ASHRAE CONTRIBUTION TO SUSTAINABILITY IN REFRIGERATION

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Introduction

ASHRAE has a direct interest in refrigerant transitions because the operation of much of the HVAC&R equipment depends on refrigerants. ASHRAE contributed to the successful effort to phase out the ozone-depleting CFC and HCFC refrigerants, and it has a significant role to play in encouraging the proper and safe use of refrigerants going forward. ASHRAE plays an active role in the following areas: policy, research, standards, codes, guidelines, technology transfer, and education.

ASHRAE plays a major role in the development of voluntary standards and guidelines governing the application and use of all types of refrigerants. Other organizations adopt the technical requirements developed by ASHRAE into various codes and regulations. The most relevant ASHRAE standards dealing with refrigerants are ANSI/ASHRAE Standard 34, Designation and Safety Classification of Refrigerants (ASHRAE 2016b), ANSI/ASHRAE Standard 15, Safety Standard for Refrigeration Systems (ASHRAE 2016a), and ANSI/ASHRAE Position Document on Refrigerants and Their Responsible Use 6 ASHRAE Standard 147, Reducing the Release of Halogenated Refrigerants from Refrigerating and Air-Conditioning Equipment (ASHRAE 2013).

ASHRAE is unique among technical engineering societies in sponsoring extensive member-supported research programs. The research plan for the Society includes items to facilitate the application of lower GWP refrigerants, to investigate methods to reduce refrigerant charge in systems, and to improve system efficiency. For example, ASHRAE has been actively involved in several research programs to understand the safety implications and to develop mitigation plans for use of flammable and mildly flammable refrigerants (ASHRAE 2016c). These results are beneficial in the development of safety standards to enable the transition to the next generation of refrigeration technology. Some of this research has been performed jointly with the Air-Conditioning, Heating, and Refrigeration Institute (AHRI) and the United States Department of Energy (DOE).

Responsible Selection and Use of Refrigerants

ASHRAE acknowledges that the use of HVAC&R systems has environmental consequences and ASHRAE is committed to making these systems sustainable. Because of the environmental impacts of refrigerants, ASHRAE holds to the principle that refrigerants should be used prudently to provide the best value to society.

ASHRAE sees that the selection of refrigerants and their systems must be based on a holistic analysis including energy efficiency and performance attributes, environmental impacts, employee and public safety, and economic considerations. A refrigerant should not be selected based on any one single factor such as GWP, operating pressure, flammability, etc. The wide range of HVAC&R applications and their requirements throughout the world necessitates a variety of refrigerants to meet these needs.

To limit direct and indirect impacts on the environment, emissions of refrigerants should be reduced through research, education, improved design, manufacturing/construction of equipment, field commissioning, maintenance procedures, decommissioning, and enforcement of applicable standards and regulations. Where possible, refrigerants should be safely recovered for reuse, recycle, reclamation, or destruction during service or at the end of the life of the equipment. Refrigerant inventory and management programs should be implemented to closely track refrigerant use.

ASHRAE is committed to supporting research to develop and advance HVAC&R technologies and practices that minimize refrigerants' impacts on the environment while enhancing performance, cost effectiveness, and safety. In addition, developing and revising guidelines and standards that improve energy efficiency and safety and reduce refrigerant emissions is required. Nonetheless, supporting responsible refrigerant use is done via education, proper training and working with societies, universities, private industries, government agencies, and international organizations.

ASHRAE recommends efforts in several areas to support responsible use and design of refrigerants. Research and guidelines development in programs investigating and adopting lower GWP refrigerants. The research programs need to include an evaluation on refrigerant flammability to further understanding of the safety implications and mitigation techniques.

ASHRAE also recommends improving the design of equipment, to increase the energy efficiency of HVAC&R equipment, among all refrigerants, with reducing the leakages of refrigerants during installation, operation, maintenance, and decommissioning of any refrigeration system. Balancing safety, energy efficiency, cost and environmental impacts of all refrigerants using a consistent and comprehensive methodology through all systems is needed. Establishing programs of refrigerant recovery, reuse and safe disposal practices is crucial. Introduce training programs and certification on setting benchmarks and competences of good practices for specialists.

Furthermore, ASHRAE recommends development of regulatory guidelines and measures that promote the use of lower GWP refrigerants and energy efficient HVAC& R systems. This includes introducing procedures and guidelines by working with UNEP, to enable sustainable procurement policies that promote the deployment of a lower total system GWP refrigerants. Responsible use during commissioning, operating, and servicing HVAC&R systems should also be regulated.

Ammonia as a Refrigerant

Ammonia is an efficient and popular refrigerant due to its superior thermodynamic properties and low cost. Ammonia is environmentally benign, having zero GWP and zero ODP. It is hazardous when released in large quantities due to its toxicity. However, ammonia does exhibit a unique refrigerant characteristic due to its irritating odor. Persons exposed to an ammonia release will not voluntarily stay near concentrations that are health-threatening. Although ammonia will burn in a narrow range of high concentrations,

it is difficult to ignite and will not support combustion after the ignition source is withdrawn. Ammonia has an ASHRAE flammability class of 2L, low flammability.

Ammonia's use in the HVAC&R industry will increase as regulatory and code officials become informed of its relative safety. Applications for ammonia-based refrigeration systems include thermal storage systems, HVAC chillers, process cooling, air conditioning, winter sports, district cooling systems, heat pump systems, supermarkets, and convenience stores.

Ammonia is increasingly used in cascade refrigeration systems with carbon dioxide. In these systems, ammonia is used in the high-temperature stage to reject heat to the environment. Carbon dioxide is used in the low temperature stage to absorb heat from the load to be cooled, and to reject the heat to the ammonia high temperature stage. Such systems allow the use of ammonia in a wider range of applications, because the less hazardous carbon dioxide can be used in more locations, while the highly efficient ammonia can be kept in a central mechanical room or rooftop package. Ammonia is also used in conjunction with other secondary fluids, such as water or glycol, for the same reasons noted above.

While the benefits of ammonia as a refrigerant are well known, (high energy efficiency, zero ODP, zero GWP, low TEWI or excellent LCCP, self-alarming pungent odor) barriers to expanding its use into HVAC&R applications must be addressed. These barriers generally relate to human health and to ammonia refrigeration system installation cost. Ammonia reacts with copper in the presence of common contaminants such as air and water. Therefore, with the exception of some copper containing bronze alloys used in compressor and pump bearings, ammonia systems are constructed using aluminum, carbon steel, and stainless-steel components. Joints are most often welded, rather than brazed. A lack of technicians trained to understand, and handle ammonia refrigeration systems also presents a barrier to its implementation, especially in markets where ammonia has not traditionally been used.

ASHRAE encourages the continued use of ammonia for industrial and commercial refrigeration, food preservation, indirect space conditioning, heat pumps and other applications. ASHRAE participates in a variety of programs to promote the economic and environmental benefits of ammonia refrigeration and will continue to provide guidance for the proper design, safe use and management of risk.

Sustainable Refrigerated Facilities and Refrigeration Systems Guide

This guide is a good example of how ASHRAE provided guides that is useful to facility designers, refrigeration product owners, contractors, and operators for the building up of this facility, and finally regulators. The guide provides a full example for a food distribution centre refrigerated facility. Although much of this book focuses on design, it is also important to realize that achieving sustainability does not end with the design of the facility. The idea of sustainability must continue into the construction and ongoing operations and maintenance of the facility.

Likewise, as sustainability does not end with design, neither does sustainability begin with design. Sustainability begins with the specification and intent of the owner. This means that both the owner of the facility and the owner of the product that passes through the facility must engage to achieve sustainability. The design and operation of any refrigerated facility is a balance of several competing factors, including the following:

- Function: Does the facility maintain temperature or provide the required cooling in specified operating conditions?
- Safety: Is the facility safe to operate? This includes safety for operators, the host community, and the eventual consumers of products from the facility.
- Economic: Can the owner afford to build the facility and to operate it profitably?
- Environmental: Is the facility's impact upon the local, regional, and global environment minimal?
- Social: Does the presence of the facility contribute positively or negatively to its host community? This can include factors such as direct employment, increasing opportunities for local producers and contractors, and the aesthetics of the facility.

The purpose of this guide is to help the reader to evaluate their own specific circumstances which are more sustainable. The intent is not to provide a list of sustainable options that can be selected, but to introduce methods of which the readers can use for evaluating sustainability of the refrigeration system.

Conclusions

ASHRAE acknowledges that the use of HVAC&R systems has environmental consequences and ASHRAE is committed to making these systems sustainable. ASHRAE recommends the research on flammability of refrigerants and their safety when applied in refrigeration systems to develop standards that can help on safety-use practice and training on low GWP refrigerants. ASHRAE also recommends improving the design of equipment, to increase the energy efficiency of HVAC&R equipment, among all refrigerants, with reducing the leakages of refrigerants during installation, operation, maintenance, and decommissioning of any refrigeration system. Furthermore, ASHRAE recommends development of regulatory guidelines and measures that promote the use of lower GWP refrigerants and energy efficient HVAC& R systems. ASHRAE encourages the continued use of ammonia for industrial and commercial refrigeration, food preservation, indirect space conditioning, heat pumps and other applications, with safety considerations. ASHRAE's continued target to is further research on making the application of ammonia safer continue to provide guidance for the proper design, safe use and management of risk. ASHRAE is unique among technical engineering societies because it sponsors an extensive member-supported research program. In 2013-2014, the ASHRAE Board of Directors has approved funding for ASHRAE research projects and grant and aid payments of nearly $3 million, some of with in in alternative refrigerants like ammonia. Finally, ASHRAE has provided a guide for Sustainable Refrigeration to aid readers to evaluate their own specific circumstances which are more sustainable.