Ammonia Refrigeration Series

Intermediate Ammonia Refrigeration Systems

December 2–4, 2015
Madison, Wisconsin

- Increase your knowledge of ammonia refrigeration
- Learn more about ammonia refrigeration equipment
- Consider system optimization strategies
- Review application tips and traps

Easy enroll options: online or by phone. See inside.
Bridge the Gap Between Principles and Practice

Building on fundamental concepts and practices, this course will enhance your understanding of the principles and operation of ammonia refrigeration systems. The intermediate-level content will further develop your background in refrigerants (ammonia), psychrometrics, thermodynamics, refrigeration cycles, and related equipment, as applied to ammonia refrigeration systems.

Key Course Topics

- Refrigeration load calculations
- Psychrometrics
- Ammonia refrigeration system principles and best practices for operation
- Troubleshooting techniques
- Optimization

Who Should Attend

The course has been specifically designed for:
- Refrigeration system operators and technicians
- Plant and facilities engineers
- Design and application engineers
- Ammonia refrigeration contractors
- Others wanting to expand their knowledge of ammonia refrigeration system principles and practices

Because this is an intermediate course, we expect attendees to have completed our Introduction to Ammonia Refrigeration Systems course or have significant working experience with refrigeration systems. To benefit fully, you should have basic knowledge of fluid properties, psychrometrics, and refrigeration system principles.

Past Participants Say…

“AN INCREDIBLE WEALTH OF KNOWLEDGE AND EXPERIENCE WITH REAL-WORLD APPLICATION!”

“I LIKED HOW DO’S AND DON’TS WERE GIVEN, AS WELL AS RECOMMENDATIONS.”

“VERY INFORMATIVE MATERIALS AND EXCELLENT PRESENTATIONS.”

“The course tied up a lot of loose ends for me. Very worthwhile.”

“I LIKED THE INSTRUCTORS’ ABILITY TO ANSWER QUESTIONS AND GIVE REAL-WORLD EXAMPLES. BOTH INSTRUCTORS WERE EXTREMELY KNOWLEDGEABLE.”

Benefits for You

- Expand your knowledge of ammonia refrigeration
- Learn techniques to optimize your system
- Increase your understanding of equipment used in ammonia refrigeration systems
- Learn application-specific tips and traps
- Receive a valuable set of ammonia refrigeration notes

Industrial Refrigeration Consortium (IRC)

The IRC, a collaborative effort between the University of Wisconsin–Madison and industry, offers its members practical refrigeration information and application-oriented research, a telephone hotline, Internet-based information resources, on-site technical assistance, and specialized publications. To learn more, check the IRC website at irc.wisc.edu, email IRC director Douglas Reindl, dreindl@wisc.edu, or phone toll free 866-635-4721.

Expert Instructors

James L. Denkmann received a BSME degree from Washington University. Denkmann spent 10 years in mechanical contracting and then served as a project manager with several large consulting firms. In 1986, he started his own consulting firm in Chicago, concentrating on thermal storage and refrigeration systems. He currently is a principal in his own consulting company. Denkmann is also an instructor in other ammonia refrigeration courses at the University of Wisconsin–Madison.

Todd B. Jekel, PhD, PE, is a research scientist and assistant director with the Industrial Refrigeration Consortium (IRC) at the University of Wisconsin–Madison. Jekel has been actively conducting research on refrigeration systems including vessel design practices, oil separators, and analysis of dehumidification alternatives for cold storage warehouses.

Douglas T. Reindl, PhD, PE, holds degrees from the Milwaukee School of Engineering and the University of Wisconsin–Madison. Reindl has been involved in field evaluation, simulation, and modeling of refrigeration systems, advanced refrigeration cycles, thermal energy storage, and HVAC systems. Reindl is a professor in the Department of Engineering Professional Development at the University of Wisconsin–Madison and director of the Industrial Refrigeration Consortium (IRC).

Daniel Dettmers is an associate researcher with the Industrial Refrigeration Consortium (IRC) at the University of Wisconsin–Madison. Dettmers’ expertise includes mechanical integrity, long-range refrigeration system planning, refrigeration system design, and related areas. An experienced instructor, he provides seminar training and technical presentations to a variety of audiences. Dettmers is a principal author of the IRC’s mechanical integrity guidebooks.
**Course Outline**

**Day 1**

**Workshop Introduction**  
*Douglas T. Reindl, PhD, PE*  
Professor, Department of Engineering  
Professional Development  
Director, Industrial Refrigeration Consortium (IRC)  
University of Wisconsin–Madison

**Refrigeration Systems Review**  
- Introduction to types of systems: direct expansion, flooded, liquid overfeed  
- System components  
- Basic arrangements  
- Refrigerant selection criteria  
*Douglas T. Reindl*

**Properties of Ammonia Refrigerants**  
- Fundamental properties: pressure, volume, temperature  
- Derived properties: enthalpy, internal energy, transport  
- Phase change  
- Diagnostics: pressure vs. enthalpy, pressure vs. temperature  
- Refrigerant comparison: CFCs, ammonia, water, CO₂  
- Flash gas  
- Subcooling and superheat  
- Influence of water in ammonia refrigerant properties  
*Douglas T. Reindl*

**Psychrometric Properties and Processes**  
- Definitions: dry bulb, wet bulb temperatures, humidity ratio, psychrometric chart  
- Psychrometric processes: latent and sensible energy changes  
- Effects of refrigerant evaporating temperature on space humidity levels  
*Todd B. Jekel, PhD, PE*  
Assistant Director, IRC

**Refrigeration Load Calculations**  
- Temperature requirements  
- Envelope, product, and internal loads  
- Evaporator fan heat gains  
- Make-up air loads  
- Door loads–theory vs. real-world  
*Todd B. Jekel*

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**Day 2**

**Refrigeration Cycles and Cycle Performance**  
- Conservation principles  
- Performance measures  
*Douglas T. Reindl*

**Ideal Cycles and Actual Cycles**  
- Capacity and required refrigerant mass flow rates  
- Overview of multi-stage systems  
*Douglas T. Reindl*

**Compressors and Compressor Performance**  
- Interpreting compressor maps  
- Correcting for actual compressor application/operation  
- Compression ratio limits  
- Off-design operation  
- Unloaders and part-load performance  
- Oil cooler heat rejection methods (screw compressors)  
- Economized ratings - when to/not to use (screw compressors)  
*Douglas T. Reindl*

**Compressor Workshop**

**Vessels and Refrigerant Pumps**  
- Types: high-pressure receiver, low-pressure accumulator, flash intercooler  
- Configurations: horizontal or vertical  
- Ratings  
- Proper practices for system integration  
- Knock-out velocity  
- Down-comer sizing  
- Pump types and performance curves  
- Net positive suction head required vs. available  
- Refrigerant pump cavitation (causes and cures)  
*Todd B. Jekel*

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**Day 3**

**Evaporators**  
- Types  
- Performance characteristics  
- Selection and operation  
- Configuration: top feed or bottom feed  
- Defrosting techniques  
- Rating  
- Evaporator pressure regulators  
- Determining optimum refrigerant feed rates (overfeed systems)  
*James L. Denkmann*  
President, Denkmann Thermal Storage, Ltd.

**Condensers and Heat Recovery**  
- Types  
- Performance characteristics  
- Selection  
- Heat recovery potential  
*Daniel J. Dettmers*  
Research Engineer, IRC

**System Troubleshooting**  
- Condensers: liquid refrigerant hold-up, proper practices for parallel condenser operation  
- Evaporator defrost best-practices  
- Open question and answer  
*James L. Denkmann*

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**Course Schedule**

Registration and course will be held at  
The Pyle Center  
702 Langdon Street  
Madison, WI

**Day 1**

8:00 a.m. to 8:30 a.m. Registration and Coffee  
8:30 a.m. to 5:00 p.m. Class

**Day 2**

8:00 a.m. to 8:15 a.m. Coffee and Conversation  
8:15 a.m. to 5:00 p.m. Class

**Day 3**

8:00 a.m. to 8:15 a.m. Coffee and Conversation  
8:15 a.m. to 2:30 p.m. Class  
Midmorning and midafternoon refreshments and noon lunches will be provided all three days.

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**ENROLL ONLINE TODAY!**
Four Easy Ways to Enroll

ENROLL ONLINE TODAY!

Course Information
Please enroll me in Intermediate Ammonia Refrigeration Systems
☐ Course #P521 December 2–4, 2015 in Madison, Wisconsin Fee: $1295
☐ Course #P521 December 2–4, 2015 in Madison, Wisconsin Industrial Refrigeration Consortium (IRC) Member Fee: $1095

Personal Information (Please print clearly.)

Name ____________________________
Title ____________________________
Company ____________________________
Address ____________________________
City/State/Zip ____________________________
Phone (_____) _______ Fax (_____) _______
E-mail ____________________________

Related Courses from UW–Madison

Process Safety Management Audits for Compliance and Continuous Safety Improvement
January 13–15, 2016, Course #P949
Introduction to Ammonia Refrigeration Systems
March 2–4, 2016, Course #P950
October 12–14, 2016, Course #R158
Fundamentals of HVAC
March 9–11, 2016, Course #P951
September 7–9, 2016, Course #R155
Ammonia Refrigeration System Safety
April 13–15, 2016, Course #P952
Design of Ammonia Refrigeration Systems for Peak Performance and Efficiency
September 12–16, 2016, Course #R156
Process Hazard Analysis (Emphasizing Ammonia Refrigeration Systems)
September 21–23, 2016, Course #R157
Principles and Practices of Mechanical Integrity for Industrial Refrigeration Systems
November 2–4, 2016, Course #R159

To receive additional information on any of these courses, please call toll free 800-462-0876 and ask for Douglas Reindl, program director. You can also send an email message to custserv@epd.engr.wisc.edu or check out these courses on our website at epd.engr.wisc.edu/ammoniarefrigeration.

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Need to Know More?
Call toll free 800-462-0876 and ask for
Program Director: Douglas T. Reindl dreindl@wisc.edu
Program Associate: Mary Danielson Or email custserv@epd.engr.wisc.edu

General Information
Fee Covers Notebook, course materials, break refreshments, lunches, and certificate.
Cancellation If you cannot attend please notify us at least seven days prior to the course start, and we will refund your fee. Cancellations received after that date and no-shows are subject to a $150 administrative fee per course. You may enroll a substitute at any time before the course starts.
Location The Pyle Center, 702 Langdon Street, Madison, WI.
Phone messages: 608-262-1122.
Accommodations We have reserved a block of guest rooms (rates starting at $119, including continental breakfast) at Lowell Center, 610 Langdon Street, Madison, WI. Reserve a room online at epd.engr.wisc.edu/online or call 866-301-7153 or 608-256-2621 and indicate that you will be attending this course under group code P521EPD. Room requests after November 1 will be subject to availability. Other fees and restrictions may apply.
Earn Continuing Education Credit By participating in this course, you will earn 20 Professional Development Hours (PDH) or 2.0 Continuing Education Units (CEU).