
ICE WESTERN

Objective of Presentation

1. Current EER Regulation
2. Identifying The Need For Change
3. Embrace New Technology

EER – Energy Efficiency Ratio

Existing EER Measure

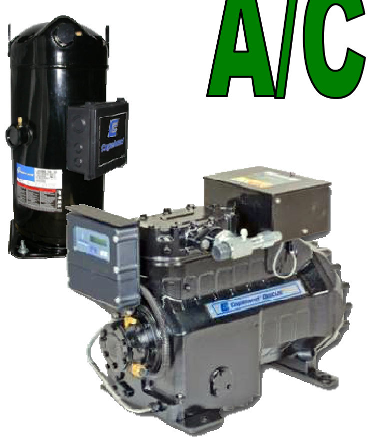
EER is a Standardized Measure of Compressor Performance

EER= (Cooling capacity in Btu/hr)/ (Input power in watts)

ARI Test Standards

Standard 540-2004 spells out conditions at which Refrigeration & A/C Compressors need to be tested for Publishing Performance Rating Data

A/C



Standard Rating Condition for Compressors and Compressor Units for Commercial Refrigeration Application				
Suction Temp.	**Compressor Type**	**Condensing Temp.**	**Return Gas Temp**	**Subcooling**
F°		**F°**	**F°**	**F°**
45	**All**	**130**	**65**	**15**

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EER – Energy Efficiency Ratio

- **Current EER Standards – ASHRAE 90.1 minimum energy efficiency limits – October 1, 2001**
- **Proposed EER Standards – Integrated Energy Efficiency Ratio (IEER) values to replace IPLV values as per – January 2010**
  – ASHRAE 90.1 – 2001 – New minimum energy efficiency limits – January 2010

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EER – Energy Efficiency Ratio

Table 8
Minimum efficiency levels
(See Clauses 7.2 and 8.5.)

ARI* type classification	Description	Condenser type	Cooling capacity range, kW (1000 Btu/h)	Level 1† EER	Level 1† COP At 8.3 °C (47°F)	Level 1† COP At −8.3 °C (17°F)	Level 1† IPLV	Level 2‡ EER	Level 2‡ COP At 8.3 °C (47°F)	Level 2‡ COP At −8.3 °C (17°F)	Level 2‡ IPLV
SP-A	Single packaged	Air cooled	≥ 19.0 < 39.6 (≥ 65 < 135)	10.3	—	—	—	11.2	—	—	—
			≥ 39.6 < 70.3 (≥ 135 < 240)	9.7	—	—	—	11.0	—	—	—
			≥ 70.3 < 223 (≥ 240 < 760)	9.5	—	—	9.7	10.0	—	—	9.7
			≥ 223 (≥ 760)	9.2	—	—	9.4	9.7	—	—	9.4
RC-A	Remote condenser, including indoor fan	Air cooled	≥ 19.0 < 39.6 (≥ 65 < 135)	10.3	—	—	—	11.2	—	—	—
			≥ 39.6 < 70.3 (≥ 135 < 240)	9.7	—	—	9.7	11.0	—	—	9.7
			≥ 70.3 < 223 (≥ 240 < 760)	9.5	—	—	9.4	10.0	—	—	9.4
			≥ 223 (≥ 760)	9.2	—	—	—	9.7	—	—	—
RCU-A-C	Condensing unit with no indoor fan	Air cooled	≥ 39.6 (≥ 135)	10.1	—	—	—	10.1	—	—	—
RCU-A-CB	Condensing unit, coil, and blower	Air cooled	≥ 19.0 < 39.6 (≥ 65 < 135)	10.3	—	—	—	11.2	—	—	—
			≥ 39.6 < 70.3 (≥ 135 < 240)	9.7	—	—	9.7	11.0	—	—	9.7
			≥ 70.3 < 223 (≥ 240 < 760)	9.5	—	—	9.4	10.0	—	—	9.4
			≥ 223 (≥ 760)	9.2	—	—	—	9.7	—	—	—
SP-E, SP-W	Single packaged	Evaporative and water cooled	≥ 19.0 < 39.6 (≥ 65 < 135)	11.5	—	—	—	11.5	—	—	—
			≥ 39.6 < 70.3 (≥ 135 < 240)	11.0	—	—	10.3	11.0	—	—	10.3
			≥ 70.3 (≥ 240)	11.0	—	—	—	11.0	—	—	—
RC-E, RC-W	Remote condenser, including indoor fan	Evaporative and water cooled	≥ 19.0 < 39.6 (≥ 65 < 135)	11.5	—	—	—	11.5	—	—	—
			≥ 39.6 < 70.3 (≥ 135 < 240)	11.0	—	—	10.3	11.0	—	—	10.3
			≥ 70.3 (≥ 240)	11.0	—	—	—	11.0	—	—	—
RCU-E-C, RCU-W-C	Condensing unit, coil alone	Evaporative and water cooled	≥ 39.6 (≥ 135)	13.1	—	—	—	13.1	—	—	—

(Continued)

APPENDIX C – ENERGY PERFORMANCE VERIFICATION LABEL

Label for Canada

ENERGY PERFORMANCE VERIFIED

RENDEMENT ENERGETIQUE VERIFIE

EP XXXXXXXXXX

Label for US

ENERGY PERFORMANCE VERIFIED

EP XXXXXXXXXX

Objective of Presentation

1. Current EER Regulation

2. Identifying The Need For Change

3. Embrace New Technology

What is Driving the Change ?

- **Demand for Energy Increasing**
- **Distribution Limitations**
- **Legislation**
    - Public Accepting Global Climate Change Is Reality
- **Refrigerant Phase out**
    - **"Green is In"**
      End Users Designing "Green" System & Forcing OEMs To Change Less Refrigerant Charge & Higher Efficiency

Higher Energy Cost
Higher End User Operating Costs
Profit Margins Shrink

Nuclear

Coal Fired

Power Distribution

ICE WESTERN

Precision Air

"Installing Carefully Designed Mechanical Systems that Include Efficient Compressors, Condensers and Evaporators Does Not Guarantee Optimum Temperature / Humidity Control, Maximum Energy Efficiency and Lowest Refrigeration Operating Expense."

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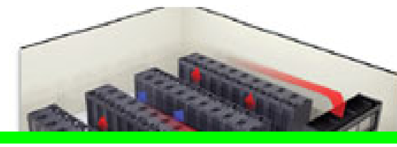
Precision Air

"Installing Carefully Designed Mechanical



Because Systems Seldom Run at Design Load, They are Often Ineffective and Inefficient at Part Load Conditions.

Efficiency Challenge

The Challenge for System Designers, Manufacturers, and Operators is to Find Effective Ways to Modulate the System Compressors, Condenser Fans, Expansion Valves, Pressure Regulators and Other Components, to Achieve Stable and Reliable System Operation and High Efficiencies While at the Same Time Closely Controlling Precise Temperature.

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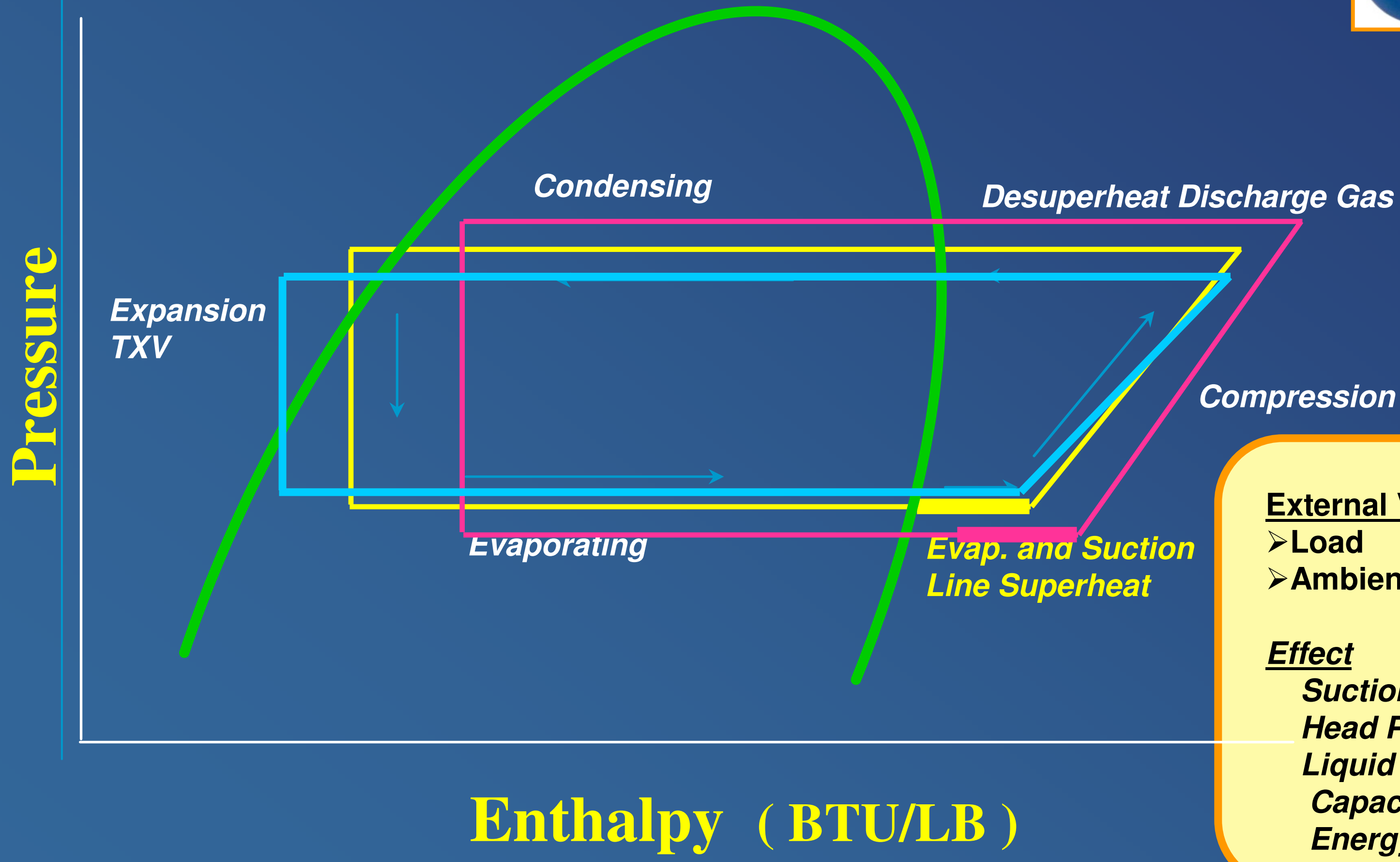
Typical Pressure Enthalpy Diagram



External Variables

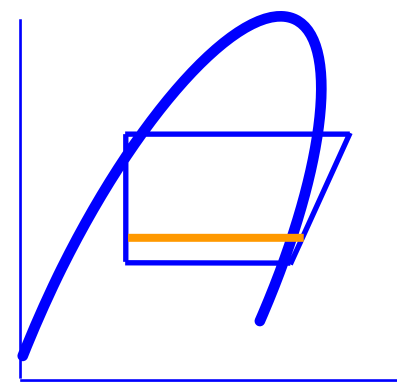
- Load
- Ambient

Effect

Suction Pressure
Head Pressure
Liquid Quality
Capacity
Energy Usage

Stabilize Suction Pressures

At the End of the Day the Key Factor in Maintaining Precise Temperature and Humidity Control is Suction Pressure



If Suction Pressure is Constant, the Evaporator Pressure is Constant Which in turn Yields a Higher Average Suction Pressure Thereby Reducing Energy

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Objective of Presentation

1. Current EER Regulation
2. Identifying The Need For Change
3. Embrace New Technology

ICG WESTERN

ICE Western’s Capacity Modulation Solution

AC-Tech VFD

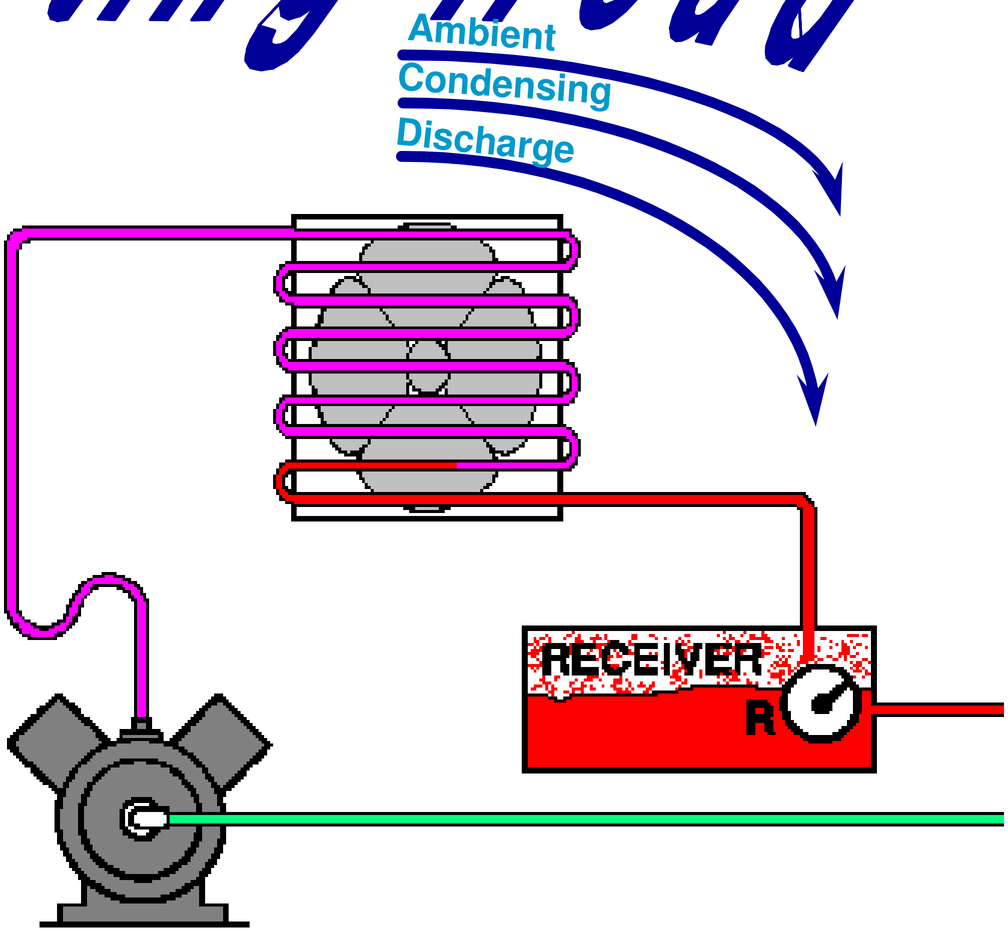
Digital Scroll (10 to 100%)

EC3-D72 Digital Scroll & Valve Controller

Electronic Valve (10 to 100%)

ICE WESTERN

Floating Head



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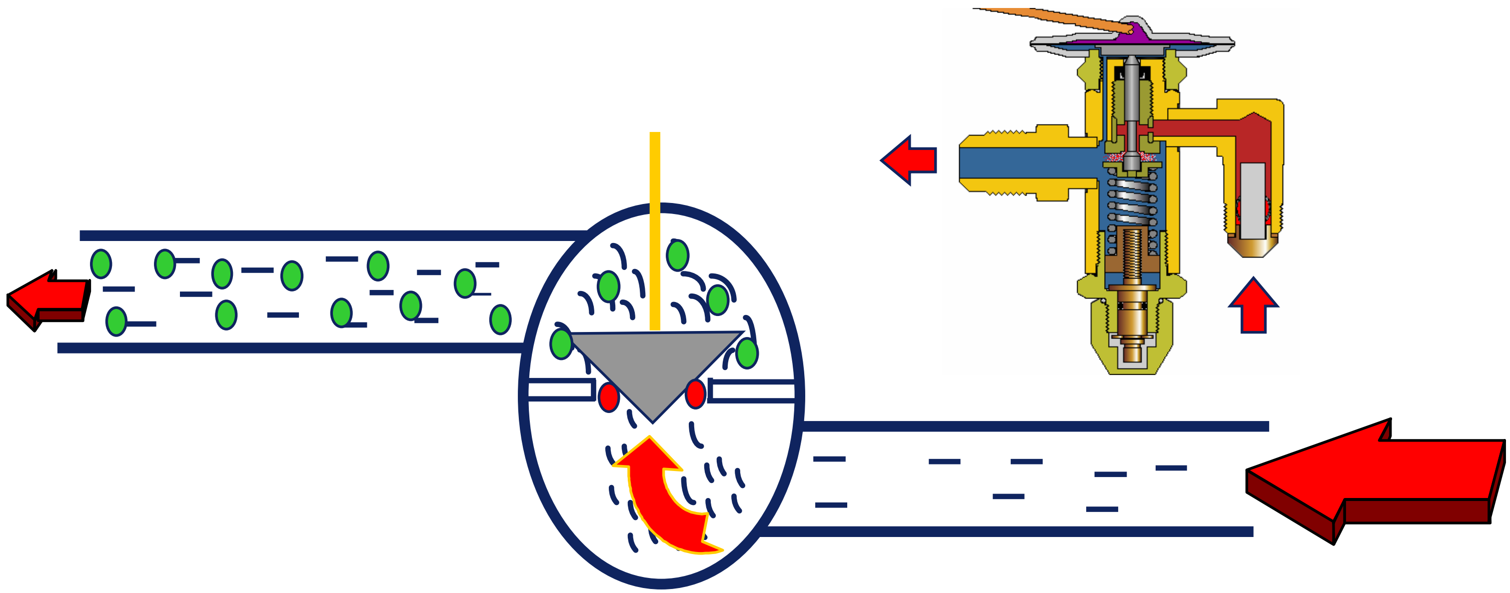
Why use Head Pressure Control ?

Maintain Liquid Subcooling
and Prevent
Liquid Line Flash Gas.



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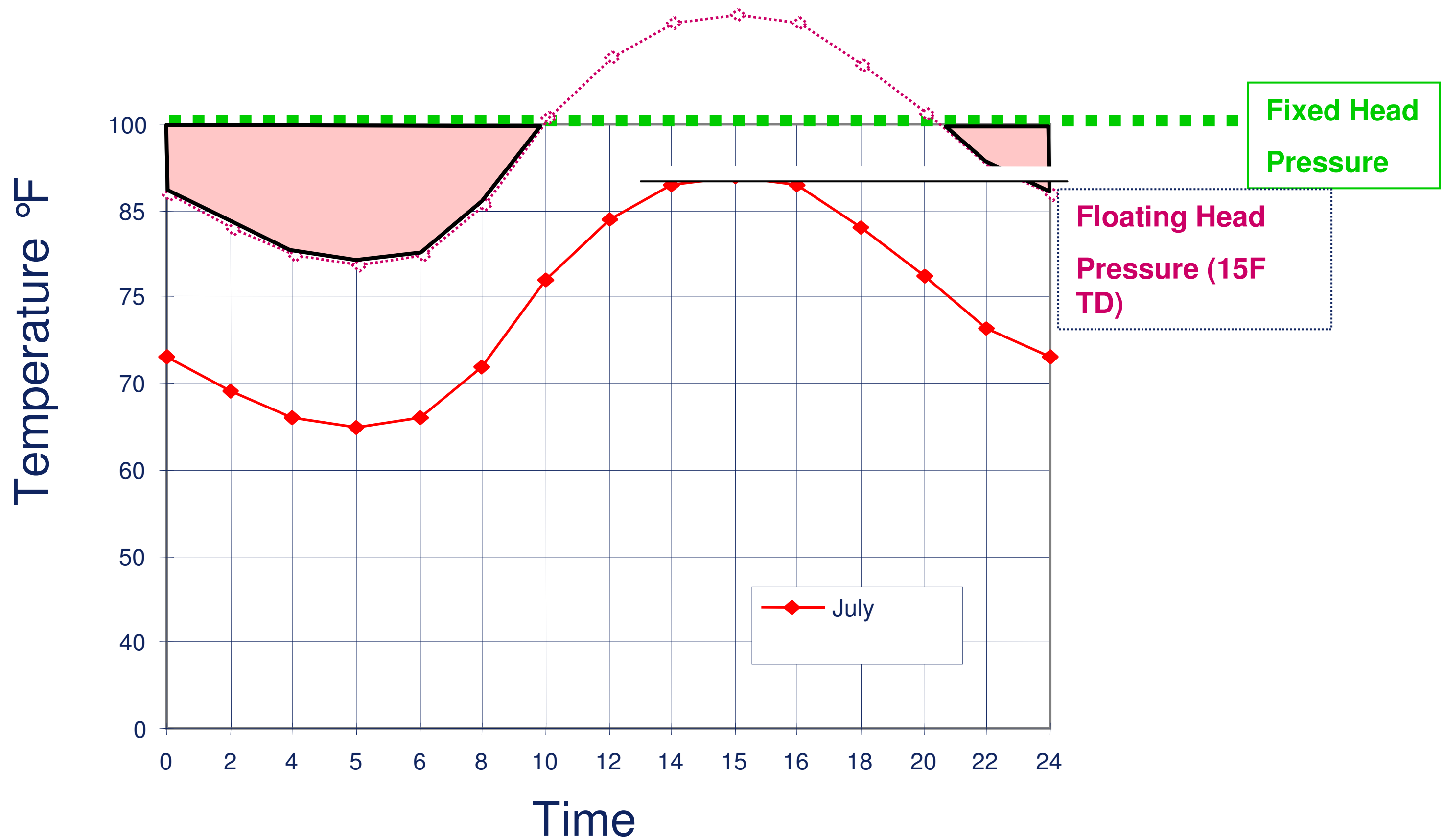
Floating Head Pressure Vs Fixed
Summer

- **Effect of condensing temperature**

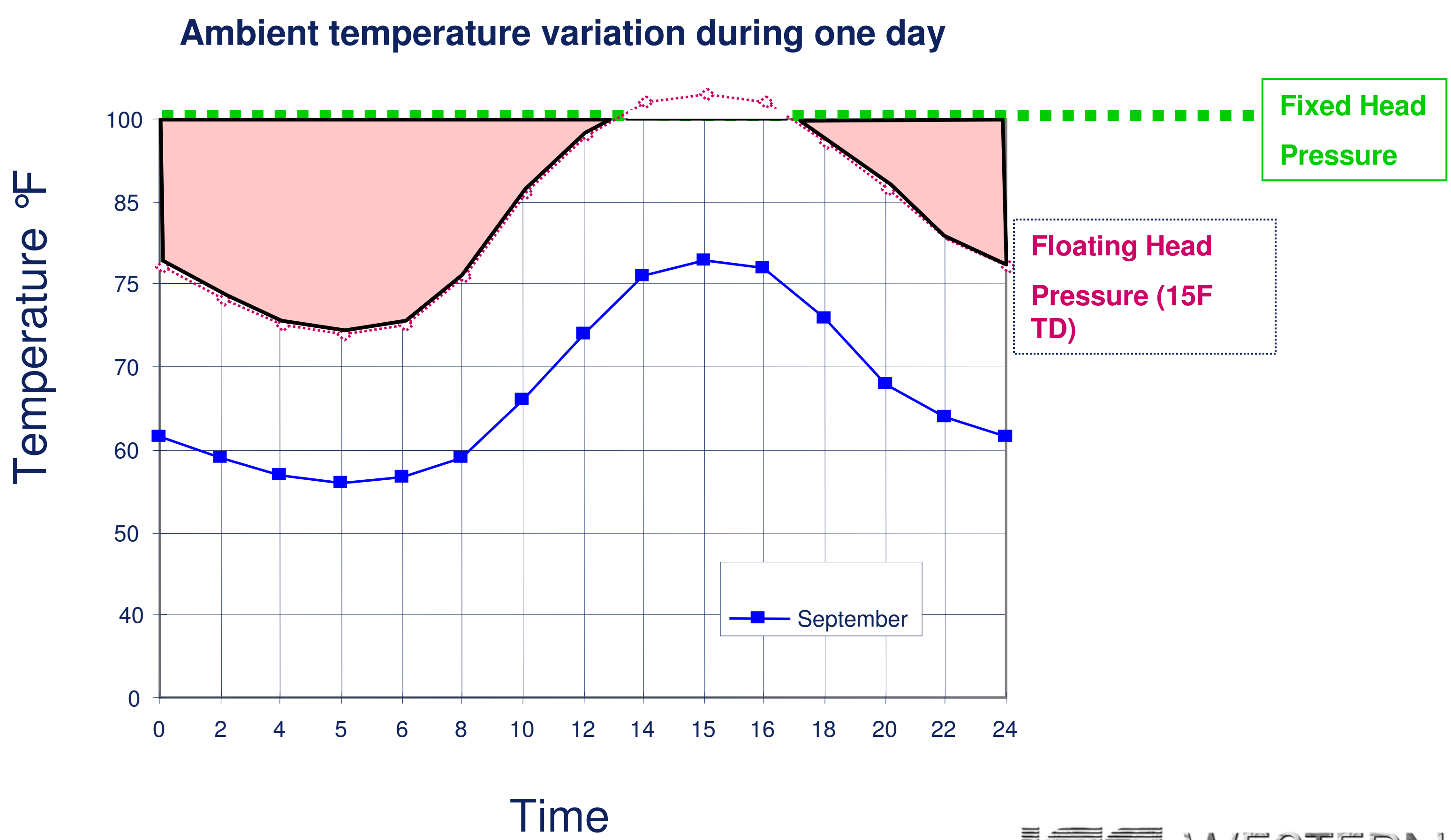


Ambient temperature variation during one day

ICE WESTERN

Floating Head Pressure Vs Fixed
Spring and Fall

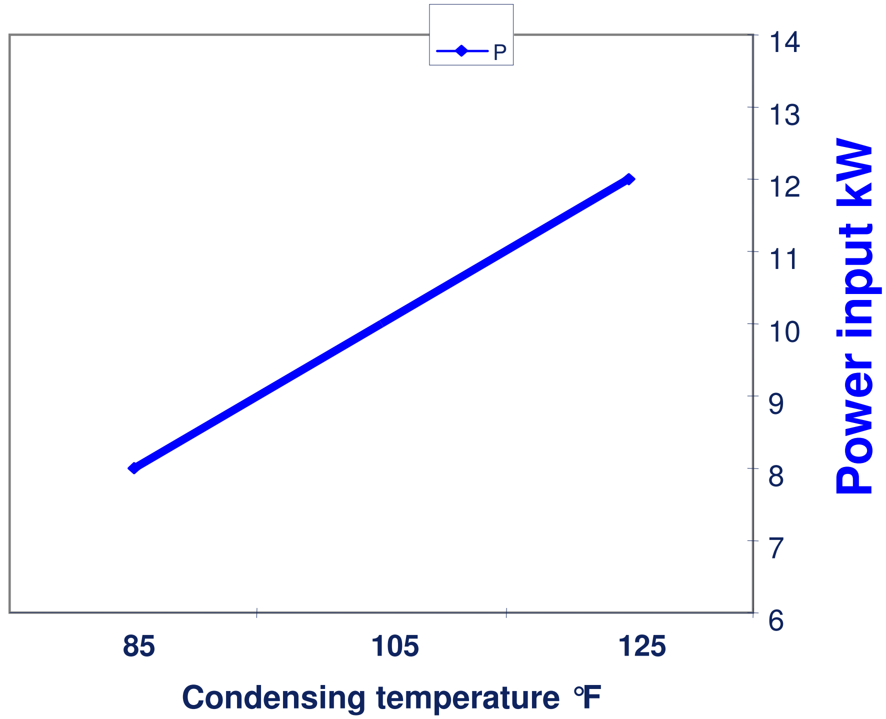
- **Effect of condensing temperature**



Energy saving

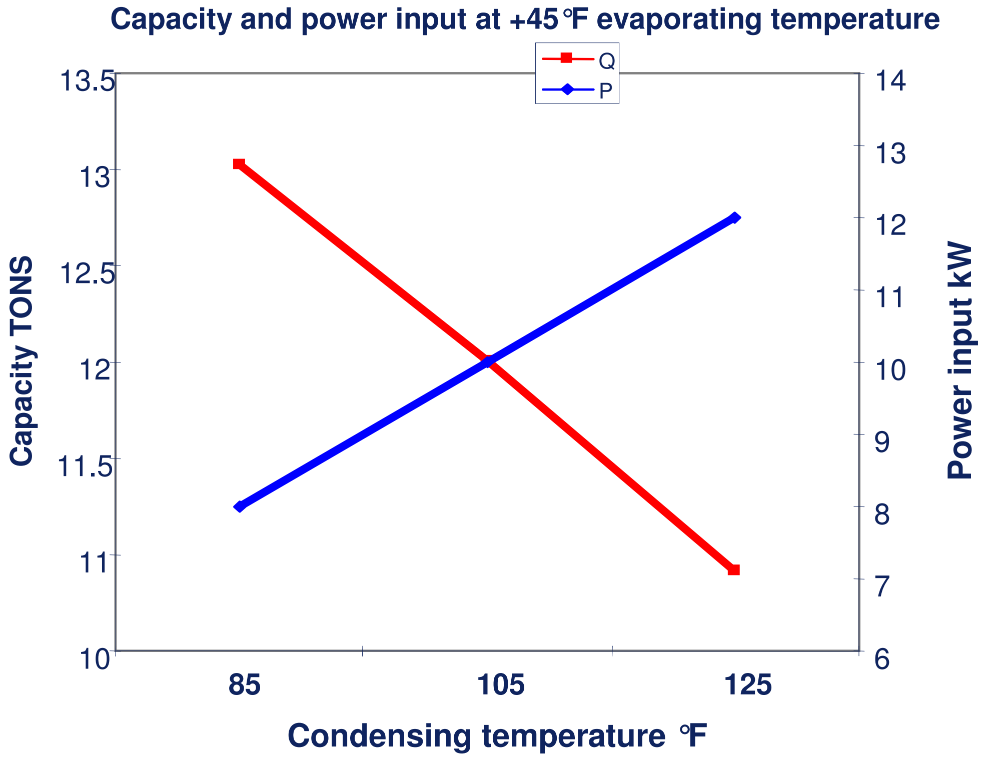
Power input

Power input at +45°F evaporating temperature



Energy saving

- **Capacity and power input**



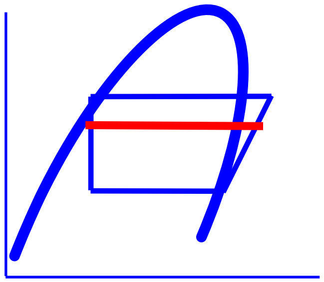
Floating Head Pressure

"for every 1 psig Decrease in discharge pressure, compressor power Is reduced approximately 0.5%"

Table 2: Effect of discharge pressure on compressor power.

Tdsat (F)	Pd (Psig)	Comp. kW	%kW/psig
70	128.1	20.14	0.65%
75	132.3	20.69	0.62%
80	143.7	22.16	0.57%
85	155.7	23.68	0.51%
90	168.5	25.24	0.48%
95	181.9	26.86	0.44%
100	196	28.52	0.41%
105	210.8	30.25	0.38%
110	226.4	32.03	0.35%
115	242.8	33.89	0.34%

Calculations done using refrigeration model with following conditions:
R407C Sat. Suction Temp=-**55**F, Case load = 200,000 Btu/hr



Abtar Singh, PH.D., CPC

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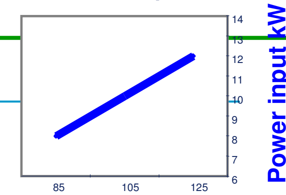
RATING CONDITIONS
20 °F Superheat
15 °F Subcooling
95 °F Ambient Air Over

60 Hz Operation

AIR CONDITIONING

ZP103KCE-TF5
HFC-410A
COPELAND SCROLL®
TF5 200/230-3-60

Power input



Condensing temperature °F

Evaporating Temperature °F (Sat Dew Pt Pressure, psig)

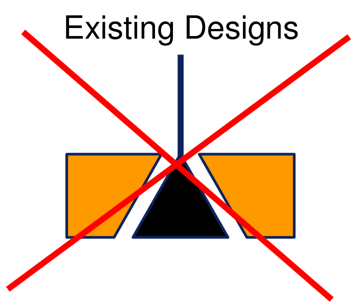
Condensing Temperature °F (Sat Dew Pt Pressure, psig)		-10(36)	0(48)	10(62)	20(78)	30(97)	40(118)	45(130)	50(142)	55(155)
150 (611)	C						78000	86500	96000	106000
	P						12400	12300	12300	12200
	A						35	34.9	34.7	34.6
	M						1360	1500	1650	1810
	E						6.3	7	7.8	8.7
	L						63.6	66.3	68.6	70.6
140 (540)	C					70000	87000	96000	106000	117000
	P					11000	10900	10800	10800	10800
	A					31.8	31.5	31.4	31.4	31.3
	M					1140	1390	1530	1670	1830
	E					6.4	8	8.9	9.8	10.8
	L					62.7	68.1	70.3	72	73.3
130 (475)	C				61500	77500	95000	105000	115000	127000
	P				9650	9600	9550	9550	9550	9550
	A				28.9	28.8	28.6	28.6	28.6	28.6
	M				940	1160	1410	1550	1690	1850
	E				6.4	8	9.9	11	12.1	13.3
	L				61.3	67.2	71.6	73.1	74.2	74.7
120 (417)	C			53000	67500	84000	103000	113000	124000	136000
	P			8500	8500	8450	8450	8450	8450	8500
	A			26.4	26.3	26.3	26.2	26.2	26.3	26.3
	M			770	965	1180	1420	1560	1710	1860
	E			6.2	8	9.9	12.2	13.4	14.7	16.1
	L			59.5	65.9	70.7	73.8	74.6	74.7	74.2
110 (364)	C		44600	58000	73000	90000	109000	120000	132000	145000
	P		7450	7450	7450	7450	7450	7500	7500	7550
	A		24.1	24.2	24.2	24.2	24.2	24.3	24.3	24.4
	M		620	790	980	1190	1440	1570	1720	1870
	E		6	7.8	9.8	12.1	14.7	16.1	17.6	19.2
	L		57.1	64.1	69.4	72.9	74.4	74.2	73.4	71.7
100 (316)	C	36400	48800	62500	78000	95500	116000	128000	140000	154000
	P	6450	6550	6550	6550	6600	6600	6650	6700	6800
	A	22.1	22.4	22.5	22.5	22.5	22.6	22.6	22.7	22.9
	M	485	640	805	990	1200	1440	1580	1720	1880
	E	5.7	7.5	9.5	11.8	14.5	17.6	19.2	20.9	22.7
	L	54	61.8	67.6	71.6	73.7	73.2	71.9	69.7	66.7
90 (273)	C	40200	52500	66500	82500	101000	123000	135000	148000	162000
	P	5700	5750	5800	5800	5800	5850	5900	6000	6100
	A	20.7	20.9	21	21	21	21.1	21.2	21.3	21.5
	M	505	655	815	1000	1210	1450	1590	1730	1890
	E	7.1	9.1	11.5	14.2	17.3	20.9	22.8	24.7	26.7
	L	58.9	65.4	69.9	72.4	72.6	69.9	67.2	63.5	58.9
80 (235)	C	43800	56000	70500	87000	106000	129000	142000	156000	171000
	P	5000	5050	5100	5100	5150	5200	5250	5350	5450
	A	19.6	19.7	19.7	19.7	19.8	19.9	20	20.1	20.3
	M	525	665	825	1000	1210	1460	1590	1740	1900
	E	8.7	11.1	13.8	17	20.7	24.8	26.9	29.2	31.4
	L	62.8	68	71	71.9	69.8	64.3	59.9	54.5	47.9

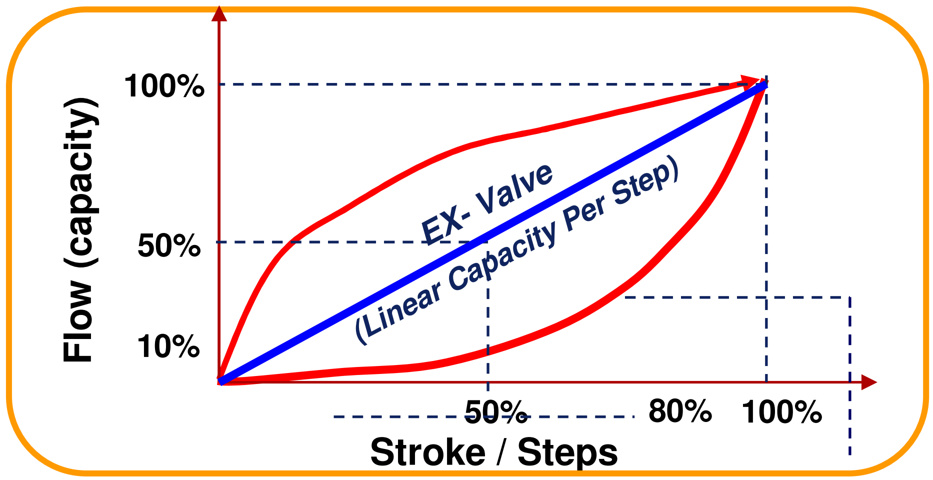
C:Capacity(Btu/hr), P:Power(Watts), A:Current(Amps), M:Mass Flow(lbs/hr), E:EER(Btu/Watt-hr), %:Isentropic Efficiency(%)

ARI Rating

HT = +45°F / 130°F

Benefits of Emerson's Electronic Valve Gate Port Design



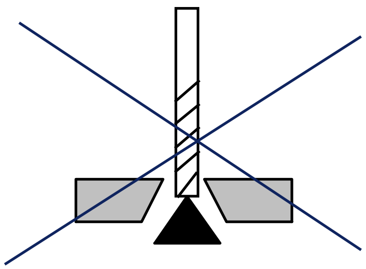


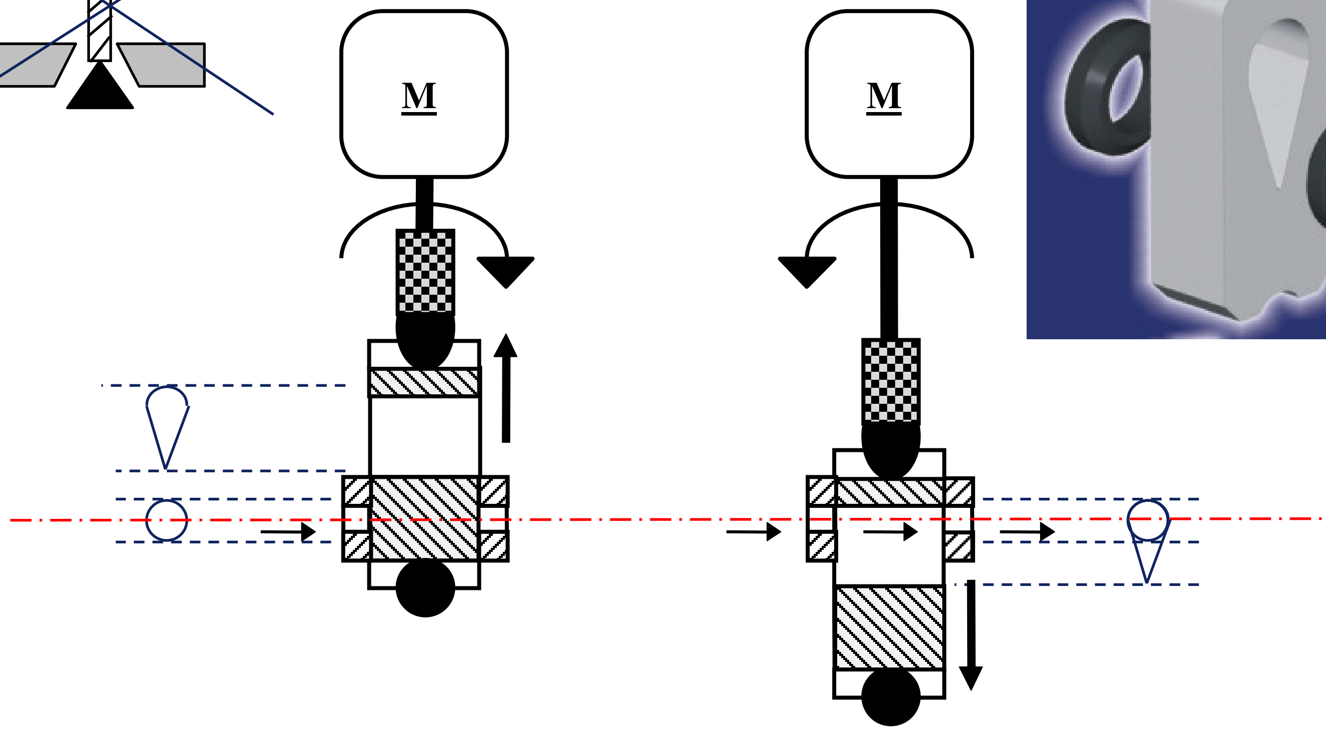
Emerson EX – Valve

Gate Port Design

Valve	Capacity Range	Travel Time
EX4 =	0.5 - 5T,	750 Steps / 1.5 Seconds
EX5 =	1.5 - 14T,	750 Steps / 1.5 Seconds
EX6 =	3 - 34T,	750 Steps / 1.5 Seconds
EX7 =	9 - 94T,	1,600 Steps / 3.2 Seconds
EX8 =	25 - 250T,	2,600 Steps / 5.2 Seconds

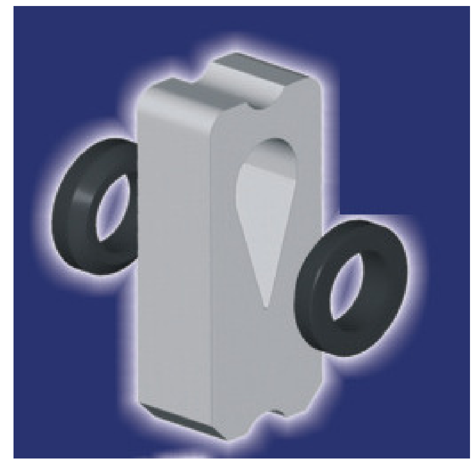
EXV vs TXV, port design





Fully close

Fully open



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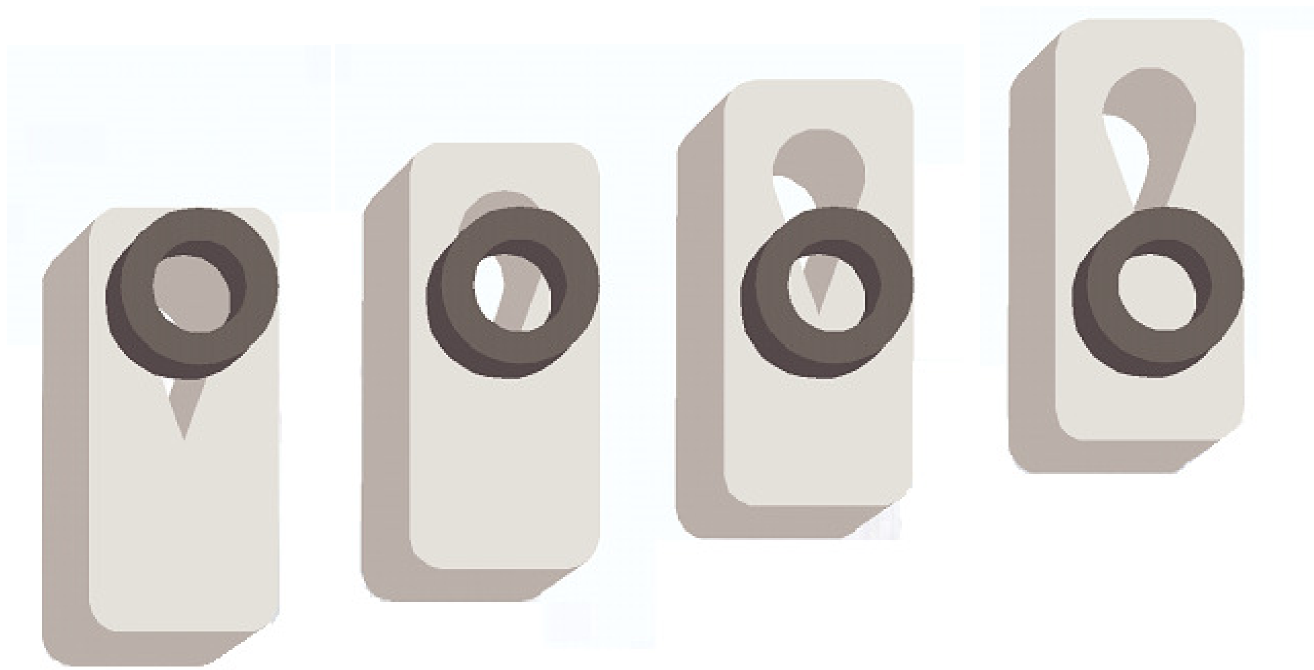
“EX” port design (100% down to 10% Range)



open **partial open** **closed**

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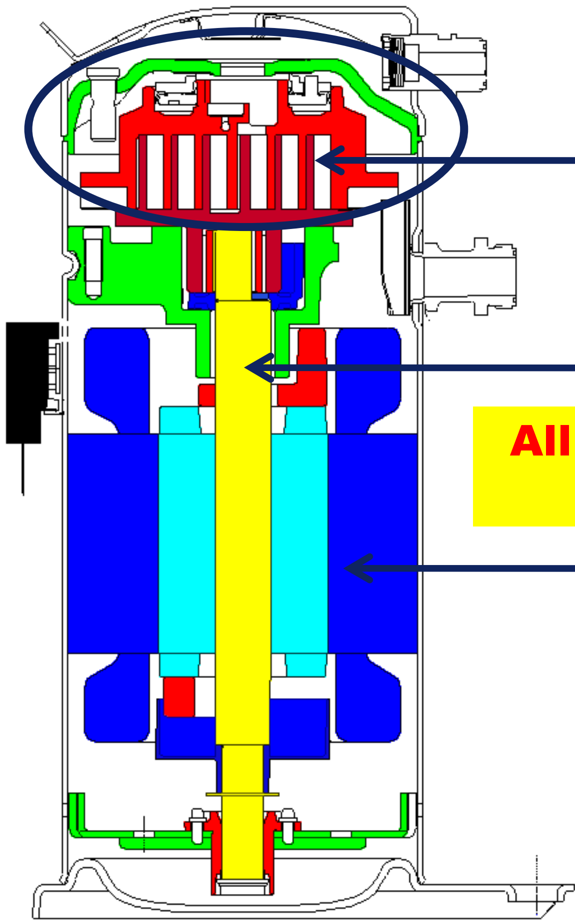
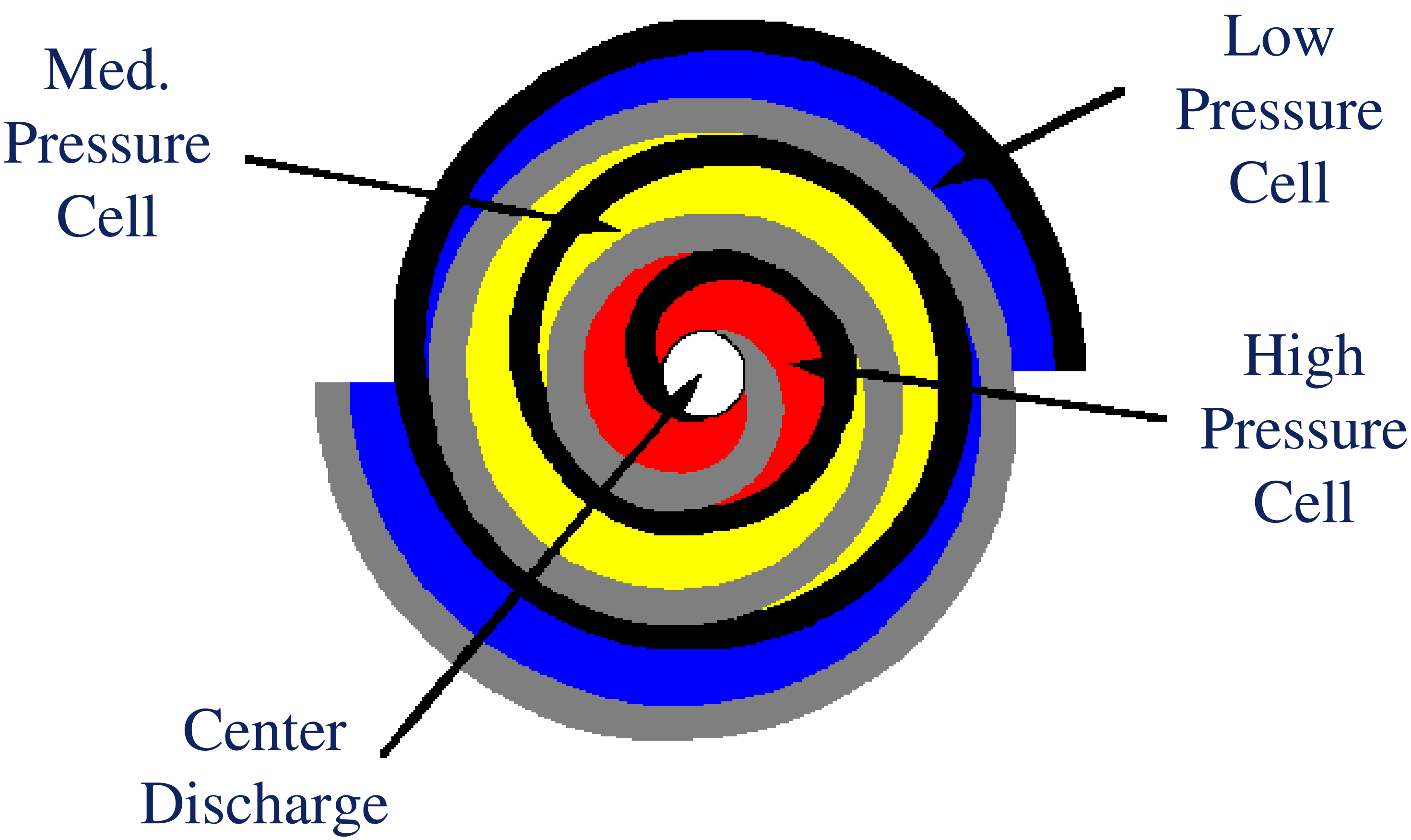
Scroll Compressor - Construction



All scrolls use 2 pole motors operating at 3500 rpm

Both Sides Pump At Once



Continuous Compression

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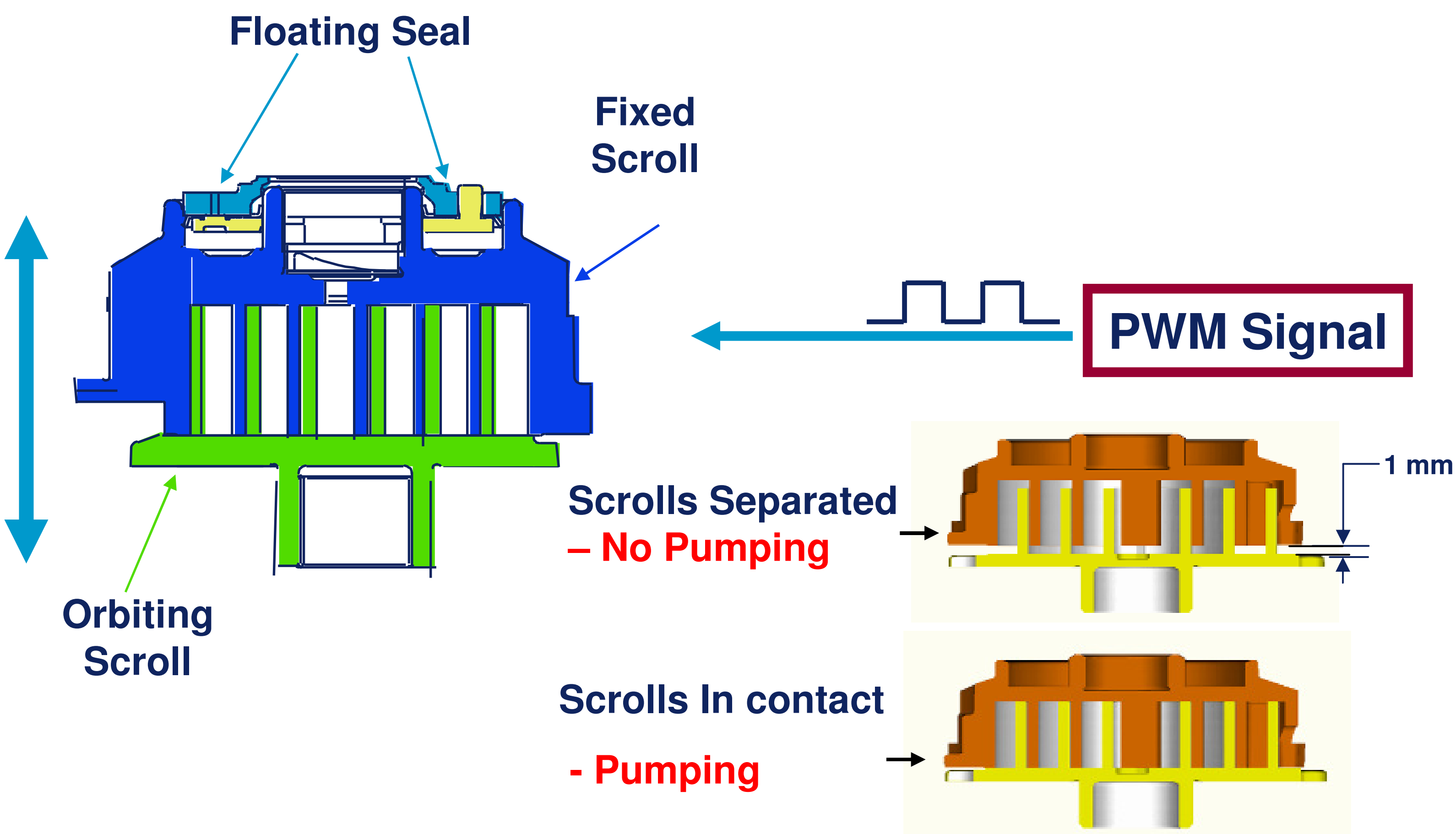
Digital Scroll Movement During Operation



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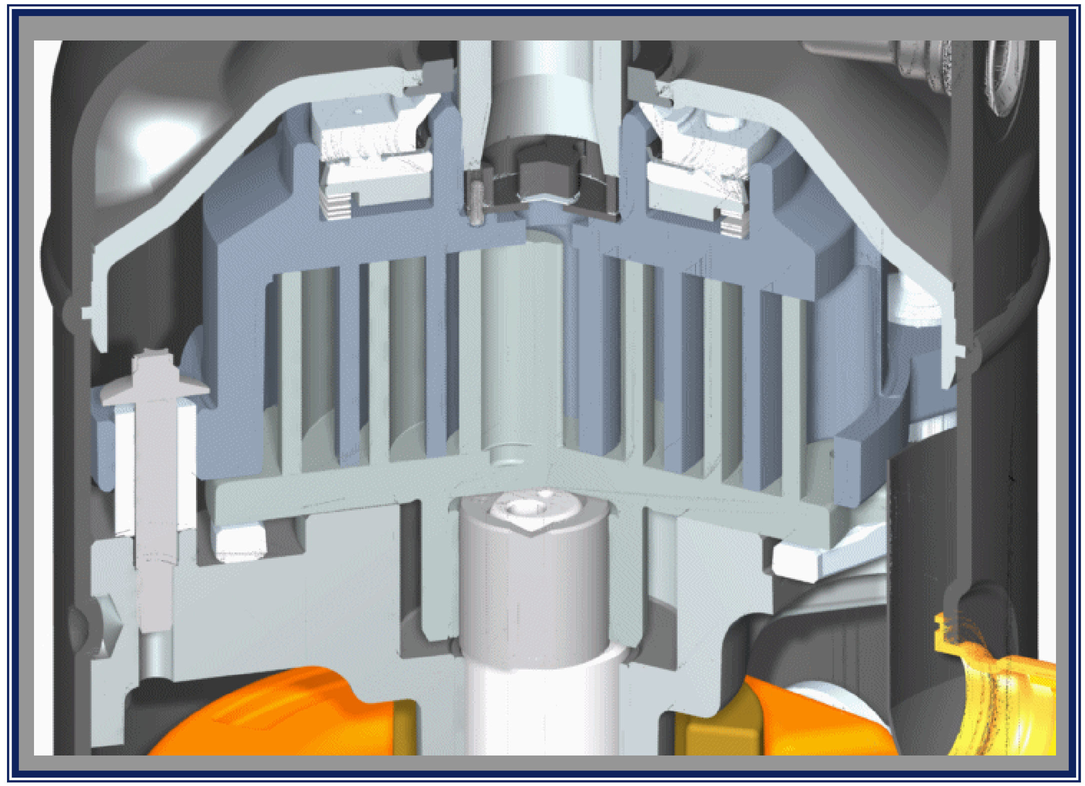
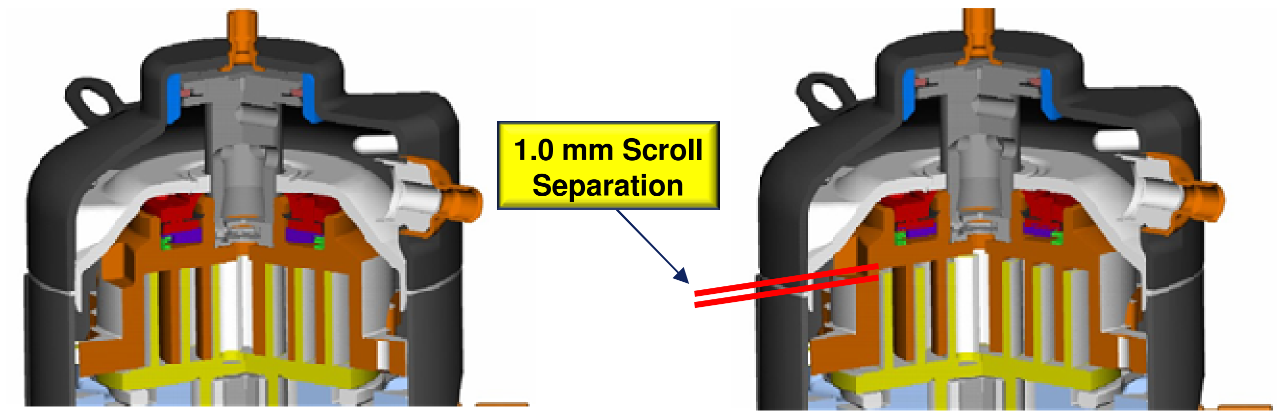
Copeland Scroll Digital™
How It Works - Animation



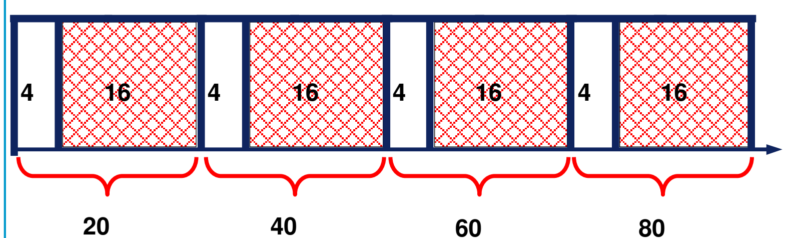
ICE WESTERN

Copeland Scroll™ Digital Compressor Operation



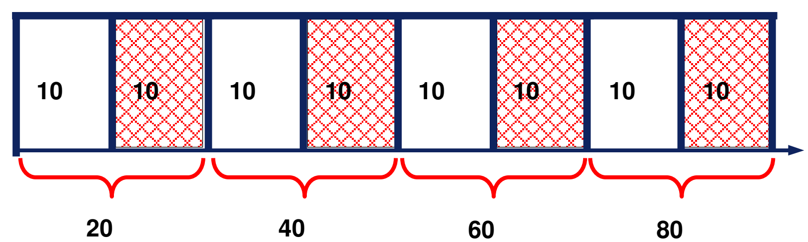
Loaded (1)
Full Capacity

Unloaded (0)
Zero Capacity



Time (sec)

20% Capacity



Time (sec)

50% Capacity

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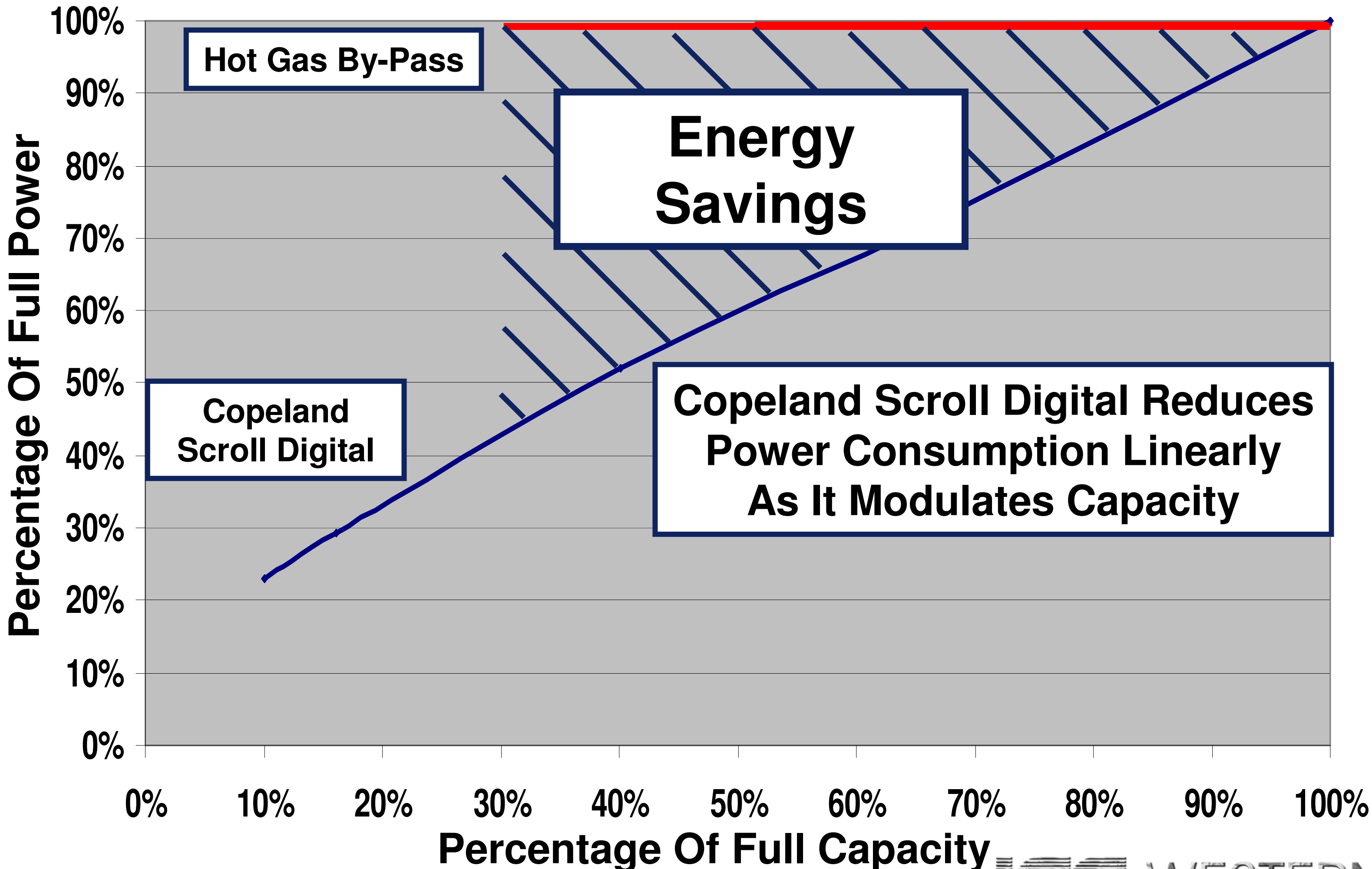
Copeland Scroll Digital™ Power Savings



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In Multiple Compressor Applications

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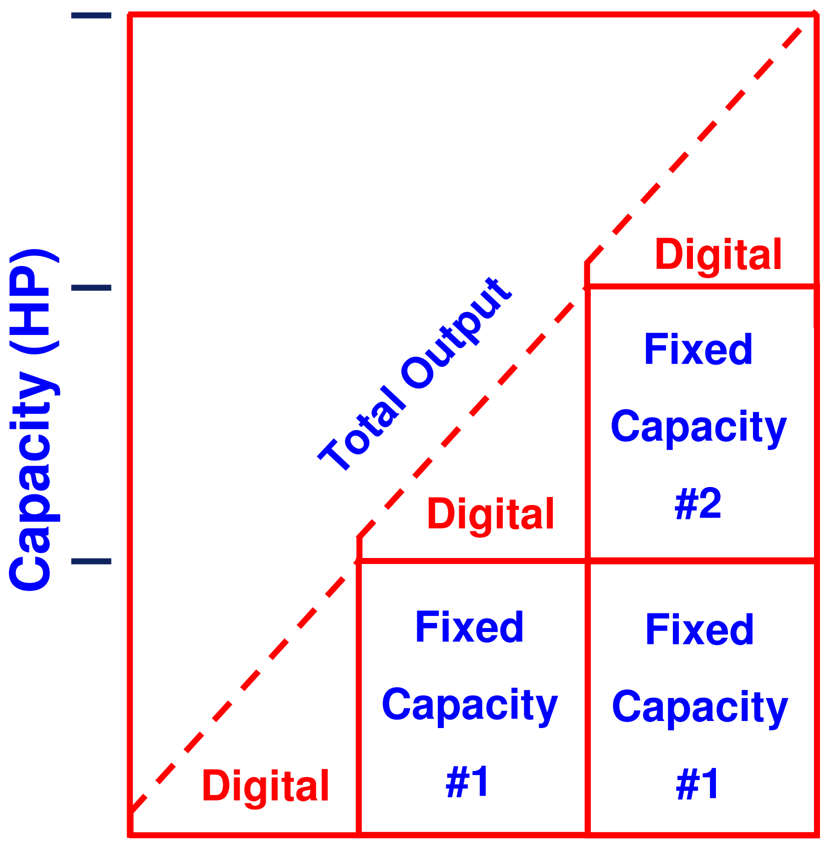
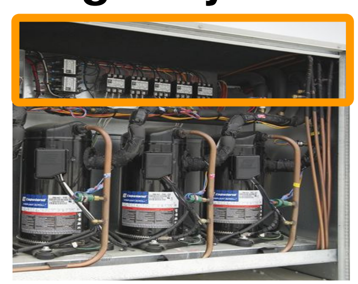
Digital Modulation Over Larger Capacities



- Digital Can Be Used In Parallel With Fixed Capacity Scrolls To Get Even Wider Range Of Capacities
- Power Savings Still Follow The Same Line
- Leverages The Cost And Capability Of One Digital Over Larger Systems



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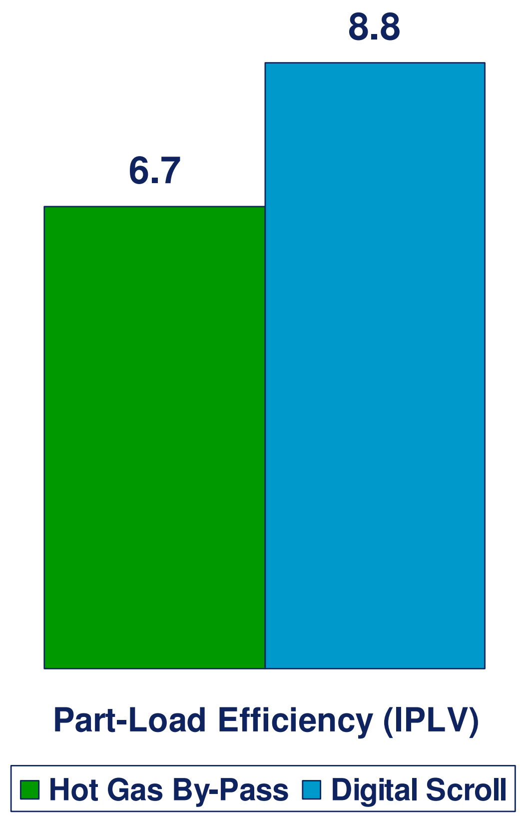
Digital Scroll Offers Superior Part-Load Efficiency Versus Hot Gas By-Pass

% Full Capacity	Hot Gas By-Pass EER	Digital Scroll EER	IPLV Weighting
25%	2.9	6.3	12%
50%	5.7	8.2	45%
75%	8.6	10.0	42%
100%	11.5	11.3	1%
Integrated Part Load Value	6.7	8.8	100%



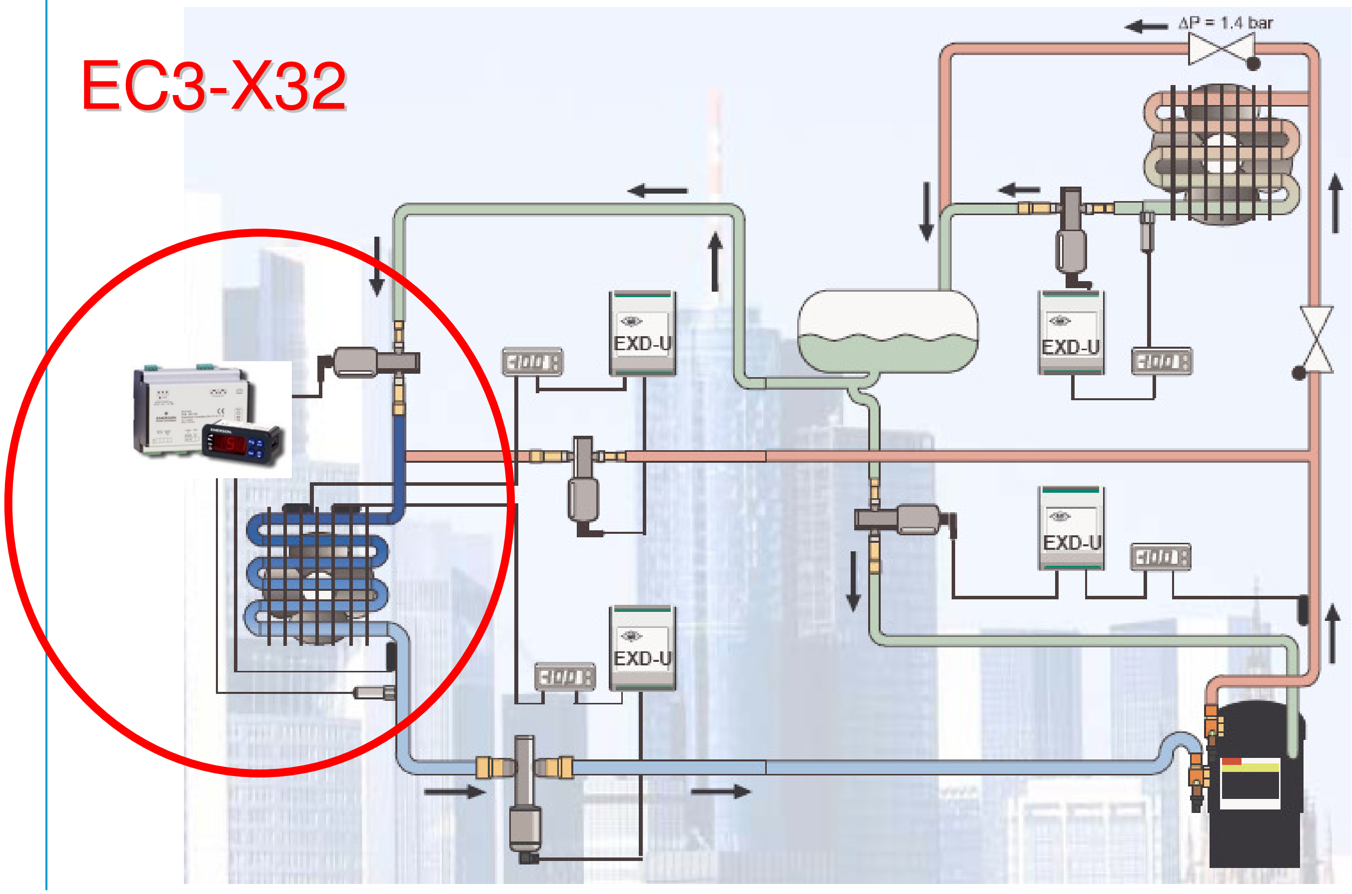
30% Part-Load Efficiency Improvement With Copeland Scroll Digital!

Digital Advantage

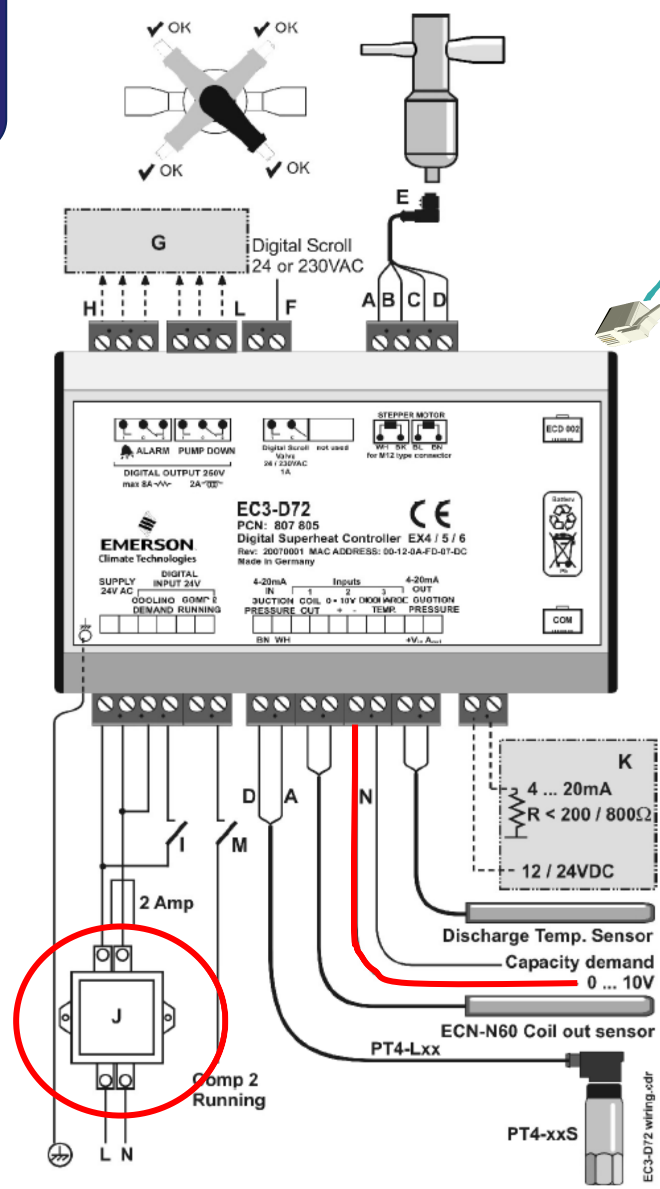
- Precise Control Of Suction Pressure And Temperature
  - Minimum Temperature Fluctuation
  - More Consistent operation of mechanical valves and regulators
- Reduced Cycling Of Compressors
  - Longer Contactor Life
  - Longer Compressor Life
  - Reduction in Inrush Current
- System Efficiency Improvement
  - Eliminates Over/Under Shooting Of Suction Pressure Set Point
  - Potential To Run System At Higher Suction Pressure Set Point

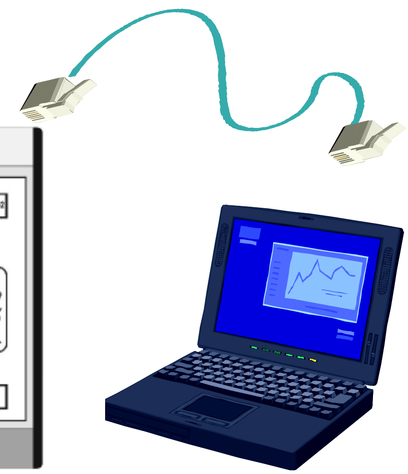
Stand Alone Superheat Controller

EC3-X32



EC3-D72
Superheat and Digital Synchronization Controller





Option 1

Direct connection to an individual PC

- It requires “cross over/link” cable
- Configuration of TCP/IP of PC
  - TCP/IP Network knowledge required

Option 2

Router with DHCP-Server Automatically assign dynamic IP-address for PC and EC3-X32

Router

Optional: ECD-002

EC3 and EX Valves

Superheat Controller and Electronic Valve

Benefits:

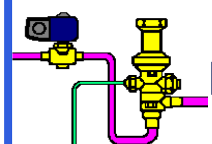
1. Precise Temperature Control
   - 10 to 100% Capacity Modulation
2. Saves Energy / Operating Cost
   - Quicker Pull Down, Without Adjustments
   - Reaches Set Point Faster
   - Reduces Run Time
   - Tighter Superheat Control
3. System Protection
   - Prevents Compressor Flood Back from Burnt out Evaporator Fan Motor
   - Alarm Notification IE Low Superheat
4. Simplifies System with Added Flexibility
   - Reduces Commissioning Time / Labor Cost
   - Lower Refrigerant Charge Due to Low Floating Head

Conventional System

- Fixed Capacity Compressor

- Mechanical TXV

- Solenoid Valve



- Hot Gas Bypass Controls

- Head Pressure Control

ICE Western Digital Solution Retrofit Option

- Copeland Digital Compressor

- Electronic "EX" Valve

- Digital / EX Valve Control

- AC Tech SMV Vector VFD

Who Benefits From ICE Western Scroll Digital Solution?

- **Applications That See Large Daily Temperature Swings**

Schools

Restaurants

Natatoriums

- **Applications With Tight Temperature/Humidity Control Requirements**

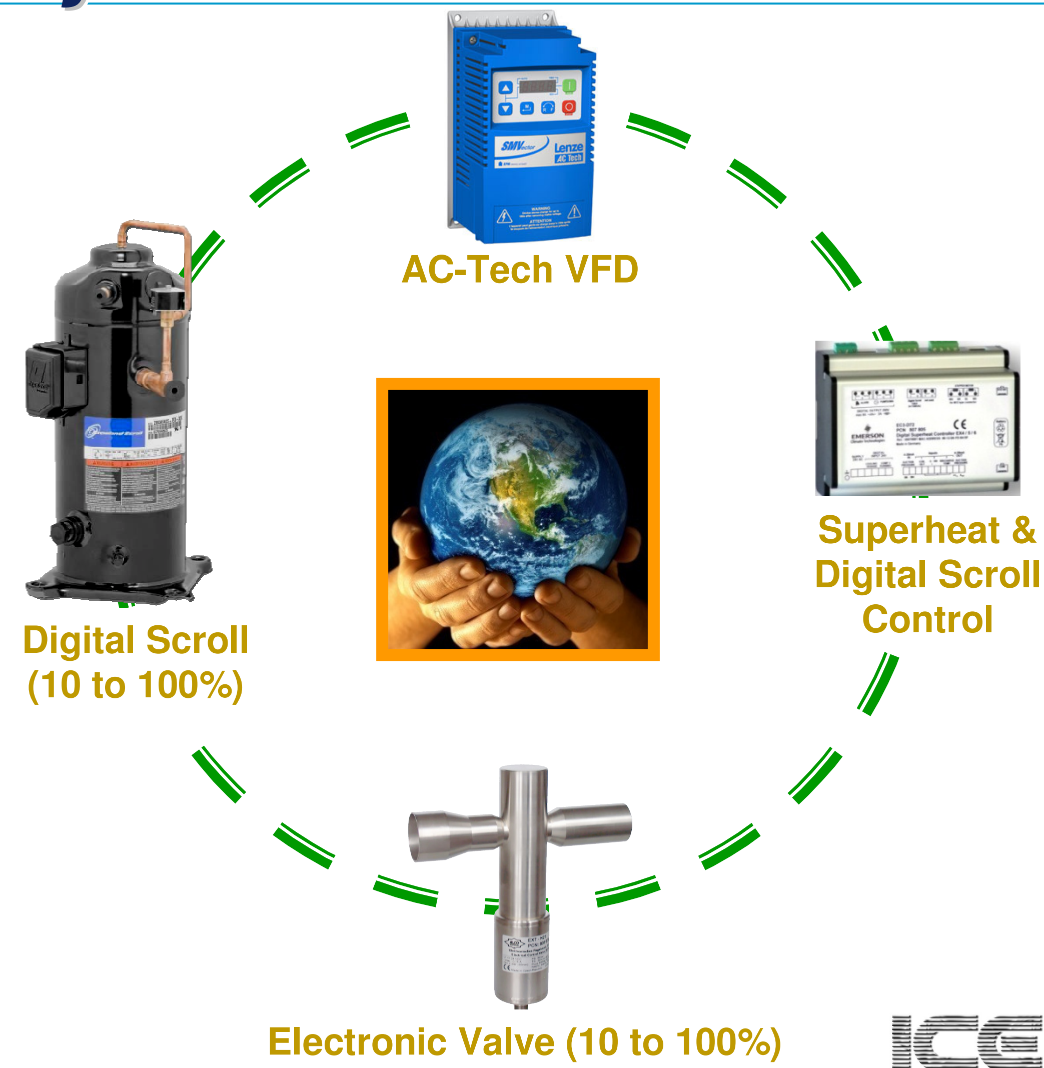
Hospitals

Museums

Telecom

ICE WESTERN

ICE Western's Capacity Modulation Solution



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Thank You

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