Refrigerant Choices and Their Impact

THE NEXT TRANSITION

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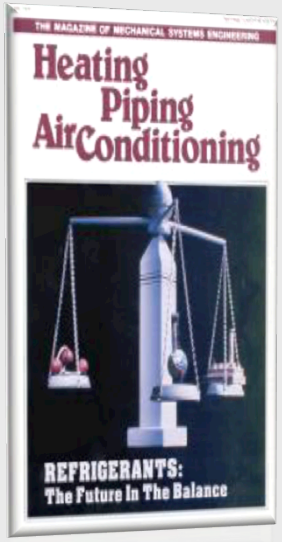
Tonight's Agenda

1. Pressures on refrigerants – why the transition?
2. The current state of HVAC refrigerants
3. Industry response – what are our options?
4. Compressor choices/technologies for the various refrigerant classifications

Refrigerant Message

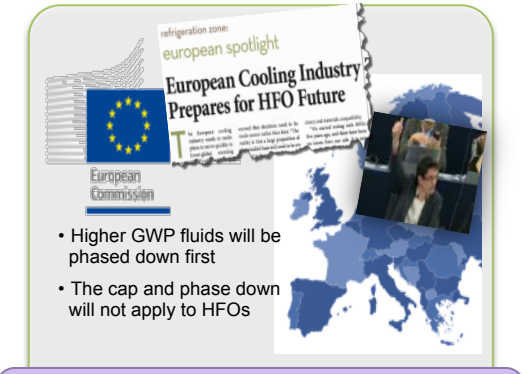
Balanced approach minimizes overall environmental impact:

- Energy efficiency
- Refrigerant emissions
- Ozone depletion
- Global warming
- Atmospheric life



Today's Regulatory Environment for Refrigerants

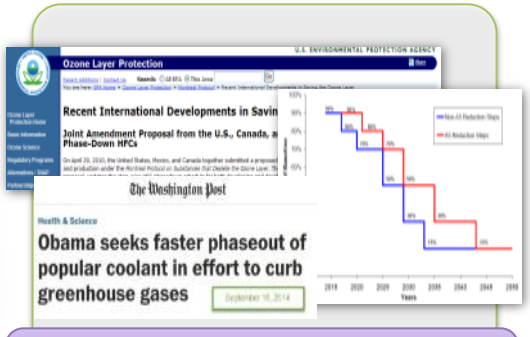
The Pressure on HFCs is Not New



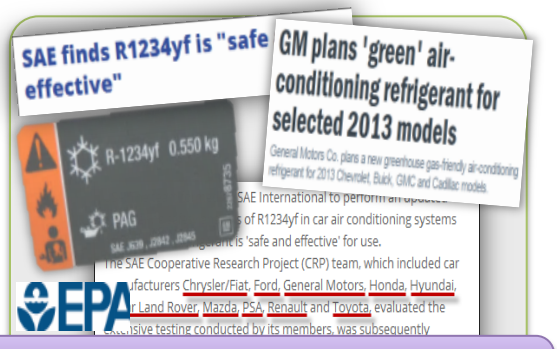
EU F-Gas Regulation (EC 842/2006)
HFC cap and phase down begins 2015

US Legislators & Regulators Begin with
Presidential Push & Global Agreements

Refrigerant Manufactures Bringing
New Solutions to Market



US, Canada & Mexico
HFC Phase Down Proposal



Auto Industry Already Shipping
Cars with R-1234yf

Increasing pressure on all refrigerants in all regions

DAILY NEWS Jan 29, 2015 9:39 AM - 0 comments

Phase down versus phase out

HPAC HEATING PLUMBING AIR CONDITIONING

HRAI forwards comments to Environment Canada on Notice of Intent to regulate HFCs.

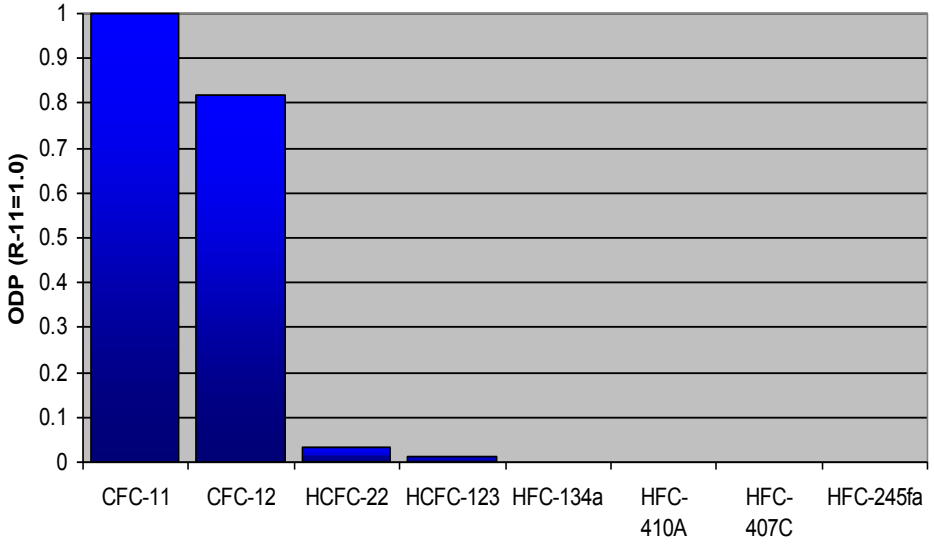
2015-01-29

The Heating, Refrigeration and Air Co
submitted comments to Environment
Conditioning, Heating, and Refrigerati
to Environment Canada's Publication
hydrofluorocarbons, which was release
associations agreed to provide consiste
sides of the border because of Canada'
regulations being proposed by the Unite
Agency (EPA).
The comments address the approach be

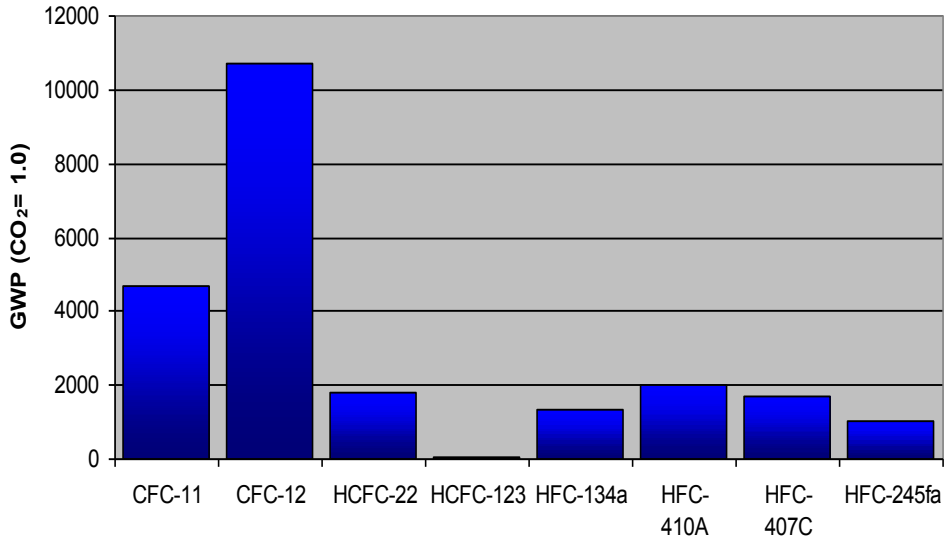
The comments address the approach being taken for commercial refrigeration equipment and the potential negative impact on the equipment and the industr that services it. Of particular concern is Environment Canada's intent to adopt the path the EPA has proposed, which is to restrict the use of certain HFC refrigerants. The proposed regulation includes prohibition of the manufacture and import of specific HFCs (134a and those with a higher global warming potential, i.e. 507 series and 404a) with use being phased out in condensing units and supermarket systems, stand-alone units and vending machines. Another measure in the notice is the prohibition of the manufacture and import

Watch the papers… new information is emerging daily

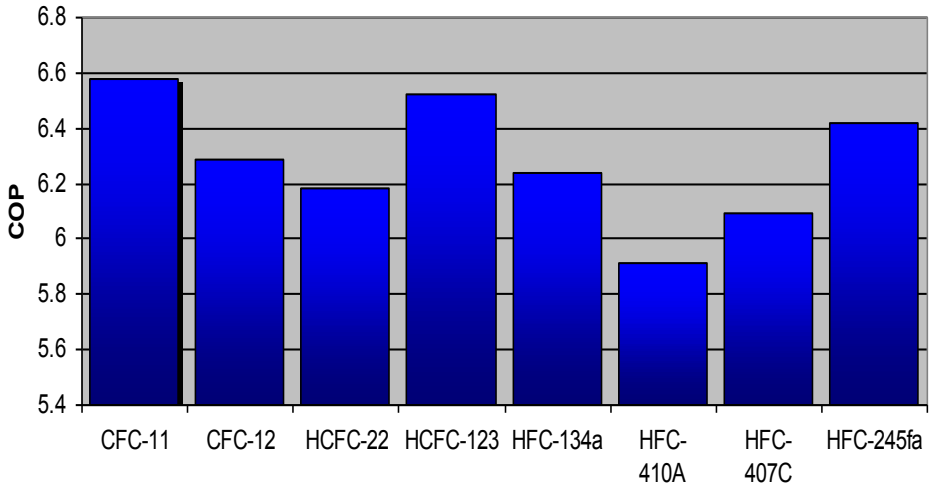
Ozone Depletion Potential (ODP)



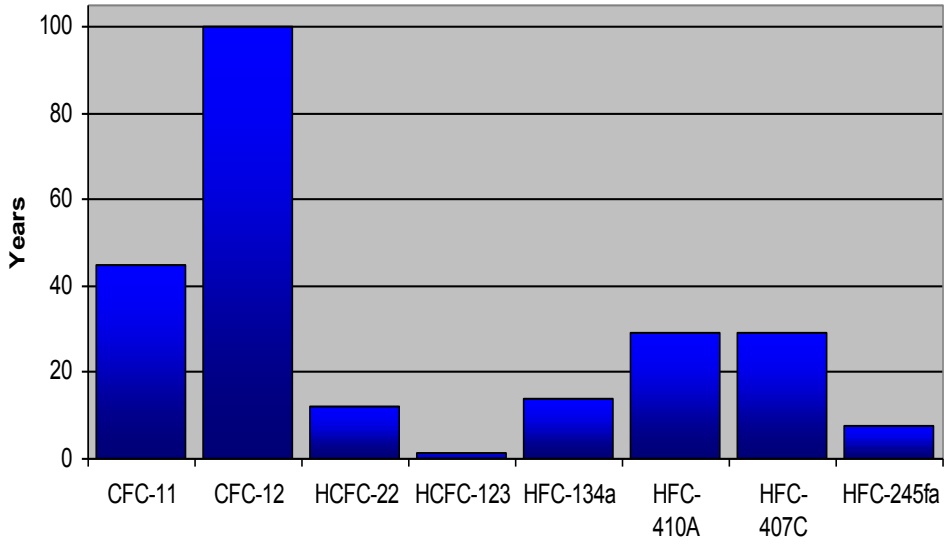
Global Warming Potential (GWP)



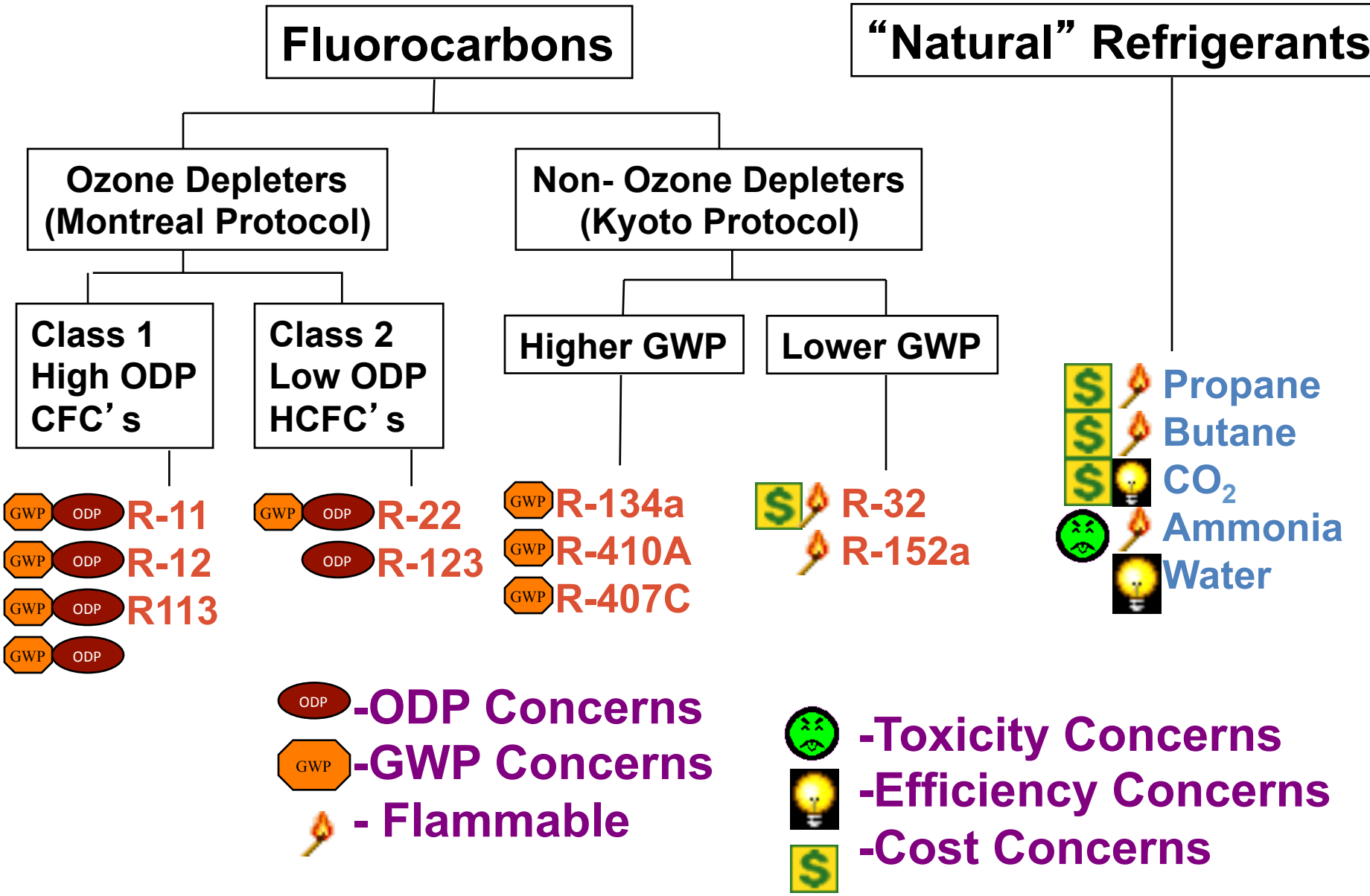
Efficiency for Chillers (COP)



Atmospheric Life (Years)

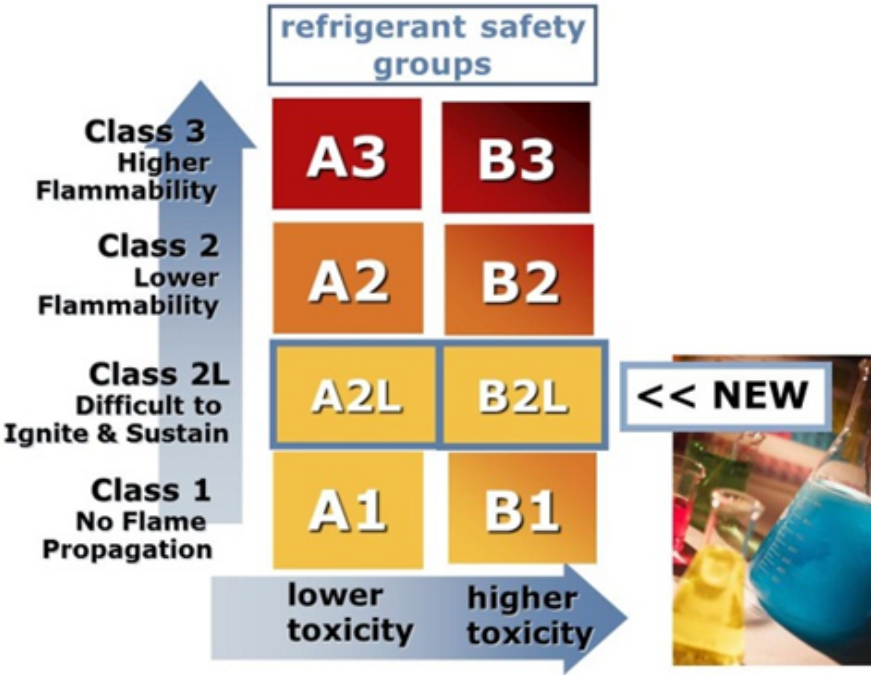


Options For HVAC Refrigerants



Refrigerant Safety Classifications

ASHRAE 34 & Proposed ISO 817



- **Flammability**
  - **Class 1, non-flammable most refrigerants used today, like R-134a, R123, 410a**
  - ***Class 2L, new class slightly flammable refrigerants <10 cm/sec burning velocity, most new HFO's, R32***
  - **Class 2, more flammable, R152**
  - **Class 3, explosive, like propane**

How is the industry responding?

- Refrigerant producers are developing new refrigerants:
  - Near zero ODP, very low GWP, energy efficient & safe
  - Expected availability – 0-5 years
- Equipment manufacturers are analyzing new refrigerants:
  - Energy efficient, safe & low emissions
  - Equipment availability by 2015 - 2018

HVAC Industry Next Transition Begins…

Past
Present
Future

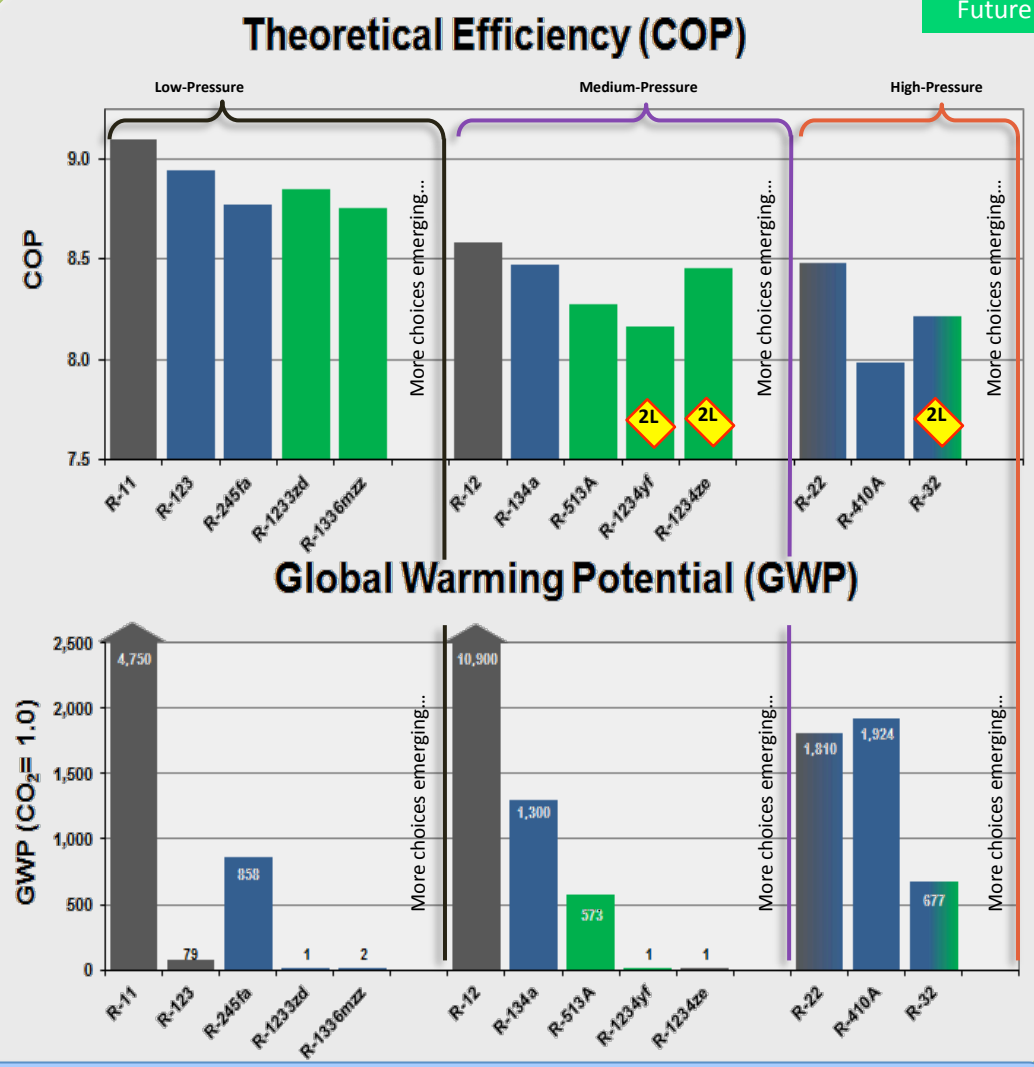
September 2014

"Obama Administration Partners with Private Sector on New Commitments to Slash Emissions of Potent Greenhouse Gases and Catalyze Global HFC Phase Down."

In total, 22 companies have already committed to cutting HFC emissions by 2020.

"Close to $2 billion has been spent … since 2009 … and over the next 10 years, the HVACR industry will invest an additional $5 billion … to develop and commercialize low-GWP technologies."

- AHRI president & CEO Stephen Yurek



Industry commitments and available options are increasing

HFO Development

High Pressure (R-22/R-410) Replacement

R-32 (GWP=716)Moderate

- GWP is a concern
- 2L flammable

HFO/R-32 blends (GWP= 400/600/)

- 2L flammable

Medium Pressure (R-134a) Replacements

R-1234yf (GWP<10) - Automobile

- Expensive, significant efficiency loss
- 2L flammable

R-1234ze (GWP<10) - Chillers

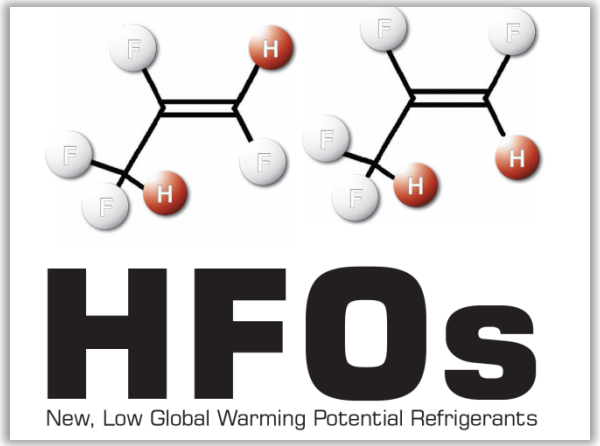
- Moderate price
- 2L flammable

Low Pressure (R-123) Replacements

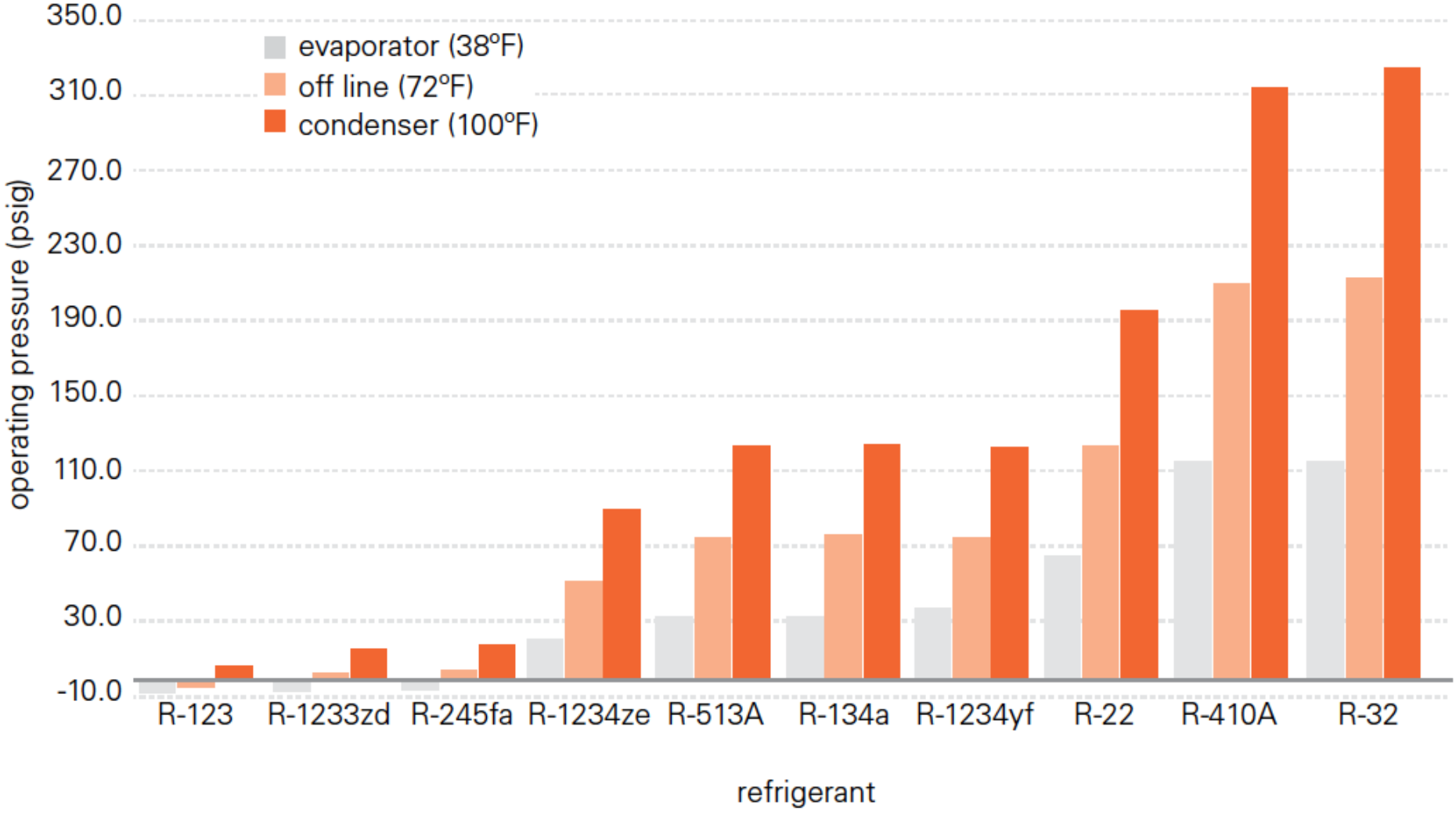
, R-1233 zd (GWP<10) - Chillers

. Moderate price

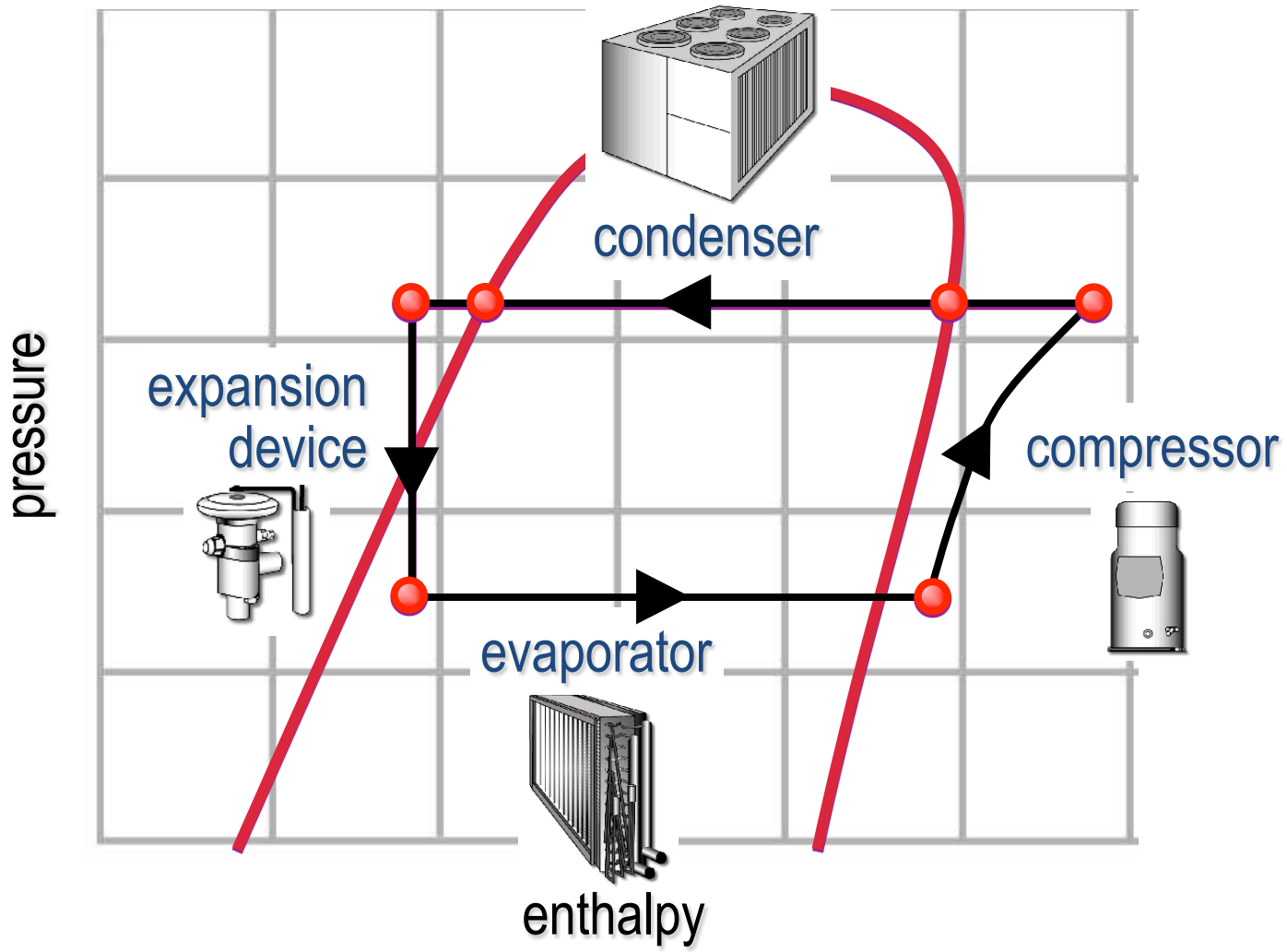
. Non-flammable



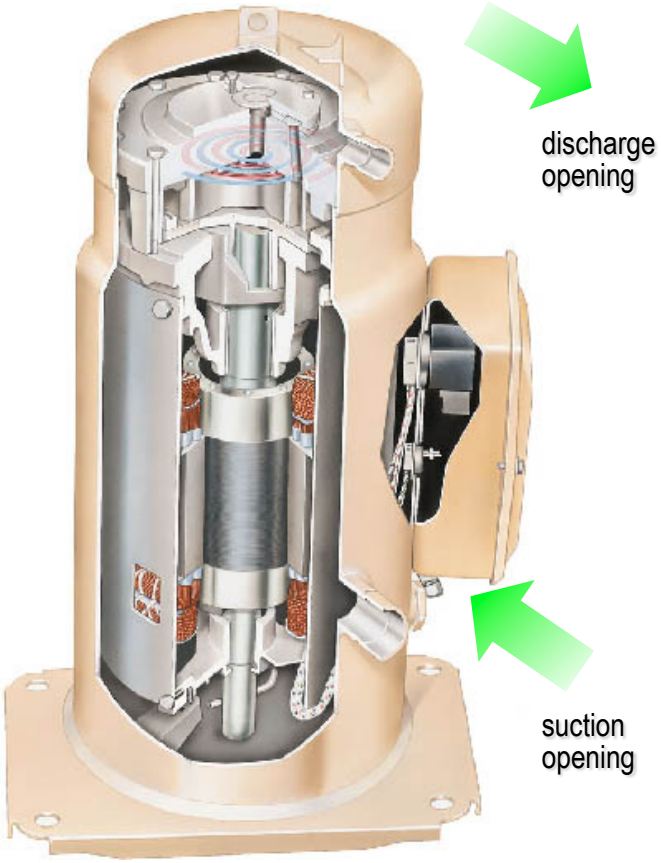
Refrigerant Operating Pressure



Refrigeration Cycle



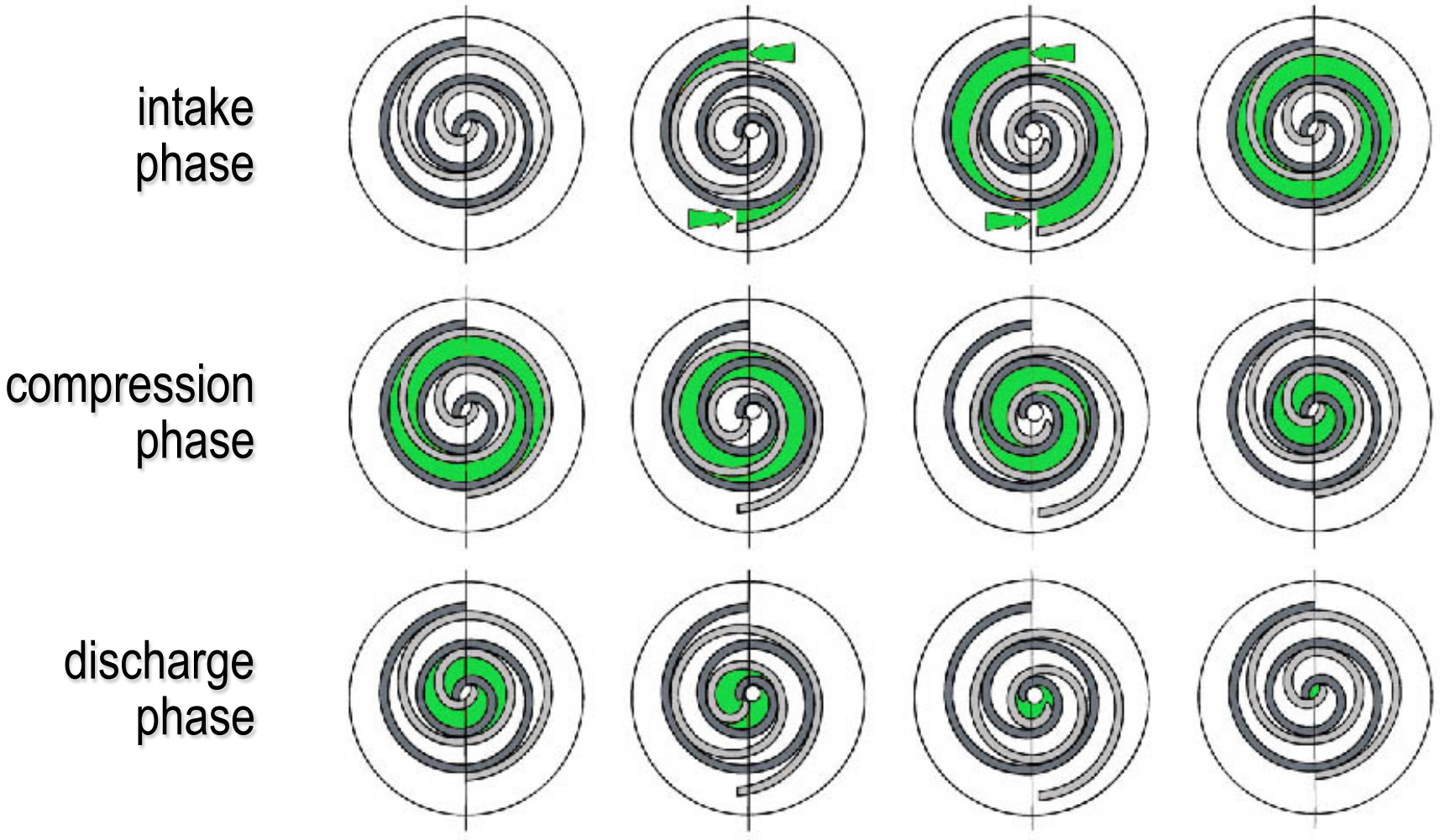
What's the compressor's job?



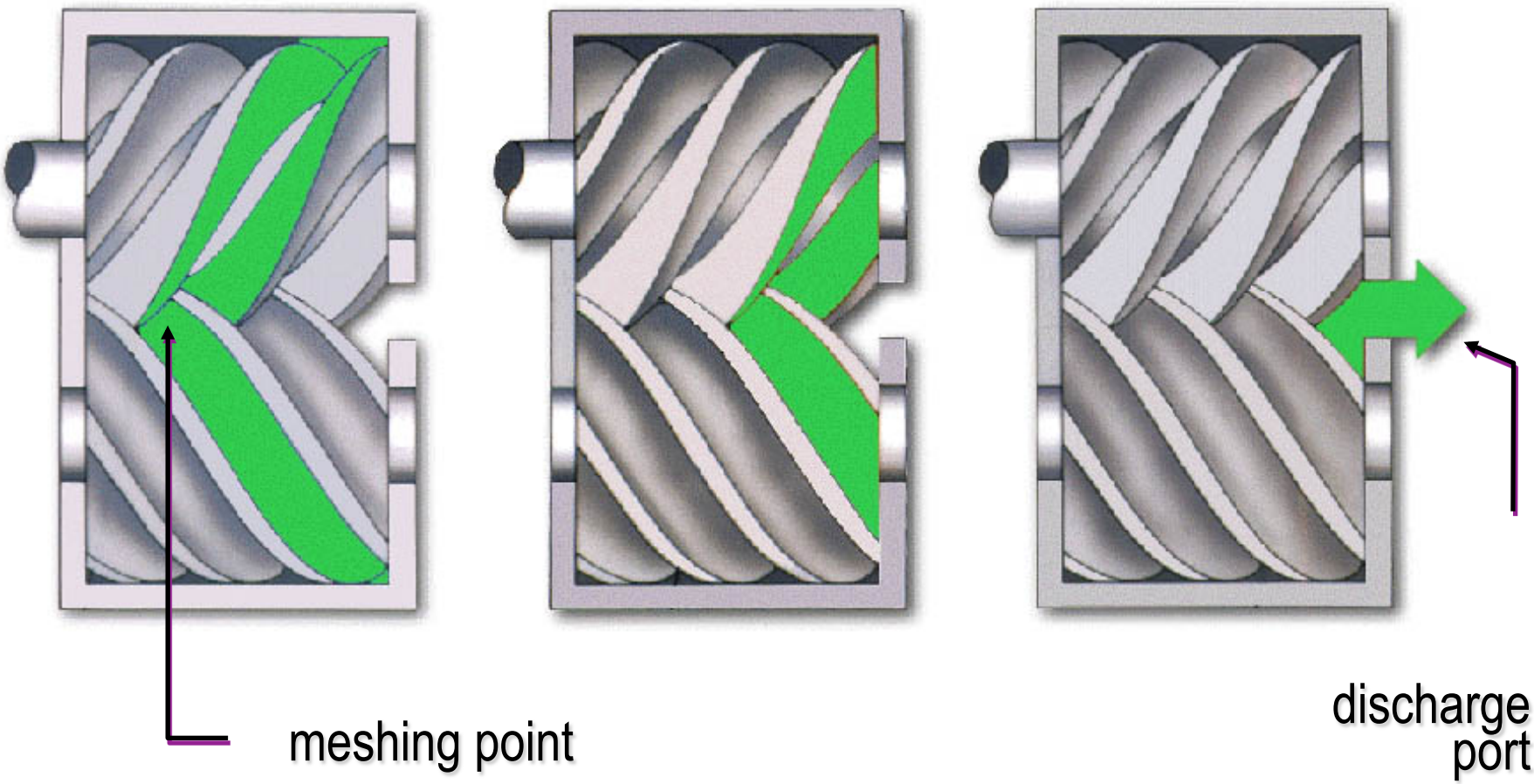
1. Move refrigerant through the system (volumetric flow rate)
2. Create pressure rise (and in close systems, temperature rise in turn)

1. Volumetric flow rate = tons
2. Pressure = condensing and evaporating temperatures

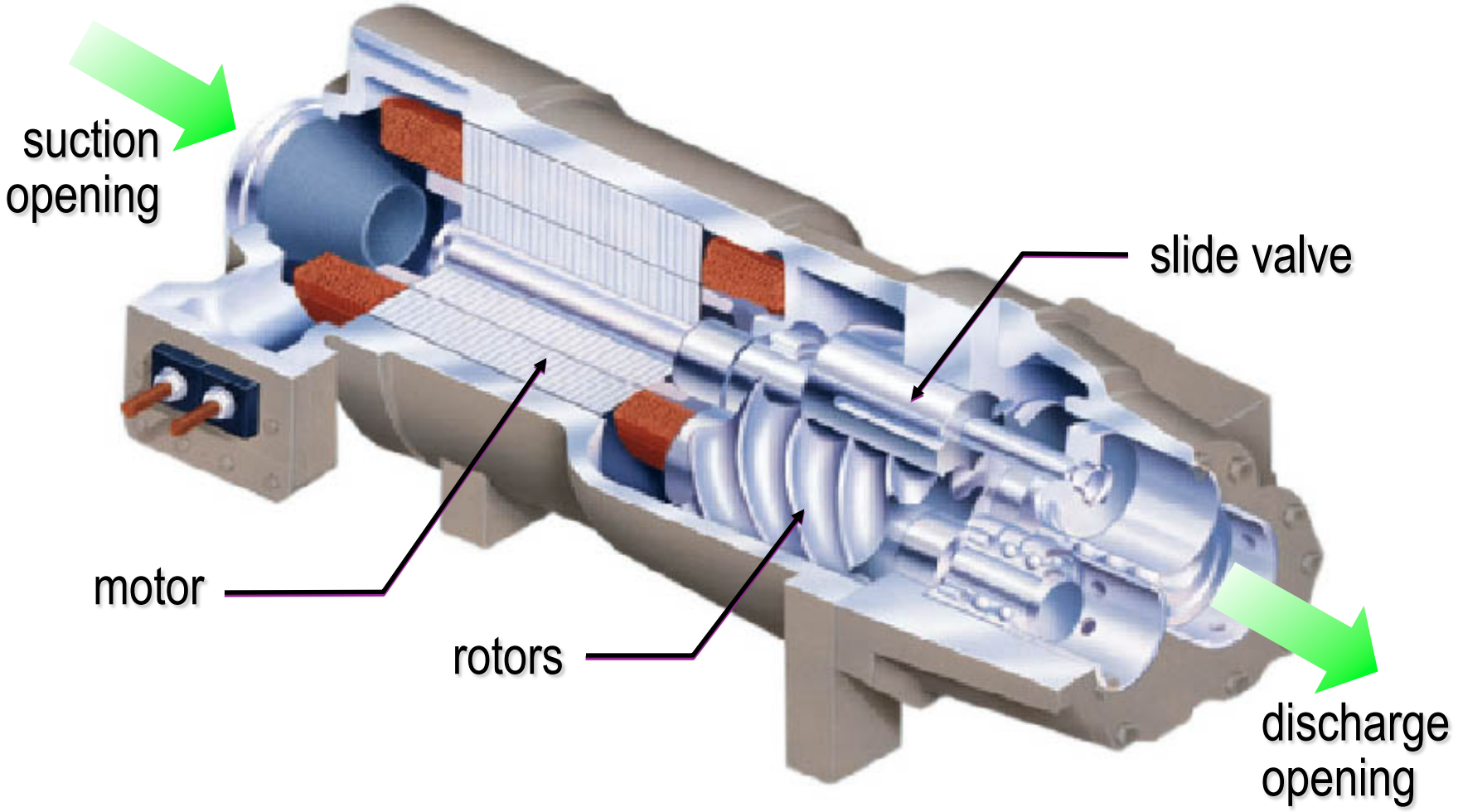
Scroll Compressor



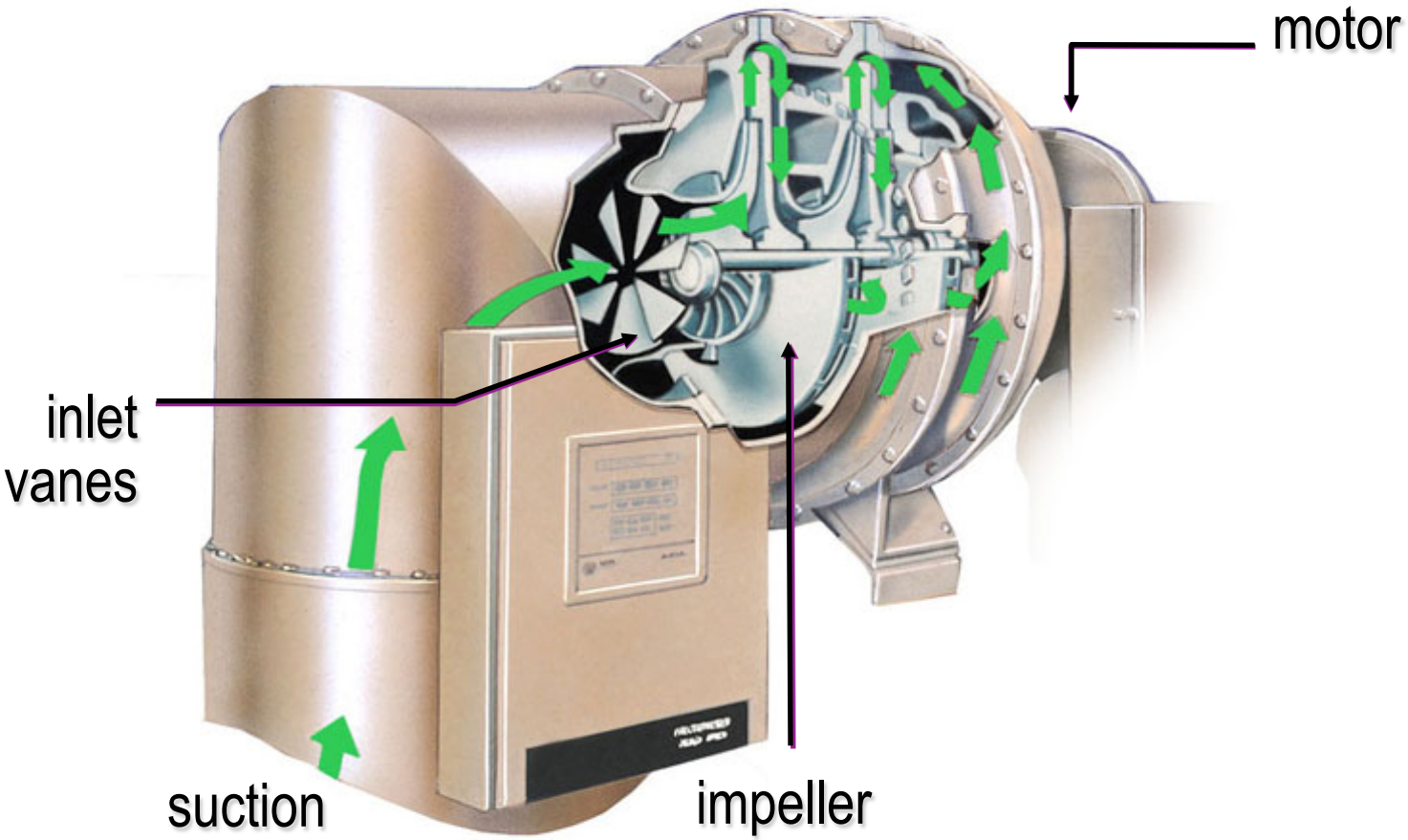
Helical-Rotary Compressor



Helical-Rotary Compressor



Centrifugal Compressor



Key takeaways on compressor/ refrigerant combos:

1. The tonnage and compressor technology define the refrigerant, not the other way around
2. Variable speed means different things for different compressor technologies