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Other matters

Making the transition to low-global-warming-potential alternatives in commercial refrigeration

Note by the secretariat

The annex to the present note contains information submitted by the United States of America about making the transition to low-global-warming-potential alternatives in commercial refrigeration. It has been reproduced as received, without formal editing.

* UNEP/OzL.Pro.22/1.

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Annex

TRANSITIONING TO LOW-GWP ALTERNATIVES IN COMMERCIAL REFRIGERATION

Background

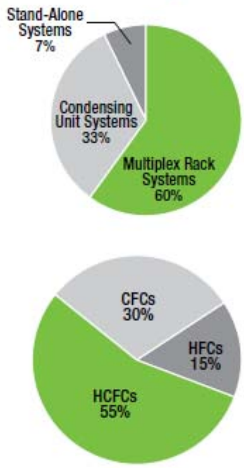
This fact sheet[1] provides current information on low-Global Warming Potential (GWP) alternatives in newly manufactured commercial refrigeration equipment relevant to the *Montreal Protocol on Substances that Deplete the Ozone Layer*. Commercial refrigeration includes refrigerated equipment found in supermarkets, convenience stores, restaurants, and other food service establishments. In 2006, there were an estimated 530,000 supermarkets worldwide, containing roughly 546,000 metric tons of refrigerant.

Due to their large charge sizes, the multiplex rack systems typically used in these supermarkets account for the greatest percentage (60%) of refrigerant installed in the commercial refrigeration sector. HCFCs account for the majority of refrigerant (55%). The figures below graphically present the distribution of the global commercial refrigerant stock by system and refrigerant type in 2006. Equipment in this end-use typically lasts approximately 15–20 years. Equipment can be broadly categorized as either self-contained or remote refrigeration systems, as explained further below.

Stand-Alone or Self-Contained Refrigeration Systems

- Integrate all refrigerating components within their structures
- Low charge sizes (~0.15 kg)
- Most often contain HCFC-22, HFC-134a, or R-404A (a blend of HFCs)
- Estimated 32 million stand-alone units in use worldwide with an additional 20.5 million vending machines

Distribution of Global Commercial Refrigerant Stock by System and Refrigerant Type (2006)



Remote Refrigeration Systems

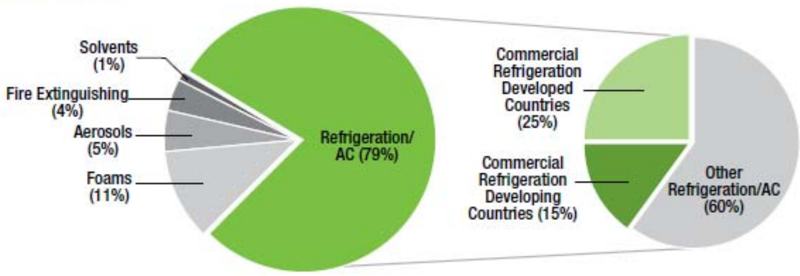
Condensing Unit Systems

- Consist of one or two compressors, one condenser, and one receiver assembled into the condensing unit system; linked to one or more display case(s) in the sales area through a piping network
- Most often contain R-134a, R-22, or R-404A
- R-407C, R-507, other HFC blends, and HCFC blends are also used
- Refrigerant charges vary in size from 0.5–20 kg
- Approximately 34 million systems are in use worldwide

Multiplex Rack Systems

- Remote refrigeration systems consisting of racks of multiple compressors contained typically in a machinery room; linked to multiple display cases in the sales area through extensive piping. Condensers are usually remotely located, such as on the roof above the machinery room.

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



Global HFC Consumption Total: 1,087 $MMTCO_2eq.$
Global Refrigeration/AC Total: 858 $MMTCO_2eq.$
Global HFC Consumption Commercial Refrigeration: 346 $MMTCO_2eq.$

- Various designs exist: direct (also called direct expansion) is most common and circulates refrigerant from a central machinery room to the sales area; indirect (also called secondary loop) systems chill an intermediate fluid, which is circulated from the refrigerant-containing equipment to the display cases.
- R-22 is the most widely used refrigerant in multiplex rack systems
- CFC-12, R-502, R-404A, R-507A, R-407A, and several HCFC- and HFC-based blends designed for retrofit of existing CFC or HCFC installations are also used
- Charge size ranges from 300–3,000 kg, depending on the size of the supermarket and on design (e.g., pipe layout and operating characteristics)

Currently, the commercial refrigeration sector accounts for approximately 32% of global HFC consumption, or 40% of HFC consumption in the refrigeration/AC sector. Developing countries account for an estimated 131 million metric tons of carbon dioxide equivalent ($MMTCO_2$eq.) or 38% of the global HFC consumption in this end-use today.

Alternatives and Market Trends

Many design strategies exist today to reduce the amount of refrigerant needed while at the same time reducing the likelihood of leaks and mitigating risks if using a flammable or toxic refrigerant. Although most of these advanced refrigeration systems still rely on HFC refrigerants, they have great potential for drastically reducing HFC consumption in multiplex rack commercial refrigeration systems. In addition, a number of climate-friendly alternatives to CFC/HCFC/HFC refrigerants are, or will become, available for use in commercial refrigeration applications. Alternatives available today include hydrocarbons—isobutane (R-600a), propane (R-290), and propylene (R-1270)—ammonia (R-717), and carbon dioxide (R-744). Other alternatives, such as new HFCs/HFOs, are also likely to enter the market in the coming years.

Advanced Refrigeration System Designs

- Distributed systems[2] and indirect systems[3] have been available for more than 20 years
  - Distributed systems can lower refrigerant charge by 30–50%
  - Indirect systems can lower refrigerant charge by 50–80%
- In the European Union, indirect systems are now the norm; in the United States, distributed systems account for 40% of new installations, and indirect systems are gaining significant market share

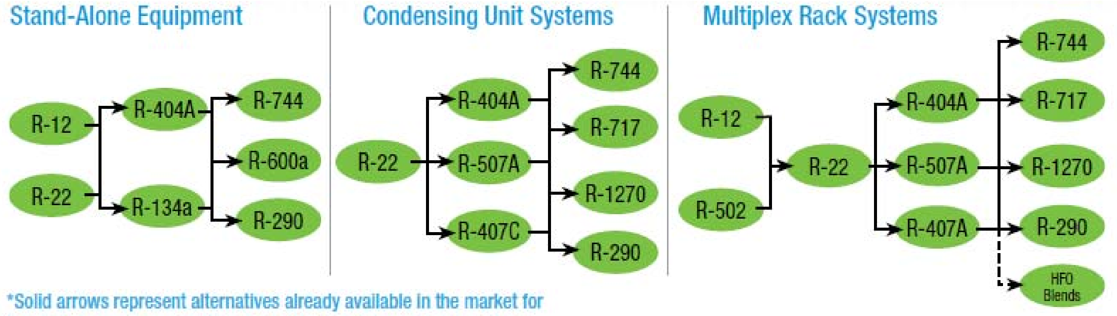
Refrigerant	GWP	ODP[a]
R-12	10,900	1
R-502	4,657	0.334
R-507A	3,985	0
R-404A	3,922	0
R-407A	2,107	0
R-22	1,810	0.055
R-407C	1,774	0
R-134a	1,430	0
R-32	675	0
R-290 (propane)	3.3	0
R-600a (isobutane)	3	0
R-1270 (propylene)	1.8	0
R-744 (CO_2)	1	0
R-717 (ammonia)	0	0

[a]ODP = ozone depletion potential

Australia's Experience

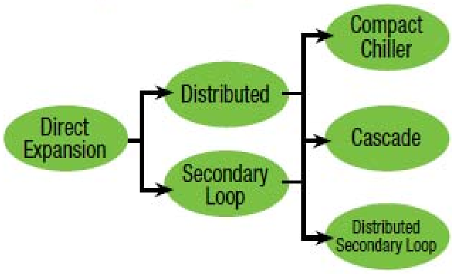
Australia's major supermarkets have committed to reducing commercial refrigeration emissions through lower GWP refrigerants, advanced refrigeration technology, and innovative store designs. The supermarket chains determined that half of their emissions are from refrigeration systems. Losses from HFC refrigerants account for a significant portion of these emissions. Supermarkets are incorporating CO_2 cascade and transcritical refrigeration systems to meet their target reductions in CO_2eq. emissions. Shifting from HFCs to CO_2 can reduce the carbon footprint of supermarkets by 25%. Since 2008, at least 23 stores have implemented this new technology. Australia has evaluated the benefits of new technologies and provided assistance to update supermarket refrigeration equipment.

Refrigerant Transition in the Commercial Refrigeration 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.

System Design Transition in Multiplex Rack Systems*



- Distributed secondary loop,[4] compact chiller,[5] and cascade[6] designs were introduced recently
- Systems often use HFC refrigerants but can also use natural refrigerants (e.g., hydrocarbons, ammonia)

Hydrocarbons

- Primarily used in many northern European countries including Denmark, Germany, Sweden, and the United Kingdom
- R-290 and R-1270 are used in condensing unit systems produced in northern Europe, as well as in indirect multiplex rack systems as a primary refrigerant
- A growing proportion of self-contained (stand-alone) equipment now uses propane (R-290) instead of R-134a
- Several large-scale beverage companies have begun producing beverage dispensing fountains with isobutane (R-600a)

R-717

- Introduced as a primary refrigerant in indirect systems in northern European countries and Africa

R-744

- Many companies producing larger vending machines use R-744 in lieu of R-134a (e.g., Sanyo)
- Used as refrigerant in condensing unit systems and multiplex rack systems, mainly in Europe
- Used as the heat transfer (i.e., secondary) fluid in indirect systems in some countries, such as the United States
- Used in the low-temperature loop in cascade systems (often with small amounts of R-134a or R-717 in the high-temperature loop)

HFO Blends

- New refrigerant blends (e.g., with HFC-32 and/or HFOs) are being developed and may become available in multiplex rack refrigeration systems in the next few years

Challenges to Market Entry and Potential Solutions

Several challenges have limited the transition to climate-friendly alternatives in this end-use. The following table summarizes the challenges associated with the various alternatives as well as potential solutions to overcoming them.

Alternative	Challenges to Market Entry	Potential Solutions
Advanced Refrigeration System Designs	• Technician and Operator Experience • Energy Efficiency Concerns	• Training and Education • Standards and Service Procedures • Case Studies and Operational Guidelines
Hydrocarbons	• Highly Flammable • Safety Code Restrictions • Liability Concerns	• Safety Devices • Standards and Service Procedures • Training and Education
R-717	• Toxic and Slightly Flammable • Building and Fire Code Restrictions	• Engineering Design • Standards and Safety Regulations • Revisions to Existing Codes
R-744	• Safety Risks • High Operating Pressure	• Engineering Design • Training and Education
HFO Blends	• Market Availability	• 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 there is much work to do 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.

References

Center for Sustainable Production and Consumption (C-SPAC). 2005. "Ecofridge: Make the Right Choice Now." *Consumer Unity & Trust Society (CUTS).* Available online at: http://www.cuts-international.org/sc98-1.htm. Accessed August 19, 2010.

Frigrite. "Woolworths Control Temperature Case Supply Agreement Executed." July 20, 2009. Available online at: http://media.wotnews.com.au/asxann/00969994.pdf. Accessed September 30, 2010.

GTZ-Proklima International. 2010. "Conversion of Supermarket Refrigeration Systems from F-Gases to Natural Refrigerants." Funded by Federal Ministry for Environment, Natural Conservation, and Nuclear Energy.

International Panel on Climate Change (IPCC). 2007. "Climate Change 2007: The Physical Science Basis." Contribution of Working Group I to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change. Solomon, S., D. Qin, M. Manning, Z. Chen, M. Marquis, K.B. Averyt, M. Tignor, and H.L. Miller (Eds.). Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA. September 2007. Available online at: http://www.ipcc.ch/publications_and_data/ar4/wg1/en/contents.html. Accessed September 30, 2010.

Kauffeld, Michael. 2008. "Trends and Perspectives in Supermarket Refrigeration." Available online at: http://www.ammonia21.com/files/papers/trends-perspectives-supermarket-refrigeration.pdf. Accessed September 30, 2010.

Mahone, D. and Roberts, J. 2008. "White Paper on Approaches to Reducing Leakage and Improving the Performance of Supermarket Refrigeration Systems." Prepared by Heschong Mahone Group, Inc. and CTG Energetics, Inc. for the California Energy Commission.

Palmer, Daniel. 2008. "Green supermarkets – the way of the future." *Australian Food News.* June 5, 2008. Available online at: http://www.ausfoodnews.com.au/2008/06/05/green-supermarkets-the-way-of-the-future.html. Accessed September 30, 2010.

Technology and Economic Assessment Panel (TEAP). 2009. "Task Force Decision XX/8 Report, Assessment of Alternatives to HCFCs and HFCs and Update of the TEAP 2005 Supplement Report Data." May 2009. Available online at: http://www.unep.ch/ozone/Assessment_Panels/TEAP/Reports/TEAP_Reports/teap-may-2009-decisionXX-8-task-force-report.pdf. Accessed September 30, 2010.

U.S. Environmental Protection Agency (EPA). 2010. "Overview on Commercial Refrigerants: where are we headed?" Presented by Jeremy Arling, U.S. EPA; Dave Godwin, U.S. EPA; Ron Vogl, Honeywell; Stephen Speltzer, Arkema; Nick Strickland, DuPont; Scott Koerper, Mexichem Flour; and David Callendar, ICOR International; at the April GreenChill Webinar. April 29, 2010. Available online at: http://www.epa.gov/greenchill/events.html. Accessed September 30, 2010.

U.S. Environmental Protection Agency (EPA). 2006. "Global Mitigation of Non-CO_2 Greenhouse Gases." June 2006. Available online at: http://www.epa.gov/climatechange/economics/downloads/GlobalMitigationFullReport.pdf. Accessed September 30, 2010.

Woolworths Limited. 2008. "Environmental Sustainability." *Woolworths Limited Corporate Responsibility Report 2008.* Available online at: http://crreport08.woolworthslimited.com.au/climate_change.php. Accessed September 27, 2010.

[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] Distributed systems use an array of separate compressor racks located near the refrigerated cases rather than having a central compressor system.

[3] Indirect systems use a chiller to cool a secondary fluid that is then circulated throughout the store to the cases and coolers.

[4] Distributed secondary systems combine secondary loops with the typical distributed design.

[5] Compact chiller versions of an indirect system rely on a lineup of 10–20 units, each using approximately 4–7 kg of refrigerant.

[6] Cascade systems use a compressor to raise the low-temperature coolant (often CO_2) from low-temperature conditions up to an intermediate temperature while a separate refrigerating system uses a different refrigerant to condense the coolant.

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