Ejector Design for Vapor Compression Systems

A short course on the design and integration of ejectors into refrigeration and air-conditioning systems

Sunday, July 10, 2022, 8:00 a.m. to 12:00 p.m.

Rawls Hall
Purdue University
West Lafayette, Indiana

Organized by
U. S. National Committee of the IIR
Ray W. Herrick Laboratories

Short Course Description

Design and integration of two-phase ejectors into vapor-compression systems for work recovery has been a topic of increasing interest for the past 10 to 15 years. Ejectors are attractive because they offer a low-cost, simple, and reliable method to dramatically improve cycle efficiency. Numerous studies have successfully designed and implemented ejectors for specific systems, from which general guidelines can be developed to design ejector systems for a variety of applications. Ejectors have made a significant impact in transcritical R744 commercial refrigeration systems and have the potential for similar improvements in many other applications as well. The use of ejectors to improve the efficiency of vapor-compression systems is likely to expand as concerns increase over the energy efficiency of refrigeration, air-conditioning, and heat pump systems. This short course will help participants to understand which systems would be good applications for ejectors and how to design the ejector and integrate it into the system to achieve optimum performance. Recognized experts in fundamental and applied ejector research will share their knowledge and experiences of successfully designing and integrating ejectors into refrigeration and air-conditioning systems for a wide range of fluids and applications.

Specific topics to be covered include:

- Basics of ejector operation
- Different types of ejectors
- Ejector design and basic design guidelines
- Modeling approaches
- Performance predictions
- Different configurations for capacity modulation
- Integration of ejectors into different types of vapor-compression systems
- Ejector selection for different refrigerants
- Cycle control with ejector systems
- Design considerations for other system components when an ejector is used
- Case studies of transcritical R744 commercial refrigeration systems with ejectors

*****_Electronic presentation files will be provided to all participants. Those attending the short course should bring a laptop computer to follow along and take notes._

EJECTOR SHORT COURSE SCHEDULE - Sunday, July 10, 2022

7:30 am Registration (continental breakfast provided)

8:00 am **Ejector Working Principles and Background**
Stefan Elbel, University of Illinois / Creative Thermal Solutions
Fundamentals of ejector operation; comparison of ejectors to expanders; heat driven ejectors vs. work recovery ejectors; heat driven ejector cycle; vapor-compression cycle with ejector for work recovery; ejector performance metrics

8:45 am **Ejector Implementation and Application**
Stefan Elbel, University of Illinois / Creative Thermal Solutions
Working fluids in ejector cycles; application of ejector work recovery; ejectors for compressor unloading vs. ejectors for evaporator improvement; alternate ejector cycles

9:15 am **Ejector Design and Modeling**
Neal Lawrence, Gradient
Ejector design guidelines and critical ejector dimensions; 0-D ejector modeling approaches and ejector performance predictions; multi-dimensional ejector modeling resources

10:00 am Coffee Break (refreshments provided)

10:15 am **Ejector Control**
Neal Lawrence, Gradient
Control of ejectors and ejector cycles; capacity modulation in ejector cycles; adjustable ejector vs. parallel ejectors; evaporator flow rate control

10:45 am **Ejectors for Commercial Refrigeration**
Shitong Zha, Heatcraft Refrigeration
Transcritical CO_2 refrigeration cycles for commercial refrigeration; high-lift, low-lift, and liquid ejectors; application of different ejector designs in CO_2 commercial refrigeration systems; successful implementation examples from industry

11:30 am **Current and Future Challenges in Ejector Research**
Stefan Elbel, University of Illinois / Creative Thermal Solutions
Other critical components that affect ejector cycle performance; low-cost ejector design

12:00 pm Box Lunch (provided)

Ejector Short Course Speaker Biographies

Dr. Stefan Elbel received his MS and PhD degrees in Mechanical Engineering from the University of Illinois at Urbana-Champaign (UIUC), where he currently holds an appointment as Research Assistant Professor. He is the Associate Director of the Air-Conditioning and Refrigeration Center (ACRC). Since 2007 he has also been the Chief Engineer at Creative Thermal Solutions, Inc. (CTS). Dr. Elbel has over 20 years of R&D experience in advanced air-conditioning and refrigeration systems for mobile and stationary applications using low-GWP refrigerants. Motivated by the renewed interest in transcritical CO_2, he was among the first researchers to systematically investigate and optimize ejectors for HVAC&R systems.

Dr. Neal Lawrence is a Thermal Research Engineer at Gradient and has previously worked as a Research Engineer at Creative Thermal Solutions, Inc. (CTS). He received his BS degree in Mechanical Engineering from the University of Wisconsin-Madison and his MS and PhD degrees in Mechanical Engineering from the University of Illinois at Urbana-Champaign. His graduate research work in the Air Conditioning and Refrigeration Center (ACRC) focused on implementation and application of ejectors in vapor-compression systems for a range of natural and synthetic refrigerants, and he continues to research design and implementation of ejectors in various systems. He has performed experimental and numerical research on ejectors for air-conditioning and refrigeration systems for over 10 years and has over 30 publications in the field of ejector technology.

Dr. Shitong Zha received her B.S and M.S. in Mechanical Engineering and her PhD in Energy Engineering in Tianjin University (China). From 2004 to 2006, Dr. Zha worked on CO_2 refrigeration, heat pump and CO_2 ejector development as a post-doctoral researcher at NTNU (Norway). She worked at Hillphoenix until 2016 on developing technologies to improve refrigeration system efficiency and decrease environmental effects, including implementation of CO_2 in commercial and industrial refrigeration systems. Her work has focused on developing advanced commercial CO_2 refrigeration systems as a Principal Engineer at Heatcraft Refrigeration Products since 2016.