microgroove™ Update

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

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PRESENTATIONS

UPCOMING EVENTS

AHR Expo Jan 21 to 23, 2014
Javits Convention Center, New York, NY
MicroGroove Exhibit: Booth 5803
Suppliers of small diameter copper tube will exhibit at this event

11th International Energy Agency Heat Pump Conference
May 12-16, 2014 • Montreal, Quebec, Canada
A technical paper on MicroGroove technology will be presented

More info on "Events" page

RESEARCH PUBLICATIONS

"Developing a Low Charge R290 Air Conditioner Using Smaller Diameter Copper Tubes," Fourth IIR Conference on Thermophysical Properties and Transfer Processes of Refrigerants, Delft, the Netherlands. www.tptpr2013.nl

"Developing a Low Charge R290 Air Conditioner Using Smaller Diameter Copper Tubes," ATMOsphere America, Case Study presented by John Hipchen. www.atmo.org/media.presentation.php?id=282

***NEW* White Paper**
"Building Better Appliances with Smaller Diameter-Copper Tubes" By Nigel Cotton, Robert Weed and Wenson Zheng, Copper Alliance, *International Appliance Manufacturing, October 2013.*

WEBINAR, JUNE 2013

"MicroGroove Copper-Tube Coils: Moving Beyond Residential Applications"
Free registration is open via www.microgroove.net/webinars or directly here.
View the MicroGroove webinar series anytime for free via MicroGrooveTech channel on YouTube.

SEMINAR, JAN 2013

Download PDF of slideshows from the **"MicroGroove Technology for Commerical Systems"** seminar as presented at the AHR Expo 2013.

More info on "Events" page

MICROGROOVE SUCCESSES SPUR NEW RESEARCH

As a result of changes in the market, research was initiated into MicroGroove smaller diameter inner grooved copper tubes. Many hurdles were overcome in bringing new products to market. Ultimately, the technology has been proven and is now widely employed in the mass production of air conditioners.

A summary of the first eight years of MicroGroove technology appears in the current issue of *International Appliance Manufacturing* [1].

Yet, as the old proverb says, "Nothing succeeds like success."

Market conditions spurred manufacturers to rethink their coil designs for many types of commercial and residential appliances. MicroGroove smaller-diameter tubes offer many advantages: improved system efficiency, reduced refrigerant volume, tolerance of higher pressures, less system weight and compact coil designs.

Here are two recently delivered research findings. The research is motivated by the desires to improve on existing MicroGroove AC applications; and to ready MicroGroove technology for new applications.

John Hipchen reported on the use of R290 with MicroGroove tubes.

ATMO DEBUT

MicroGroove made its debut at an ATMOsphere event this year both as a sponsor and a presenter. Around 200 HVAC&R stakeholders gathered at ATMOsphere America 2013 in Washington, D.C. to discuss the business case for natural refrigerants in the U.S. and Canada and the game-changing role North America could assume in the mainstreaming of natural refrigerant technologies.

Representatives from over 100 different companies and organizations engaged in lively discussions and debates about the latest natural refrigerant market developments, as well as the regulatory and economic barriers that still need to be overcome. Leading suppliers presented their latest technology case studies; consumer-goods brands and industrial end-users spoke about their experiences with CO2, ammonia and hydrocarbons; and representatives from different governmental bodies addressed recent regulatory developments in both the U.S. and Canada.

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One of the main conclusions drawn from ATMOsphere America 2013 was that natural refrigerants are not just beneficial for the environment; they can also be very efficient, safely operable and economically viable, and they are ripe for expansion in the North American market.

ICA CASE STUDY ON R290

The technology case study titled "Developing a Low Charge R290 Air Conditioner Using Smaller Diameter Copper Tubes" was presented by John Hipchen, President of Exel Consulting on behalf of Wenson Zheng, Deputy Director of Technology for ICA [2]. The ICA-sponsored research project involved the development of a split air-conditioning systems with 5-mm MicroGroove copper tubes in the evaporator and 7-mm MicroGroove copper tubes in the condenser.

As a result of using the smaller diameter copper tubes, the refrigerant charge in the evaporator was only a fraction of the total refrigerant charge. Furthermore, without compromising the performance, the total charge was substantially reduced compared to product designs using larger diameter copper tubes.

The ICA-sponsored research results were of special interest to product design engineers from companies looking ahead toward the adoption of hydrocarbons and carbon dioxide as refrigerants.

The Technology Case Study Session 2 at ATMOsphere America 2013 was moderated by Michael Englebright of Carel who is shown here at the podium. Seated from left to right are Brian Porter of Blissfield; Benoit Radier of Cimco; Jim Hower of Danfoss; Derek Hamilton of Star Refrigeration; Ilana Camber and Preston Blay of BAC; and John Hipchen of Exel Consulting.

MORE R290 CASE STUDIES

Several case studies presented at ATMOsphere addressed the use of R290 in applications such as bottle coolers, plug-in units, light commercial freezers and air conditioners. The current 150-gram maximum allowable propane charge limit recently became permissible in the US for certain domestic and light commercial refrigeration applications. Approaches for complying with these charge limits were outlined by Douglas Schmidt of Embraco North America and Vicente Guilabert Hernandez, from Huayi Compressor Barcelona S.L.

Representatives from over 100 different companies and organizations engaged in lively discussions and debates at the 2013 ATMOsphere America event.

"Heat transfer engineers at the major OEMs are discovering that smaller is better when it comes to air-conditioners, heat pumps and refrigeration systems operating efficiently with eco-friendly refrigerants. ICA members are ready to deliver MicroGroove tubes in volume just as the design engineers seek to overcome barriers to the adoption of economical and eco-friendly refrigerants," says Nigel Cotton, MicroGroove Team Leader for the International Copper Association.

The ICA presentation by John Hipchen as well as all other conference presentations can be downloaded directly from the ATMO website (www.atmo.org/media.presentation.php?id=270). The ICA presentation can also be found online at microgroove.net.

CONFERENCE ON THERMOPHYSICAL PROPERTIES

Meanwhile, a paper on R290 applications of MicroGroove technology was also presented at the Fourth IIR Conference on Thermophysical Properties and Transfer Processes of Refrigerants. The TPTPR conference is an international conference held every four years in various cities. See www.tptpr2013.nl for more information on the 2013 conference held in Delft, the Netherlands.

The ICA research paper titled "Developing a Low Charge R290 Air Conditioner Using Smaller Diameter Copper Tubes" was a culmination of research on 11 different heat exchanger designs [3]. Preliminary results for one design were presented at the 2012 Purdue Conferences [4].

The research was conducted by Yifeng "Frank" Gao and Ji "Kerry" Song of the ICA Shanghai office in cooperation with Jingdan Gao and Professor Guoliang Ding of the Institute of Refrigeration and Cryogenics, Shanghai Jiao Tong University, Shanghai.

A step-by-step methodology for optimizing fins to smaller diameter tubes is presented.

ELEVEN DIFFERENT FIN-AND-TUBE HEAT EXCHANGERS

Furthermore, laboratory results are given as a graph representing the performance of eleven designs of heat exchangers with fin pitches between 1.4 mm and 1.1 mm. As the fin pitch decreases, the experimentally measured values of the Colburn heat transfer factors increases. The resultant graph of proposed Colburn heat transfer factor (or *j* factor) versus air Reynolds number allows for the prediction the heat transfer rate of fin-and-tube heat exchanger with 5-mm diameter tubes. The mean deviations of the proposed *j* correlation are 6.5 percent.

When using smaller diameter copper tubes, the highest efficiencies can be realized by optimizing the fin design to the smaller diameter tubes. The investigators optimized the louver fins for 5-mm diameter tubes using a method based on Computational Fluid Dynamics (CFD).

WHAT'S IN THE WORKS

Looking ahead, MicroGroove is making inroads into many other product applications.

Look for new research on software tools for the development of commercial heat exchanger coils as well as new research results on heat pumps, R744 systems and all copper antimicrobial coils.

"This ICA-sponsored research is of special interest to product design engineers from companies that are switching to MicroGroove smaller diameter copper tubes for condenser and evaporator coils," says Nigel Cotton. "ICA is developing tools to assist in the development of coils optimized for the smaller diameter copper tubes. Further, working with many refrigerants, these research results can be applied and coil design methodologies followed to optimize system designs."

References

[1] Nigel Cotton, Robert Weed and Wenson Zheng, Copper Alliance, "Building Better Appliances with Smaller Diameter-Copper Tubes," *International Appliance Manufacturing*, October 2013.

[2] "Developing a Low Charge R290 Air Conditioner Using Smaller Diameter Copper Tubes," ATMOsphere America, Case Study presented by John Hipchen. http://www.atmo.org/media.presentation.php?id=270

[3] "Developing a Low Charge R290 Air Conditioner Using Smaller Diameter Copper Tubes," Fourth IIR Conference on Thermophysical Properties and Transfer Processes of Refrigerants, Delft, the Netherlands. www.tptpr2013.nl

[4] "Principle of Designing Fin-and-Tube Heat Exchanger with Smaller Diameter Tubes for Air Conditioner," Fourteenth International Refrigeration and Air Conditioning Conference at the Purdue Conferences in West Lafayette, Indiana, July 2012. https://engineering.purdue.edu/Herrick/Events/2012Conf

SPOTLIGHT ON STEFANO FILIPPINI

The LU-VE way of conceiving and making refrigeration and air conditioning products, using avant-garde technologies, has become a benchmark for the entire industry. It is noteworthy that the Group has 1,300 square meters of R & D Laboratories. The LU-VE Group is an industry leader in developing more compact products with higher performance than earlier technology.

As the technical director, Stefano Filippini coordinates the activities of the Technical Office, developing new products, looking after special projects, and managing the laboratory where thermodynamic, aeraulic, electrical and acoustic testing is performed, to assure the continuous technological advancement of LU-VE products.

Filippini is also responsible for the development of software for the sizing and technical selection of LU-VE products and manages the collaboration with external research institutes and universities, in particular the *Politecnico di Milan*.

He has participated in international seminars, delivering papers on the most important new technical innovations developed at LU-VE. Since 2000 he has represented the company at the periodic meetings of *Eurovent*, which is an international certifying body comprising the major European manufacturers in this sector and he has been Chairman of the Heat Exchanger Committee since October 2011.

MICROGROOVE IS ONLINE

WWW.MICROGROOVE.NET

Visit MicroGroove online for the latest information about webcasts, technical papers and exhibits.

This multilingual catalog-brochure describes the new LCM condensers from LU-VE.

NANOGIANT AIR-COOLED CONDENSERS FROM LU-VE GROUP BOAST SMALLER DIAMETER COPPER TUBES

The LU-VE Group is a much admired manufacturer of ACR products. Its main offices are in Uboldo, about 20 km from Milan. However, LU-VE is very much an international entity. Seventy percent of its production is exported to 90 countries and there are fifteen sales companies in the LU-VE Group located in Australia, Austria, China/HK, Costa Rica, France, Germany, India, Poland (Gliwice and Warsaw), Russia, Singapore, Spain, UAE, and the United Kingdom.

Thanks to the work of the LU-VE Group Research and Development Laboratory, the brand new technology of the MINICHANNEL® coil is now available: It is a miniaturized solution with 5-mm diameter copper tubes and louvered aluminum fins. The MINICHANNEL coil is the basis for a new line of condensers, collectively dubbed the NanoGiant® condensers.

The midsized condensers are grouped into three classes based on fan diameters of 350 mm, 500 mm and 630 mm. The NanoGiant LCM 350 uses one to four fans for capacities from 9.3 to 44.0 kilowatts; LCM 500 uses one to three fans for 17.5 to 105.9 kW; and LCM 630 uses one to four fans for 24.8 to 247.2 kW.

Full specifications can be found in the NanoGiant catalog from the LU-VE Group.

Search for "NanoGiant" at www.luve.it or click here.

The air-cooled condensers are suitable for a wide range of refrigeration and air conditioning applications in a variety of residential and commercial buildings.

COIL RESEARCH

Stefano Filippini is the technical director at the LU-VE Group Research and Development Laboratory. He was an early proponent of MicroGroove technology, having delivered a paper at the IIR Second Workshop on Refrigerant Charge Reduction Conference, Stockholm, Sweden, 2010. That paper compared a typical MicroGroove smaller-diameter copper tube coil with a microchannel coil made of flat aluminum tubes with respect to many features, including refrigerant volume. In the paper, Filippini noted that the refrigerant volume for the coil made with 5-mm tubes could be made much less than the refrigerant volume for MicroChannel coils, because of the large header that is required to accommodate the tubes of the microchannel coils. The first webinar in the MicroGroove series of webinars highlighted the differences between MicroGroove and microchannel as tabulated by the Filipinni.

About the new coils made by LU-VE, Stefano Filippini says, "The extraordinarily efficient performance of the heat exchanger is due to the optimal combination of special-profile aluminum fins and high-efficiency 5-mm diameter copper tubes with internal grooves." According to Filippini, the coils are made in a consolidated production process that provides maximum flexibility and reliability.

Presently, the LCM product line is designed for HFC refrigerants, including R410A, with a standard maximum operating pressure equal to 50 bar. Apart from the LCM product line, interesting new applications for the MINICHANNEL coil include a compact refrigeration machine that uses hydrocarbons as refrigerant. Thanks to the extreme reduction in refrigerant charge, it is possible to reach high capacity and remain within the low charge levels specified by international standards. Another hot topic has to do with the use of carbon dioxide (R744) as a refrigerant. According to Filippini, the thermophysical properties of smaller-diameter copper tubes and R744 refrigerant are ideally suited to each other.

For more information, visit www.luve.it and contact one of the LU-VE sales offices in fifteen countries.

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