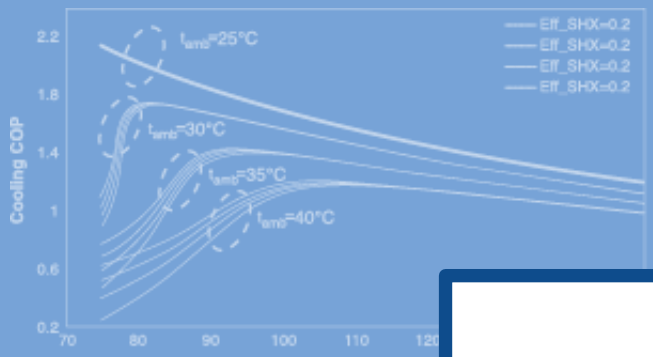
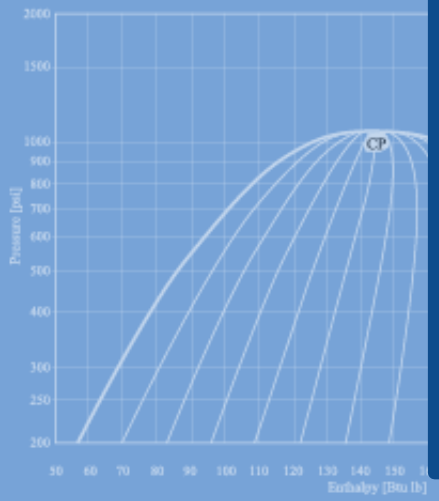
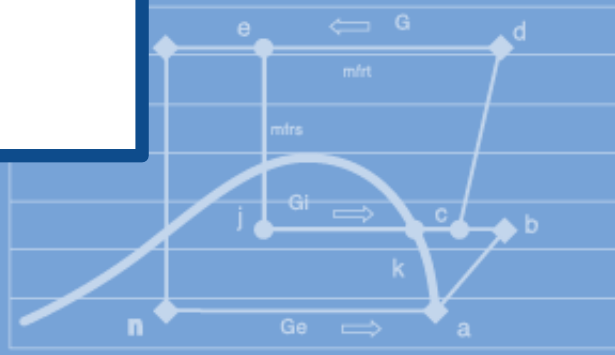


$$COP \equiv \frac{T_m}{T_m - T_o}$$

Making Sense

Webinar Series





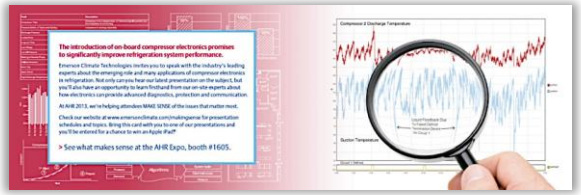
$$D = \frac{1.86 \;\; 10^{-3} T^{3/2} \sqrt{1/M_1 + 1/M_2}}{p \sigma_{12}^2 \Omega}$$

EMERSON
Climate Technologies

Making Sense Webinars

Making Sense Webinars

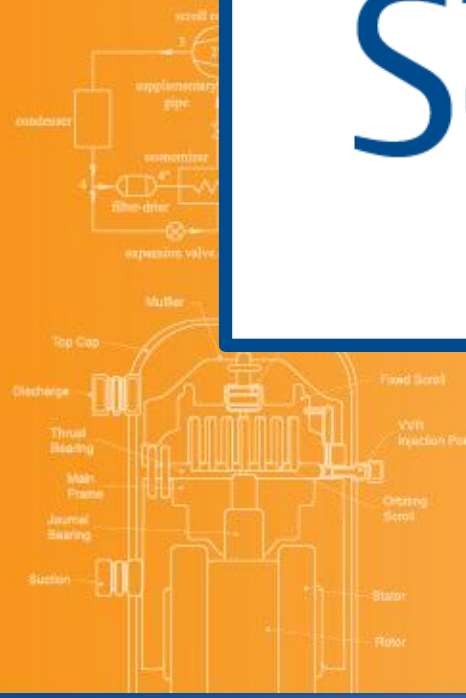
Emerson and Our Partners Giving Insight on the Three Most Important Issues in Refrigeration



Making Sense

$$V_s = V_d \sqrt[k]{Pd/Ps}$$

Making Sense of innovations in energy-reduction technologies.



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

Making Sense Webinar Series

EMERSON Climate Technologies

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

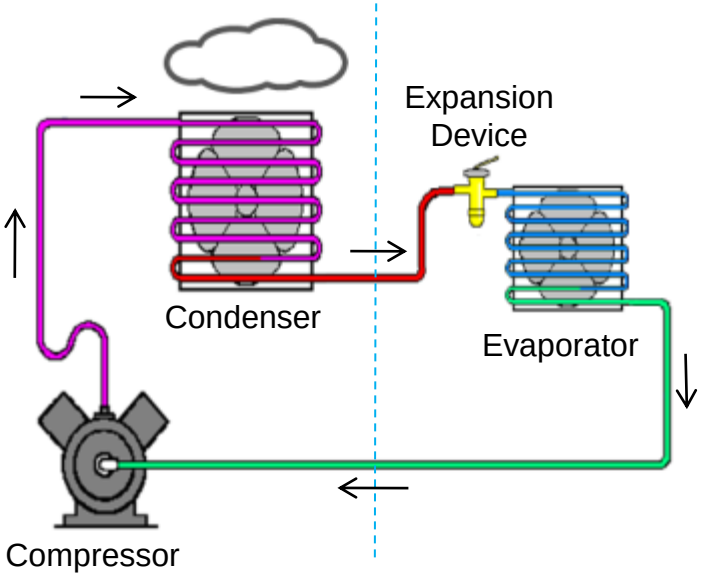
Andre Patenaude
Director of Marketing
Emerson Climate Technologies Canada

Agenda

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

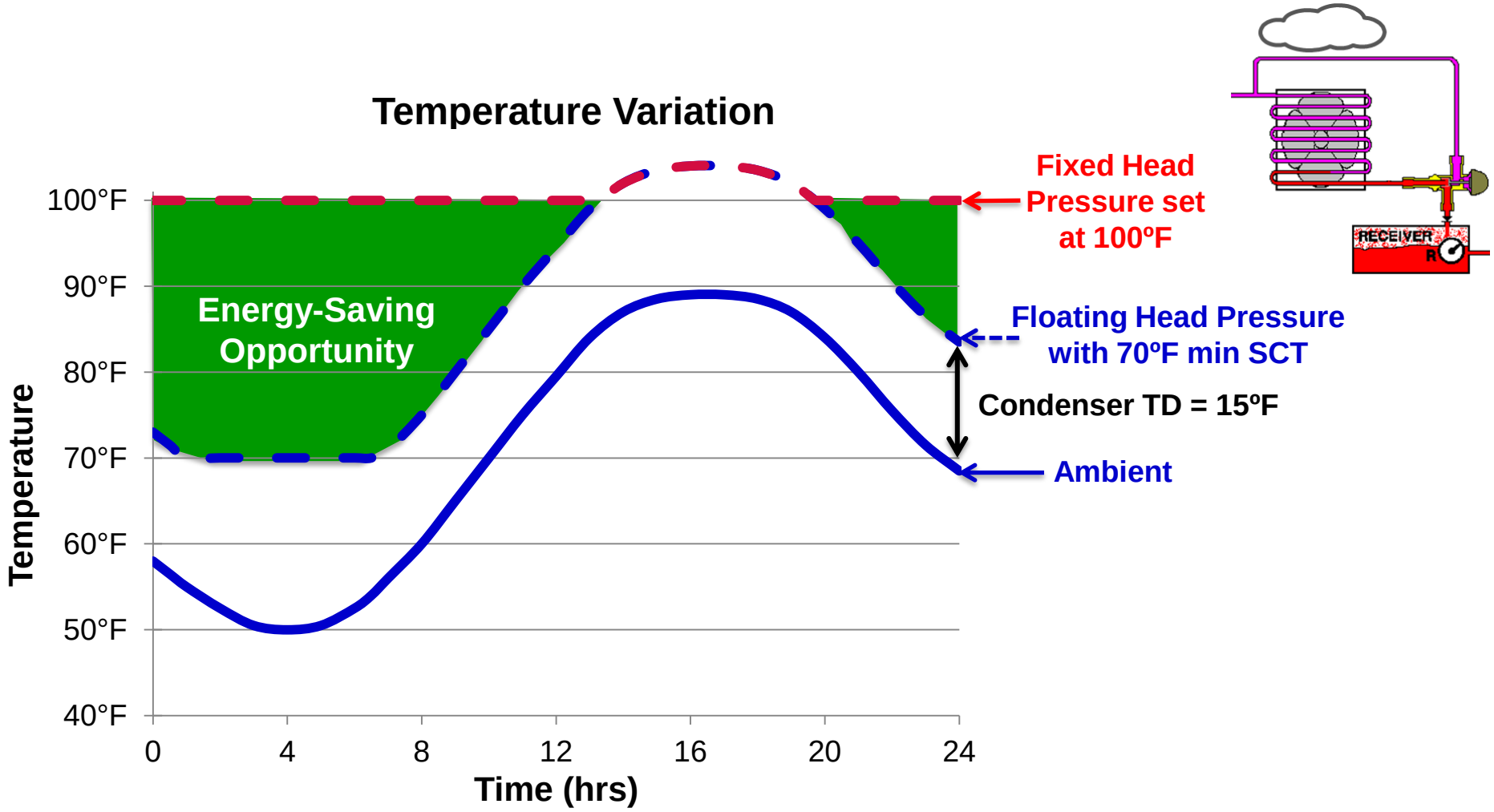
Definitions

- **Fixed Head Pressure**: Condensing pressure is held above 105ºF, typically by a head pressure control valve or fan cycling.
- **Floating Head Pressure (Ambient Following):** Condensing pressure is a function of ambient temperature (typically 10-20ºF 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.



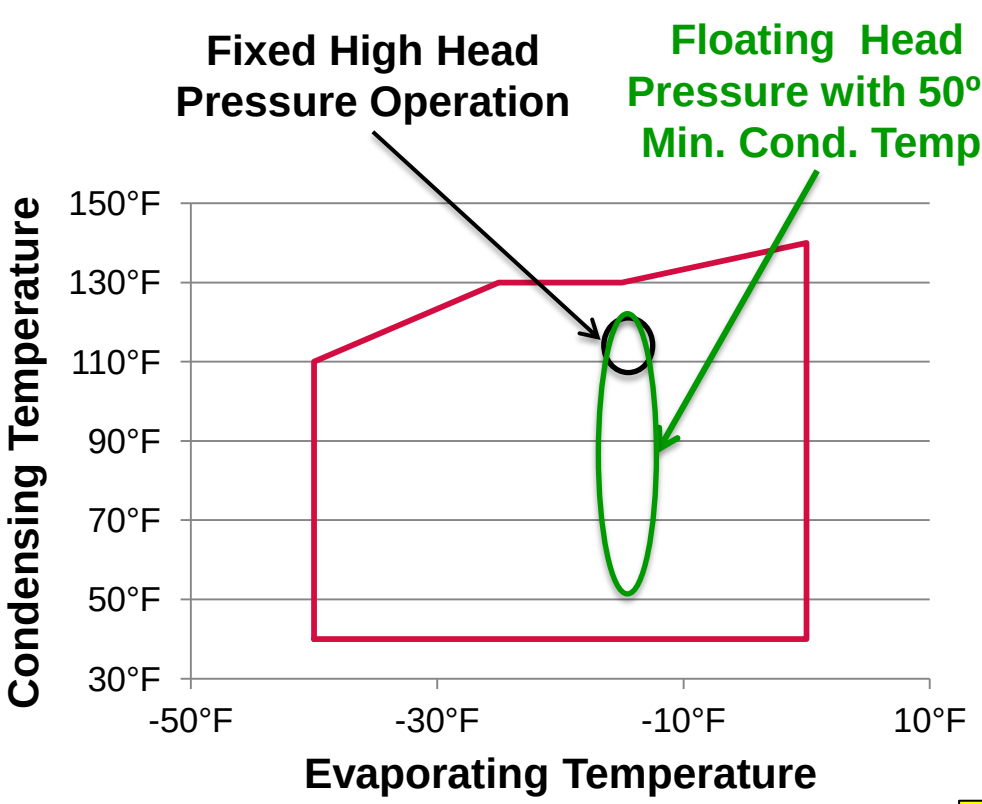
- **Condenser TD:** The temperature difference between ambient and the saturated condensing temperature of the refrigerant.
- **Floating Suction:** Evaporating control that allows the suction pressure setpoint of the system to raise if case temperatures are being satisfied. (Another energy saving method, but NOT the topic of this webinar).

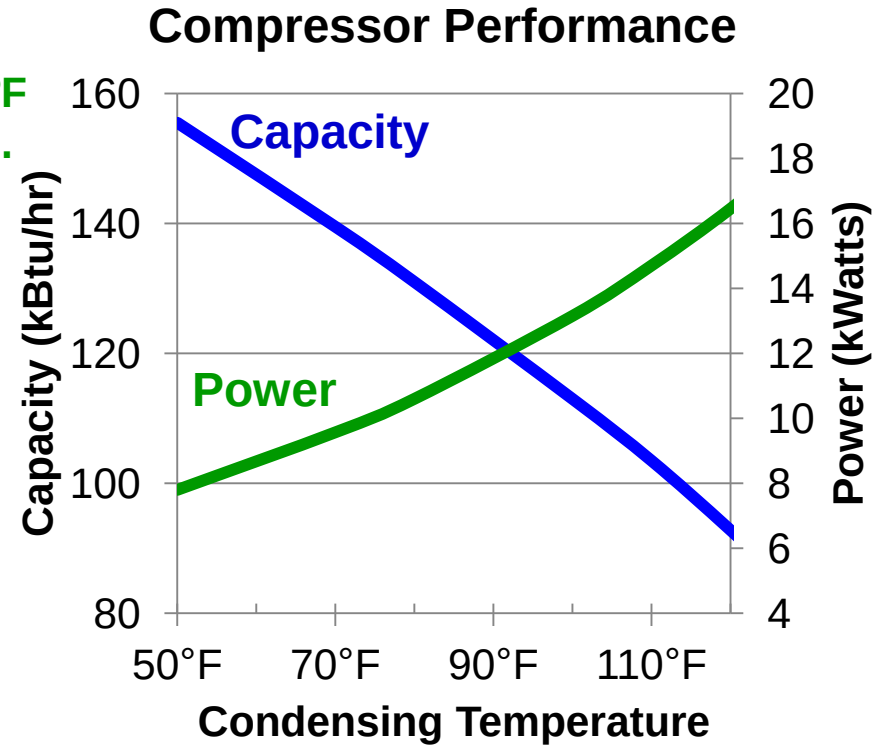
Low Condensing Introduction



Making Sense

Low Condensing Operation

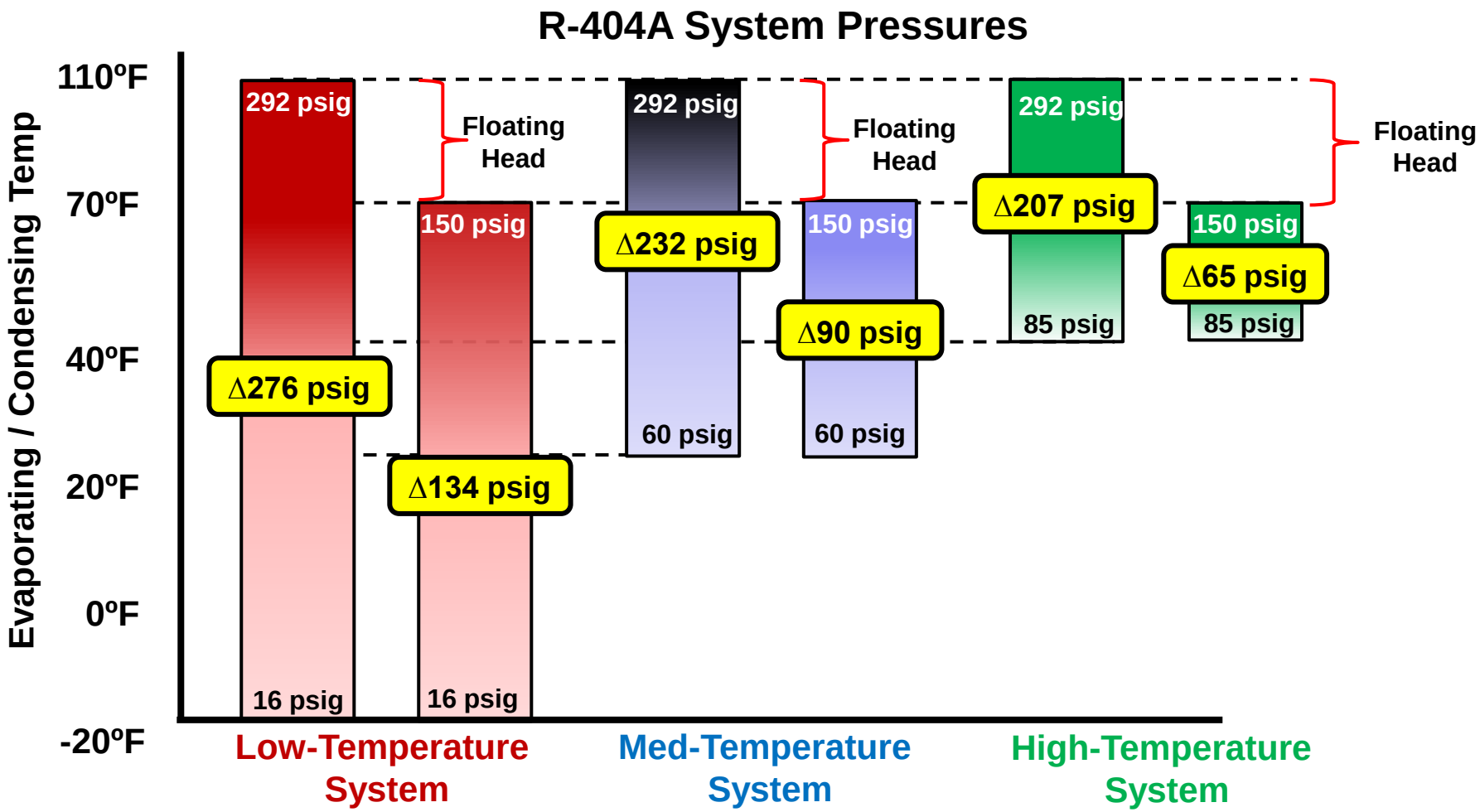




≈20% Increase In Compressor Efficiency for a 10º Drop in Condensing Temperature

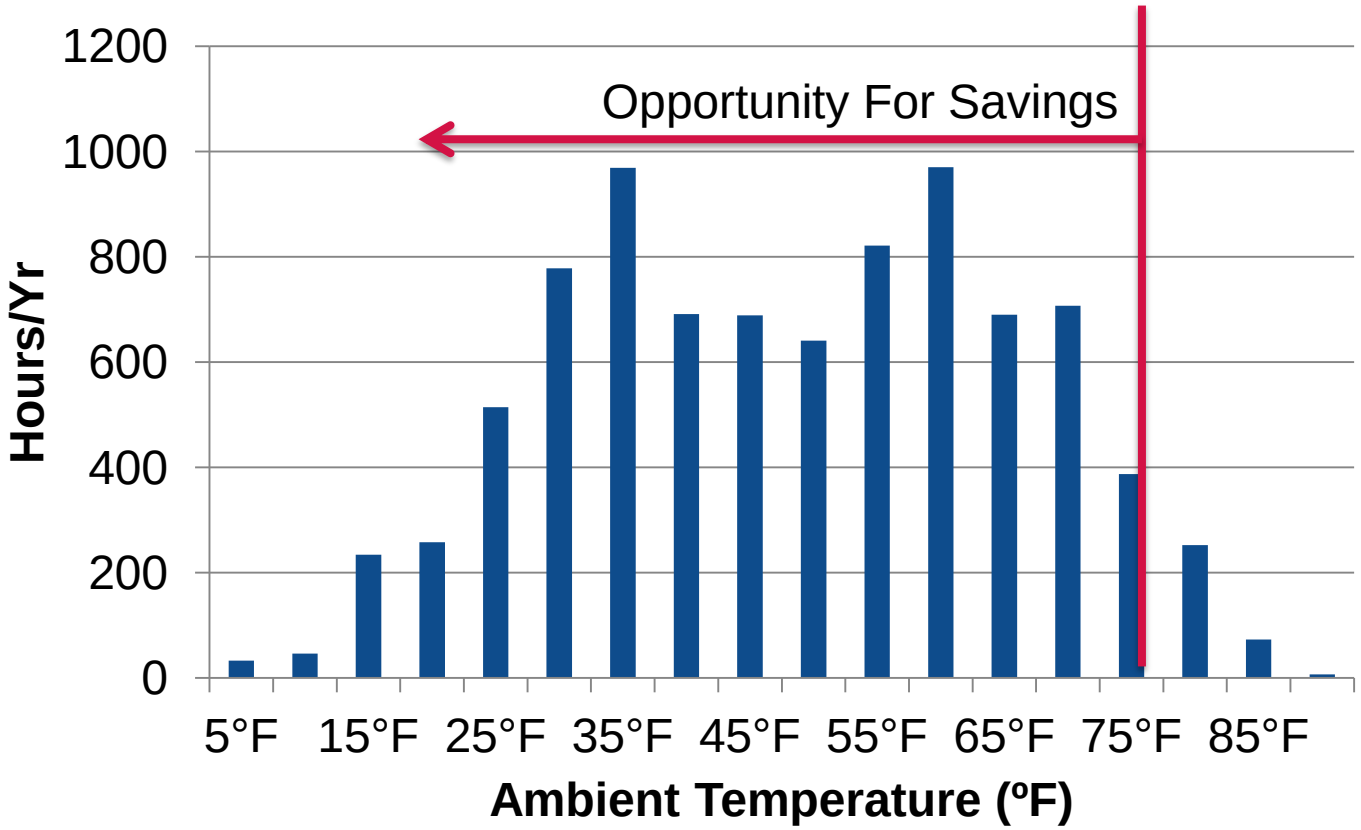
Making Sense

Greater Capacity, Less Power Achieved by Reducing Compression Ratio



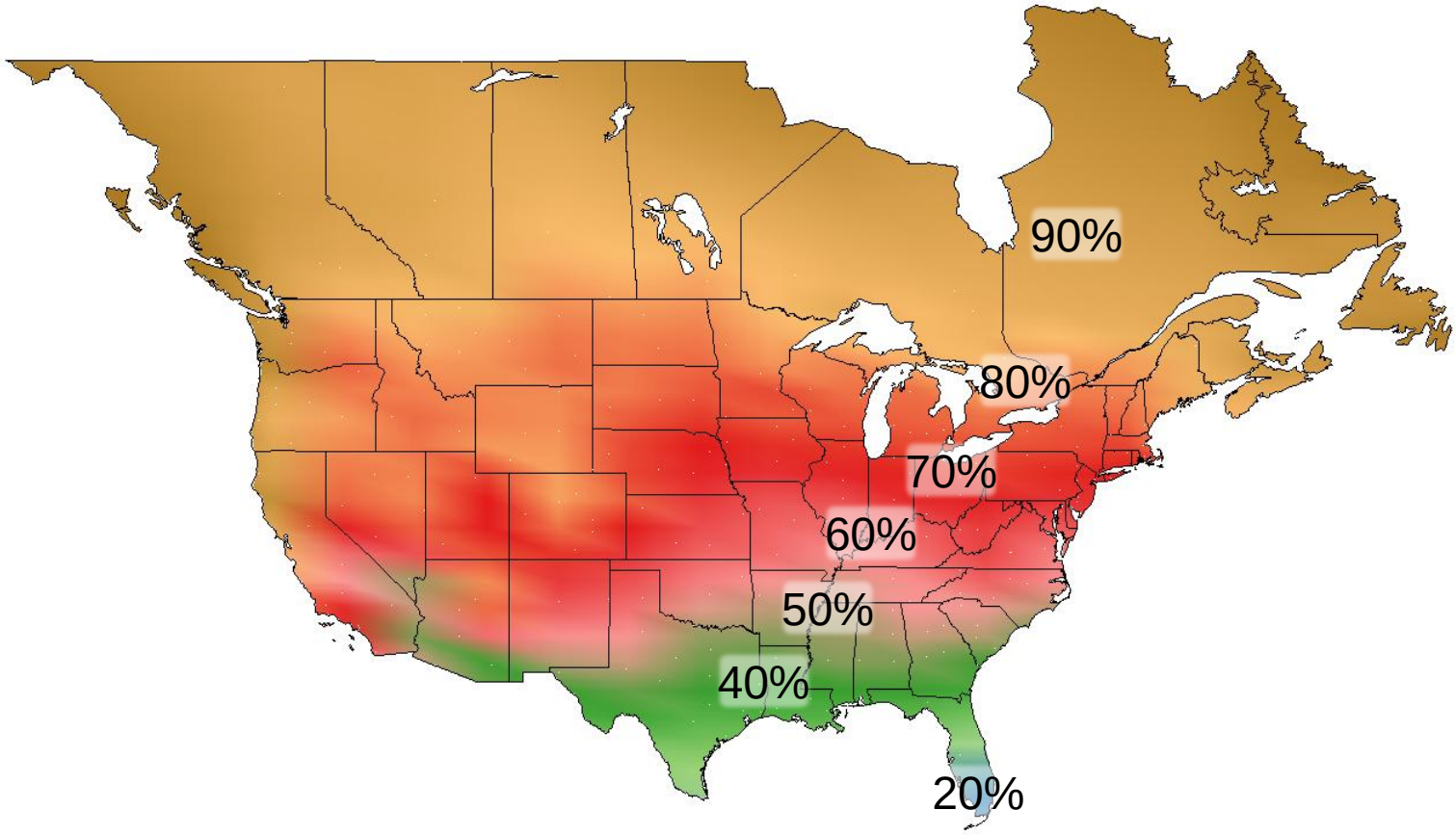
Making Sense

Annual Temperatures – Boston



Making Sense

Percentage of Time Spent Below 60°F

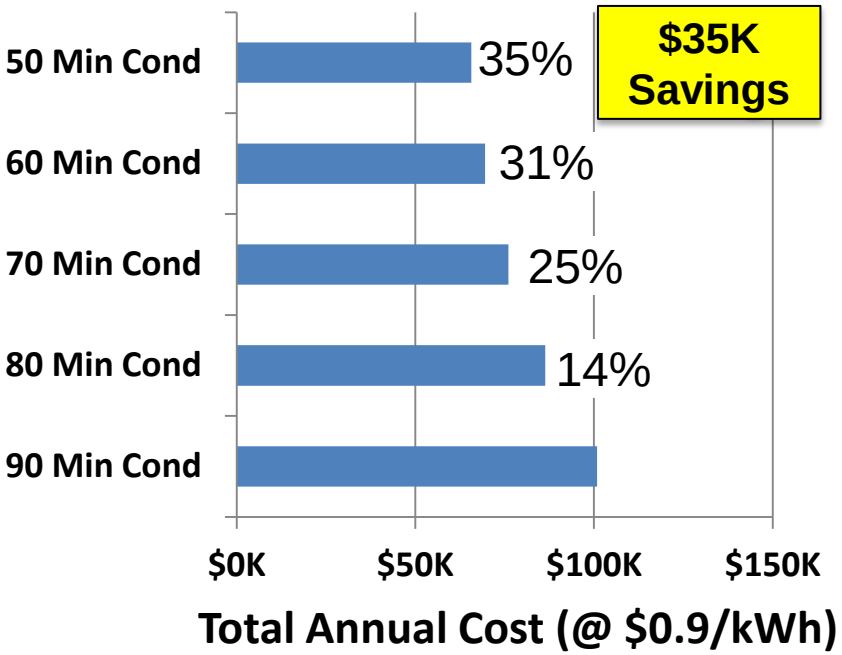


Significant Opportunity for Savings

Making Sense

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

Making Sense

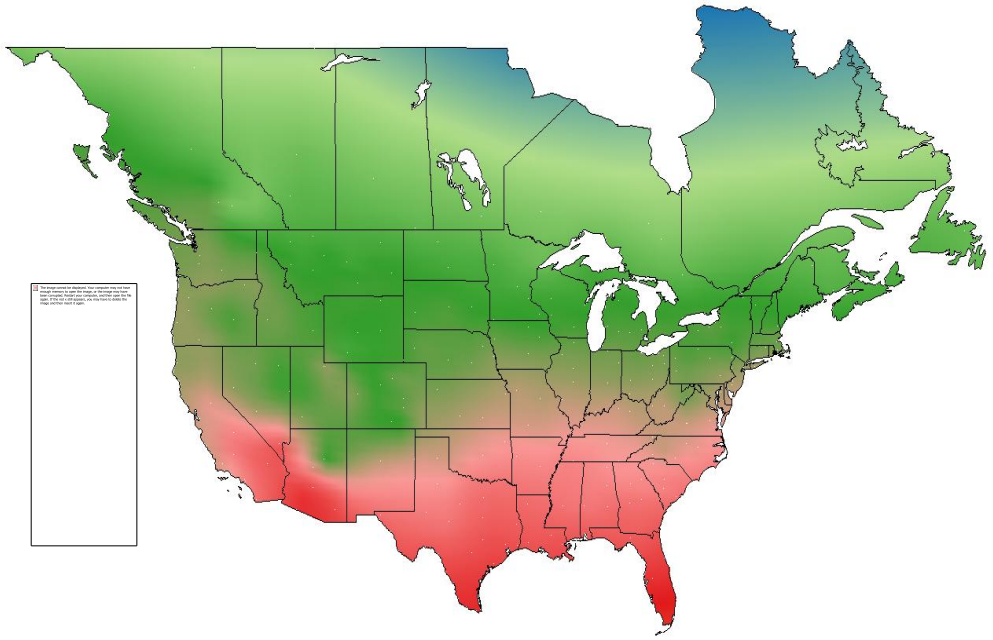
Typical Supermarket Annual Savings

90ºF vs. 50ºF 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

Making Sense

Low-Condensing Regulations and Incentives

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

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

Making Sense

What Has Prevented Low Condensing Adoption?

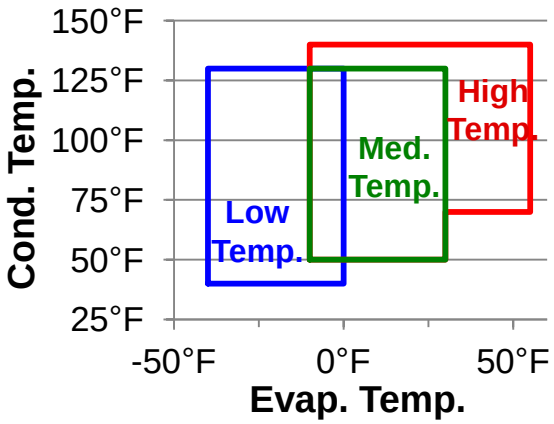
- **Industry Understanding of Head Pressure**
  - Generally accepted myth: High head pressures required for reliable system operation
  - Design intent not communicated to service personnel
- **Reliability**
  - Limitations of mechanical controls
  - Simple TXV circuits proved to be much more dependable 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

Compressor Cycling

Digital Installed => 56% Cycle Reduction

Standard Compressor Operating Envelopes*



- **Wide Capacity/Mass Flow Range**
  - Compressors Selected with 10% Oversize at 110ºF Are 155% Oversized When Operating at 70ºF
  - Expansion Valve Must Ensure Superheat Control across Entire Capacity Range

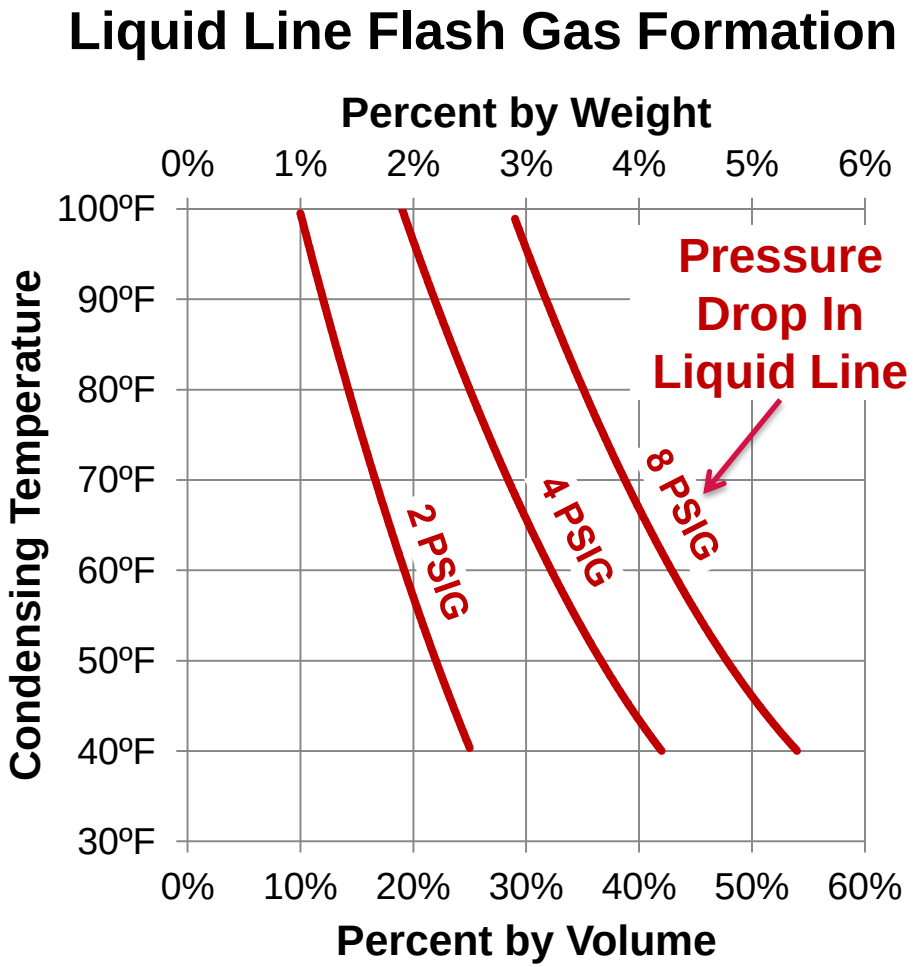
- **Lower Pressure Ratio Operation**
  - Copeland Compressors Approved* to Operate At:
    - 50°F Min. Cond. Temp. for Medium Temp. Applications*
    - 40°F Cond. Temp. For Low Temp. Applications
  - Expansion Valve Must Handle Low-Pressure Differentials (≥30 PSIG)

*Please Consult AE Bulletin for Specific Product/ Refrigerant Envelopes

Making Sense

Low Condensing Challenges

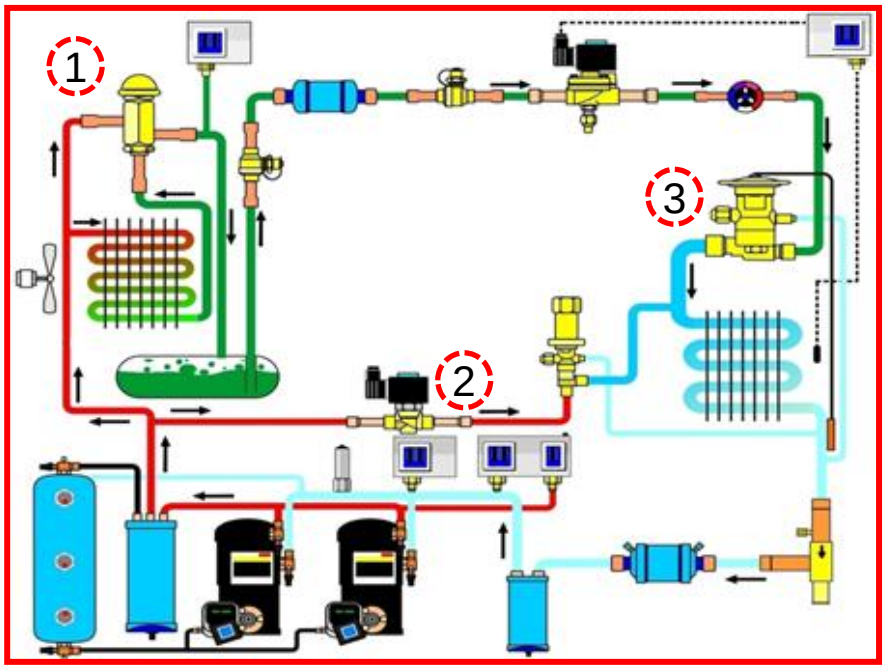
- **Increased Flash Gas**
  - The Same Pressure Drop in the Liquid Line Results in More Flash Gas Formation at Low Condensing Temperatures
  - If Not Considered, Inadequate Cooling Can Result
  - Methods to Manage:
    - Subcooling ✓
    - Eliminate Pressure Drop
    - EEV Sizing ✓



Making Sense

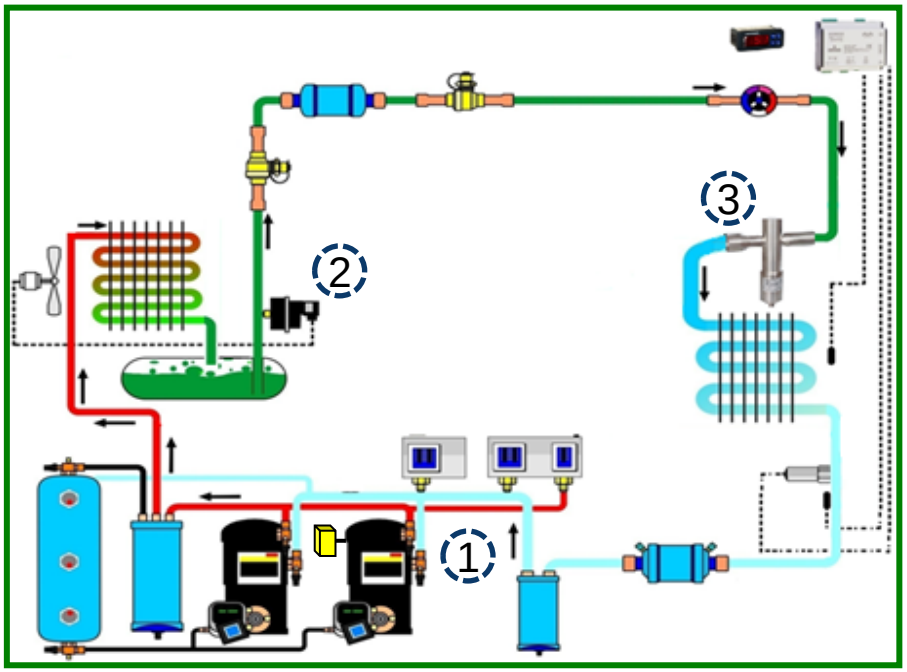
Low Condensing Implementation

Conventional System



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

Low-Condensing System

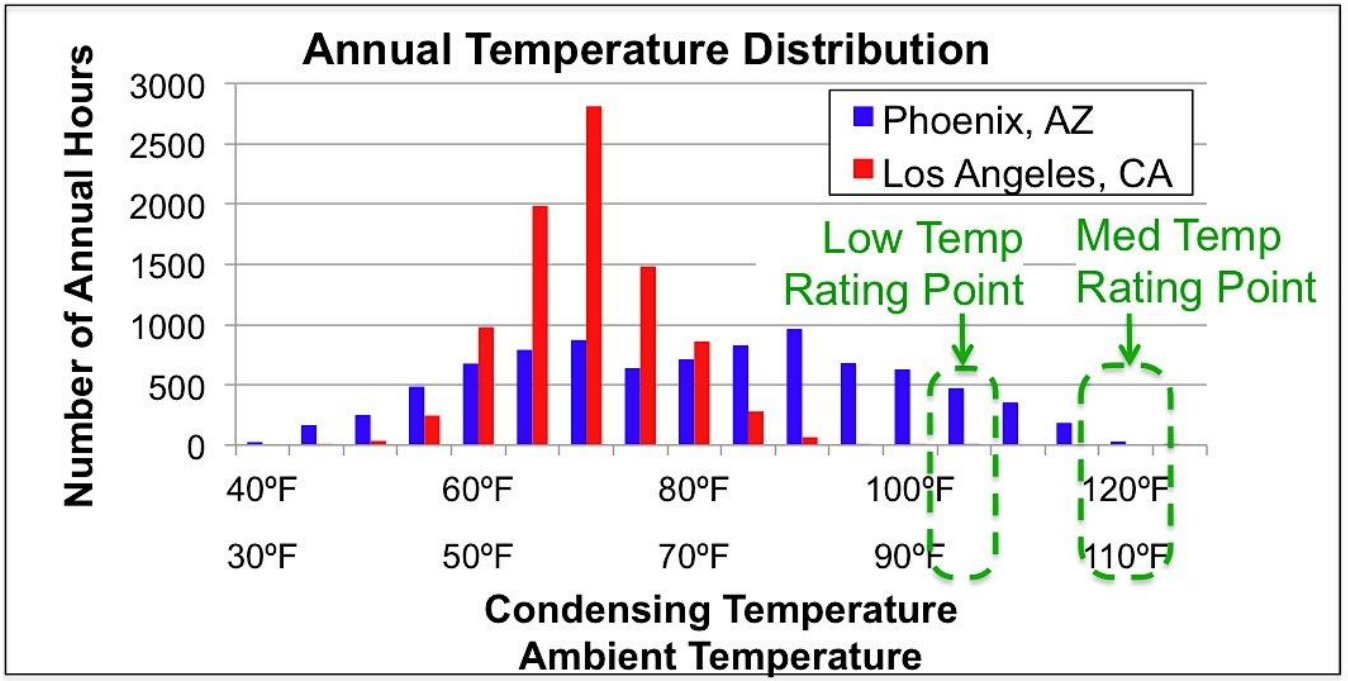


Add
1. Compressor Modulation
2. Variable Fan Speed Control
3. Electronic Expansion Valve

Making Sense

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



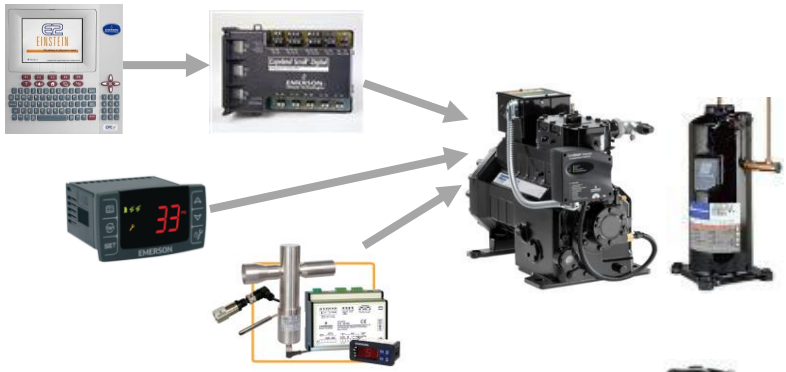
Select Compressors Optimized at Low Condensing to Minimize Energy Usage

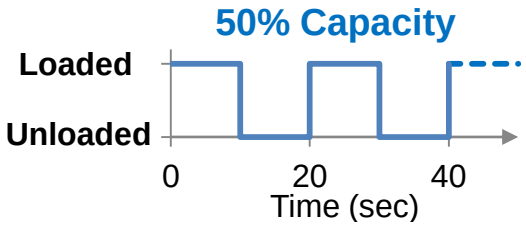
Making Sense

Compressor Selection

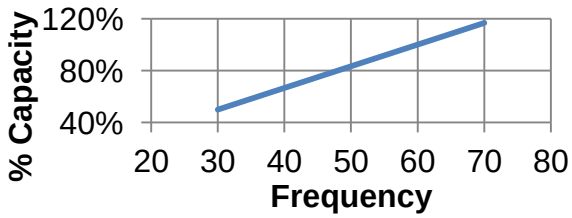
- **Compressor Modulation Recommended to Prevent Excessive Cycling at Low Condensing in Single Compressor Systems**
  - 10-100% Digital Modulation Available On Copeland Discus & Scroll
  - Variable Speed Operation Also An Option
- **System Controller Must Be Capable of Variable Capacity Control**

Digital Modulation



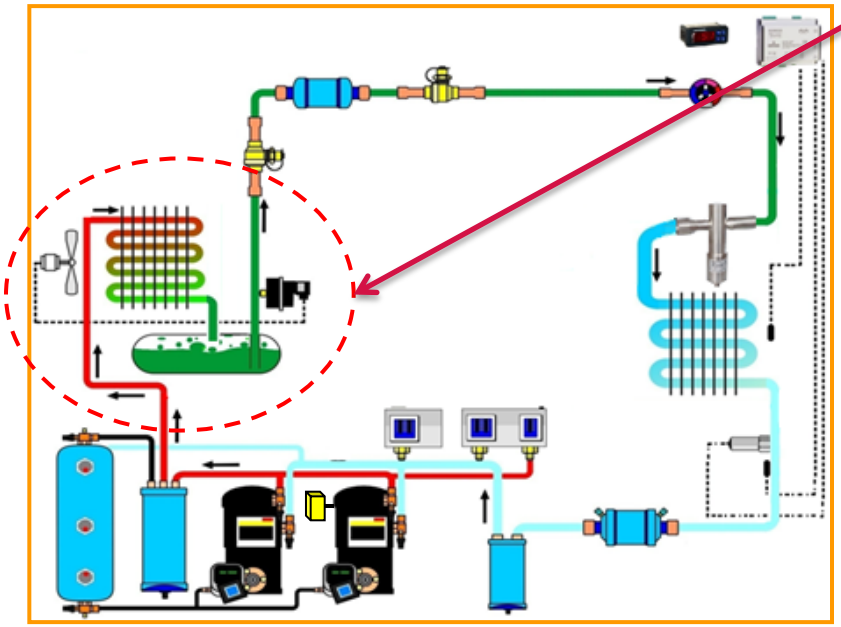


Variable Speed



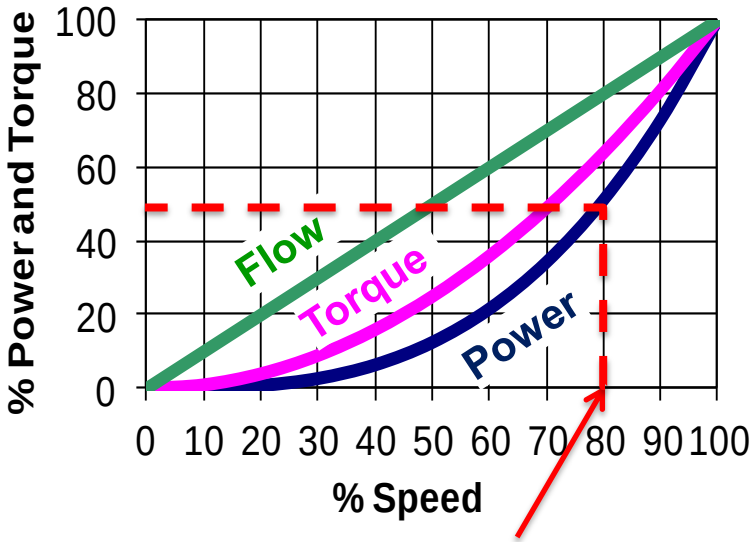
Making Sense

Condensing Control



Variable Frequency Drives for Three- Phase Fan Motors

Affinity Law For Fan Motors



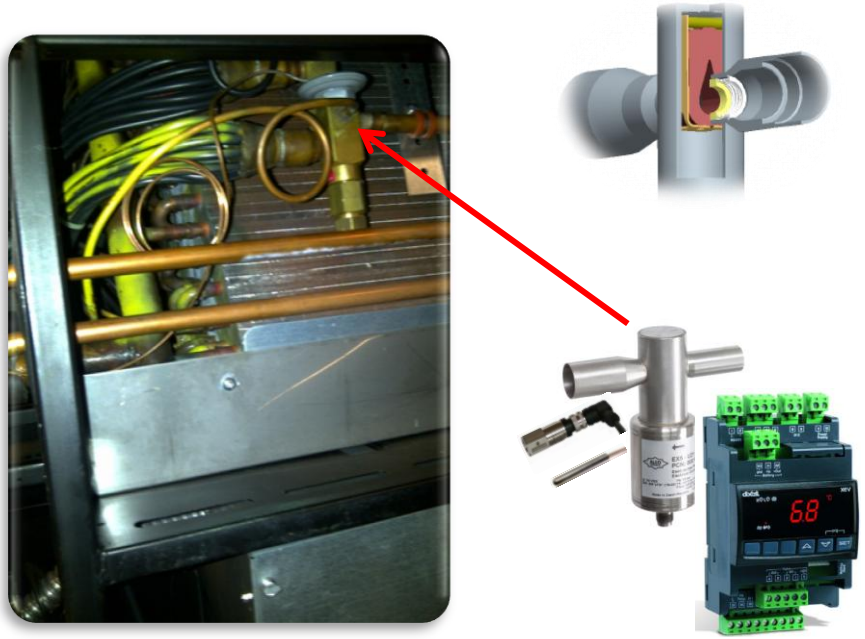
80% Speed (Flow) Equals
50% Theoretical Power Consumption

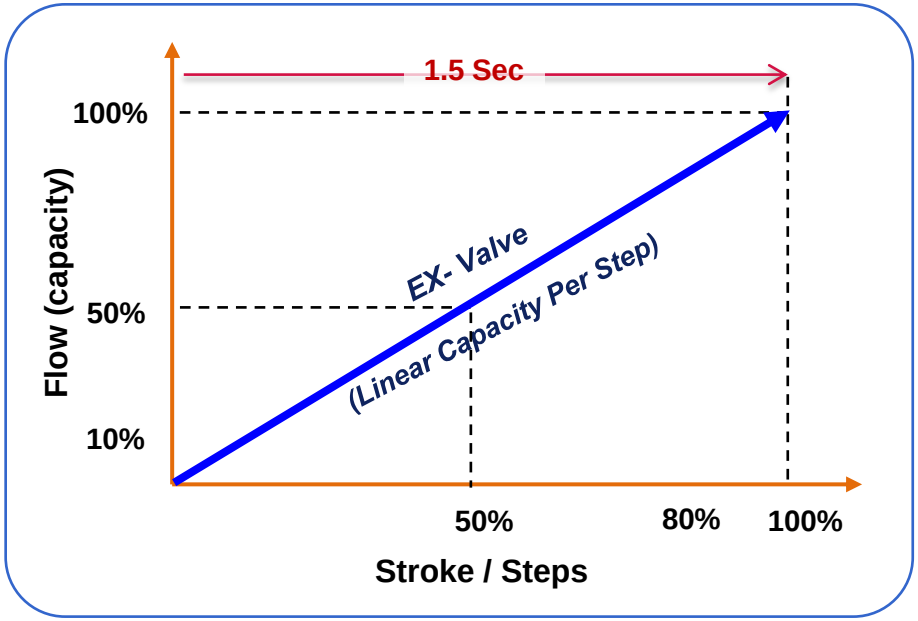
Making Sense

Expansion Valve Selection

Emerson Electronic Expansion Valve

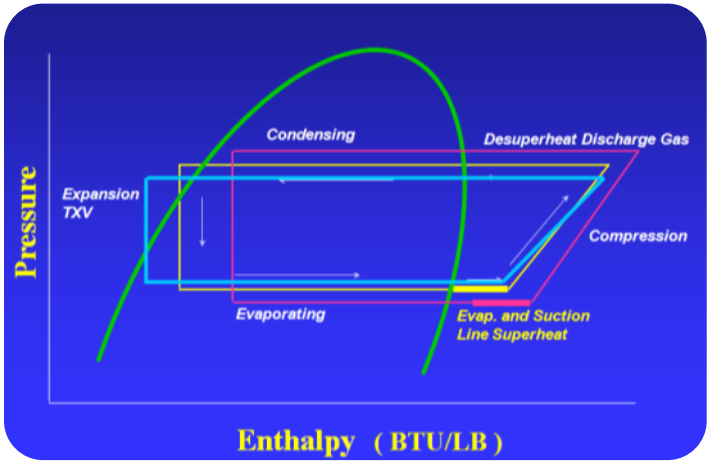
- The key to unlocking the energy savings of the compressor is the ability of the electronic valve to effectively control the evaporator under all loading conditions, liquid quality and head pressure





Making Sense

Evaporator/Superheat Control



The MOST efficient systems will have evaporators that can operate at maximum efficiency under the following conditions:

- **Max load**
- **Min load**
- **Pull down when the TD Increases**
  - After defrost
  - When room is loaded
- **Various head pressures**
- **Various liquid temperatures**
- **Various liquid quality due to:**
  - Fan cycling
  - Floating head
  - Heat reclaim
  - Hot gas defrost

Making Sense

Ideal Applications

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

Making Sense

Freezer “EX Cold Room Control”

- **Customer Pain**
  - Slow Pull Down in Temperature
  - Units Runs 24 hrs/ day
  - Latent Pain, Early Compressor Failures
- **Execution**
  - Dropped the Head from 110ºF to 70ºF 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

Making Sense

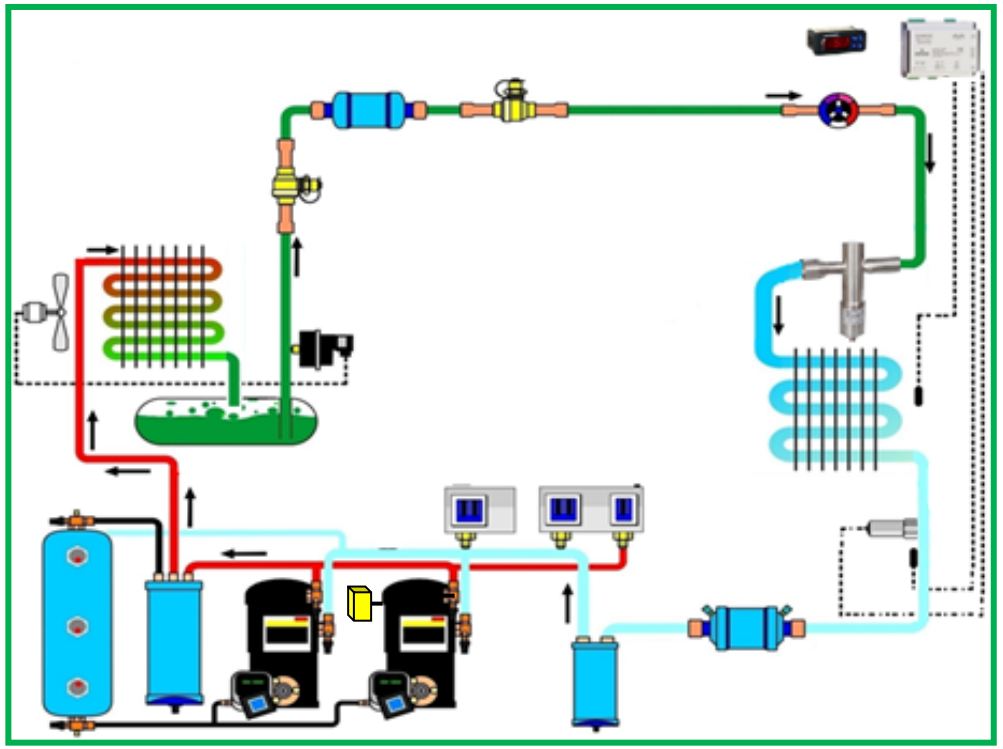
Apple Storage Project

- **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 110ºF to 70ºF 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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