TRANSITIONING TO LOW-GWP ALTERNATIVES IN UNITARY AIR CONDITIONING

Background

This fact sheet[1] provides current information on low-Global Warming Potential (GWP) alternatives for new equipment in unitary air conditioning (AC) relevant to the *Montreal Protocol on Substances that Deplete the Ozone Layer*. The unitary AC sector consists of systems that cool enclosed spaces ranging from single rooms to large exhibition halls. These systems have a typical lifetime of 15 years and generally fall into four categories:

Small, Self-Contained Air Conditioners

- Window-mounted, portable, and through-the-wall
- Capacities of 1–10.5 kW
- Average charge size of 0.7 kg

Non-Ducted (or Duct-Free) Split Residential and Commercial Air Conditioners

- Compressor/heat exchanger units installed outside the space to be cooled/heated
- Capacities of 2–20 kW for a mini-split (single evaporater), 4.5–135 kW for a multisplit system
- Charge sizes of 0.5–90 kg

Ducted, Split Residential Air Conditioners

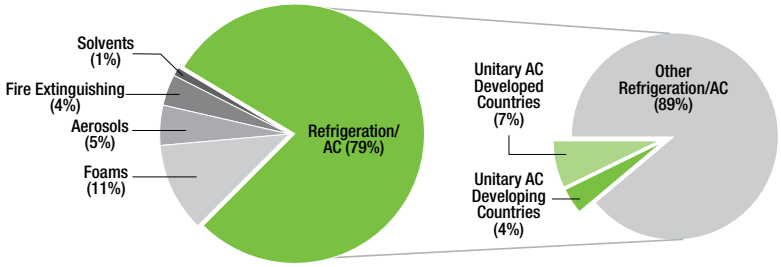
- Duct supplies cooled/heated air to each room or zone
  - Used primarily in developed countries, especially in North America
- Capacities of 5–17.5 kW
- Charge sizes of 1–6 kg

Ducted, Commercial, Split and Packaged Air Conditioners

- Mounted on roofs or on the ground adjacent to buildings
- Capacities typically range from 5–420 kW

Unitary AC equipment accounts for an estimated 91 million metric tons of carbon dioxide equivalent ($MMTCO_2eq.$) or 8% of global HFC consumption in 2010. In the refrigeration/AC sector, unitary AC accounts for 11% of consumption. This percentage is expected to increase as the transition from HCFCs to HFCs matures. An estimated 38% of HFC consumption in the unitary AC sector (35 $MMTCO_2eq.$) is in developing countries.

2010 HFC Consumption
(Estimates Presented in $MMTCO_2eq.$)



Global HFC Consumption Total: 1,087 $MMTCO_2eq.$
Global Refrigeration/AC Sector Total: 858 $MMTCO_2eq.$
Global HFC Consumption Unitary AC: 91 $MMTCO_2eq.$

China's Experience

China manufactures half of the world's 50 million mini-split AC systems annually. It's the largest manufacturer of AC equipment in the developing world. A significant portion of production is for the export market—China supplies nearly 85% of the window, wall, and mini-split AC imports to the United States. While R-22 continues to dominate unitary AC domestically, China manufactures both R-22 and R-410A units. The R-410A units are in high demand as exports to developed countries. China has commercialized room ACs with R-290 and is researching unitary AC products with R-32.

HFC Alternatives and Market Trends

Today, most unitary AC systems use HCFC-22. Since 2000, developed countries have been transitioning to R-410A and, to some extent, R-407C. Most developing countries continue to rely on R-22. Currently, R-22 represents approximately 85% (1.2 million tons) of refrigerant stocks in existing unitary AC systems worldwide. Of the units sold today, R-22 accounts for approximately 60%, while R-410A and R-407C account for most of the remainder; propane (R-290) accounts for less than 1%.

Carbon Dioxide (R-744)

- Research to improve efficiency is underway
- Custom-built applications and demonstration units are available
- Increased use is expected in cool to moderately warm climates

Refrigerant	GWP	ODP[a]
R-410A	2,088	0
R-22	1,810	0.055
R-407C	1,774	0
HFO Blends	<1,032[b]	0
R-32	675	0
R-1234ze	6	0
R-1234yf	4	0
R-290 (propane)	3.3	0
R-744 (CO_2)	1	0

[a] ODP = ozone depletion potential

[b] Value shown is based on a blend that mirrors the composition of R-407C, substituting R-1234yf for R-134a

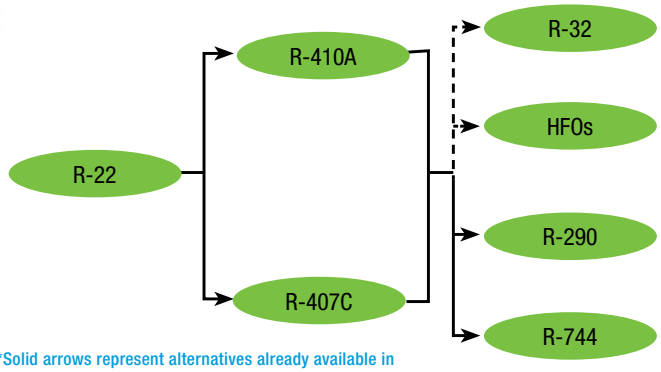
R-290

- Performs very similarly to R-22
- Charge size is about 40% of an R-22 unit
- Refrigerant costs less than R-22
- Successfully used in small units with <1 kg of refrigerant:
  - Largest Chinese AC manufacturer has commercialized room AC units using R-290
  - Portable units have been sold in Europe for years
- Use in low-charge units expected to increase globally, but use in more common applications (e.g., ducted split systems, non-ducted mini- and multi-splits) will require more time

HFC-32

- A major component of blend R-410A
- Higher capacity and efficiency than R-410A
- Investigated as a replacement for R-22, especially in Japan, China, and Indonesia

Refrigerant Transition in the Unitary AC End-Use*



*Solid arrows represent alternatives already available in the market for these systems; dashed arrows indicate those likely to be available in the future.

HFO-1234yf and HFO-1234ze[2]

- If used to replace R-410A, would require system redesign due to lower pressure
- Could be used in small and medium AC units
- Research is underway to identify lower GWP blends using these agents

Challenges to Market Entry and Potential Solutions

Some climate-friendly alternatives in the unitary AC sector face technical challenges, such as flammability and toxicity. Additional research is needed to identify appropriate substitutes for unitary AC equipment, particularly given the relatively recent and gradual transition from R-22 to HFCs.

Alternative	Challenges to Market Entry	Potential Solutions
R-290	•High Flammability – Challenges for Use in Equipment with a High Refrigerant Charge •Safety Code Restrictions •Liability Concerns	•Safety Devices •Secondary Refrigerant Loop for Larger Systems, if Performance Penalties Can Be Avoided •Leak Testing and Pump Down Circuits •Standards, Service Procedures, Training, and Education •Engineering Design, Research, and Development
R-744	•Acute Toxicity/Safety Risks •High Operating Pressure •Low Critical Temperature; Can Lead to Low Efficiency	•Engineering Design •Training and Education •Research Is Being Conducted to Overcome Safety and Efficiency Barriers
R-32	•Low Flammability •High Pressure •Has Not Been Submitted to EPA's Significant New Alternatives Policy (SNAP) Program	•Engineering Design – Limited Technical Challenges •Research and Development •Regulatory Approval
R-1234yf, R-1234ze	•Low Flammability •Relatively Low Pressure That Would Require Significant System Redesign	•Engineering Design •Use in a Blend with HFCs to More Closely Match the Performance of R-22 and R-410A •Research and Development

Future Outlook

Together, the suite of known alternative chemicals, new technologies, and better process and handling practices can significantly reduce HFC consumption in both the near and long term, while simultaneously completing the HCFC phaseout. Although much work remains to fully adopt these chemicals, technologies, and practices, and some unknowns still remain, the industries currently using HCFCs and HFCs have proven through the ODS phaseout that they can move quickly to protect the environment.

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[1] The four fact sheets in this series (October 2010) cover domestic refrigeration, commercial refrigeration, motor vehicle air conditioning, and unitary air conditioning. These four end-uses represent about 85% of HFC consumption in the refrigeration/AC sector. The remaining HFC consumption in the refrigeration/AC sector comes from other end-uses including chillers, cold storage, industrial process refrigeration, and refrigerated transport. Any service-related consumption is attributed to the specific end-use.

[2] HFOs (hydrofluoro-olefins) are unsaturated HFCs. HFO-1234yf refrigerant is also commonly referred to as HFC-1234yf or R-1234yf, as it is referred to in the remainder of this fact sheet. HFO-1234ze is also commonly referred to as HFC-1234ze or R-1234ze.

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