microgroove™ Update

Attain High Energy Efficiency with Less Materials Using Smaller-Diameter, Inner-Grooved Copper Tubes

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PRESENTATIONS

TECHNICAL PAPERS

The Tenth IIR Gustav Lorentzen Conference on Natural Refrigerants

1. "Developing Low Charge R290 Room Air Conditioner by Using Smaller Diameter Copper Tubes" by Guoliang Ding, Wei Wu, Tao Ren, Yongxin Zheng, Yifeng Gao, Ji Song, Zhongmin Liu and Shaokai Chen

The Fourteenth International Refrigeration and Air Conditioning Conference

1. "Principle of Designing Fin-And-Tube Heat Exchanger with Smaller Diameter Tubes for Air Conditioner" by Wei Wu, Guoliang Ding, Yongxin Zheng, Yifeng Gao and Ji Song

2. "Simulation-Based Comparison of Optimized AC Coils Using Small Diameter Copper and Aluminum Microchannel Tubes" by John Hipchen, Robert Weed, Ming Zhang, Dennis Nasuta.

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Small Tubes of Copper in ACR Applications

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NEW RESEARCH UNDERSCORES BEST PRACTICES IN COIL DESIGN

Computer simulations and design case studies illustrate how to design heat exchangers using smaller diameter copper tubes. The International Copper Association supports several research initiatives that are exploring the design space for coils made from smaller diameter copper tubes both in the US and China.

New research results are slated for presentation at two international conferences this year, including the Tenth Gustav Lorentzen Conference on Natural Refrigerants in June (GLC); and the Fourteenth International Refrigeration and Air Conditioning Conference in July (Purdue).

Evolving Design Principles

Professor Guoliang Ding of the Institute of Refrigeration and Cryogenics (IRC) at SJTU has been researching ways to minimize refrigerant volume for safe room air conditioners with R290. Ding and his colleagues will present simulations and case studies of recent research at both GLC and Purdue. In both case studies, the refrigerant volume is significantly reduced by reducing the diameter of the copper tubes while still meeting performance objectives.

From this research, various design principles have emerged of great value to anyone seeking to optimize material usage in air conditioning and refrigeration applications, whether for an evaporator or a condenser. The design and optimization of heat exchangers requires the use of computational fluid dynamics (CFD) methods to analyze the airflow around the tubes and fins and also involves computer simulations of refrigerant flow and temperatures inside the tubes. Professor Ding and his group have refined useful design principles as applied to smaller diameter copper tubes. The knowledge based evolution method (KBEM) has been developed into a step-by-step procedure that simulates and optimizes every aspect of the heat exchanger design, from tube spacing to fin type to tube circuitry.

Professor Ding will present a new case study on an R290 room air conditioner with 5 mm tubes at GLC and his student Wei Wu will describe these design principles along with another new case study on a split system at the Purdue Conferences.

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RTPF or BAM

Given set of performance criteria, a round tube plate fin (RTPF) heat exchanger made with smaller diameter tubes can be made smaller and lighter than one made with conventional tubes. Now new research also compares a RTPF heat exchanger with a brazed-aluminum multichannel (BAM) heat exchanger. The method of comparison was simple. A search was made for a state-of-the-art, best-in-class BAM heat exchanger. The performance specifications were then identified and set as a target for the RTPF heat-exchanger. The design space was searched for candidate RTPF designs that met the performance specification. The simulations were performed at Optimized Thermal Systems, College Park, Maryland and the research results will be presented at the Purdue Conferences in July.

This latest research is considered vital by many system designers who wish to compare the best RTPF designs directly with the best BAM designs in terms of size, weight and refrigerant charge reduction. Other factors such as manufacturing costs, durability and drainage must also be considered when selecting a heat exchanger for any particular application.

Step-by-Step Design

A methodical approach to the design of heat exchangers using smaller diameter copper tubes is summarized by the following steps.

Step 1: Determine the best ratio of transverse tube pitch to longitudinal tube pitch by fin efficiency analysis.

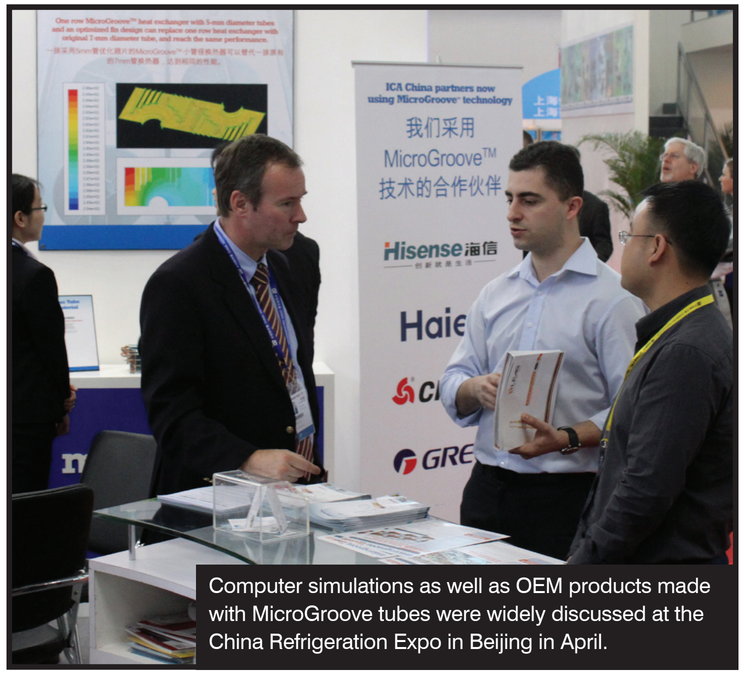
Step 2: Optimize transverse tube pitch and longitudinal tube pitch by analysis of performance and material cost.

Step 3: Optimize fin pattern by comparing performances of fins with different patterns through CFD-based simulations.

Step 4: Test the performance of heat exchanger with smaller diameter tubes.

Step 5: Develop empiric equations for predicting performance of heat exchanger with smaller diameter tubes.

For details about the design principles, attend the Gustav Lorentzen Conference or the Purdue Conferences and see the conference proceedings. Visit www.microgroove.net for information about smaller diameter copper tubes and where to obtain them.



Computer simulations as well as OEM products made with MicroGroove tubes were widely discussed at the China Refrigeration Expo in Beijing in April.

IN THE SPOTLIGHT

Professor G.L. Ding

The Institute of Refrigeration and Cryogenics at Shanghai Jiao Tong University

DING Guoliang (G. L. Ding) was graduated from the Institute of Refrigeration and Cryogenics at Shanghai Jiao Tong University (SJTU) in 1993 and subsequently promoted to professor in 1998. He is the chairman of the Department of Power and Energy Engineering, SJTU; the president of Shanghai Society of Refrigeration; and the editorial board member of three international journals and three domestic journals. At various times, he worked as a post-doctoral researcher and a visiting professor at the University Karlsruhe, in Germany; and as a visiting professor at the University of Tokyo, in Japan.

Professor Ding has published 11 books, about 100 domestic journal papers, and about 80 international journal papers. These publications collectively have received more than 2000 citations. He owns 30 Chinese patents and 4 international patents. His major contributions are simulation and optimization techniques for refrigeration and air conditioning systems. The simulation and optimization techniques developed in his research group have been implemented with significant impact at many of top refrigeration and air conditioning companies in the world.

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