2018 RESEARCH HIGHLIGHT IN MANUFACTURING ANALYSIS

End Uses of Advanced Refrigerants

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SNAPSHOT:
Understanding global refrigerant consumption will promote adoption of advanced refrigerants across a spectrum of industries and end-uses.

- Hydrochlorofluorocarbon (HCFC)-22 is the most widely produced fluorocarbon globally and is likely to be produced in large quantities for the near future.
- Refrigerants are used in large quantities for more than just cooling. Foam production, aerosols, fire suppression, and chemical production are important end uses of these materials.
- Non-fluorinated refrigerants play a major role in applications outside of vapor compression systems.
- Even within vapor compression applications, there are market segments (i.e., residential refrigerators, mobile air conditioning) where the use of advanced refrigerants is well established already and has a sizeable market share.

CEMAC
Clean Energy Manufacturing Analysis Center

Refrigerants are used in a wide range of heating, ventilation, air conditioning, and refrigeration (HVAC&R) applications, as well as chemical processing, foam blowing agents, aerosols, chemical solvents, and fire suppression. Understanding the global refrigerant market and trends is an important component of current efforts to transition toward lower GWP refrigerants. This fact sheet estimates global refrigerant consumption by application for 2010–2017.

The National Renewable Energy Laboratory (NREL), in partnership with Oak Ridge National Laboratory, under the Clean Energy Manufacturing Analysis Center (CEMAC) umbrella, assessed the current state of existing and advanced refrigerants for major end-use applications. This work supplements other U.S. Department of Energy (DOE) efforts to support research activities on refrigerants and their applications, including a refrigerant research and development roadmap and outlook into global air-conditioning markets (Goetzler et al. 2014, 2016).

Within each end-use category listed in Table 1, many different refrigerants are used. Table 1 provides quantitative use estimates for the most common refrigerants, disaggregated by end-use category. This includes the three classes of fluorocarbon refrigerants: hydrochlorofluorocarbons (HCFC), hydrofluorocarbons (HFC), and hydrofluoroolefins (HFO) as well as hydrocarbon and other natural refrigerants.

HCFC-22 has the highest production of any fluorocarbon refrigerant, even as it is being phased out in developed countries. Considering emissive uses only, HCFC-22 is used in quantities that are comparable to those of the individual hydrocarbons used in aerosols. Approximately half of the total HCFC-22 production is for non-emissive uses in chemical production, most notably as a feedstock for polytetrafluoroethylene (PTFE).

Consumption as a chemical precursor (feedstock use) is an important, but sometimes overlooked, use of several refrigerants, primarily HCFC-22, HCFC-142b, and hydrofluorocarbon (HFC)-152a. The use of HCFCs and HFCs as chemical feedstocks is not prohibited by international agreements because the chemicals are never released into the atmosphere. Therefore, substantial production capacity of HCFCs and HFCs for feedstock use will likely continue into the foreseeable future.

Aside from HCFC-22, HFC are dominant fluorocarbon refrigerants currently in use. HFO refrigerants are the newest class of fluorinated refrigerants; consumption is small now but is a growing part of the global market.

There are two major refrigerant chemical end uses where hydrocarbons are the dominant refrigerant: foam blowing agents and aerosols. The most common foam blowing agents are pentanes, while aerosols typically use propane or butane. The importance of hydrocarbons in these areas is likely to increase as regulations reduce the availability and/or increase the cost of existing fluorocarbons.

The global refrigerants market is large, complex and is projected to grow rapidly. Understanding end uses and the types of refrigerants that are used is important for improving refrigerants to most efficiently meet this growing market demand.

Table 1. Annual End Uses of Major Refrigerants in North America, European Union, China, and Japan in ktons,[a] Including Quantities Used in Blends

Refrigerant	Polymer Precursor	Refrigeration & A/C	Foam Blowing Agents	Aerosols	Solvents	Fire Suppression
HCFC-22	360	248–400	34	-	-	-
HCFC-141b	-	-	60	-	5	-
HCFC-142b	106	6	11	-	-	-
HFC-32	-	157	-	-	-	-
HFC-125	-	143	-	-	-	0.4
HFC-134a	-	190–240	70	-	-	-
HFC-152a	50	17	16	38	-	-
HFC-245fa	-	-	28–62	-	-	-
HFC-143a	-	71	-	-	-	-
HFC-365mfc	-	1	8	-	-	-
HFC-227ea	-	-	-	-	-	0.6
HFO-1234yf	-	15–30	-	-	-	-
HFO-1234ze	-	<1	1–4.5	Unknown	-	-
HFO-1233zdE	-	<1	4	-	-	-
HFO-1336mzz	-	Neg	Neg	-	-	-
Pentane (R-601c)	-	-	355	-	-	-
Carbon Dioxide (CO_2) (R-744)	-	70–80	15	52	-	-
Propane (R-290)	-	37–46	-	420	-	-
Ammonia (R-717)	-	9–26	-	-	-	-
Isobutane (R-600a)	-	6–11	-	420	-	-
n-butane (R-600)	-	-	-	420	-	-
Total[b]	516	970–1,228	610–649	1,350	14	13

[a] Greenpeace 2012; Charlie Hon, True Manufacturing, personal communication, April 2017; Clodic et. al 2010; IHS 2014a, 2014b; BSRIA 2015; Building Green 2010; Business Wire 2016; Transparency Market Research 2016; Grandview Research 2016; CNCIC Consulting 2015; Shecco 2012, 2013, 2015, 2016; Hella 2011; Chemours 2016; EJARN 2015a, 2015b; Godwin, Van Pelt, and Ferenchiak 2014; Eurostat 2017; EPA 2016

[b] Includes minor refrigerants not listed here; rows may not sum to the total.

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NREL/BR-6A20-72250 • Revised April 2019

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