HCFC Refrigerant Transition Helical Rotary Chillers

Jeff Moe

VP & Chairman, Environmental Policy Council

Trane

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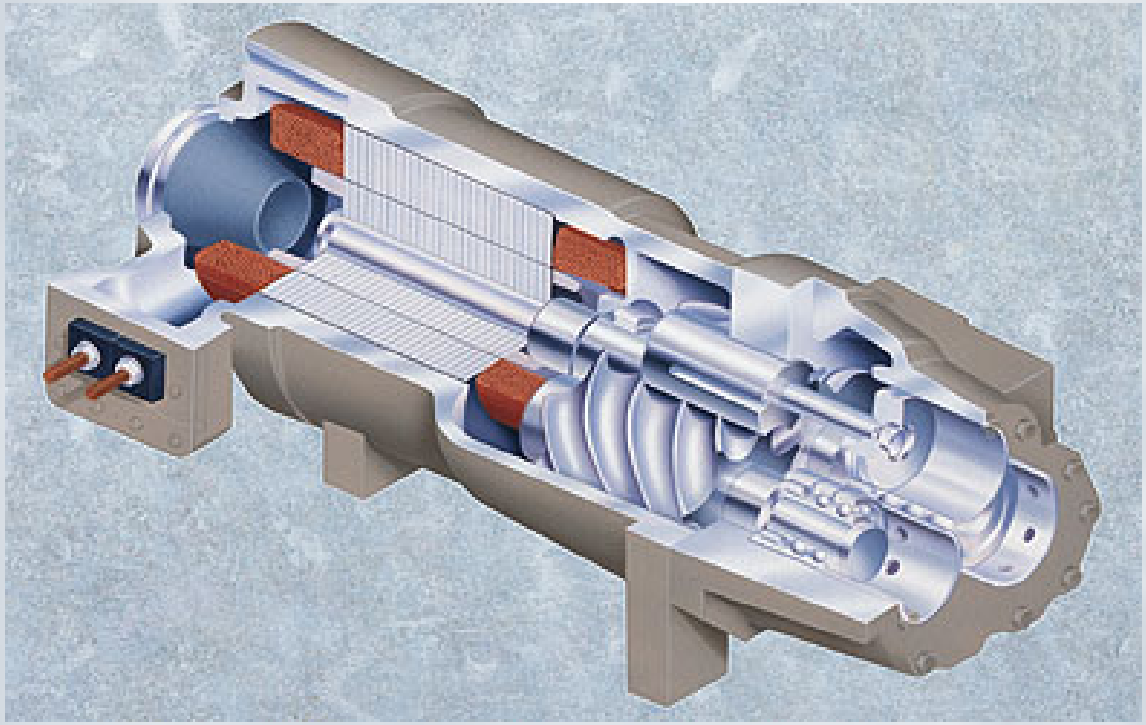
Compressor type



Compressor cut-away

Compressor rotors

Applications

Deliver chilled water for air conditioning or process cooling applications
(70 tons/245 kw to 500 tons/1750 kw)

Air-Cooled (outdoor)

Water-Cooled (indoor)

Key points

- **Solution-of-choice: HCFC-22 ➔ HFC-134a**
- **While solutions are known, they are not fully commercialized in A5 countries**
- **Alternative selection needs to consider energy efficiency, fluid Global Warming Potential, safety, cost**
- **A coordinated volume ramp-up between refrigerant, equipment manufacturing, and service infrastructure development is important to minimize cost impact and make for a smooth transition**
- **Service infrastructure is important and takes time for proper development**

Global product markets*

	Air Cooled	*Water Cooled*
US$	1.3 billion	0.8 billion
Units	25,000	20,000
Average size (tons/KW)	148/503	220/748
Refrigerant amount (millions of kg)	3.4	4.0

**Trane estimates*

>40% is in A5 countries

Environmental impact

- **ODP impact:**
  - A5 Countries = ~176 ODP-tonnes (100% HCFC-22)
- **Direct GWP opportunity:**
  - A5 Countries = ~1.2 million tonnes CO2-eq (100% transition from HCFC-22 to HFC-134a)
- **CO2 emissions impact from energy efficiency**
  - Specifics depend on country policies
  - Energy efficiency impact > direct GWP impact

Investments

- **Refrigerant capacity & supply chain development**
  - Facility expansion or transition
  - Capacity/demand ramp-up is critical

Global & country-specific capacity vs. demand growth is critical to smooth ramp-up

Investments

- **Product technology transfer**
  - Varies significantly by facility type (from <US$1 million to US$10 million)
  - New hardware (refrigerant-handling equipment) …capital investment
  - New software (run-test facilities) …manpower/expense investment

Solutions are known, execution is critical

Investments

- **Service infrastructure**
  - Training (By person)
  - New equipment (By truck or facility)
  - Cannot happen all at once

Solutions are known, execution is critical

Challenges for the transition

Capacity & supply chain development

- Certainty of transition is important to cost & reliable supply

Technology transfer

- Performance/cost
- Product reliability
- Non-refrigerant customer requirements

Service infrastructure

- Training
- Equipment acquisition
- Over time, not all at once

Consumers show little value for non-ODS fluids

- Investments are risky without firm phase out schedules
- The tendency is to retain HCFC-22 systems

Consensus needed for a balanced solution, considering fluid GWP, energy efficiency, safety

Non-HFC fluid technology

Non-HFC fluid technology was considered, but it increases indirect CO2 emissions due to poor energy efficiency or raises significant human safety considerations

CO2 efficiency comparison

Coefficient of Performance

HFC-410A	6.56
HFC-134a	6.94
CO2	3.40
HCFC-22	6.98

105-93% advantage over CO2

Trane estimates: theoretical fluid efficiency

Chilled water application conditions

Human safety considerations

Use in current designs has significant safety concerns:

- Hydrocarbons
  - High explosive energy
  - Servicing and for building occupants
  - Residential and commercial applications
- Ammonia:
  - Flammable and toxic
  - Most applications today are installed remotely, at significantly higher costs

Lessons learned

- **Performance/cost penalty when moving from HCFCs to HFCs**
  - Non-refrigerant technology needed to offset cost add
  - Examples: Heat exchanger, compressor
- **Service infrastructure development takes time**
  - Start awareness early, clarify phase out schedule
- **Energy efficiency policy coinciding with HFC introductions leverages development**
  - Minimize cost increase
  - Cost-effective climate change mitigation

What does the future hold?

- Considering energy efficiency, fluid GWP, safety and cost…
- Considering that vapor compression technology delivers, by far, the most cost effective energy efficiency…
- Considering indicators in energy efficient, safe, low GWP alternatives…

- Now: “Best” solutions for near-term compliance
- Next: “Efficient, safe, Low-GWP alternatives” within next decade
- Following: commercialization into applications