May 2012

Condenser

Published by the International Institute of Ammonia Refrigeration
as a service to its members and the Industrial Refrigeration Industry

iiar®
International Institute of
Ammonia Refrigeration

EZ-SRV Relief Valve

REVOLUTIONARY CARTRIDGE DESIGN

HANSEN

REFRIGERATION SOLUTION EXPERTS

HANSEN TECHNOLOGIES CORPORATION | 800.426.7368 | SALES@HANTECH.COM | WWW.HANTECH.COM

evapco®

eco-PMC

Evaporative Condensers

Available with Optional *Pulse~Pure*® or SMART SHIELD™ Water Treatment Systems

SAVE WATER AND ENERGY!

Eco-Condensers are the Ideal Solution for:

- Lower Water Usage
- Reduced Energy Consumption
- Ice Management
- Higher Dry Bulb Switchover Temperature

EVAPCO, Inc. • P.O. Box 1300 • Westminster, MD 21158 USA
Phone: **410-756-2600** • *Fax:* **410-756-6450**
E-mail: marketing@evapco.com • www.evapco.com

U.S. Green Building Council Member

IARW International Association of Refrigerated Warehouses

Member of iiar International Institute of Ammonia Refrigeration www.iiar.org

AHRI Air-Conditioning, Heating, and Refrigeration Institute

2013 Call for Technical Papers

The International Institute of Ammonia Refrigeration issued its annual "call for papers," in preparation for the 2013 IIAR Industrial Refrigeration Conference & Exhibition in Colorado Springs, Colorado, March 17–20.

The technical papers are a central part of the Institute's annual meetings, representing a vital exchange of information within the field and serving as a forum for technical experts, engineers and operations managers as they address important issues within the industry.

The role of IIAR in fostering an environment of collaboration "is one of the most important services we provide to our industry," said Marcos Braz, chair of IIAR's 2013 conference. "We depend on the involvement and active participation of IIAR members to move our industry forward, and presenting a technical paper is one of the best ways to take an active role in that evolution of ideas and technology."

IIAR is currently requesting proposals for technical papers, including Spanish-language technical papers. Abstracts that address any topic related to ammonia refrigeration are invited. However, papers that address specific topics will receive preferential consideration.

With the increased focus on broadening the reach of the IIAR into the international community, and the continuing need to examine reduction in ammonia charge and energy consumption, technical papers that address the improvement of safety and efficiency through design and innovation will receive special attention.

For a technical paper to be considered by IIAR, a paper proposal must be submitted and should include a 150 to 200 word abstract as well as a 50 to 75 word description of the practical applications of the paper's proposed contents. IIAR's proposal submission deadline for the 2013 conference is June 1, 2012.

Technical paper abstracts will be chosen for development by June 15th, and authors will be asked to commit to a development timeframe that will begin with the submission of a first draft on September 1st. Subsequently, each Technical Paper will undergo a peer review with final edits completed by November 30th. Contact information such as name, address, phone and fax number must be submitted with each author's proposal.

Once a paper is chosen, IIAR offers each primary author a complimentary conference registration. Every year, the two highest rated presentations receive the *Andy Ammonia* award. Recipients of this prestigious award each receive a complementary registration for next year's IIAR conference.

IIAR 2012 Andy Ammonia Award Winners

Andy Ammonia awards for the 2012 IIAR Industrial Refrigeration Conference & Exhibition were presented to Dr. Forbes Pearson of Star Refrigeration (left) for the presentation of his paper, *Charge Minimization* and to Christian Ali Muñoz Duran of A. Blasquez E. Refrigeración Industrial (right) for the presentation of his paper, *El flash gas en su sistema de refrigeración* (*Flash Gas in Your Refrigeration System*). The awards were presented by conference chair Bob Port. The winners of the Andy Ammonia Awards are determined based on the results of the technical paper evaluation forms completed by those who attend the technical paper sessions.

CONTENTS

International Institute of Ammonia Refrigeration
1001 North Fairfax Street, Suite 503
Alexandria, VA 22314 | www.iiar.org
Phone: 703-312-4200 | Fax: 703-312-0065

Condenser Staff

Publisher | Bruce Badger | bruce_badger@iiar.org
Managing Editor | Andrea Fischer | andrea_fischer@iiar.org
Layout & Design | Laura Dugan
Illustrator | Ron Curameng

Chairman's Message

by Joe Mandato

IIAR's 2012 Industrial Refrigeration Conference was one of the best, drawing more than 1,100 of our industry's business leaders and technical experts to Milwaukee. The attendance numbers represented a record for a non-heavy equipment show event, and according to the post-conference survey results, more than 93 percent of those attendees gave the meeting an overall rating of good or better.

If you were not among the end users, engineers, manufacturers, and academics who met to discuss the best strategies for driving down operating costs and boosting energy efficiency, you might be missing out on the best our industry has to offer.

The packed technical paper sessions, workshops and technomercials were the usual highlights of our annual meeting, as well as the exhibit hall, which was crowded this year with more than 100 manufacturers, service providers, and educational organizations.

Conference Chair Bob Port led and coordinated the event. Because of Bob's outstanding work, exhibitors and attendees alike experienced one of the most informative and productive meetings yet.

This year, IIAR was pleased to deliver a program that was not only at a venue that appealed to IIAR's end user members, but also included the Institute's first-ever Ammonia Safety Training Day, a free event that preceded the conference and presented an introduction to regulatory and code responsibilities.

Another focus of the recent meeting, and an ongoing effort for IIAR, was the expansion of the organization's global reach.

Representatives from the recently formed Association of Ammonia Refrigeration in India traveled to Milwaukee to attend the IIAR conference this year, marking the continuation of a close effort between IIAR and AAR to bring IIAR standards and practices to India.

The cold chain in India is expanding, but the refrigeration industry there needs standards and training to design, install and operate safe, efficient refrigeration systems. The industry in India is getting pressure at the local level to step up the training, and IIAR has the standards and training tools that can help.

Partnerships such as this one, where IIAR's research and expertise is put to use in expanding ammonia refrigeration operations around the world, will only grow in the coming year.

In addition to India, attendees from dozens of other countries traveled to Milwaukee, including representatives from the Chinese Association of Refrigeration, the Colombia Association of Air Conditioning and Refrigeration, the Institute of Refrigeration of the United Kingdom, the Global Cold Chain Alliance and Europe's Eurammon.

This year, we'll be continuing to build our global presence, strengthening our global ties, and confirming IIAR's international brand. That effort is more important than ever before, as technology advances open up new applications and opportunities for ammonia refrigeration.

One topic related to those new applications, the use of ammonia refrigeration in supermarket refrigeration systems, received plenty of attention in Milwaukee when the subject was addressed as a technical paper. This year, the technical program included a total of nine workshops, eight technical papers, five Spanish technical papers, and educational panels.

While it's hard to turn our attention away from all the excitement of our most recent conference – you'll find a full wrap up beginning on page 20 – it's time to start thinking about how to use that renewed enthusiasm in the coming year to strengthen IIAR's member presence and plan for our next event.

The IIAR Industrial Refrigeration Conference & Exhibition will be held at the Broadmoor Hotel and Resort in Colorado Springs, Colorado, in 2013.

If you have a Technical Paper or a workshop that you would like to present in Colorado Springs, please contact Eric Smith at IIAR headquarters to submit your abstract as soon as possible. Technical Paper and session topics are the fabric of IIAR meetings, and will be selected before summer to allow presenters plenty of time to prepare their presentation.

Your membership in IIAR and participation in the technical activities of the group is what drives the open communication and exchange of information that is so vital to our industry. Through the efforts of IIAR's members, we're looking forward to another productive year as we expand our education, research, and advocacy on behalf of the industry. iiar

IIAR Program Answers Industry

with Small Facility Safety Guidelines

By Andrea Fischer

Facilities that use less than 10,000 lbs of ammonia have long been subject to federal safety requirements. The question of how to develop guidelines that work well for smaller systems has now been resolved.

The consequences of an operation-related incident are not confined to larger systems. When it comes to safety, prevention is the most important factor in avoiding unwanted consequences. Whether a facility is working with 900 lbs or 90,000 lbs of ammonia, the risks of an incident are similar. The severity of a potential problem could be less with a smaller facility, but the risk is still there.

As the industry sees a greater prevalence of smaller systems put on the market to replace synthetic refrigerants, as well as increasing OSHA awareness of the potential hazards affecting those systems, industry safety practices go a long way in protecting the reputation of smaller facilities.

For example, a smaller facility may not see the level of off-site consequences an incident at a larger facility would see, but it would certainly face on-site consequences, an outcome no company can afford, especially when such an incident could prompt local news media coverage.

Given those challenges, how should a small ammonia refrigeration facility determine the practices that are the most effective for its own operations in the face of so much conflicting and often redundant information about safety practices that may or may not actually apply to smaller operations?

Enter the Ammonia Refrigeration Management Program, a program developed by the International Institute of Ammonia Refrigeration to help small facilities answer that question by helping them create a good safety plan focused on prevention.

Traditionally, larger ammonia refrigeration facilities – with charges greater than 10,000 lbs – have been required to comply with OSHA's Process Safety Management Program and EPA's Risk Management Program requirements. In part because of those regulations, in place since the 1990s, the most common misconception among smaller facilities has been that they are exempt from compliance issues because the size of their charge is less than 10,000 lbs. Nothing could be further from the truth, said Larry Basel, past president of IIAR and Director of Environmental Health and Safety for the East Region at Dean Foods.

"Sometimes it's hard to determine what all those safety factors are and how they should be applied unless they are laid out according to the institutional knowledge of the industry, and that's where the Ammonia Refrigeration Management Program is an incredibly valuable tool," said Basel.

In addition to the safety and public relations considerations, there is a regulatory compliance issue for smaller facilities. The general duty clauses of OSHA and the EPA, cover every refrigeration facility, including those with less than 10,000 lbs of ammonia. These regulations can be found in 29 USC 654(a)(1) (OSHA) and the Clean Air Act Section 112(r)(1) (EPA). They set a minimum safety standard and place

Small Facility Safety Guidelines continued on page 6

RIGHT NOW

The world's leading food processors are not only saving 50 percent on energy costs, they're topping it off with a reduction in water consumption of 30 million gallons a year.

Emerson's innovative heat pump technology, featuring Vilter single-screw compressors, saves money and the environment.

This new, ammonia-based heat pump solution for industrial applications recovers the wasted heat from refrigeration systems to deliver hot water 500-600 percent more efficiently than gas or coal-fired burners. Plus, heat pumps reduce the load on your existing evaporative condensers, significantly reducing your plant's water consumption. The combined payoff is considerable cost savings, impactful environmental benefits and proven return on investment. Learn more about putting this critical competitive advantage to work for you. Visit **EmersonClimate.com/IndustrialHeatPumps**.

Scan with your smartphone for more information.

EMERSON™
Climate Technologies

EMERSON. CONSIDER IT SOLVED.™

Small Facility Safety Guidelines continued from page 4

responsibility on employers to keep workers and neighbors safe from hazardous chemicals.

The IIAR's ARM program is one tool any small facility can use to meet the challenges posed by the current regulatory environment, an environment that often delivers non-prescriptive specifications for safety. Drawing on the cumulative experience of the industry, ARM helps companies and facilities identify specific safety practices they should pursue, answering the common question: What basic safety processes should small ammonia refrigeration facilities observe and how should they build a safety program that is suited to their unique operations?

While safe and efficient operation has always been a driving force behind the innovations of the industry, even larger companies with multiple small facilities are turning their attention to safety programs as they increasingly expand their operations beyond a central, large facility, to facilities with less than 10,000 lbs of ammonia.

As the industry continually evolves to meet the demands of a complex regulatory environment and fast-paced supply chain, the need to develop and implement ARM programs at small facilities is indeed a challenge faced by everyone in the industry, said Jim Marrella, Co-chair of the IIAR ARM task force and Coordinator of OSHA and EPA Compliance and Training for United States Cold Storage.

"The operation of a safe and efficient system is our primary goal, but over the years the definition of what exactly that means has evolved through the work of IIAR and its members as well as members of the regulatory community," said Marrella.

Dean Foods' Basel agreed, saying, "Our job has always been to operate a safe ammonia system. There are certain basic things that everyone in our industry must be aware of, but the rest of the safety process is often determined by what each plant decides to do depending on its workforce and size, and that's where the process can get confusing."

The ARM program is a streamlined version of the Institute's PSM/RMP compliance guidelines, said Marrella.

The ARM Program addresses topics such as the management system, documentation, contractors, mechanical integrity, and emergency response, and simplifies the record keeping and program maintenance elements of the more complex PSM and RMP requirements.

"With larger facilities, we've got more people and we've been following PSM since the 90's. As an industry, we're required to have operation and maintenance procedures written down and we have a more formal infrastructure run by employees with developed skill sets and specialists with a specific knowledge of PSM/RMP," said Basel.

"That capability doesn't necessarily apply to our small facilities, but we still need a way to do the same thing at the small facilities we operate in order to meet safety requirements. ARM allows you to formalize training and procedures and document what you have, how it works and how it should be maintained."

Peter Jordan, senior principle engineer at MBD Risk Management and past IIAR Chair, said the genesis of IIAR's ARM program came as OSHA and the industry as a whole turned its attention to safety practices at small facilities as process safety management became an industry standard at larger facilities.

"At the time, it was known that a number of larger companies were developing programs for their smaller facilities – to reflect the spirit of PSM/ RMP – but also to respond to the general duty clause. The idea was that the industry as a whole was looking for a way to apply these practices to smaller facilities," said Jordan.

With ARM, IIAR formalized the effort to extend broader industry knowledge and safety practices to smaller companies and facilities.

"We basically took apart process safety management to look at what was absolutely necessary to have a safe system, and we tried to make that as simple and straightforward as we could. There are certain basics across the industry that ARM identifies, as well as suggested practices that may or may not apply to small facilities," Jordan said.

The end result is a program that includes ten general elements that a facility, operating with less than 10,000 lbs of ammonia, should consider including in its program as well as specific guidelines contained in these elements that may or may not be appropriate for every facility given the wide range of operating conditions and acceptable safety management practices.

For smaller facilities, ARM is becoming a standard industry resource.

"Forty percent of my plants are following programs developed with ARM because they those plants are small operations," said Basel. "And the reason is that I can't impose a PSM program on a plant with two people in it. At small facilities, there's simply not the skill sets or the manpower to get that done."

Basel added that his company has used ARM as a way to outline basic practices and set up essential training for the number of small facilities it operates. "We are implementing ARM for small facilities at Dean Foods because we have so many of them. If you use ammonia, even if it is a small amount, you need to operate your plant safely. ARM says, 'here's what you need to do,' even if you don't have enough people to implement a PSM or handle the paperwork that goes with it."

Long term, said Basel, the company hopes to institute ARM as a formal program that covers all of the company's small facilities.

"We really think this program would be great for every smaller plant we operate, and it's also a great tool for smaller, independent facilities without the resources of a large company behind them," said Basel. "We've been very successful with the ARM plan in the plants where we've instituted it, and we've had a lot of success with the EPA as well."

In addition to serving as an important tool within the industry, ARM has garnered attention from regulators outside of the industry. A California regulatory program, the California Accidental Release Prevention Program (CalARP) is designed to minimize the risk that extremely hazardous substances will cause immediate harm to the public and environment, and extends to ammonia facilities in the state, including a facility used to test ARM.

The program requires that an owner or operator of a business handling more than the specified threshold quantity of a regulated substance in California evaluate the use of the substance, to determine the potential for and impacts of an accidental release. Under the CalARP regulations these facilities must submit a Risk Management Plan to the department. The RMP is then used to determine the potential accident factors and to implement measures to reduce the accident potential.

While CalARP has not officially endorsed IIAR's ARM program, the agency and IIAR members have worked closely in the past, prompting CalARP to embrace ARM as a program worthy of implementation and recognize it as a significant step in maintaining the safety of the industry.

"ARM is an important program for everyone who operates small facilities in our industry, it makes us operate our systems smarter and it's a really great starting point for smaller facilities and companies because it guides them through the process of maintaining their systems safely," said Marrella. "ARM is really an essential tool for anyone running a facility with under 10,000 lbs of ammonia."

The ten elements that make up the ARM program are:

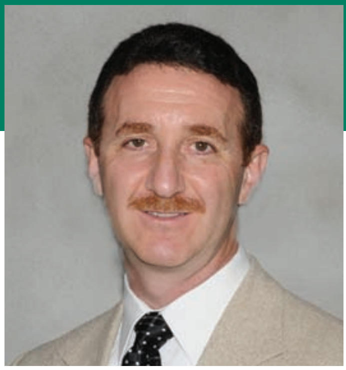
A management system: to ensure that any safety program will be developed and maintained by knowledgeable personnel so that the program will succeed. The guidelines for this element describe how to identify the personnel responsible for the program, help ensure that system operators are involved in the program, and allow the facility to periodically review the program.

Refrigeration system documentation: to help facilities identify and understand the hazards posed by their own system. Having system documentation available at managers' fingertips also speeds-up the development of the rest of the ARM Program and allows future modifications to the refrigeration system to proceed more efficiently. Documentation that may be collected includes flow diagrams, operating limits and design calculations.

Operating procedures: to provide useful documentation for training new and existing ammonia refrigeration system

Small Facility Safety Guidelines continued on page 23

IIAR Code Advocacy Update



By Jeffrey M. Shapiro, PE., FSFPE

Are We Going 2L?

Since ratification of the Montreal Protocol more than 20 years ago, the refrigeration industry has been on a path to limit the use of refrigerants that are ozone depleting or otherwise contribute to global warming. That path has, to some extent, led us full circle to the early days of refrigeration, when flammable refrigerants were used in air conditioning and refrigerating systems.

In the U.S., the move towards more widespread use of flammable refrigerants won't come easily. For decades, model codes and standards have been structured to strictly limit the use of flammable refrigerants and promote the use of refrigerants that don't support combustion, such as chlorofluorocarbons (CFCs), hydrochlorofluorocarbons (HCFCs) and hydrofluorocarbons (HFCs). The most notable exception to that trend has been, and continues to be, ammonia refrigeration in industrial occupancies.

Research seeking to define the next generation of mainstream refrigerants with low ozone depleting potential (ODP) and low global warming potential (GWP) has seemingly pointed towards two options; pure hydrocarbons, which are highly flammable, and hydrocarbon blends, which are flammable to a lesser degree. Flammable refrigerants in non-industrial applications have traditionally been limited to systems with very small charges that will not reach ignitable concentrations if dissipated into a room or open area, and there appears to be little appetite on the part of public safety officials to change that approach. However, new hydrocarbon blends are being scrutinized to determine whether less stringent regulations might be warranted based on their reduced flammability hazard, which has been quantified by the creating a new refrigerant classification category known as Group 2L.

The Group 2L category modifies the longstanding refrigerant classification system established by ASHRAE 34. This system divides the world of refrigerants into safety groups based on material toxicity and flammability properties (see Figure 1). Toxicity is ranked using two categories, "A" and "B," with the "A" category reflecting refrigerants with low toxicity and the "B" category reflecting refrigerants with higher toxicity. Flammability is divided into three categories, "1," "2" and "3," with "1" assigned to refrigerants that do not sustain combustion, "2" assigned to refrigerants with low flammability, and "3" assigned to refrigerants that are highly flammable.

ASHRAE 34 prescribes specific performance benchmarks that delineate all of these categories based on quantifiable test measurements. Toxicity ratings are determined based on a refrigerant's permissible exposure limit (PEL) or equivalent. A PEL represents the maximum concentration of gas that nearly all workers putting in an 8 hour day and 40 hour week may be repeatedly exposed to without adverse health effects.

ASHRAE 34's flammability rating system is more complex. To determine a flammability rating three criteria are considered:

1) Ability of the refrigerant to propagate flame,
2) The lower flammability limit (LFL), which represents the least concentration of gas that supports combustion, and
3) The heat of combustion, which reflects energy released when the gas burns.

It's interesting to note that ASHRAE 34's flammability classification scheme does not directly correlate with the system used to classify gas flammability under the hazardous materials regulations in model building and fire codes or transportation regulations. For example, ASHRAE 34 quantifies the LFL based on gas density expressed in kg/m^3. Model codes and standards, on the other hand, quantify LFL based on percent of volume in air or concentration in parts per million.

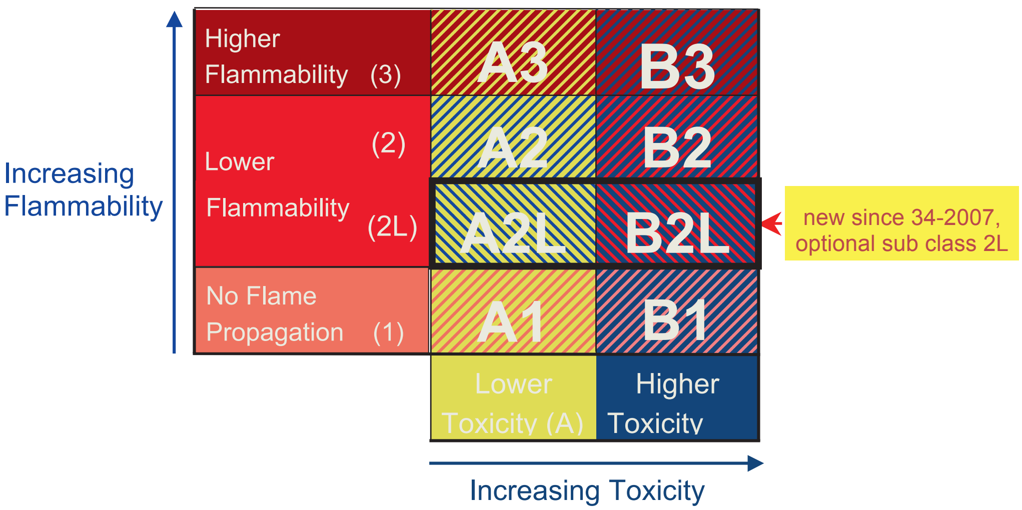


Figure 1. ASHRAE 34 Refrigerants Safety Group Classifications

Code Update continued on page 10

Code Update continued from page 8

Unfortunately, while both measurement systems determine LFL, calculations are required to compare the results.

To determine the appropriate safety group for a particular refrigerant, the toxicity and flammability ratings are combined into an alphanumeric identifier. For example, a low toxicity refrigerant that does not support combustion will be assigned to safety group A1; whereas, a refrigerant with higher toxicity that is highly flammable will be assigned to safety group B3.

With this background in mind, we can look at the new group 2L category. This category was created as a subset of the group 2 flammability class, and it was slipped between group 1 and group 2. The 2L category is subdivided into two safety groups, A2L and B2L, which are differentiated based on toxicity.

Conceptually, the goal of the group 2L classification was providing a way to uniquely recognize refrigerants that are capable of sustaining combustion but present a "lower than low" flammability risk (since group 2 refrigerants are already considered to have a low flammability risk). The approach originated outside of the U.S. via ISO standards and was picked up by ASHRAE 34 beginning with an addendum to the 2007 edition.

The unique property that qualifies a refrigerant to be classified as group 2L, versus group 2, is the burning velocity of the refrigerant when it combusts. To qualify as group 2L, the burning velocity of a refrigerant cannot exceed 10 cm/sec. Group 2L refrigerants are otherwise governed by the LFL and heat of combustion limits established for group 2. Presently, there are five refrigerants assigned to the group 2L category, including ammonia (see Table 1).

Refrigerant	Safety Group
R32 (difluoromethane)	A2L
R143a (1,1,1-trifluoroethane)	A2L
R717 (ammonia)	B2L
R1234yf (2,3,3,3-tetrafluoro-1 propene), and	A2L
R1234ze (trans-1,3,3,3-tetrafluoro-1-propene)	A2L

Table 1. Safety Group 2L Refrigerants

Promoters of Group 2L refrigerants assert that the 10 cm/sec burning velocity cap limits the ability of these refrigerants to propagate flame in a highly destructive manner. However, that conclusion conflicts with real life experience and full-scale fire tests involving ammonia, which is classified as B2L based on LFL and burning velocity. Although it's well established that ammonia is difficult to ignite, it is common knowledge that ammonia is capable of yielding a destructive event in a very narrow range of circumstances that pair a high concentration of gas and an adequate source of ignition. True, such events can be prevented by providing suitable mitigation measures, most importantly ventilation, but if an ignition somehow does occur, the potential consequences can be significant if a large volume of gas is involved.

So, what's the real concern? What promoters of group 2L refrigerants are seeking is a relaxation of regulations in ASHRAE 15 and model mechanical codes to permit increased quantities of these refrigerants in air conditioning systems used for human comfort and refrigerating systems that directly expose air in occupied spaces to evaporator coils. The fundamental question is whether a health or safety hazard would result from such changes.

Research being done on this issue reportedly indicates that ventilation and control of certain ignition sources will adequately mitigate the potential for ignition of gas that might escape into an occupied space in the event of a leak. I say "reportedly" because some of this information has been designated as proprietary and complete documentation of the underlying tests has not been released to the public for review. Philosophically, basing changes to model codes and standards on information that is not available for public review is inconsistent with principles of openness and transparency that govern how we do business in the code development arena.

There is also some concern with respect to the reliability of safety systems that might ultimately be provided as mitigation measures for group 2L refrigerants. For unitary or small charge systems, leak detection and interlocks can be scrutinized for functionality and reliability as part of a test laboratory listing process and/or through a manufacturer's quality control/quality assurance program. However, for field erected systems that may expose building occupants to a large volume release, we currently lack a clear basis for selecting, installing, testing and maintaining safety equipment that might be necessary to ensure public safety. This is particularly concerning for the case of flammable gases that do not have an alarming odor and cannot be detected without a reliable detection system.

In summary, it's pretty clear that group 2L refrigerants represent a path forward to reduce the use of ODP and GWP refrigerants. Outside of the U.S., these refrigerants have already gained a foothold, and they have been accommodated in ISO standards. Nevertheless, recognition by international standards is not, in itself, a basis for automatic acceptance in the U.S. As long as we continue to promulgate ASHRAE 15 and our model mechanical codes for U.S. adoption, it is incumbent on the experts who participate in development of these regulations to exercise due diligence in reviewing and acting on proposed changes. In that regard, neither ASHRAE 15 nor the model mechanical codes have granted special allowances for group 2L refrigerants, and that seems to be the right decision pending full disclosure of research that substantiates any changes and thoughtful deliberation of appropriate safety measures. iiar.

IIAR Government Affairs

by Lowell Randell, IIAR Government Affairs Director

OSHA and EPA Regulatory Update

In January 2012, the Occupational Safety and Health Administration (OSHA) released its Fall 2011 semi-annual regulatory agenda. The agenda includes a number of items of interest to the industrial refrigeration industry. Below is a summary of some key issues included in the agenda:

Globally Harmonized System of Classification and Labeling of Chemicals

On March 20, 2012, OSHA released its final rule addressing the harmonization of classifying and labeling chemicals with the international community. The rule will revise the Hazard Communication standard to align with the United Nations' Globally Harmonized System of Classification and Labeling of Chemicals. The process of harmonization began in 1992 at the "Rio" Earth Summit where participants agreed to a mandate that "A globally harmonized hazard classification and compatible labeling system, including national safety data sheets and easily understandable symbols, should be available, if feasible, by the year 2000." Since that time, many countries have moved forward with harmonization. With OSHA's final rule, the United States will now join the list of countries utilizing the harmonized system.

Advocates for the U.S. adopting the harmonized system argued that because American companies are major importers and exporters of chemicals, inconsistent requirements could create trade disruptions and lead to confusion and reduced protections for workers and the public.

Under the final rule, the basic framework for the Hazard Communication Standard is maintained. Chemical manufacturers and importers are responsible for providing information about the identities and hazards of chemicals they produce or import. All employers with hazardous chemicals in their workplaces are still required to have a hazard communication program, and provide information to employees about their hazards and associated protective measures. However, there are some significant changes that will require action by employers.

Hazard Classification

The final rule provides specific criteria for classification of health and physical hazards, as well as classification of mixtures. Manufacturers and importers must classify each chemical and determine the appropriate hazard class and category based on evaluation of full range of available data and evidence.

Labeling

Chemical manufacturers and importers will be required to provide a label that includes a harmonized signal word, pictogram, and hazard statement for each hazard class and category. Precautionary statements must also be provided. The use of pictograms is a significant change to U.S. requirements. OSHA is maintaining a flexible approach to workplace signs and labels, so the use of third party hazard rating systems such as the NFPA diamonds and HMIS are still valid approaches in the workplace.

Safety Data Sheets

The harmonized system requires employers to use a 16 section safety data sheet. OSHA will not enforce Sections 12 through 15, as they address information outside OSHA jurisdiction such as ecological, disposal and transportation issues.

Employee Training

Employers are required to train workers by December 1, 2013 on the new labels elements and safety data sheets format to facilitate recognition and understanding. Training should address workers, emergency responders, and those involved with preparation of labels, SDS and HazCom strategies as part of risk management systems.

Key Implementation Dates

December 1, 2013	Train employees on the new label elements and SDS format.
June 1, 2015	Comply with all modified provisions of this final rule.
December 1, 2015	Distributors may ship products labeled by manufacturers under the old system until December 1, 2015.
June 1, 2016	Update alternative workplace labeling and hazard communication program as necessary, and provide additional employee training for newly identified physical or health hazards.

It is important to note that during the transition period companies may comply with either the current standard or the new standard detailed in the new globally harmonized standard. A copy of the final rule and other resource materials can be found at: http://www.osha.gov/dsg/hazcom/ghs-final-rule.html.

Government Affairs continued on page 14

Government Affairs continued from page 12

OSHA Injury and Illness Prevention Program (I2P2)

Another item on the OSHA regulatory agenda is the advancement of OSHA's Injury and Illness Prevention Program (I2P2). I2P2 would establish a requirement for employers to find and fix potential workplace hazards regardless of whether they specifically relate to an existing OSHA standard. OSHA sites the use of I2P2 type programs in a number of states as demonstrating the success of this proactive approach to preventing workplace injuries. However, there are concerns about the costs and burdens that would be placed on employers if the new program goes into effect. Much like the General Duty Clause, it is feared that OSHA will use the I2P2 standard to cite employers for failing to address a hazard, even if it there is not an established hazard specific standard. For example, some believe that I2P2 may be a way for OSHA to address ergonomics without advancing a rule on that specific topic.

The actual regulatory text of the proposed I2P2 rule has not been released, but OSHA has indicated that it will be one of the agency's top priorities in 2012. OSHA initiated the SBREFA process, by which the Small Business Administration's Office of Advocacy will convene a panel of small businesses to provide feedback on the proposed rule before it is published by OSHA. It is anticipated that the SBREFA panel will begin its process this spring to address the impact of I2P2 on small businesses.

OSHA Permissible Exposure Limits

The OSHA regulatory agenda also indicates that the agency would like to revisit the permissible exposure limits (PELs) for hazardous substances in 2012. Many of the PELs have not been revisited since the 1970s and OSHA believes that some of the limits are outdated. OSHA has stated that "there is widespread agreement among industry, labor, and professional occupational safety and health organizations that OSHA's PELs are outdated and need revising in order to take into account newer scientific data that indicates that significant occupational health risks exist at levels below OSHA's current PELs." OSHA has indicated that the focus of their effort will be on chronic exposure related substances, so it is not anticipated that the PEL for ammonia will be affected. OSHA plans to release a Request for Information in August 2012 seeking input from the public to help the agency identify effective ways to address occupational exposure to chemicals.

EPA Proposes Public Access to Offsite Consequence Analysis

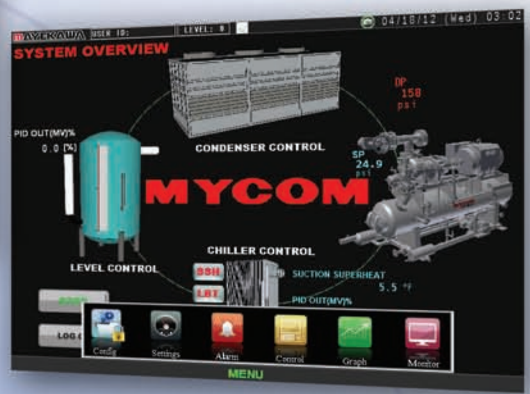
In addition to regulatory actions being considered by OSHA, the Environmental Protection Agency is also proposing changes that could impact the industrial refrigeration industry. In February 2012, the Environmental Protection Agency (EPA) announced its plans to make public the Non-Off-Site Consequence Analysis sections of the Risk Management Plan database. This includes security sensitive subject matter including lists of covered chemicals used, preventative measures in place, and the location in a plant where those chemicals are used. This information was available on-line prior to the attacks of September 11, 2001. After September 11th, it was then decided that public access to this information was a threat to security and that it should be taken off of the Internet.

EPA's stated rationale for allowing public access is that restricting access places a burden on the agency due to excessive time required to process Freedom of Information Requests related to this information. EPA's proposal has met with sharp criticism and numerous Congressional and industry leaders have expressed their concerns with making this information public. IIAR shares these concerns and has written to EPA, the Department of Homeland Security and the Federal Bureau of Investigation urging that EPA's proposal not be implemented.

EPA initially planned to make this information publicly available again as early as July 2012. However, in response to concerns raised by IIAR and like minded organizations, the EPA has decided to postpone their target date for releasing RMP database information indefinitely. IIAR is pleased that EPA has responded to our concerns and we will continue to work with the agency to help ensure that security sensitive information continues to be well protected. iiar

MYCOM

Scan Here for Brochure



Touch Screen
Easy To Use Interface
Ethernet Connectivity
Basic System Control Capabilities
Remote Screen Monitoring via Internet
Easy HMI Program Update via Ethernet or USB
Screen Capture & Trend Data to USB Storage Device
Backward-compatible with MYPRO CP-IV
Supports All Control Features of MYPRO CP-IV

MYPRO TOUCH

Compressor Package Control System

MAYEKAWA

(800)80-MYCOM / (800)806-9266
info@mayekawausa.com
www.mayekawausa.com

Causes and Prevention of Corrosion

on the Interior Surface of Metal Jacketing Used on Mechanical Insulation

By Jim Young, Director of Technology, ITW Insulation Systems, Phone: (989)486-3073, Email: jyoung@itwinsulation.com

Presented at the 2011, Global Insulation Conference in Toronto on 9-26-11

Summary:

Mechanical insulation systems are used on cold and hot pipe, tanks, ducts, vessels and equipment to conserve energy, prevent surface condensation, prevent contact burns, and more. In most outdoor applications and some indoor locations, these systems use an outer protective metal jacketing to provide UV resistance, damage resistance, and water shedding. Regardless of metal type, this jacketing is susceptible to galvanic and pitting/crevice type corrosion on the interior surface caused by the intrusion of water into the insulation system. The best way to prevent this corrosion is to factory heat laminate a 76 μm (3 mil) multilayer polysurlyn moisture barrier to the interior surface of the metal jacketing.

Background:

Insulation is used on the exterior surface of pipe, tanks, ducts, vessels and equipment for the same reason insulation is used on building envelopes–to reduce the flow of heat. In this application, the insulation is part of a complex construction generically called a mechanical insulation system which can include one or more layers of insulation, adhesive at the insulation joints, vapor retarder, and metal jacketing. These systems are often more complicated than building envelope insulation because of their complex geometry, the unidirectional heat/moisture flow, the extreme temperatures of the mechanical equipment being insulated, and the often outdoor exposed location of the systems. Table 1 shows some common examples of outdoor mechanical insulation systems, their operating temperatures, and a brief description of the insulation system.

Mechanical insulation systems for hot applications are applied to pipe/equipment that can be hotter than 649°C (>1200°F) and the main purposes of the insulation system is to improve energy efficiency, prevent contact burns, and maintain process control. Secondary effects of the insulation system can include improved fire resistance and sound deadening. Examples of the applications for hot mechanical insulation systems are mundane hot service water in a commercial building, power plants, oil/gas refining and cracking, petrochemical manufacture, and food production.

Mechanical insulation systems for cold applications are applied to pipe/equipment that ranges from just below ambient temperature to near absolute zero –273°C. The

Insulation System Type	Pipe/Equipment Contents	Operating Temp. °C (°F)	Outdoor Mechanical Insulation System Description
Power plant	Exhaust gas	>649°C (>1200°F)	Refractory fiber / stainless steel jacketing
High pressure steam	Steam	>260°C (>500°F)	Mineral wool / aluminum jacketing
Hot oil/gas and petrochemical	Various organics	38 to 260°C (100 to 500°F)	Mineral wool / aluminum or stainless steel jacketing
Cold oil/gas and petrochemical	Various organics	–101 to 16°C (–150 to 60°F)	PIR insulation / vapor retarder / aluminum jacketing
Commercial bldg. air conditioning	Chilled water	4°C (40°F)	Phenolic insulation / vapor retarder / aluminum jacketing
Food/Beverage Refrigeration	Ammonia, CO_2, HCFC	–51 to 4°C (-60 to 40°F)	Multi-layer XPS insulation / vapor retarder / aluminum jacketing
Liquid natural gas (LNG)	Liquid methane	–165°C (–265°F)	Three layer PIR insulation / two vapor retarders / aluminum jacketing

Table 1 – Common mechanical insulation systems

Causes and Prevention of Corrosion continued on page 28

IIAR Announces New CO_2 Committee

The International Institute of Ammonia Refrigeration announced that it has approved the formation of a new, standing CO_2 committee. The new committee will be IIAR's eleventh committee, and will focus on the use of CO_2 as a natural refrigerant for industrial and commercial applications.

IIAR's committees exist to further the Institute's goals including producing training materials, publications and updating technical information.

"This committee was formed because IIAR was looking for ways to expand the focus beyond just ammonia to include other natural refrigerants," said IIAR President Bruce Badger. "These days, as synthetic refrigerants are being replaced with natural refrigerants, it's important to remember that a natural refrigerant like CO_2 enables the greater use of ammonia, for example in a cascade system, or in a jurisdiction where the use of ammonia may be restricted to the mechanical room."

Badger added that while the idea of forming a CO_2 committee was not new to IIAR, the Board's recent action was timely, given the evolution of technology in the industry over the last several years. "The effort to form this committee began years ago, but it only evolved into a practical consideration recently as certain technical limitations were resolved and the industry advanced."

According to IIAR's Board of Directors, the purpose of the new committee will be "to provide technical support for the IIAR membership and work with other IIAR Committees and IIAR Alliance partners to ensure the safe and efficient use of CO_2 as a primary refrigerant, secondary refrigerant or the low temperature refrigerant in a cascade system." The Board said the committee will also provide technical interpretations in support of the IIAR Technical Director.

Among several responsibilities, the new CO_2 committee will oversee the revision and maintenance of IIAR's CO_2 Handbook, including the addition of the most up to date data and relevant technical information. The CO_2 committee is currently accepting new members. Those interested in participating in this committee please contact IIAR headquarters at (703) 312-4200.

ARF Board of Directors

Back row:
Harold Streicher, Mark Stencel, Bruce Nelson, Jim Wright, Bruce Badger

Seated:
Joe Mandato, Adolfo Blasquez, Doug Sweet

ARF Sponsors Relief Valve Project

The Ammonia Refrigeration Foundation reported that it is continuing to work towards its $3 million funding goal, after raising nearly half that amount in the last two years. The money is used to fund the education and research programs of the foundation.

Among several goals for 2011, ARF said it sponsored a relief valve project to produce research that would lay the groundwork for a statistical pressure relief replacement interval calculator.

The foundation sponsored a follow-on project to prove the viability of postmortem testing of relief valves to predict an appropriate replacement schedule for the valves. The testing was successfully conducted and the standard was deemed workable and accepted by IIAR. The product of this research is the statistical pressure relief replacement interval calculator, ARF said.

The Ammonia Refrigeration Foundation was established in 2005 as a non-profit research and education foundation organized by IIAR members to promote educational and scientific projects related to industrial refrigeration and the use of ammonia and other natural refrigerants.

ARF's fundraising progress builds on the early efforts of the foundation, which focused on generating the capital resources needed to fund research and education scholarships.

The IIAR Research Committee advises the foundation on projects that have the potential to benefit the industry and merit funding. The Education Committee also advises the foundation regarding educational opportunities.


Annual Meeting
Saturday, March 17
keep cool

IIAR2012

INDUSTRIAL REFRIGERATION CONFERENCE & EXHIBITION

milwaukee wisconsin march 18–21

IIAR 2012 Conference Draws Record Turnout

The ammonia refrigeration industry's business leaders, networking groups and technical experts recently met in Milwaukee, Wisconsin, for the International Institute of Ammonia Refrigeration's 2012 Industrial Refrigeration Conference & Exhibition.

The event featured the release of two important publication updates, an educational Ammonia Safety Training Day and a technical program that focused on a broad range of applications for industrial refrigeration technology.

"This was really an upbeat conference for all of the exhibitors and visitors," said IIAR 2012 Conference Chair, Bob Port. "Not only did we see record attendance numbers for a non-heavy equipment show event, but we also delivered a program at a venue that appealed to IIAR's end user members."

The decision to bring the IIAR Conference to Milwaukee in 2012 was made in response to requests from IIAR's end-user members to focus the event in an area of the country traditionally known for its high concentration of end-user facilities and headquarters.

As part of that effort, IIAR spotlighted its first Ammonia Safety Training Day, a free event that preceded the conference and presented an introduction to regulatory and code responsibilities, followed by an overview of emergency planning and personal protective equipment.

Port said the goal for the Ammonia Safety Training Day was to provide enough training that each attendee walked away with the knowledge of what they should be doing in order to plan effectively, and appropriately respond to an ammonia release event.

"Judging from the positive response, we met that goal and provided a very useful service to the safety community as well as IIAR's own members," he said.

In addition to IIAR's Ammonia Safety Training Day, the conference also featured a session focused on exploring a beneficial relationship with the Occupational Safety and Health Administration, specifically through a volunteer program developed by OSHA and aimed at the end-user community.

"This year, we really saw a lot of participation from end users and contractors, but we also had a lot of involvement and representation from trade unions and regulatory bodies like OSHA and the EPA," said Port. "Everyone was making an effort to learn something and to make the industry an even better, safer place. These are groups that typically are not at our shows, so this year's events turned out to be a great way for them to interact with our industry."

Port said the Safety Training Day event drew 250 attendees, while the Conference & Exhibition drew 1,147 attendees, a record turnout for the IIAR's annual conference when the event does not include a heavy duty equipment component.

The IIAR's Conference & Heavy Equipment Show takes place every three years and traditionally draws the largest number of attendees.

In addition to general attendance, the conference attracted a record number of exhibitors for an event of its kind. Port said122 exhibitors showcased ammonia refrigeration's most promising new technology and equipment.

Meanwhile, the technical program included nine workshops, eight technical papers, five Spanish technical

2012–2013 IIAR Board of Directors

Back Row: David Blackhurst, Martin Timm, Jim Adler, Mark Stencel, Paul Bishop, Harold Streicher, Kem Russell, John Collins

Middle Row: Bob Czarnecki, Walter Teeter, Dennis Halsey, Bruce Nelson, David Bersaglini, Doug Reindl, Bent Wiencke, Gary Webster

Seated: Thomas Leighty, Marcos Braz, Bob Port, Joe Mandato, Adolfo Blasquez, Bruce Badger

papers, and educational panels designed to give the most thorough update on operations and maintenance within the industrial refrigeration industry, while at the same time exploring the applications of ammonia refrigeration in new environments such as supermarkets.

"We had many positive comments about the technical program," said Port. "There was something there for everyone, and the focus on new applications for our industry, beyond the normal discussion of operations was refreshing."

Technical paper topics ranged from a review of the feasibility of ammonia in U.S. supermarkets to Hot Gas Defrost and Charge Minimization.

In addition to the heavy attendance of IIAR's domestic membership, the Institute's strong international program drew a large turnout of delegations from China, India, Europe and Latin America, building on an already strong collaboration between IIAR and international organizations like the Chinese Association of Refrigeration, the Association of Ammonia Refrigeration in India, and Eurammon.

"This year, there was a very nice mix of people from overseas in attendance, making this a truly international conference," Port said. "From an international perspective, we've built on our last event."

Record Turnout continued on page 22

Record Turnout continued from page 21

IIAR held two seminars in Latin America in 2011, and the International Committee is currently planning similar events for 2012 in Peru, Chile and Costa Rica, followed by Ecuador, Colombia and Argentina in 2013, said IIAR Chairman (2011-12) Adolfo Blasquez.

Nevertheless, the advancement of an international presence was only one part of the progress the Institute made on its initiatives in the last year. Other projects, like an update to IIAR's PSM/RMP guidelines, and a new chapter for the Piping Handbook were on display in Milwaukee this year.

Built on real-world experience and application, the updated PSM/RMP guidelines represent a consolidated package of materials that will reduce duplication of effort in compliance with both regulations. The complete guidelines come in 2 volumes, accompanied by a Microsoft Word, CD version, which can be used to create a customized PSM/RMP program.

Both the PSM/RMP update and the new chapter of the Piping Handbook were released at the conference, and are currently available for sale on the IIAR website.

Many IIAR leaders have contributed to the different IIAR publications and leadership that produces them, an effort the Institute recognized with its "Member of the Year" and "Honorary Life Member" awards.

IIAR Chairman Adolfo Blasquez presented both awards at the conference. The 2012 IIAR member of the year award went to Bob Czarnecki of Campbell Soup Company in Camden, New Jersey, while the honorary life member award was presented to Jeff Welch of Welch Engineering Corporation in Ponte Vedra Beach, Florida.

"Both of these IIAR members deserve appreciation from their colleagues for the outstanding contributions they have made to our industry through their extraordinary service to our association over the past twelve months," said Blasquez. "It is my pleasure to name them IIAR member of the year and honorary life member in recognition of their work."

IIAR's 2013 Industrial Refrigeration Conference and Exhibition will be held March 17 – 20 in Colorado Springs, Colorado.

IIAR Names Member of the Year Honorary Life Member

Member of the Year

As a previous chair of IIAR's Standards Committee, Bob Czarnecki "has led IIAR through an exciting period of standards development," said IIAR Chairman Adolfo Blasquez, adding that Czarnecki's work has resulted in the publication of two standards – IIAR 1, *Definitions and Terminology*, and IIAR 5, *Start-up and Commissioning of Closed-Circuit Ammonia Mechanical Refrigerating Systems* – in addition to the development and revision of four other standards. "Bob is always ready to devote his time and professional attention to the work required to take a standard from development to publication," said Blasquez. "His contribution to our industry is invaluable."

Honorary Life Member

IIAR's honorary life member, Jeff Welch, was recognized by IIAR for his consistent contribution to the organization and his dedication to the ammonia refrigeration industry as an advocate and representative for IIAR. The honorary life membership award is given by IIAR to members whose service extends well beyond their traditional terms of office and who have made contributions that have a lasting impact on the industry. "Jeff's leadership skills and devotion to our organization was clearly demonstrated in the year he served as IIAR chairman, where he oversaw an organizational change at IIAR," said IIAR Chairman Adolfo Blasquez. "That devotion has continued with his representation of IIAR at many industry events in the international arena, including several seminars in the People's Republic of China."

Small Facility Safety Guidelines continued from page 7

operators. The guidelines for this element describe how to write standard operating procedures, develop procedures to maintain system logs, and document safe work practices such as lockout and tag-out procedures.

A preventive maintenance program: to ensure that the manufacturer's recommendations, along with other relevant factors, are carefully considered when maintaining refrigeration equipment. The guidelines for this element describe how to identify the equipment included in the program, specify the tests and inspections used to maintain the equipment; and develop procedures to document maintenance activities.

A contractor program: to ensure that refrigeration contractors and subcontractors are qualified to work on a company's ammonia refrigeration system. The guidelines for this element describe how to identify who is covered by the program, develop a list of approved contractors, and establish procedures for contractors to follow while they are working on-site.

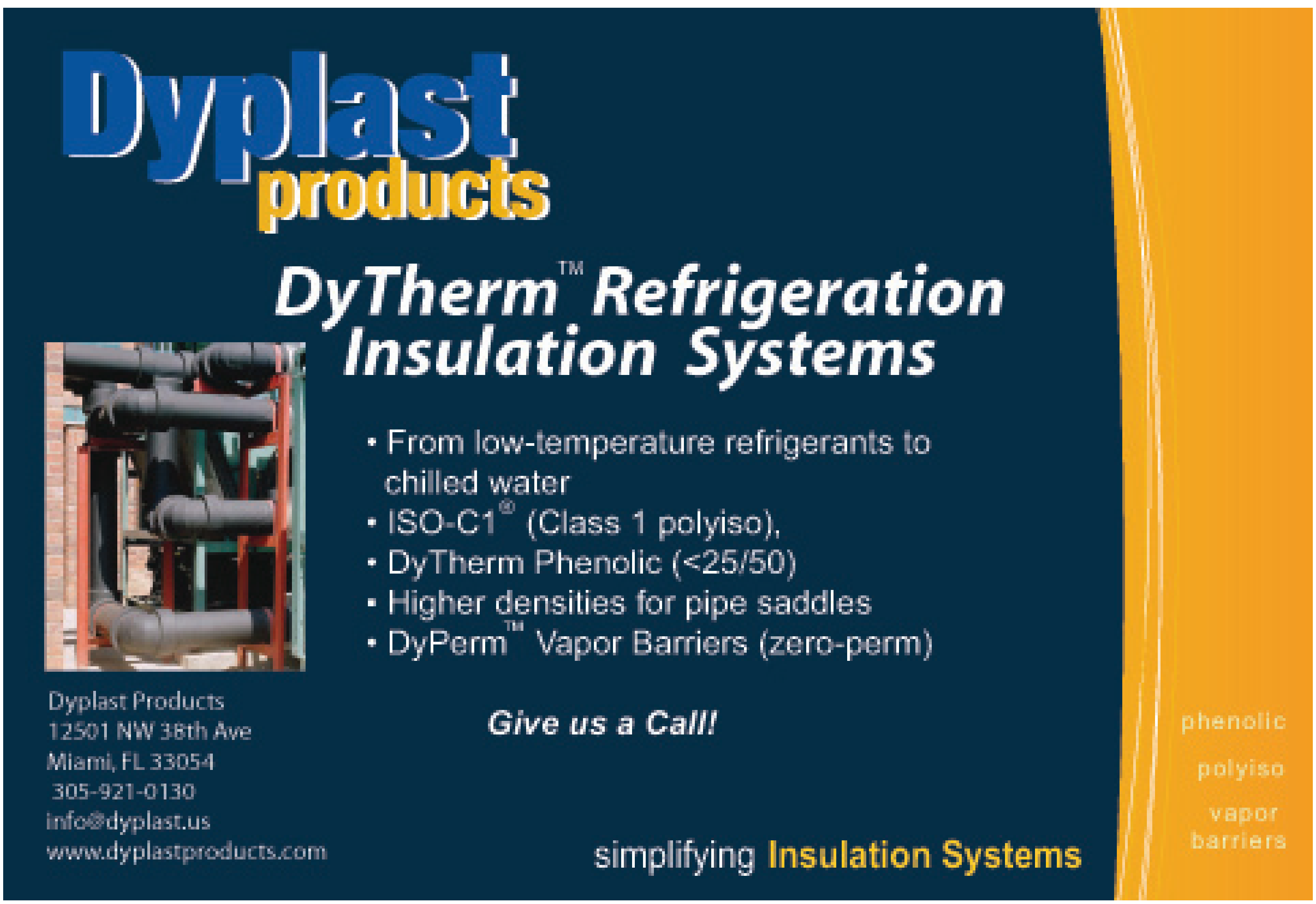
An emergency response program: to ensure that there are procedures in place to respond to ammonia releases. The guidelines for this element describe how to develop an emergency action plan, develop procedures to respond to accidental ammonia releases, and coordinate the plan with off-site responders.

Incident investigation procedures: to ensure that ammonia incidents and near misses are fully investigated to prevent a reoccurrence of these incidents. The guidelines for this element describe how to develop procedures to investigate odor complaints and procedures to investigate serious ammonia incidents.

A training program: to ensure the ammonia refrigeration system is operated and maintained by trained and knowledgeable personnel. The guidelines for this element describe how to identify who is covered by the program, describe the topics covered by the program, describe the options that can be used to provide training, and describe the procedures followed to provide refresher training.

Hazard review procedures: to identify, analyze and evaluate potential hazards associated with an ammonia refrigeration system. The guidelines for this element describe how to choose an appropriate review method, how to conduct the review, and how to address the recommendations identified during the review.

Refrigeration system change procedures: to ensure that any changes made to the ammonia refrigeration system are properly reviewed and that the ARM Program is updated to reflect the changes. The guidelines for this element describe how to identify the types of changes that can be addressed by these procedures and describe the specific procedures that can be used to address the changes. iiar



Global View

by Chris Combs, International Programs Director

IIAR's New International Committee

At an historic meeting held on Saturday morning, March 17th in Hilton Milwaukee City Center, Paul Bishop laid out a completely new vision for the IIAR International Committee (IC) for which he serves as Chairman. He began by presenting a new Mission, Purpose and Scope for the committee. The IC's mission is "to promote the safe and efficient use of Ammonia and other natural refrigerants through membership and participation in the IIAR, the distribution of IIAR standards, training materials and safety publications directly or through alliances with refrigeration organizations globally."

Among the new structural features described by Bishop is the creation of a new Senior Vice-Chair position and several Regional Vice-Chairmen positions responsible for initiatives in specific areas of the world. The regional structure put forward by IIAR includes the following categories:

- North America (including Canada, the U.S. and most Caribbean countries)
- Latin America (all Spanish speaking countries in the western hemisphere plus Brazil)
- Europe (Western and Eastern including Russia)
- Middle East/Africa (including Central Asia and Pakistan)
- India/South Asia (including Bangladesh, Sri Lanka, Myanmar and Malaysia)
- China (including Hong Kong and Mekong Basin countries)
- Japan/Korea/Philippines
- Australia/New Zealand/Oceania (including Indonesia, etc.)

He emphasized that the regional plan is not fixed and that there is room for adjustment according to language, size or other considerations such as the number of active members in the region.

Bishop reviewed other aspects of the newly formalized IC structure including the distinction between voting and corresponding members and the introduction of Task Forces that would be responsible for executing specific IC objectives. He asked committee members to consider and make recommendations for candidates for the Vice Chairmen positions for their respective regions.

The IC Purpose and Scope statements both talk about working with Alliance partners in pursuing IIAR's strategic objectives around the globe. Potential and actual Alliance partners include other refrigeration organizations that share common interests with the IC and IIAR such as developing "programs to promote safe and efficient industrial refrigeration systems, training programs for operators and technicians" and insuring that "emergency planning and response is provided for each ammonia refrigeration facility throughout the world."

In fact, visiting delegations at the Industrial Refrigeration Conference in Milwaukee represented both existing and potential Alliance partners. Besides IIAR's well established relationship with the Chinese Association of Refrigeration (CAR), IIAR is already working with the new Association of Ammonia Refrigeration (AAR), located in Pune, India which was represented by Samir and Veeraj Shah at the meeting. AAR was created to respond to the need for standards for ammonia installations in India. Representatives from prospective Alliance partners were also present, including Silvio Toro and Mauricio Baena from ACAIRE, the Colombian Association of Air Conditioning and Refrigeration; and Stefan Jensen from the new Australia Refrigeration Association (ARA) which aims to minimize the use of HFC's.

In Europe, IIAR and Eurammon will be sharing a booth at the upcoming Chillventa show in Nuremburg, Germany from October 9 to 11. According to Monika Witt, IIAR members attending the show are invited to join the Friends of Natural Refrigerants Breakfast sponsored by Eurammon. Another event in Europe worth noting is the IIR Gustav Lorentzen Conference on Natural Working Fluids from June 25-27 in the city of Delft in the Netherlands.

In Latin America, IIAR is working with manufacturer and local contractor members in planning three regional meetings in 2012:

- Buenos Aires, Argentina: July 30–31
- Santiago, Chile: August 2–3
- Lima, Peru: August 6–7

At the International Committee meeting, I led the discussion about other IIAR initiatives for Spanish speaking countries including the priorities for new Spanish publications and determining the timing and locations of additional seminars in order to effectively cover the different sub-regions within Latin America.

I also discussed the new International Affiliate Individual Membership Program which applies to any person in the industry from the BRIC countries (Brazil, Russia, India and China) and those operating under Article 5 of the Montreal Protocol. Fifteen individuals had joined under this new category by the time of the Milwaukee meeting. Arrangements with Alliance partners in these countries are a promising source for new international affiliate members. iiar.

IIAR Expands Global Outreach

By Bruce Badger, IIAR President

In this age of instant communication, incidents at ammonia refrigeration facilities grab headlines around the world. At the same time, our industry is hard at work laying the groundwork for a higher level of operational safety on the international level. The IIAR continues our program of developing standards that are then adopted, directly or indirectly, into codes. We also continue to expand our library of training materials.

Recent incidents, including a pipe explosion that sent dozens of people to the hospital in a southern Philippine city, highlight an unfortunate fact that there is a safety divide between North American and European countries and many countries with developing economies, despite a rapid rise in the use of ammonia refrigeration around the world.

If IIAR is to fulfill its mission to advance the ammonia refrigeration industry and the practices and technologies that make it safe, the organization must turn its attention to the important process of bringing standards development and safe operating practices to the international community.

IIAR has begun that process by focusing on the development of training seminars that can be staged in many places around the world. As a low-cost and effective tool, these training seminars are the first step in a meaningful effort to bring our industry's safe practices and standards to the places that need those standards the most.

IIAR has recently extended special membership opportunities to individuals in Article 5 countries – designated by the Montreal Protocol as part of the developing world – as well as Brazil, Russia, India and China, also known as the BRIC countries. Article 5 and BRIC country members will receive IIAR content electronically, including the Condenser, industry news bulletins and industry standards.

In addition to IIAR's individual international membership effort in these countries, the Institute has also developed alliance partnerships and relationships with existing industry organizations around the world, including countries like China and India.

IIAR is well on its way to developing a broad international outreach program. In the last year, the organization hired International Programs Director, Chris Combs (you'll find his column in this issue of the Condenser). Also this past year, IIAR held two successful safety and standards seminars in Latin America. I urge you to follow the progress of IIAR's international program as we bring our collective experience and resources to the rest of the world's industrial refrigeration community.

As we promote safe and efficient ammonia refrigeration systems we also grow IIAR membership, attendance at our annual Conference and the sale of our training materials. It is clear that all IIAR members benefit from this new and important International initiative wherever they are located in our global community. iiar

Causes and Prevention of Corrosion continued from page 16
main purposes of the insulation system are to improve energy efficiency, minimize condensation on the system surface, prevent contact burns, and maintain process control. Examples of the applications for cold mechanical insulation systems are food/beverage refrigeration, commercial building chilled water air conditioning, liquid natural gas handling and shipping, and petrochemical manufacture.

Due to the complex nature of mechanical insulation systems, they are typically designed by engineers hired directly by the facility owner or architect, or by a subcontracted engineering design firm. Specifications for mechanical insulation can range from very simple short documents to more than 100 pages depending on the complexity of the job and insulation system.

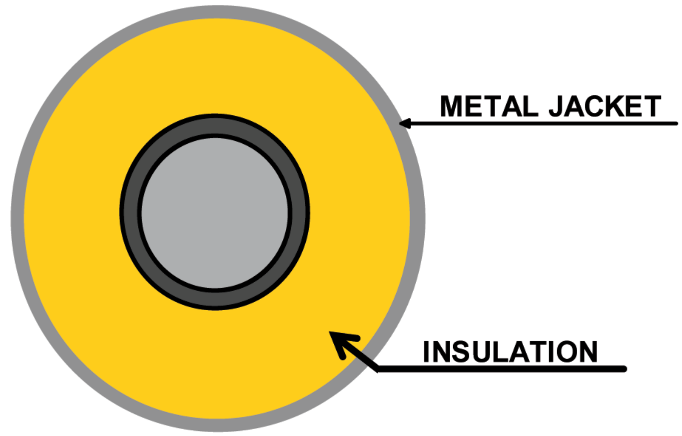
Metal Jacketing and Interior Surface Corrosion:

Entire volumes could and have been written on the subject of mechanical insulation systems but this document will focus on the metal jacketing and, more specifically, on specific types of corrosion that metal jacketing on mechanical insulation systems is prone to.

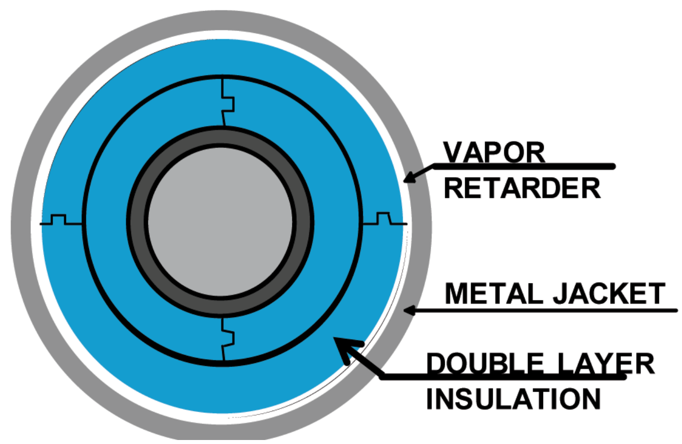
Very few insulation materials can be left exposed in outdoor applications so metal jacketing is widely used to protect the insulation system from damage due to UV exposure, physical abuse, and environmental water. Many types of metal have been used as jacketing including aluminum, stainless steel, aluzinc, aluminized steel, and even galvanized steel. Of these, the most commonly used in North America are aluminum and stainless steel and the use of both of these materials is growing outside of North America also. Outside of North America, aluzinc and aluminized steel are very popular. All metal types have various benefits and disadvantages but all have two key weaknesses germane to this discussion. They all have joints which are impossible to perfectly seal against water penetration and all can exhibit the type of interior surface corrosion that is the focus of this paper.

Water intrusion into the insulation system through the joints in the metal jacketing is inevitable because these joints cannot be made water-tight using adhesives/sealants. In addition, damage to metal jacketing is common due to factors such as hail, wind, being walked on, and leaning of ladders against. The source of the water which enters the insulation system from the ambient surroundings includes rain, condensation, dew, mist, fog, snow, cooling tower spray, and even ocean spray.

When water does enter the insulation system, its specific location will depend on various factors including whether a vapor retarder is present on the surface of the insulation and the integrity of this vapor retarder. Hot applications typically do not have a vapor retarder present and in this case, any water that enters can migrate throughout the insulation system subject to the influence of gravity, temperature, and other factors. Cold applications usually have a vapor retarder which should be fully intact on the outer surface of the insulation. Any water that penetrates through the joints in the metal jacketing will collect in the small space between the vapor retarder and the metal jacketing. This is shown pictorially in Figure 1.



Hot system – water can be anywhere in the insulation system



Cold system – water is trapped between vapor retarder and metal jacket

Figure 1 – Location of water in hot and cold insulation systems

When water penetrates through the joints in the metal jacketing it can cause corrosion of the interior surface of the jacketing and, in some cases, of the pipe/equipment. This type of corrosion is not the classic corrosion under insulation (CUI) which refers to corrosion of the pipe/equipment and is caused by water in direct contact with the pipe/equipment. This is also not corrosion of the edges of the metal jacketing which can occur with the coated steel type jacketing (aluzinc, galvanized, and aluminized steel). Because this type of corrosion occurs on the interior surface of the jacketing, it is very hard to detect until it becomes so egregious that the corrosion penetrates completely through the metal leaving visible holes in the jacketing. Often, this type of corrosion is assumed to actually be corrosion that begins on the exterior of the jacket because it is not observed until a hole has formed in the jacket at which point the two loci of corrosion (interior and exterior) are difficult to distinguish.

This interior corrosion can occur starting almost immediately after installation and reach the point of forming holes in the jacketing in as quickly as 6 months. This corrosion cannot be repaired either at its beginning stages or at the point where it has formed holes in the jacket. All that can be done to fix this problem is to replace the metal jacketing; a very expensive endeavor. As with most corrosion, it is far better to protect the metal initially so as to prevent the corrosion from occurring than to attempt to fix the problem after it has occurred. Figure 2 shows several pictures of interior jacket corrosion that has progressed to form holes through the jacketing.

Types of Corrosion Causing Interior Surface Jacket Corrosion:

This paper will not address the detailed chemistry of corrosion but will discuss briefly the two types that can lead to interior surface jacket corrosion – galvanic and crevice/pitting.

Galvanic or dissimilar metal corrosion occurs when two different metals are coupled in the presence of an electrolyte. V. Mitchell Liss describes the source of galvanic corrosion in mechanical insulation systems as, "Galvanic corrosion generally results from wet insulation with an electrolyte or salt present that allows a current flow between dissimilar metals (i.e., the insulated metal surface and the outer jacket or accessories)."[1] Galvanic corrosion can occur with all types of metal jacket and is most prevalent in hot applications where wet insulation can touch both the jacket and the pipe/equipment forming a bridge between the dissimilar metals. When this occurs, the more active metal corrodes. This is usually the jacket but can be the pipe/equipment when stainless steel jacketing is used with carbon steel pipe/equipment. The presence of water in the insulation system is necessary for this type of corrosion since it is both the electrolyte and an excellent source for the ions that give the water its electrical conductivity. A convenient way to describe galvanic corrosion is that it occurs when two dissimilar metals are coupled in a single environment.

It should be noted that the use of an effective insulation vapor retarder eliminates galvanic corrosion between the pipe and the jacket, but does not eliminate the possibility of pitting or crevice corrosion occurring on the interior surface of the jacketing.

Crevice and pitting corrosion are very similar in both their chemistry and result. Since it is unclear if one or both of these occurs in interior jacket corrosion, they will be considered together as the other type of corrosion. Crevice/pitting corrosion is a localized form of corrosion associated with a stagnant solution in contact with metal. This corrosion type can occur when a small droplet of water is trapped between the interior surface of the metal jacketing and either the insulation or a vapor retarder on the outside surface of the insulation. This thin space between the jacket and the underlying surface acts like a crevice & moisture trapped in this "crevice" can lead to crevice/pitting corrosion, especially when chlorides are present in the water as they are in most environmental sources of water. To function as a corrosion site, this "crevice" must be large enough to permit entry of water but small enough to keep the water stagnant. This can readily occur in the thin gap between metal jacket and vapor retarder. Crevice/pitting corrosion can occur with aluminum, coated steel, and even stainless steel type jacketing. All stainless steels are susceptible to crevice corrosion. The commonly used type S304 stainless is susceptible to crevice/pitting in the presence of salty water above about 10°C (50°F) and the less commonly used type S316 stainless is more resistant but can be attacked if the temperature increases even slightly above 10°C (50°F)[2,3]. Pitting and crevice corrosion together account for perhaps 25% of all corrosion failures in stainless steel[2,3]. Most mechanical insulation systems are designed such that the jacket temperature is fairly close to the ambient temperature and NOT to the pipe/equipment temperature so it is very easy to get above 10°C (50°F). A convenient way to describe

Figure 2 – Holes resulting from interior jacket corrosion

Causes and Prevention of Corrosion continued on page 30

Causes and Prevention of Corrosion continued from page 29
crevice/pitting corrosion is that it occurs when one metal type is in the presence of two connected micro-environments.

As this section makes clear, corrosion science offers an explanation for why corrosion on the interior surface of metal jacketing can occur. But where has this type of corrosion been observed? The next sections will describe the lab testing where this corrosion can be seen and the real world installations where corrosion on the interior surface of metal jacketing has led to expensive repairs.

Lab Testing of Resistance to Interior Surface Jacket Corrosion:

Lab corrosion tests were conducted to examine the potential for galvanic or pitting/crevice corrosion of various metal jacketing and to demonstrate how effective polysurlyn moisture barrier (PSMB) was at preventing this type of corrosion.

For the first of this testing, a mock-up of a common mechanical insulation system was constructed. Standard carbon steel pipe was covered with mineral wool insulation which was then covered with various types of metal jacketing both with and without PSMB lining. When PSMB lined metal jacketing was used, an X was scribed through the PSMB to mimic damage that might occur during handling and installation. The fibrous insulation used in this test was a way to keep the pipe and jacket separated while also allowing the added salt water to form a bridge between these two metals due to the open-cell/fibrous nature of the mineral wool. The mineral wool insulation was wetted with salty water and an induced electrical potential was applied between the pipe and jacket to accelerate galvanic corrosion. Each test lasted only 75 minutes. At the end of this time the underside of the metal jacketing was examined for evidence of corrosion.

Four different types of metal jacketing were examined in this test, 3105 aluminum alloy, aluzinc coated steel, galvanized steel, and aluminized steel. For all four bare metal types, there was significant corrosion visible on the surface of the jacketing that was in contact with the insulation. In the tests where a PSMB was applied to the metal jacketing, there was no jacket corrosion present. Figure 3 shows pictures of the jacketing after this testing was complete.

In a second lab test, a similar experiment was conducted but the jacketing was stainless steel and the pipe was carbon steel. In this case the corrosion would be expected to occur on the pipe. Four 75 minute long voltage applications were made and the pipe examined after these exposures. When both type S304 and S316 bare jacketing was used, the pipe exhibited significant corrosion. When both types of stainless jacketing were lined with PSMB, no pipe corrosion occurred. Figure 4 shows the pipes after this testing was completed.

In addition to the visual observation of corrosion, the mass loss due to corrosion for each pipe was determined.

Figure 3 – Corrosion results from lab testing of various types of metal jacketing

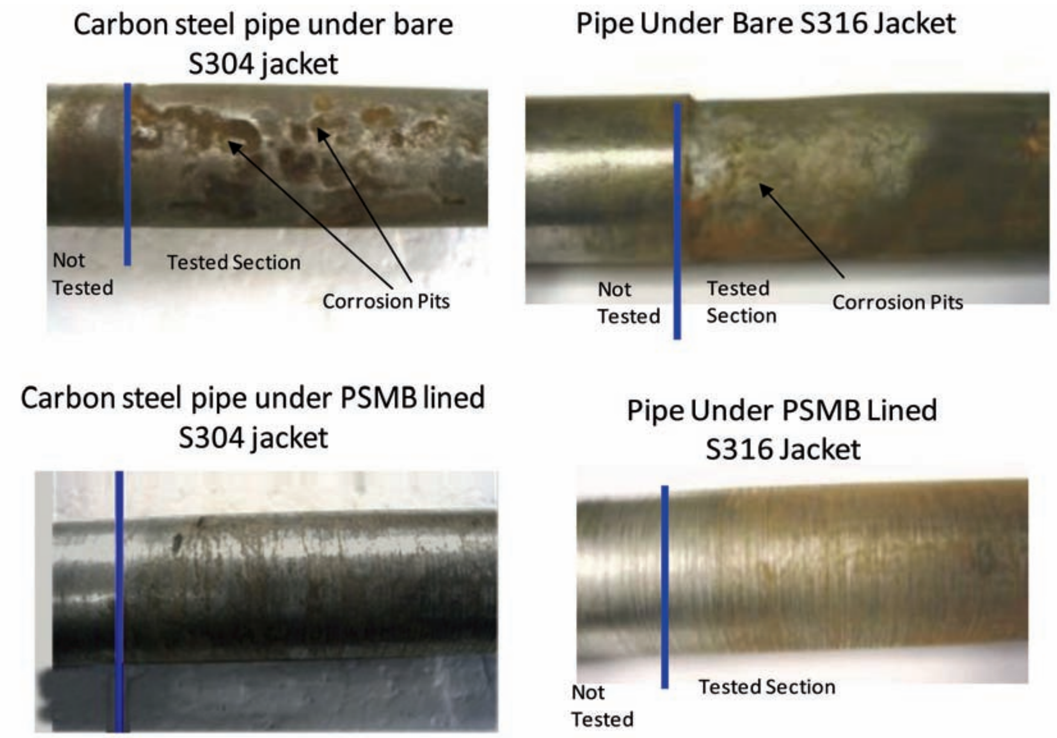


Figure 4 – Pipe corrosion results from lab testing of various types of stainless steel jacketing

It was found that when the stainless steel jacketing had a PSMB there was no mass lost from the underlying pipe due to corrosion. When bare stainless steel jacketing was used, the mass lost from the pipe was 3.5% for type S304 stainless jacket and 2.5% for type S316 stainless jacket. Note that this large amount of mass loss occurred after only four 75 minute exposures to the corrosion conditions. Figure 5 shows this result graphically.

In this case, the corrosion science previously discussed and the lab testing are in agreement. Science shows why the corrosion can occur and why an effective moisture barrier on the interior surface of the metal jacketing should prevent this type of corrosion. The lab results are in complete agreement with the theory. Bare metal jacketing leads to interior surface jacket (or pipe) corrosion and the use of PSMB prevents this corrosion from occurring. The use of PSMB on metal jacketing protects all types of metal jacketing from this corrosion and protects the pipe under the insulation from this corrosion when the jacket is stainless steel.

While this lab testing was a simulation, the difference between these accelerated lab tests and actual field experience is only the time required for failure.

Real-World Results:

In this section, several real-world examples will be provided showing the results of using an inadequate moisture barrier and how an effective moisture barrier can prevent interior surface jacket corrosion. When examining problems or failures in real-world installations it is usually difficult to obtain high quality information. Everyone involved in these type problems including facility owners, design engineers, and installation contractors are reluctant to publish or even allow discussion of their problems. In some cases there are even legal agreements prohibiting the parties from discussing the issues. In addition, when there is a real-world problem or failure, the facility owner wants it corrected as quickly as possible to minimize shutdown time. These factors along with the many variables involved in a real-world situation make it difficult to be scientific and it is hard to quantify these problems or carefully examine the solutions. Even with all of these constraints, examples still exist of facilities where interior surface metal jacket corrosion has occurred and enough information is known to make discussion of the failure a useful learning opportunity.

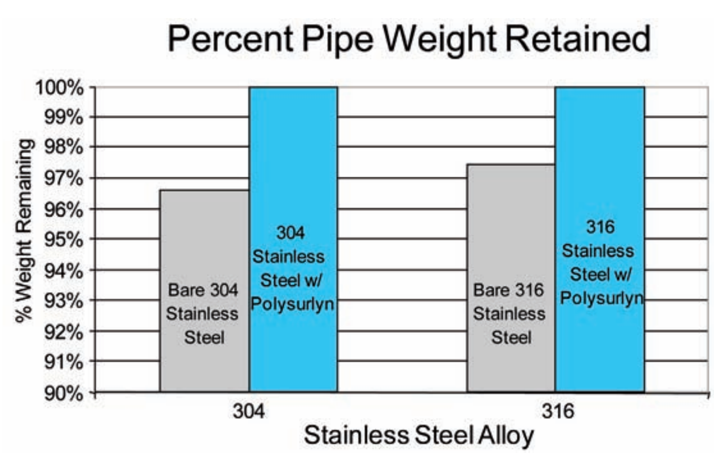


Figure 5 – Mass lost from carbon steel pipe with stainless jacketing during lab corrosion test

Causes and Prevention of Corrosion continued on page 32

Causes and Prevention of Corrosion continued from page 31

Table 2 below describes six real-world cases where interior surface metal jacket corrosion was encountered. For obvious reasons, no specific company or facility names are used. In all of these real-world examples the metal jacketing was aluminum with a polykraft moisture barrier.

Figure 6 shows pictures of the poor condition of the polykraft moisture barrier and the interior surface corrosion holes in the metal jacketing from the first real-world example in Table 2.

In addition to these examples of corrosion actually occurring when polykraft moisture barrier is used, there is an important related observation. ITW Insulation Systems is one of the largest global providers of metal jacketing for mechanical insulation systems and the employer of this author. They sell primarily jacketing with PSMB and have never had a claim or any knowledge of a case of interior surface corrosion occurring when a PSMB was used on the metal jacketing.

It has been shown that corrosion science, lab test results, and now real-world field experience are all in agreement. Interior surface jacket corrosion is an equal opportunity thief. It can steal longevity from insulation systems in all industries, all applications, using all insulation types, with all metal jacketing types, and in all climates. The best way to prevent the occurrence of this type of corrosion is the use of an effective moisture barrier like PSMB on the interior surface of the metal jacketing.

Moisture Barriers:

There are three general types of moisture barriers used on metal jacketing in mechanical insulation systems – paint, polykraft, and polysurlyn. Painted moisture barrier is a thin (~18 μm, 0.7 mil) layer of lightly pigmented paint that is typically applied in the mill that produces the metal coils. This type of moisture barrier is common on pre-formed two-piece elbows where it is probably acceptable due to the ultrapure corrosion resistant alloy of aluminum used on these elbows. Polykraft is a layer of kraft paper laminated to a single thin layer of polyethylene film. This lamination is performed by a metal jacketing company. Polykraft is an outdated and ineffective technology, and has comparatively poor water resistance. Polysurlyn moisture barrier (PSMB) is a thick three layer film that is applied by a jacketing company and represents the current state of the art for moisture barriers.

The real-world examples described above strongly indicate that polykraft is ineffective and PSMB is quite effective at preventing this corrosion but why is this? To answer this, the properties of the various moisture barriers must be considered in light of the main purpose of the moisture barrier which is to keep water from contacting the underside of metal jacketing to reduce corrosion potential.

With this purpose in mind, the key properties of a moisture barrier are:

- Pinholes – Each pinhole is a place where corrosion can start
  - Fewer is better and zero pinholes is most desirable
- Water resistance – Keep the corrosive water from touching the interior metal surface
  - Low water absorption and low water vapor transmission rate are desirable
- Toughness/durability – Damaged or decayed moisture barrier from the inevitable rough handling and installation is a locus for possible corrosion
  - Strong, tough, scratch resistant, and durable film is desirable
- Flammability – Lower flammability is preferred

Facility Description	Application Type	Insulation System	Climate Type	Corrosion Observations
Food/beverage plant in PA, USA	Ammonia refrigeration, continuous use	PIR with ASJ vapor retarder	Cold	Significant interior surface jacket corrosion six years after installation. Jacketing was replaced
Four power plants in NE, USA	Hot pipe, intermittent use	Mineral wool	Cold	Significant interior surface jacket corrosion
Three asphalt plants in USA	Hot pipe, intermittent use	Glass fiber with ASJ vapor retarder	Cold	Significant interior surface jacket corrosion
Six cold storage warehouses	Rooftop ammonia refrigeration, continuous use	XPS Pipe Billet with ASJ vapor retarder	Hot & cold	Water present between ASJ and jacket. Significant interior surface jacket corrosion. Jacketing was replaced
Heavy equipment factory	Chilled water, continuous use	Cell glass with ASJ vapor retarder	Hot	Significant interior surface jacket corrosion
Hospital	Chilled water, summer use only	Glass fiber with ASJ vapor retarder	Cold	Significant interior surface jacket corrosion

Table 2 – Real-world examples of interior surface metal jacketing corrosion

Table 3 shows the performance of each moisture barrier type in these key properties.

As corrosion science, lab testing, real-world examples, and now moisture barrier properties demonstrate, polysurlyn moisture barrier is the most effective way to prevent interior surface corrosion of metal insulation jacketing because it:

- Has proven performance
- Has no pinholes
- Is a multilayer film
- Has very low water vapor transmission rate
- Has very low water absorption
- Is tough, scratch resistant, and durable
- Has very low flammability
- Has excellent adhesion to metal substrates
- Is available on all metal types
- Is available from many metal jacketing manufacturers

Contractor and Facility Owner Recommended Actions:

Insulation contractors should minimize damage to the moisture barrier during cutting, field fabrication, and installation. They should educate workers on moisture barriers and their importance. They should buy metal jacketing only with PSMB. For aluminum jacketing, the easiest way to assure it has a PSMB is to use the new ASTM standard for this type of jacketing and specify that it comply with ASTM C1729, Type I, Grade 1 or 2, Class A. Lastly, contractors should recommend the use of PSMB lined metal jacketing to specifiers, engineers, and owners who are unaware of its importance.

Owners and engineers should specify metal jacketing only with PSMB. For aluminum jacketing, the easiest way to assure it has a PSMB is to use the new ASTM standard for this type of jacketing and specify that it comply with ASTM C1729, Type I, Grade 1 or 2, Class A. Lastly, owners and engineers should ensure that contractors know about PSMB and know to minimize damage to it during handling and installation.

Conclusions:

Interior surface corrosion of metal jacketing on

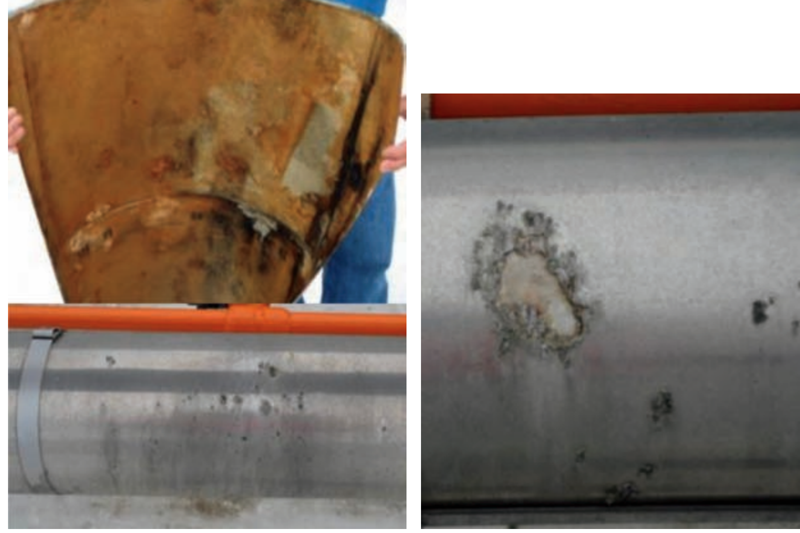


Figure 6 – Pictures of real-world interior surface metal jacket corrosion

mechanical insulation is a major potential problem with all metal types. All metal insulation jacketing should have 76 μm (3 mil) thick polysurlyn moisture barrier (PSMB) factory heat laminated on the inside surface to protect against jacket corrosion for aluminum and aluminum coated steel jacket and to protect against pipe corrosion when stainless steel jacket is used. Use of PSMB is cheap insurance to prevent the very costly alternative of jacket corrosion.

Contractors and Owners should use/specify PSMB on the inside surface of all metal jacketing and minimize damage to the moisture barrier during handling and installation.

References:

1 V. Mitchell Liss, corrosion engineering consultant, Preventing Corrosion Under Insulation, Bulletin of the National Board of Boiler and Pressure Vessel Inspectors, January, 1988

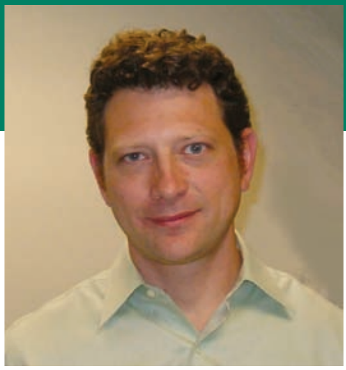
2 www.corrosionist.com

3 www.corrosion-doctors.org

Property	Paint	Polykraft	Polysurlyn
Moisture Barrier Description	1 layer at ~18 μm (0.7 mils) thick	1 layer of 38 μm (1.5 mil) thick PE film with Kraft paper backing	3 layer polymer film with total thickness of 76 μm (3 mils)
Pinholes per 4.6 m^2 (50 ft^2) via ASTM C1729 Method	>19	16	0
Water Resistance WVTR (g/100 in^2-day)	Unknown	Poor at about 1.0	Excellent <0.05
Toughness	Easily scratched	Paper easily damaged	Strong and scratch resistant
Flammability	Good	Unknown but exposed paper surface has Autoignition temp of ~232°C (450°F)	Tested on aluminum using ASTM E84 yielding flame/smoke of 0 / 5 Autoignition temp for polysurlyn is >316°C (600°F)

Table 3 – Properties of moisture barriers

From the Technical Director



by Eric Smith, P.E., LEED AP, IIAR Technical Director

If you could not attend all the sessions at the IIAR annual conference, this article provides a summary of important technical topics discussed.

A joint session of the Code and Standards committees was held so that both groups could be simultaneously updated. The Code Committee announced efforts to summarize various codes and their impact on the industry. Jeff Shapiro informed the committees of important deadlines for submitting code changes to code bodies. There was a discussion about the feasibility and need for submitting several forthcoming standards to the code bodies. It was felt that it was in the interest of IIAR and the industry to do this before some other agency does it for us. The Standards Committee announced the establishment of permanent working groups for creating and maintaining all of the existing and forthcoming standards. By the year's end, five of eight planned standards will be complete. One of these is the existing ANSI/IIAR-2. It is up for revision in 2013, per ANSI rules, and changes are being discussed now. There are several debatable issues with this standard which were reviewed in my last article and vetted in a panel session at the conference.

The Piping Committee continued their drive toward establishing a color "code" for ammonia piping. This issue has been debated for years and there are a number of concerns about standardizing color schemes. If you think "how hard could that be?", you have not heard the debates. There are several precedents that could be followed, and some are in conflict with each other.

The Safety and Education Committees continue to develop educational tools. The Education Committee is currently working on the pump video. The Safety Committee is developing PowerPoint presentations on mechanical integrity considerations. Next year's conference will include a session presenting IIAR educational materials.

The last "Condenser" reported on the "Weibull analysis" of relief valve testing, which was presented during the Research Panel Session. The Research Committee is also developing a scope for the quantitative risk analysis of using dilution tanks. The goal is to establish a technical background to discontinue the use of dilution tanks in most circumstances. Alternatives to release scenarios are to be considered.

There were the usual technical presentations of technical papers, workshops and technomercials. The technical papers can be found on the IIAR website. Some of the workshops will be developed into articles for the *Condenser*.

There were three panel discussions. In addition to the Research Committee Panel mentioned above, two other panel discussions were very important in providing feedback on current topics. The Natural Refrigerants panel presented arguments for and against the IIAR expanding its scope to include other natural refrigerants. Arguments against an expansion of scope revolved around the need to strive toward perfection of ammonia technology and limited resources for expanding scope. Arguments for scope expansion include end-users who are interested in CO_2 and perhaps other natural refrigerants, and there is no better community to provide this technology than IIAR with all of its categories of refrigeration professionals. The audience overwhelmingly supported an expansion of the IIAR into other natural refrigerants, and some even offered that a name change was in order. There was some written dissent provided by the feedback forms. Subsequently, the IIAR Board of Directors moved that a permanent committee was needed for CO_2 technology. Anyone willing to offer their expertise in this field should contact the IIAR to discuss upcoming committee work. The need for work on hydrocarbon refrigerant technology will be re-evaluated periodically.

The "Big Issues" session was conducted to get membership feedback on a few controversial topics. Arguments for and against "shunt-tripping" were presented by the panelists. Most in attendance were proponents of shunt tripping (being able to remove all electrical power to an engine room). There are some additional considerations to be made before the IIAR will act to implement shunt tripping requirements in our standards, such as how this might affect process room equipment of all types, and whether or not we are inviting the classification of electrical equipment co-located with ammonia systems to be considered NFPA Class I, Division 2. These considerations will be meted out in the next couple of years in preparation for a revision to IIAR-2. Dilution tanks were also discussed. Overwhelmingly, there was no support for continuing this requirement, and current efforts to remove it from codes should continue in earnest. The location ammonia equipment within process rooms was discussed. The result of this was less definitive. Most agreed that it is best if this equipment could be eliminated or reduced as much as possible. In cases where it is not possible, safety requirements should be implemented. The ASHRAE 15, section 7.2.2 exception for limitations on refrigerant use in industrial facilities was discussed. It was noted that the language requiring all refrigerant containing parts in systems exceeding 100 hp (evaporators and condensers excepted) was likely derived from a classic (older style) high pressure liquid distribution system. Reconsideration of this language could allow for some flexibility in the application of certain equipment.


1706

GALAXY™ Series

High Efficiency Packaged Chillers

- NH_3 – A Sustainable Refrigerant
- Low Refrigerant Charge
- Reduced Installation Costs
- Quality GEA Plate and Frame HX
- Reduced PSM Requirements
- GForce™ Touch-Screen Controls

GEA Refrigeration Technologies

GEA Refrigeration North America, Inc.
3475 Board Rd., York, Pennsylvania 17406
Tel: 800-888-4337
Tel: 717-767-6411
Fax: 717-764-3627
Email: sales.fes@geagroup.com
Web: www.geafes.com