TECH TIP

A Case for Natural Refrigerants: An Environmental Point-of-View

What is a natural refrigerant? The American Society of Heating, Refrigerating and Air-Conditioning Engineers, Inc.[1] defines a natural refrigerant as a "range of organic and inorganic compounds suitable for use in a variety of refrigeration and air conditioning system applications." Also, "Natural refrigerants occur in nature's biological and chemical cycles without human intervention. These materials include ammonia, carbon dioxide, natural hydrocarbons, water and air." The focus in this TechTip is a comparison of the environmental compatibility of natural vs. synthetic refrigerants.

Global Warming Potential (GWP) is a term used to rate the potential for a substance to contribute to climate change. CO_2 is used as the "base value" and is rated with a 1 GWP rating. This rating represents the amount of heat absorbed by one (1) ton of CO_2 in an equivalent time frame. A GWP rating greater than 1 indicates that the substance absorbs more heat than the equivalent weight of CO_2 within the same time. Similarly, a GWP less than 1 indicates that a substance absorbs less heat within the same time.

Ozone Depleting Potential (ODP) is another metric used to measure the impact of a chemical on the environment. J.M. Rodriguez defines ODP in *Treatise on Geochemistry* (2007) as "a measure of the effectiveness of a given compound in removing ozone, relative to a standard compound, which is taken to be CFC-11"[2]. In other words, ODP is the ratio of global loss of ozone due to the given substance to the global loss of ozone due to CFC-11 of the same mass. Trichlorofluoromethane (R-11 or CFC-11) is used as the "base value" of 1.0 ODP. Most compounds are below 1.0 ODP, which is why both the GWP and ODP values are pertinent in evaluating the environmental sustainability of compounds.

What does this mean? According to the tables below[3] (reformatted to fit this publication), there are several environmentally compatible refrigerants that, if released into the atmosphere, have minimal impact on the environment. Meaning, they absorb heat energy (which is damaging to the ozone layer and contributes to climate change) equivalent to or less than CO_2 in the same quantities. While some may be more flammable or more toxic (topic saved for another TechTip), the environmental impact of synthetic refrigerants is estimated at thousands of times more impactful than CO_2.

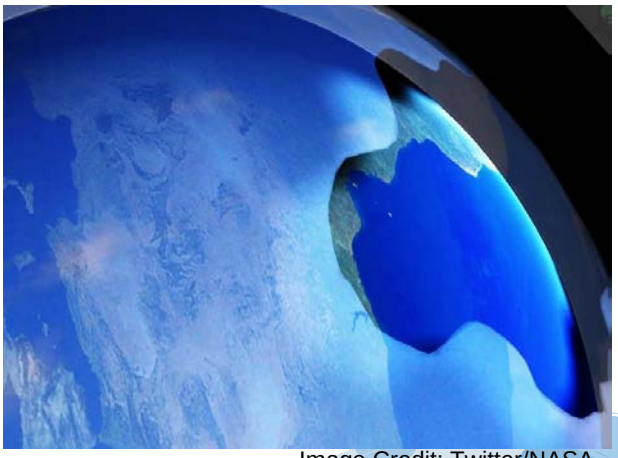

Image Credit: Twitter/NASA

This is critical to decision-making for constructing new facilities / systems as well as upgrading or retrofitting older facilities / systems. It is even more significant when considering an environmentally aware generation, especially on the global platform. Environmental concerns have been on the rise for decades and continue to significantly contribute to business decisions, especially in certain parts of the United States. As more research is done on environmentally sustainable options, the use of natural refrigerants regularly emerges as the better choice.

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Natural Refrigerants	ODP	GWP	Flammability	Toxicity
Ammonia (R717)	0	0	1	3
Carbon Dioxide (R744)	0	1	0	0
Propane (R290)	0	3.3	4	2
Isobutane (R600)	0	3	4	1
Air (R729)	0	0	0	0
Water (R718)	0	0	0	0

Synthetic Refrigerants	ODP	GWP	Flammability	Toxicity
Freon-12 (R12)	1	10,900	0	0
HCFC-22 (R22)	0.05	1,810	1	2
1,1,1,2-Tetrafluoroethane (R134a)	0	1,430	0	1
Freon 404A (R404)	0	3,922	0	1
Freon 507 (R507)	0	3,985	0	2

With the recent phasing out of hydrochlorofluorocarbons (HCFCs), starting in California and making its way around the country, design engineers, owners, and managers are considering not only the environmental impact of the refrigerants they are using, but the business sustainability of the chosen refrigerant(s) as well. How could the environmental impact of these systems change the way refrigeration systems are designed? Will the industry be facing another ban on additional synthetic refrigerants in the future? Are these synthetic refrigerants “innovative” or do they present potential additional business and operational complications for the future? Specifically in California, synthetic refrigerants are regulated to the same approximate degree natural refrigerants. Is there a cost-benefit to either type of refrigerant simply because the product costs less if the regulatory burden is equivalent?

Natural refrigerants have stood the test of time. Natural refrigerants have been utilized since artificial refrigeration systems were invented. They have been, and continue to be, effective substances for their purpose. In addition, operator, maintenance, and engineering training is well-established and well-implemented as a standard. Most importantly, the environmental and health impacts are well known for these refrigerants, which makes them more predictable and more dependable on how they will react or how they should be treated in emergency situations.

Resources

1 https://www.epa.gov/sites/production/files/documents/ASHRAE_PD_Natural_Refrigerants_2011.pdf

2 Treatise on Geochemistry – Ozone Depletion Potential

3 IIAR Green Paper (must be a member to access)

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About the Author:

Ms. Smith is a Senior Engineer and has been with Risk Management Professionals for over 7 years. She is involved in a variety of activities associated with CalARP, NDEP CAPP, EPA RMP, and OSHA PSM compliance programs. She specializes in ammonia refrigeration, power generation, agriculture, water / wastewater treatment, and manufacturing industries.
Connect with Stephanie on LinkedIn