Recent Activities of the American Society of Heating, Refrigerating and Air Conditioning Engineers (ASHRAE) in Refrigerant Technology and Sustainability: Walking the Talk

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Introduction

Someone once said, "If we don't change direction soon, we'll soon get to where we're going."

Funny but true, particularly when it comes to protecting our environment. The entire built environment industry has been slow in coming to the realization that green, sustainable buildings must now become "business as usual." This is ironic given that our industry uses a tremendous amount of natural resources – over 50% of all energy consumed is by the built environment and, of that, the heating, ventilating and air conditioning (HVAC&R) systems account for 60% of the total use.

The American Society of Heating, Refrigerating and Air Conditioning Engineers (ASHRAE) has always made energy conservation and protection of the environment a top priority in our research, standards writing and publication of information. However, ASHRAE has taken a renewed and increased emphasis on sustainability in all of our activities. This year, for example, we have begun work on Standard 189P - High Performance Green Buildings in cooperation with the US Green Building Council (USGBC) and the Illuminating Engineering Society of North America (IESNA). The first draft of that Standard is already out for public review. Work has also started on Standard 191P – Water Conservation, which is intended for use and adoption around the world. And, the latest version of our Standard 90.1 for Energy Conservation in Commercial Buildings, which is used as the basis for building energy codes in most of the United States, will be issued later this year. The 2004 version of this Standard provided significant energy usage reductions over the 2001 version, and this latest version will offer continued improvement.

ASHRAE last year began publishing the *Advanced Energy Design Guide* series. Each of these publications is targeted at a specific building type – office buildings, retail stores, warehouses, schools, etc., and the information included in each one provides building designers with procedures for reducing energy usage in their buildings at values of at least 30% over 90.1 building code requirements. The next version of this series will provide guidelines for reducing energy usage by 50% over current codes.

But, the theme of this conference is focused on refrigerants and refrigeration technology. Refrigerants are a vital part of the built environment and are used in many types of products and systems worldwide; and ASHRAE's efforts for improving sustainability and environmental protection also include much work in the areas of refrigerant technologies.

Standards

ASHRAE continues to refine its Standards related to the classification and use of refrigerants. The new versions of two of our major refrigeration standards are being updated and published this year. ASHRAE Standard 15, *Safety Standard for Refrigeration Systems*, will contain modifications to enhance the safety of pressure protection designed for relief internal to systems. Standard 15 also contains an expanded list of refrigerants and the corresponding properties required for determining compressor relief capacity.

Also being revised this year is ASHRAE Standard 34, *Designation and Safety Classification of Refrigerants,* which will contain some 23 new addenda. Among the key changes are the addition of 13 new refrigerants; revision of the refrigerant flammability classification and inclusion of details on the required flammability and fractionation testing procedures; and the addition of toxicity values for single-compound refrigerants.

In the area of international standards, ASHRAE is very involved with the International Organization of Standardization (ISO) technical committee 86, ISO/TC 86, Refrigeration and Air-Conditioning, which deals with refrigerants. Their ISO Standard, *Refrigerants – Designation system,* currently is under revision to include a safety classification system. The ISO safety classification system will differ from the current ASHRAE system in Standard 34 by the inclusion of a new test method to determine the burning velocity of a refrigerant. Also, when the revision of ISO 817 is published, ISO will begin to accept refrigerant applications. A maintenance agency will be established within ISO/TC 86 to accept new refrigerant applications and process the designations and classifications in coordination with ASHRAE Standard 34.

Publications

Perhaps the most well known of ASHRAE's many publications is our Handbook series. The *ASHRAE Handbooks* consists of four volumes with one new volume issued each year. The latest edition of the *Refrigeration Volume* was published last year in 2006. This new edition included, for the first time, guidance on the use of CO2 as a refrigerant. Work is already starting on the next *Refrigeration Volume*, to be published in 2010. We recently held a Handbook Improvement Workshop where a focus group of refrigeration practitioners developed recommendations for improving the *Handbook Refrigeration Volume*, and also reviewed some of the volume's individual chapters.

Some key points of discussion for the 2010 publication included:

- Adding a chapter on service safety, plus adding focused information in other chapters
- Expanding the information on CO2 refrigeration into a dedicated chapter
- Defining sustainability for refrigeration systems, and encouraging new content development on the topic

These will be discussed at ASHRAE's upcoming meeting in June.

Research

ASHRAE currently provides around $3,000,000 per year for basic research in the sciences of heating, air conditioning and refrigeration. Many of these projects are for research in the areas of refrigerants and refrigerant technology. Here is a description of some of the innovative projects related to refrigerants that are currently active or waiting for funding.

Carbon Dioxide Research

Carbon dioxide continues to be evaluated as a more ecologically benign alternative to hydro fluorocarbons (HFCs). CO2 has zero ozone depletion potential, and, while CO2 is considered to be a "greenhouse gas", in its use as a refrigerant it has significantly lower global warming potential compared to most HFCs. Three projects that are either out for bid
now, or are getting ready for solicitation of bids, deal with the use of CO2 as a refrigerant. These projects are:

- **RTAR-1409,** *Stability of Candidate Lubricant for CO2 Refrigeration*
- **RTAR-1446**, *Physical Properties Measurements of CO2 / Lubricant Mixtures*
- **TRP-1394,** *Study of Carbon Dioxide Condensation in a Chevron Angle Plate Geometry Heat Exchanger*

The first of these projects, RTAR-1409, will generate stability and compatibility data with CO2/lubricant systems at reasonable CO2 concentrations and at temperatures high enough to accelerate kinetically slow reactions. An additional objective of this project is to develop and document an experimental protocol to conduct these studies. Testing is to be conducted at elevated temperature and pressure. Current test methods that use sealed glass tubes will not survive these aging conditions when charged with CO2/lubricant pairs (pressure too high). Therefore, this research will also most likely lead to new test vessels and a new standard that can be used in other studies

RTAR-1446 will study the physical properties of a number of CO2 lubricant mixtures to obtain an accurate body of data to characterize the solubility, miscibility, liquid density and viscosity for these mixtures over the range of interest for air-conditioning and refrigeration systems. Since very little information is available for CO2/lubricant mixtures, this project will cover a large scope of lubricants for study in the following families: napthenic and paraffinic mineral oils, polyalkylene glycols, linear and branched polyol esters, and alkyl benzenes. The intent of this research is to understand the effect of
dilution above and below the critical point for CO2 systems and give Engineers the information they need to design these systems for the future.

The third CO2 Research Project, TRP-1394, studies the use of plate and frame heat exchangers for CO2 refrigerants. Plate heat exchangers are used on a regular basis in industry. There is a limited amount of heat transfer and pressure drop data available for a few halocarbons in this application; however, no correlation or design information is currently available for carbon dioxide condensation in the open literature. The proposed project would help understand the physics of condensing phenomenon of carbon dioxide in complex geometries such as plate heat exchangers and also help in optimizing such exchangers for industrial applications.

Ammonia Research

Another group of current projects provide research into the design of heat exchangers and piping arrangements for ammonia systems. As you know, ammonia is a primary refrigerant in the industrial refrigeration industry. The results of this new research will benefit international food and beverage industries (refrigeration end-users), refrigeration system designers, and contractors. The ease of use of these new, practical tools should lead to their rapid adoption by the refrigeration industry. The ammonia related research projects are:

- **URP–1444,** *Experimental Evaluation of Two-Phase Pressure Drops and Flow Patterns in U-Bends for R-134a, R-410a, and Ammonia*
- **RP-1327**, *Flow Pattern and Pressure Drop Determination for Two-Phase Ammonia Flow in Various Pipes*
- **RP-1352**, *Evaporation in Flooded Corrugated Plate Heat Exchangers with Ammonia and Ammonia/Miscible Oil*

Project URP-1444 concerns the important problem of two phase, frictional pressure drops and flow patterns in the vertical and horizontal U-bends connecting horizontal straight tubes, a geometry typical of evaporator and condenser coils. The experimental results for ammonia use from this research will be added to the data already collected within the framework of an ongoing European Union funded project named EFROST that began on September 1, 2005.

RP-1327 will determine the minimum velocity for safe liquid transport in large diameter ammonia risers. The minimum velocity will be determined for a number of saturation temperatures, riser diameters and liquid overfeed ratios. In addition, the pressure loss in the riser must be determined at and above the minimum velocity.

The final ammonia related research project, RP-1352, will, first, survey and compile the known literature concerning evaporation of ammonia in flooded plate heat exchangers, and, then, set up and perform appropriate experiments to quantify the effects of plate geometry, operating parameters and oil concentrations on heat transfer coefficients.

Other Research

Two other current ASHRAE research projects of note are **URP – 1476,** *Woven Compressor Enabling Economic and Scalable R718 Chillers,* which is studying compressor designs that would potentially lead to the common use of water (R718) as a natural refrigerant; and
RP-1308, *Identification and Evaluation of Working Fluids for High Temperature Heating Applications (Replacement for R-114)*, which is evaluating the use of natural refrigerants (water, ammonia, and CO2) for use in high temperature heat pumps.

"Walking the Talk"

ASHRAE's mission is to provide research, technical information and educational programs to advance the arts and science of heating, air conditioning and refrigeration. But this year we have a unique opportunity to practice what we preach, or as our President, Terry Townsend, likes to say "Now we can walk the talk". This fall, ASHRAE will begin renovating its headquarters in Atlanta, Georgia as a sustainable building, and the entire project will become a "living lab." We won't be just another office building, and the building won't just be one of many outwardly similar sustainable buildings. In the new headquarters, we will be putting to the test all of the work members like you do every day. The building itself will support ASHRAE research as a rich resource of data on building, system and equipment performance; a demonstration of performance monitoring; and space for limited "real world" investigations. Anyone will be able to see how the building is performing in real time by logging into the ASHRAE website.

As currently designed, ventilation requirements for the entire building will be handled by a DX dedicated outdoor air system. In order to take advantage of the waste heat from the compressors, this outside air unit will use hot gas refrigerant for enhanced desiccant activation (when needed) instead of heat from virgin electric power.

The first floor of the building, which will include a new training center, will feature a variable refrigerant flow system for temperature control. Variable refrigerant flow (VRF) systems have been in wide use in Japan and also here in Europe for almost 25 years, but the type of system is just now being accepted and more widely used in the United States. ASHRAE is excited to be using this innovative technology in our headquarters.

On the second floor of our building temperature control will be provided by a system of water source heat pumps. These heat pumps will be connected to a system of geothermal wells which will be located under the parking lot if the building which will provide an efficient and sustainable energy source.

ASHRAE is very excited about this renovation, and we look forward to sharing the building's progress and results with you as construction progresses.

Closing

Sharing of knowledge is a powerful thing. As some of us at ASHRAE work together to create a more energy efficient headquarters, I am reminded that perhaps the best way to solve the world's energy and climate problems is by working together as well. That is why we are joined here today – members of the building environment industry from around the world. We have come together to gain technical knowledge and to share it. As we do, it is important to remember that the source of this knowledge is the summation of our collective efforts. That is why conferences, such as this one, are so critical to the success of our mission - improving the quality of life for people around the world.

With the push to build and operate buildings the best we can, we must step forward in a bold and effective manner to provide a sustainable future. We are the pioneers in the reawakening of our industry to a new sustainable world.

Thank you.