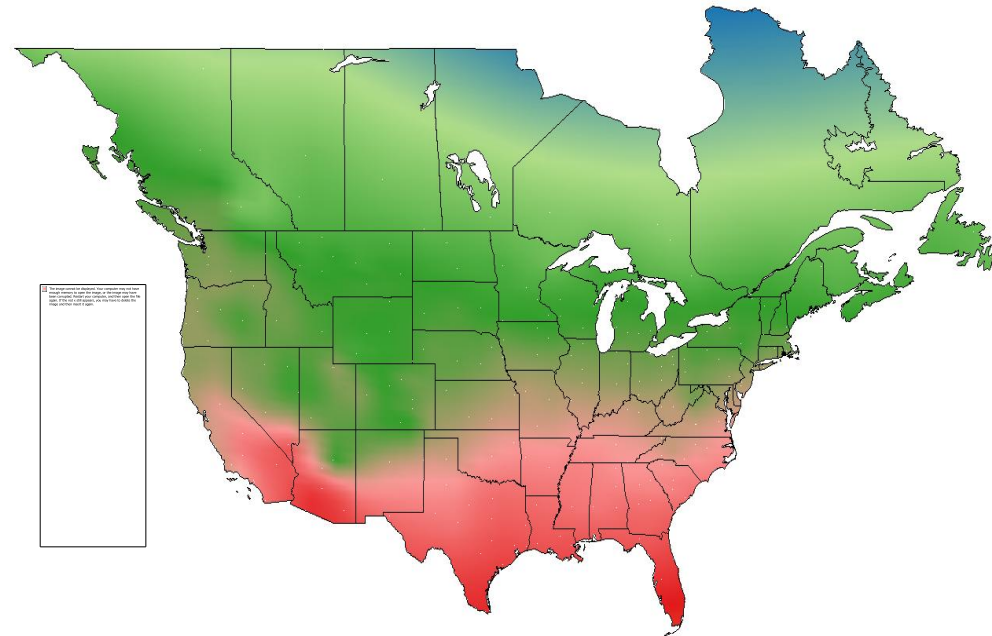
Typical Supermarket Annual Savings

90°F vs. 50°F Minimum Condensing

City	\$ Saved*
Toronto, ON	\$37,815
Boston, MA	\$35,252
St. Louis, MO	\$29,677
Atlanta, GA	\$25,539
Phoenix, AZ	\$16,018
Mexico City, MX	\$24,435

*Based on 750MBU MT, 235MBU LT

Annual Average Temperatures



**Energy Saving Varies by Location:
The Cooler the Climate, the More the Savings**

Low-Condensing Regulations and Incentives

California Title 24 Will Require 70°F Minimum Condensing Temperature for Supermarket Refrigeration

California 2013 Title 24 Supermarket Refrigeration



California Energy Commission

Title 24 Base Code Measures

- Floating head pressure
- Remote condenser specific efficiency

Floating Head Pressure

- The refrigeration system condenser controls for systems with **air-cooled** condensers shall use **variable-setpoint control** logic to reset the condensing temperature setpoint in response to ambient **drybulb** temperature.
- The minimum condensing temperature setpoint shall be **less than or equal to 70°F**.
- **Attractive economics in all locations and for all story types.**

California Title 24 Proposed Code Changes

38

Regional Utilities Offering Incentives for Energy Savings Associated with Low-Condensing Operation

Southwestern Ontario pork processor uses energy savings to help expand its business

CASE STUDY

Walnut Hill Farm

PROJECT STATS

- Installation of a new energy-efficient refrigeration system, including new compressors and evaporators. Installation of insulated panels throughout the facility and energy-efficient evaporator fans.
- 40 percent reduction in annual electricity costs.
- Energy usage is estimated to fall to 61,000 kWh from 103,000 kWh, a saving of 42,000 kWh annually.
- Incentive: \$5,600

Walnut Hill Farm, a pork processor in Gads Hill, Ontario, is using an estimated 40 percent reduction in electricity costs to help pay for the expansion of its business to \$1.3 million from \$750,000.

"The electrical savings we gained by investing in more energy-efficient equipment will be used to pay for the additional electricity we need to expand the business," says John Koch, who, with his wife, Julieanne, owns and operates the Perth County business. "Electricity bills will be about the same as before, but we've added 40 percent more refrigeration. We'll be paying the same amount, but getting more bang for our buck."

Walnut Hill Farm produces a wide range of specialized pork products for its own customers, as well as for Perth Pork Products.

To meet growing customer demand for more specialty pork products, Walnut Hill Farm increased the number of its refrigeration rooms to 10 from six.

The electricity savings will come from a new high-efficiency refrigeration system that Walnut Hill added in 2012, which has more efficient compressors, evaporators and insulated panels throughout the facility.

The old refrigeration system, while effective in controlling and maintaining proper cooling, was two to three generations behind the current technology and inefficient, Mr. Koch says. It used seven separate compressors (158,000 Btu/hr) to provide cooling to refrigeration rooms throughout the facility.

"It was costly to operate. Electricity is one of the farm's highest fixed costs. Anything you can save on hydro is a plus," he says.

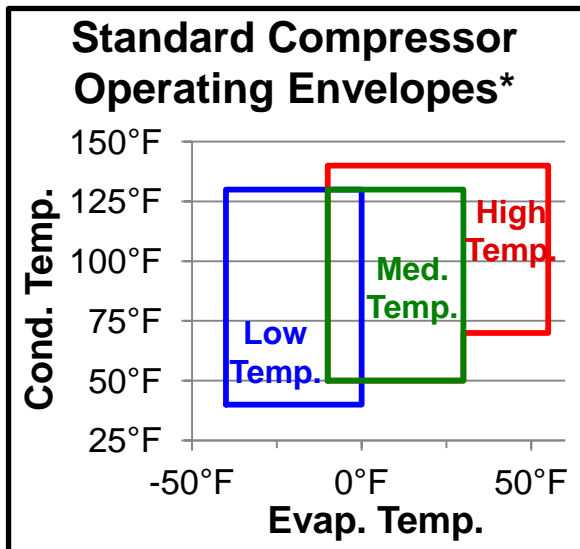
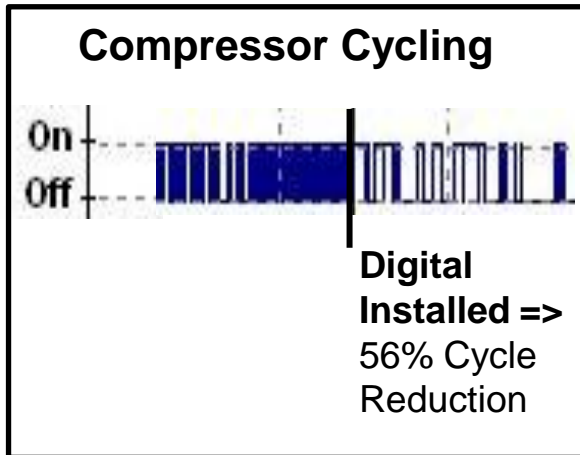
ONTARIO POWER AUTHORITY

What Has Prevented Low Condensing Adoption?



- **Industry Understanding of Head Pressure**
 - Generally accepted myth: High head pressures required for reliable system operation
 - Design intent not communicated to service personnel
- **Reliability**
 - Limitations of mechanical controls
 - Simple TXV circuits proved to be much more dependable with fixed operating conditions
- **1st Cost/Technology Availability**
 - Electronic expansion valves, variable speed fans and compressor modulation availability and cost
- **Heat Reclaim vs. Low Condensing Tradeoffs**
 - Location and load dependent

Low Condensing Challenges



■ Wide Capacity/Mass Flow Range

- Compressors Selected with 10% Oversize at 110°F Are 155% Oversized When Operating at 70°F
- Expansion Valve Must Ensure Superheat Control across Entire Capacity Range

■ Lower Pressure Ratio Operation

- Copeland Compressors Approved* to Operate At:
 - 50°F Min. Cond. Temp. for Medium Temp. Applications*
 - 40°F Cond. Temp. For Low Temp. Applications
- Expansion Valve Must Handle Low-Pressure Differentials (≥ 30 PSIG)

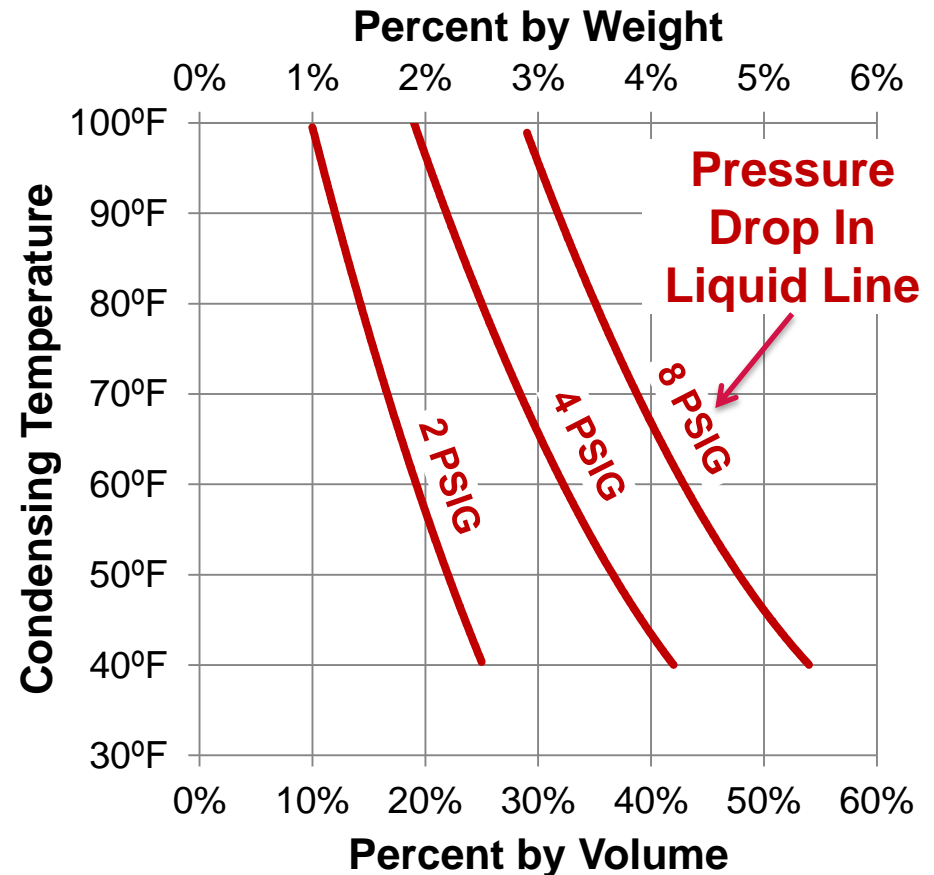
*Please Consult AE Bulletin for Specific Product/ Refrigerant Envelopes

Low Condensing Challenges

■ Increased Flash Gas

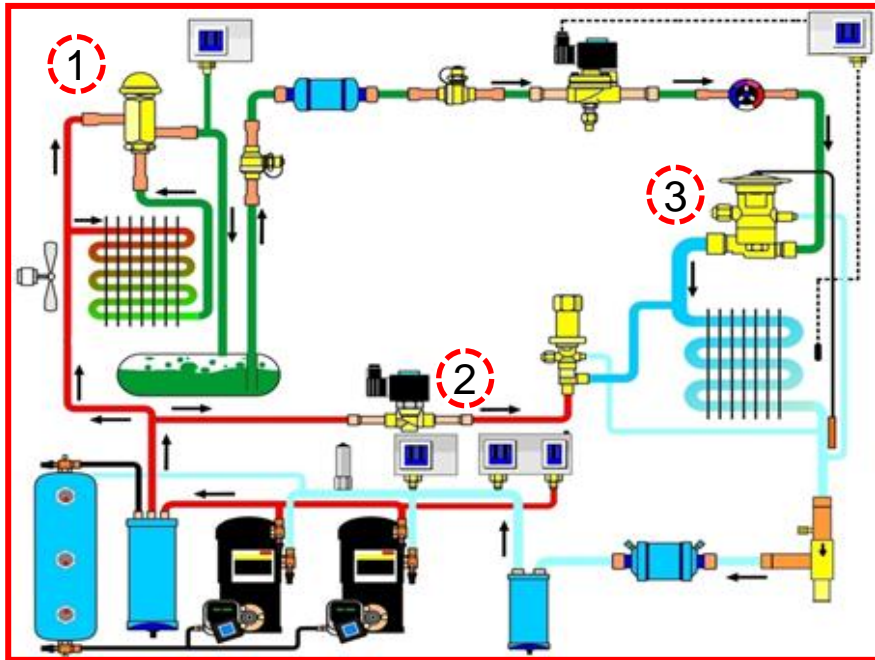
- The Same Pressure Drop in the Liquid Line Results in More Flash Gas Formation at Low Condensing Temperatures
- If Not Considered, Inadequate Cooling Can Result
- Methods to Manage:
 - Subcooling ✓
 - Eliminate Pressure Drop
 - EEV Sizing ✓

Liquid Line Flash Gas Formation



Low Condensing Implementation

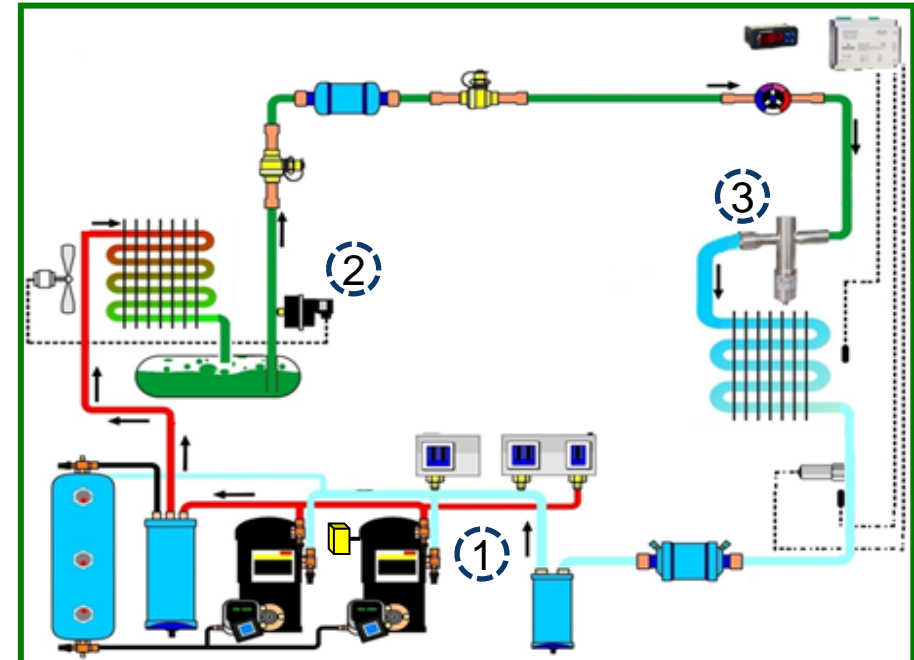
Conventional System



Remove

1. Head Pressure Control Valve
2. Hot Gas Bypass
3. TXV

Low-Condensing System

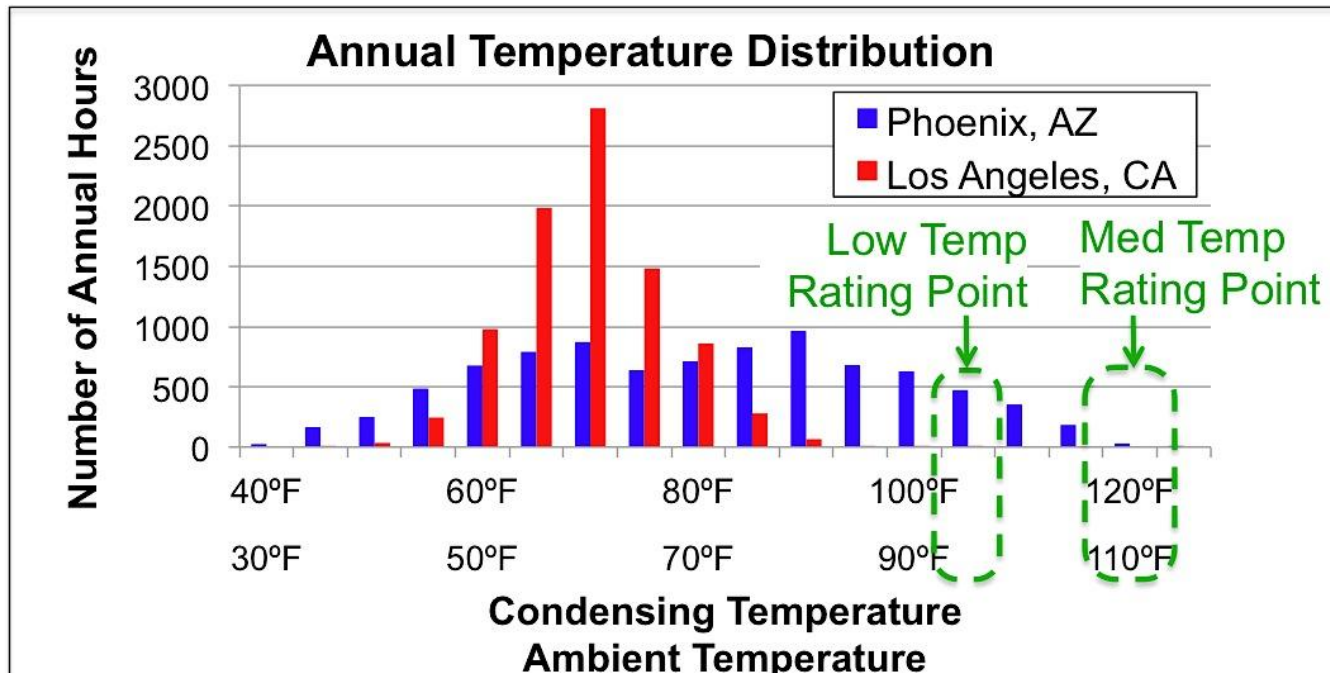


Add

1. Compressor Modulation
2. Variable Fan Speed Control
3. Electronic Expansion Valve

Compressor Selection

- **Compressors Do Not Spend Significant Time at Rating Conditions**
 - LT: -25F/105F/0F Subcool/65F Return Gas
 - MT: 20F/120F/0F Subcool/65F Return Gas

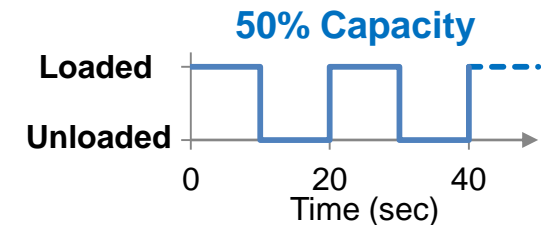
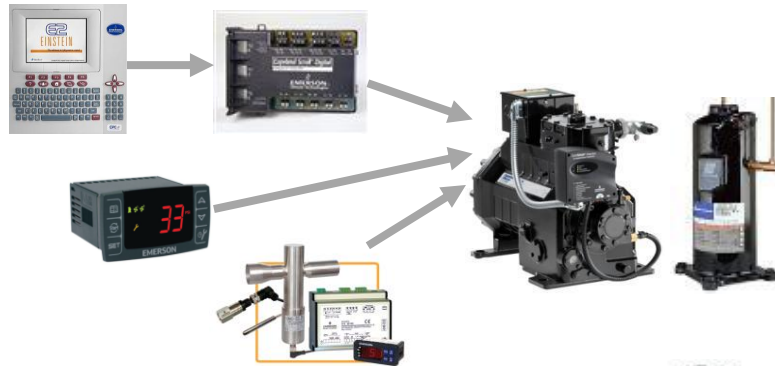


Select Compressors Optimized at Low Condensing to Minimize Energy Usage

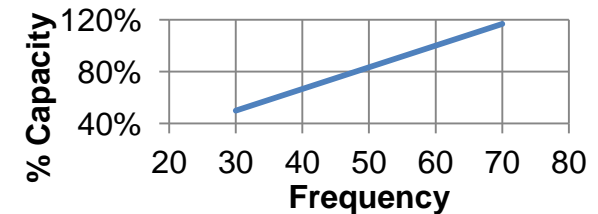
Compressor Selection

- **Compressor Modulation Recommended to Prevent Excessive Cycling at Low Condensing in Single Compressor Systems**
 - 10-100% Digital Modulation Available On Copeland Discus & Scroll
 - Variable Speed Operation Also An Option
- **System Controller Must Be Capable of Variable Capacity Control**

Digital Modulation

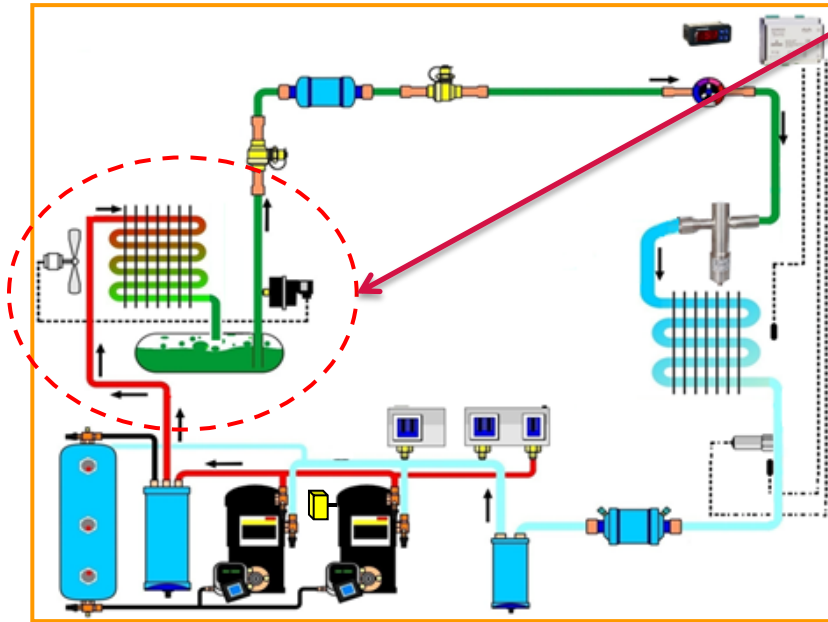


Variable Speed

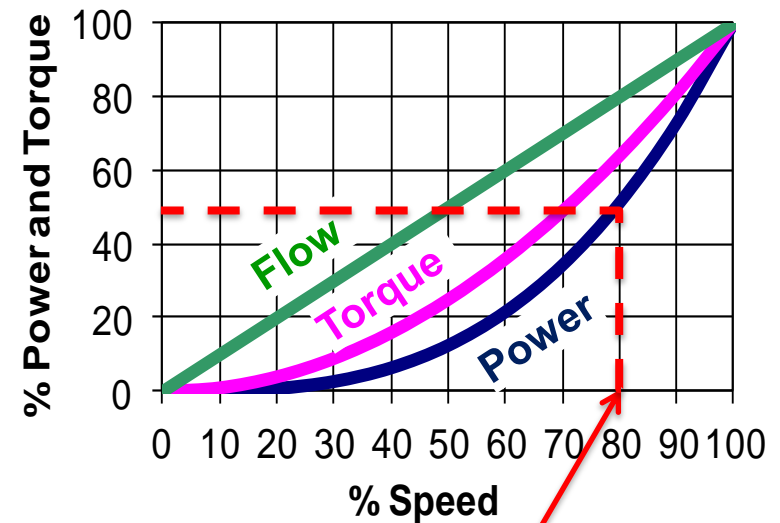


Condensing Control

Variable Frequency Drives for Three-Phase Fan Motors



Affinity Law For Fan Motors

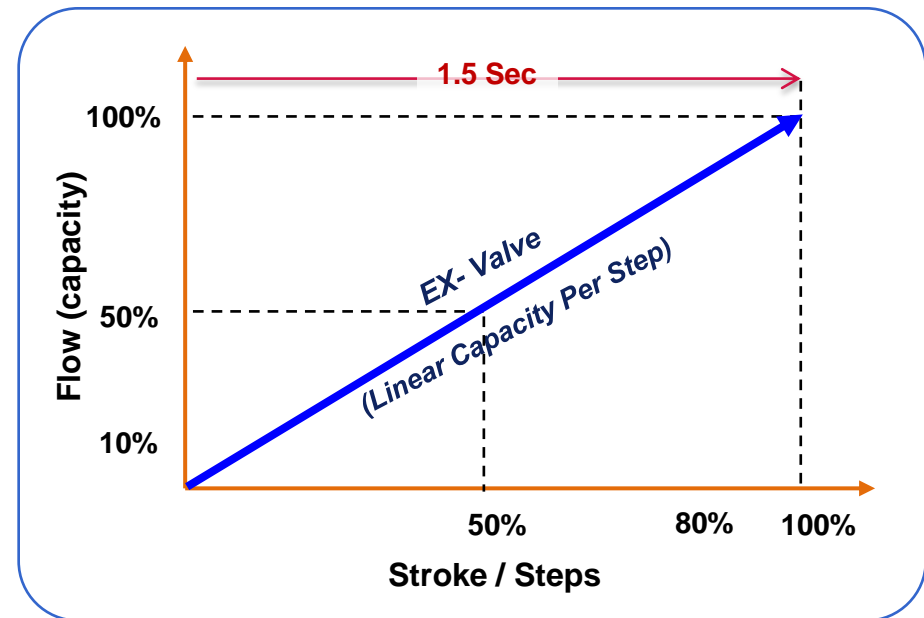
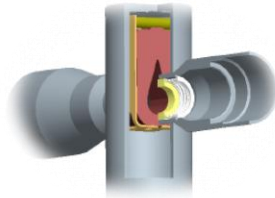


80% Speed (Flow) Equals
50% Theoretical Power Consumption

Expansion Valve Selection

Emerson Electronic Expansion Valve

- The key to unlocking the energy savings of the compressor is the ability of the electronic valve to effectively control the evaporator under all loading conditions, liquid quality and head pressure



Ideal Applications

- **Large Cold Rooms/Food Storage**
- **Food Processing**
- **Data Centers**
- **Supermarket - Secondary Fluid Systems**
- **Air-Cooled Chillers**
- **And Many More.....**



Freezer “EX Cold Room Control”



We're always trying to stay ahead of the curve

"We are constantly looking at ways of exceeding our customers' expectations. With Emerson's industry-defining controls we are able to consistently deliver on those goals. The Emerson Electronic "EX" system is probably the best thing that's come along in refrigeration in a very long time. It's the only product that allows full system modulation while optimizing evaporator efficiency. Emerson's electronics are the key to providing our customers increased reliability while reducing their overall carbon footprint and energy bills. That's why we consider Emerson, a partner in providing solutions."

BEN KUNGL
President, Oxford Energy Solution Inc.

www.EmersonClimate.com



EMERSON. CONSIDER IT SOLVED.

- **Customer Pain**
 - Slow Pull Down in Temperature
 - Units Runs 24 hrs/ day
 - Latent Pain, Early Compressor Failures
- **Execution**
 - Dropped the Head from 110°F to 70°F SCT
 - Added EX Valve to Every Evaporator
- **End User Benefits**
 - Faster Pull Down
 - 50% Reduction in Energy (\$86K to \$42k/yr)
 - Eliminated Compressor Failures Due to High Temp.
- **Contractor Benefits**
 - Premium Service
 - Secured Service Contract

Apple Storage Project

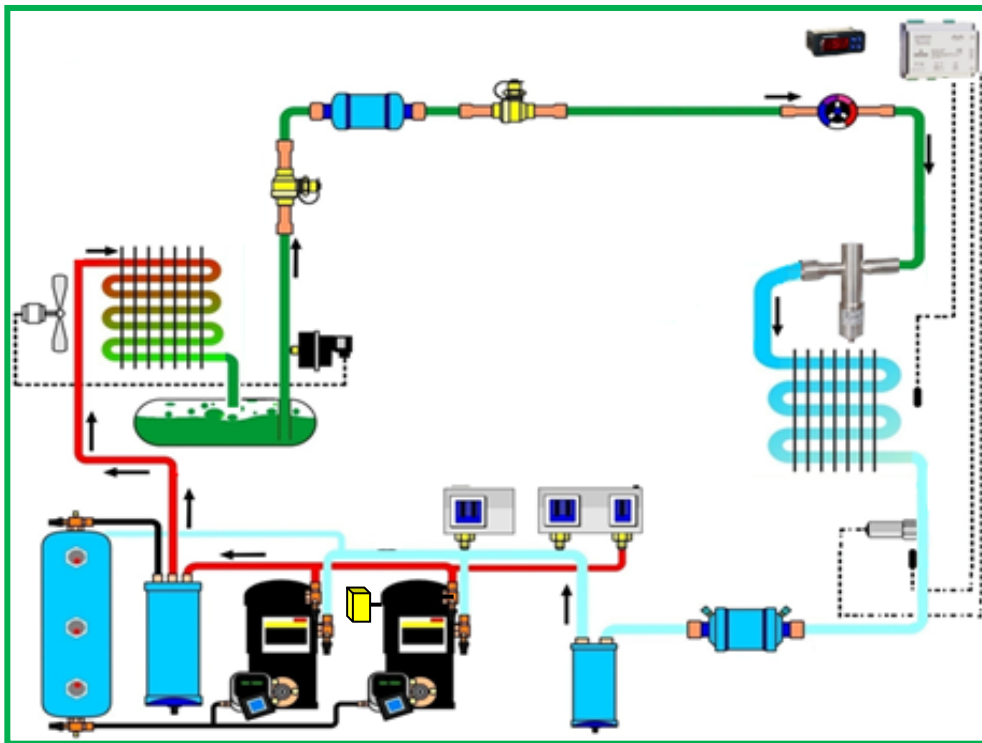


- **Customer Pain**
 - Poor Temperature Controls at Light Loads
 - Lack of Connectivity
- **Execution**
 - Installed Electronic Expansion Valve
 - Implemented Variable-Speed, Condensing Fan Control
 - Dropped Head from 110°F to 70°F SCT
 - Added Supervisory Control
- **End User Benefits**
 - Increased Capacity from 5 to 8 Rooms with Same Compressor HP
 - Precise Temperature Control Under Light Loads
 - Remote Adjustment and Monitoring
 - Lower Energy Cost
- **Contractor Benefit**
 - Next Job Secured
 - Local Power Authority to Provide Incentives

Low-Condensing System Benefits

With Variable Compressor Capacity + Wide Range EX Valve + Electronic Controls

Simplified Efficient Solution



- Reduce Energy Usage/Costs
- Potential Energy Incentives (Regional)
- Precise Temperature Control
- Precise Humidity Control
- Reduced Defrost Time
- Improved Product Quality
- Increased System Capacity
- Reduce Refrigerant Charge
- Reduced Leaks
- Reduced Downtime
- Reduced Maintenance Cost
- Complete Capacity Modulation
- Improves Profitability

Thank You!

Questions and Answers

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