

2018 Winter Conference ★ Chicago, IL

Impact of Refrigerants on Compressor Design

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Learning Objectives

- Describe the major market and regulatory trends impacting chiller and compressor design.
- Explain how design choices for compressor, heat exchangers and other major components are inter-related.
- Define how compressor design is impacted by part load efficiency focus. Including modulation via speed and mechanical means.
- **Describe the impact of new refrigerants on compressor design.**

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Outline

- Refrigerants Landscape
- Compressor Design Considerations
 - Performance
 - Thermal Management
 - Oil Selection
 - Envelope
- Conclusion
- Questions

Refrigerant Landscape

Refrigerant	Composition		
	R32	R125	R1234yf
R410A	50%	50%	---
R32	100%	---	---
R452B	67%	7%	26%
R454B	69%	---	31%

Pressure

■ A1 – Non Flammable
■ A2L – Mildly Flammable

■ A3 – Flammable
■ B2L – Toxic, Mildly Flam.

R-410A
Like

R32, R452B,
HFO Blends
400-675

R410A

R407 /
R22 Like

CO₂
NH₃
R290

HFO
Blends
150 -
300

< 1500
R32/HFC/HFO
Blends

R22
R407C

R134a
Like
R123-Like

HFO 1234yf
HFO 1234ze

~600
HFC/HFO
Blends

R134a

<150

500

<750

1000

<1500

1500

2000

GWP Level

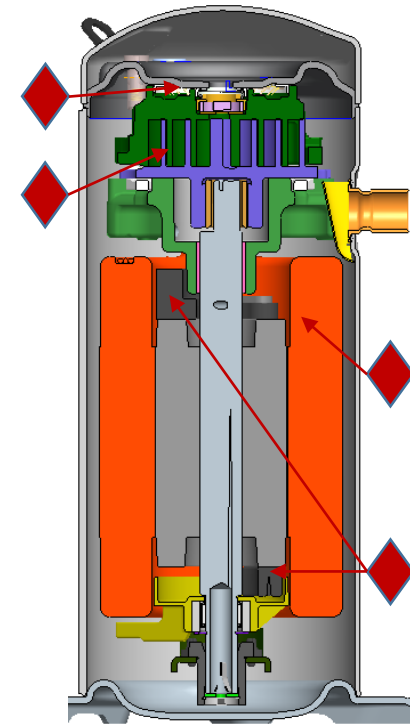
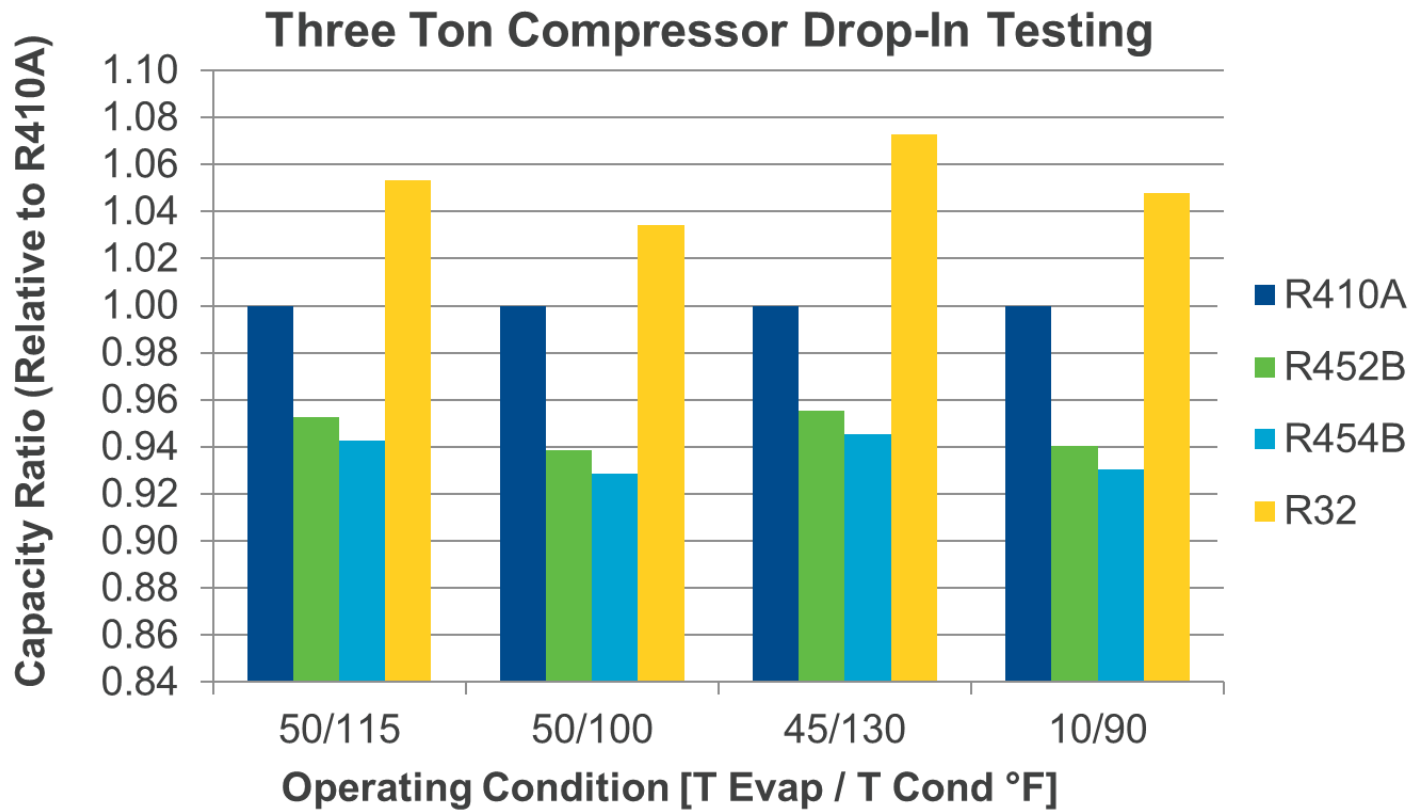
Compressor Design Considerations

✓ = Discuss Today

- ✓• Capacity
- ✓• Efficiency: EER, IEER, IPLV, SEER and HSPF
 - Field Life / Reliability
- ✓• Envelope Capability
- ✓• Discharge Temperature Management
- ✓• Chemical Compatibility
- ✓• Oil: Selection and Circulation Rate
 - Capacity Modulation
 - Sound, Vibration, Gas Pulsation
 - Motor Protection
 - Pressure Vessel
 - Cost
 - Complexity Management
 - And More...

Capacity Varies with Refrigerant

◆ Potential changes in scroll elements influence key design areas: counterweights, motors, seals, and more

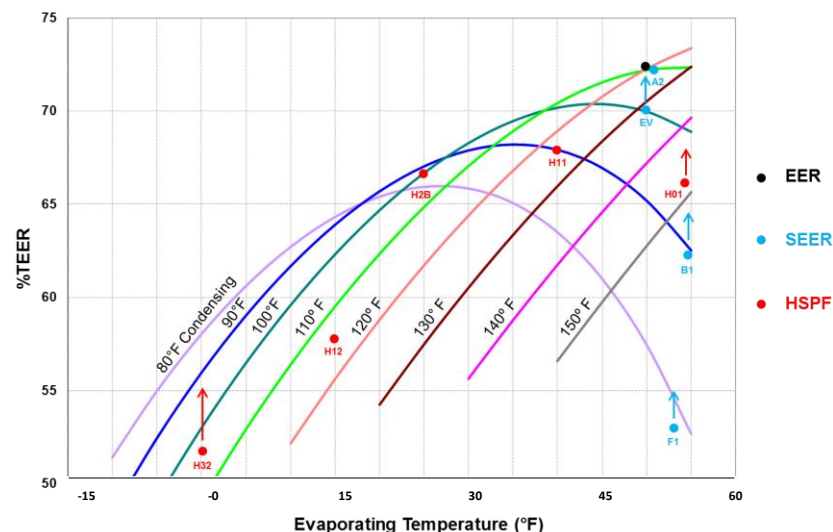
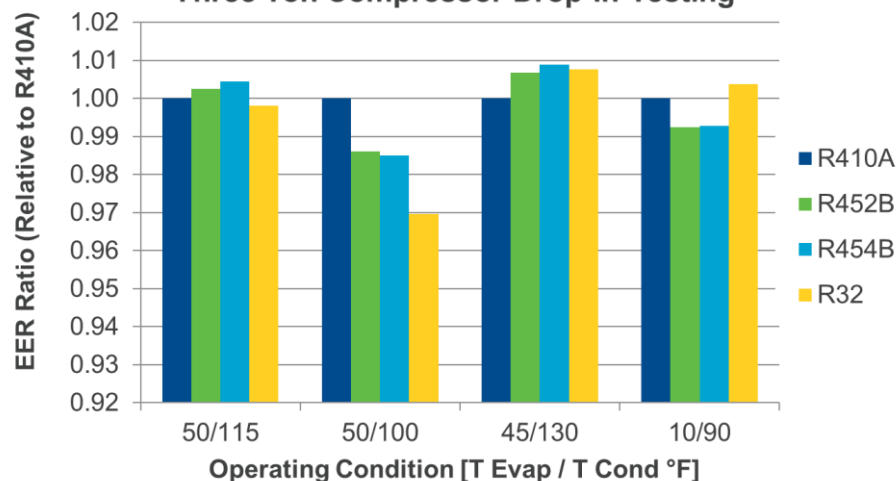


Efficiency Varies with Refrigerant

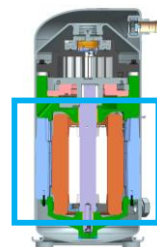
Refrigerant changes may require compressor modifications to optimize EER

Regulation shifts to part load ratings may require new scroll and motor design strategies

Three Ton Compressor Drop-In Testing



Optimizing volume ratios with valves can help mitigate compression losses

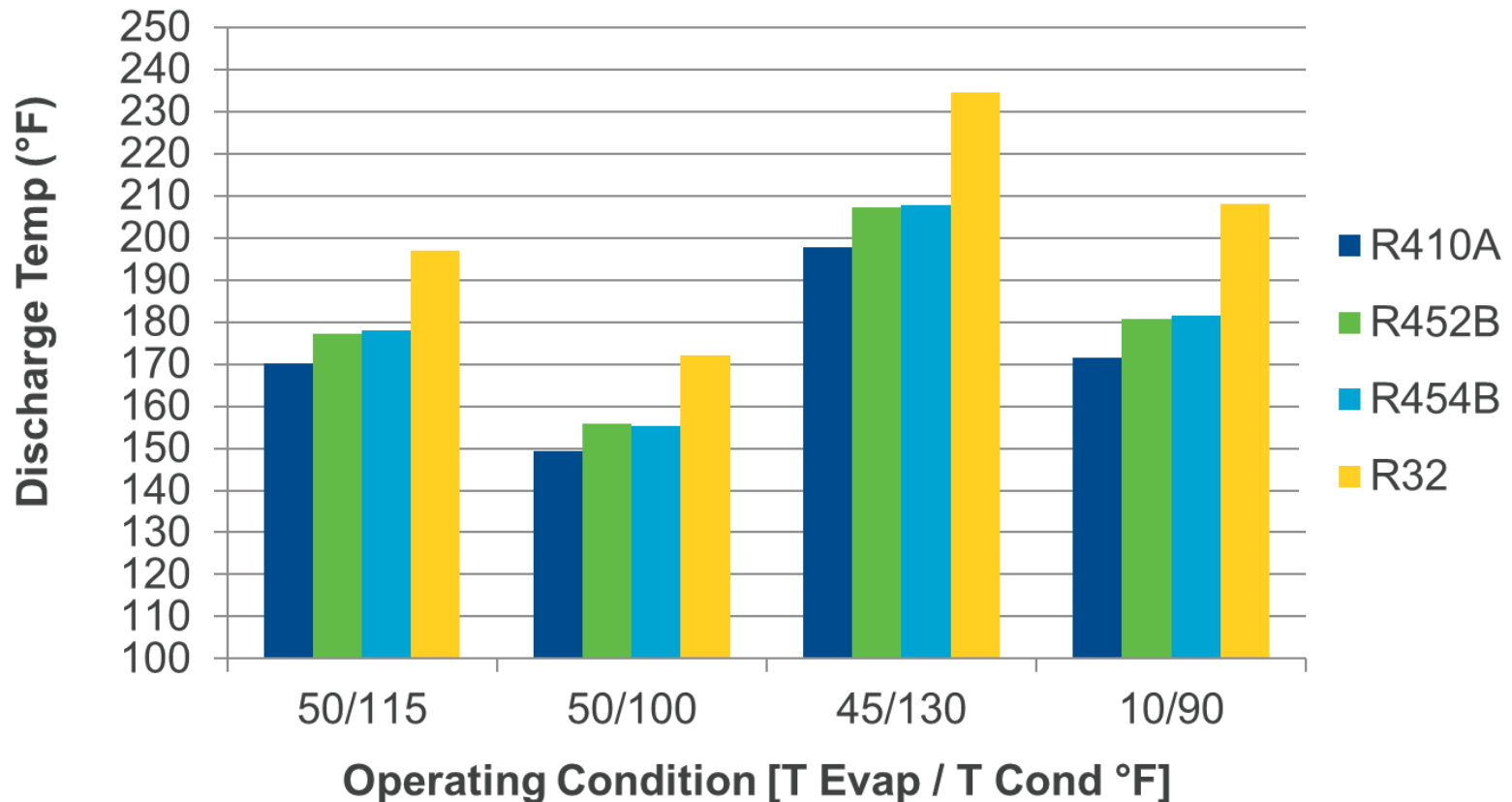


Motor optimization can be tuned to favor multi-point ratings

Discharge Temperature Management

New refrigerants may drive changes in scroll elements, system superheat control, material selection, and more to manage increased temperatures

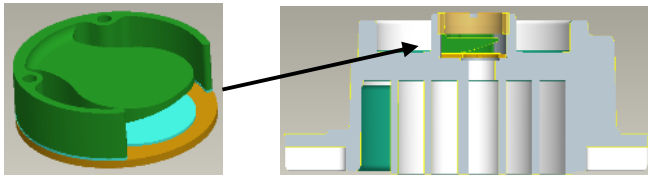
3 Ton Compressor Drop-In Testing



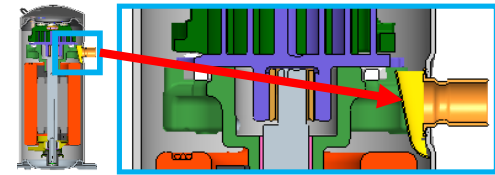
Many Solutions Exist for Discharge Temperature Management

There are several viable technologies for reducing discharge temperatures including the examples shown here

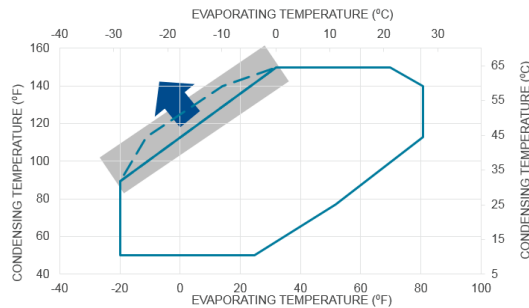
Objective: Select the right technologies to meet applications needs



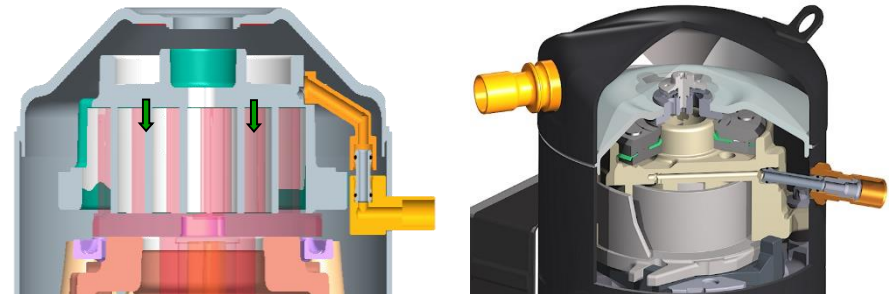
Scroll discharge valves can help mitigate compression losses



Managing scroll suction inlet temps can help reduce discharge temps



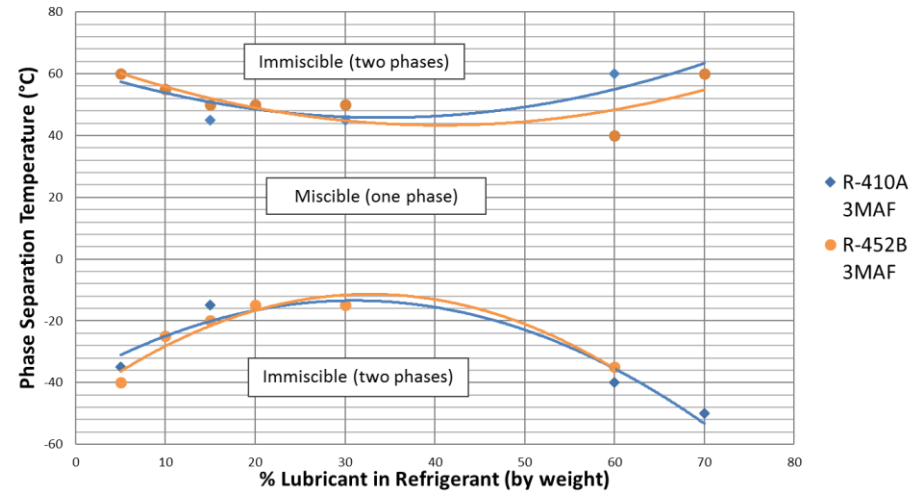
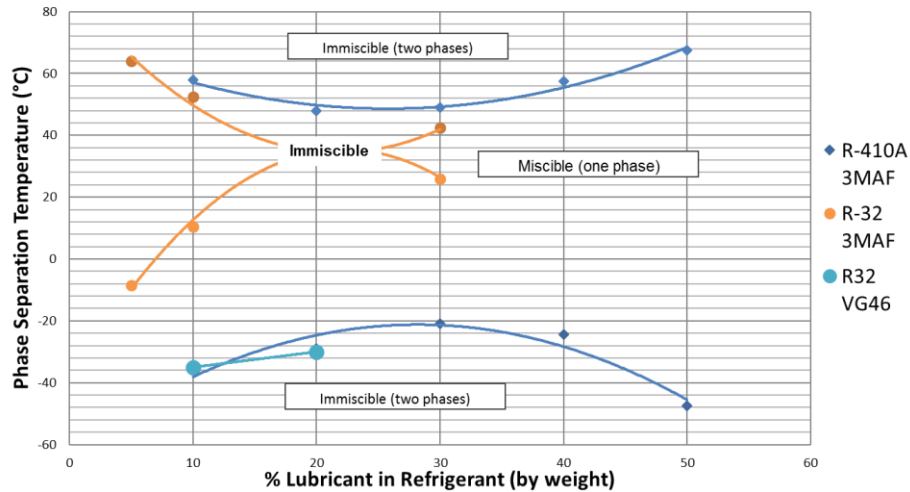
Reducing system superheat can help reduce discharge temps



Vapor / liquid injection schemes help mitigate heat of compression

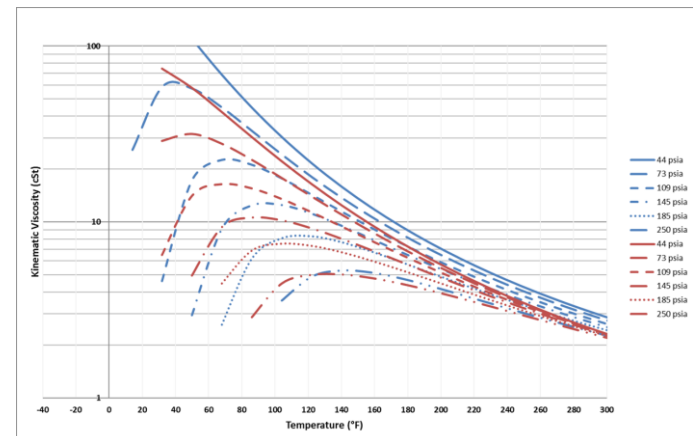
Oil Compatibility

Refrigerant selection requires selecting oils that remain miscible for intended applications



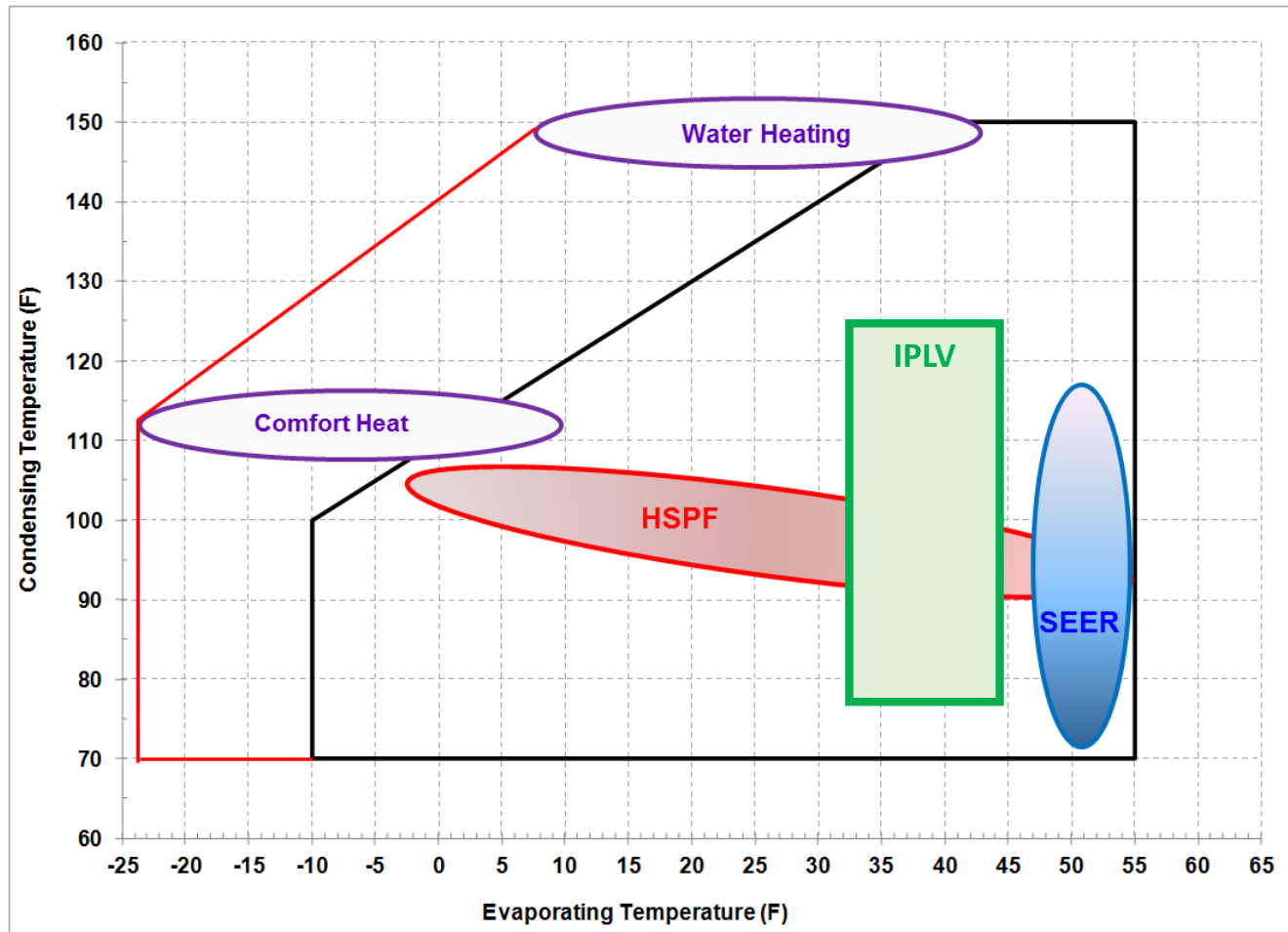
Refrigerant selection requires selecting oils that satisfy many requirements:

- Viscosity
- Solubility
- Chemical compatibility
- Thermal stability
- And more...



Operating Envelope

The resulting envelope is a composite result of all technical concerns, often spread across multiple applications



Conclusions

- New refrigerants will drive compressor design changes
 - Particularly when coupled with higher system efficiency requirements
- The impacts of new refrigerants on compressor design are challenging but manageable
 - Known technologies can be improved, optimized, and deployed in new ways
 - New technologies and control solutions beyond the compressor continue to evolve

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Questions?

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