microgroove™ Update

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

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PRESENTATIONS

UPCOMING EVENTS

ATMOsphere America
MicroGroove is a Sponsor
June 25-26, 2015
Atlanta, Georgia

IIR International Congresses of Refrigeration (IIR ICR)
MicroGroove is a Sponsor
August 16-22, 2015
Yokohama, Japan

(More info on "Events" page)

TECHNICAL PAPERS

Ohrid Conference

1. Yoram Shabtay, John R.H. Black and Nigel D. Cotton, "New Copper-Based Heat Exchangers for R744 Refrigerant, Part I: New Technologies for Tubes and Coils"
2. Yoram Shabtay, John R.H. Black and Nigel D. Cotton, "New Copper-Based Heat Exchangers for R744 Refrigerant, Part II: System Design and Case Studies"

WEBINARS

The Copper Alliance recently provided a webinar presented by Brian McConnell, President of BOTI, in which the manufacturing technology to produce heat exchanger coils from MicroGroove Copper Tubes was described.

"The Manufacture of High-Efficiency Coils with MicroGroove Copper Tubes," with Brian McConnell, President of Burr Oak Tool can now be viewed on YouTube. https://youtu.be/YdSCto6FEVU

For more information, see the MicroGroove "Webinars" webpage www.microgroove.net/webinars on microgroove.net; and the MicroGrooveTech channel www.youtube.com/user/MicroGrooveTech on YouTube.

NEW COPPER TUBE TECHNOLOGIES

With a general trend toward downsizing bringing about material and refrigerant savings, smaller-diameter, inner-grooved, thin-walled tubes with outer diameters of 7 mm, 6.25 mm and 5 mm are now used in residential and commercial air conditioning and refrigeration applications, ranging from large commercial-sized heat exchangers to small heat exchangers for cold vending machines.

Such smaller-diameter copper tubes first appeared in window-type air-conditioners and evaporator coils for split systems as well as in outdoor condensers for residential applications. Initial manufacturing hurdles have been overcome and such tubes have now become the industry standard for a wide range of commercial, industrial, light commercial and residential air-conditioning, heat pump and refrigeration applications.

Now we can ask "What's next?" for the industry.

Several new tube technologies were briefly described in a review paper given at the recent Ohrid Conference on natural refrigerants and also in a presentation at the 2015 ATMOsphere America conference.

HIGH-STRENGTH COPPER

For higher-pressure applications, e.g., R744 refrigeration, the tubes, fittings and components must withstand high pressures. Plain and inner-grooved seamless tubes and fittings are available in a high-strength copper-iron alloy known as CuFe2P (and also known as C19400 or CW107C). The alloying elements are iron, zinc, phosphorus and magnesium. These alloys allow for a reduction of wall thickness and hence less material usage. What's more, existing machines and tools usually can process these alloys, and they are perfectly brazeable and weldable. These alloy tubes can sustain pressures 100 percent higher than standard ACR tubes. Various sized tubes for refrigerant distribution typically are rated to handle pressures up to 120 bar (i.e., 1740 psi or 12 MPa).

Another type of copper tube is made from deoxidized high phosphorus (DHP) copper, which is useful up to pressures of 120 bar, or more, depending on the tube diameter and tube wall thickness.

The product literature of copper tube suppliers should be consulted for more information.

MICROGROOVE DESIGN SOFTWARE

To obtain the highest performance from air conditioners made with small diameter tubes, it is necessary to apply certain principles to the design of fin-and-tube heat exchangers, including design principles for tube-and-fin geometries and spacing, fin-configuration and tube circuitry.

Research at leading international universities has resulted in the development of new airside and refrigerant-side correlations, particularly for 5-mm MicroGroove tubes. To make such correlations readily available to HVAC&R system designers and heat exchanger engineers, the Copper Alliance is working with Optimized Thermal Systems Inc. to implement the newly developed correlations into CoilDesigner® software, a proprietary heat exchanger simulation and design optimization tool developed by the Center for Environmental Energy Engineering (CEEE) at the University of Maryland.

LOOKING AHEAD

Smaller-diameter MicroGroove copper tubes are the current benchmark for heat exchanger coils but are not the final word. Investment in research and development is ongoing on new copper tube technologies that could enable new levels of heat transfer efficiency and capacity for next generation heat exchangers.

IN THE SPOTLIGHT

"HEAT TRANSFER SOLUTIONS" TAKES ADVANTAGE OF MICROGROOVE

Heat Transfer Solutions (HTS) is one of the world's largest suppliers of Heatcraft heat exchangers and ECO coolers for the HVAC&R markets. HTS is the culmination of many decades of growth, development and acquisition. HTS offers four key areas of thermodynamics expertise: 1) Stationary climate solutions; 2) Mobile climate solutions; 3) Food storage and transport-refrigeration solutions; and 4) Industrial processes solutions.

HTS has played a major role in developing and manufacturing custom heat transfer products for the commercial, industrial, telecommunications, transportation, and replacement markets. It has expanded its product offerings to accommodate nearly every heat transfer application, utilizing many types of materials to produce coil technologies that best fit its customers' requirements.

CO2 REFRIGERANT FOR COLD VENDING MACHINES

For the heat transfer surface industry, the development of refrigeration systems based on natural refrigerants has been one of the more interesting developments in recent memory. With an extensive line of products, software tools and market experience, HTS has led the way with the development of heat exchangers that use natural refrigerants and smaller-diameter copper tube. This work paves the way for CO2 refrigeration to be used in a wide range of commercial applications, from small vending machine applications to larger supermarket systems.

This Heatcraft heat exchanger with smaller diameter copper tubes is suitable for use with R744 refrigerant.

As a refrigerant, CO2 has many benefits, not the least of which is its low index for global warming potential. The GWP index is based on the assigned value of "1" for a molecule of carbon dioxide. High-GWP refrigerants can have GWP values of several thousands so a GWP of one is considered very low and very eco-friendly. As a consequence, NGOs such as "Refrigerants, Naturally!" have supported the development and use of CO2 refrigeration by large corporations [1, 2].

Meanwhile, compact heat exchangers suitable for use in CO2 refrigeration systems have been developed and proven successful. The heat exchangers offered by HTS are made from heavy-wall 5 mm, 7 mm, 1/4" and 5/16" diameter copper tubes. They have been widely used in cold vending machines and display cases, including both the evaporator and the condenser.

The smaller-diameter copper tubes provide higher strength, while keeping the heat exchanger weight down; and they allow for lower refrigerant volume, while saving on material costs. As a refrigerant, CO2 has a very high vapor density, which means it works very well with smaller diameter tube because of the minimal pressure drop. Typical operating pressures are 60 bars (870 psi) on the evaporator side and 130 bars (1885 psi) on the condenser/gas cooler side.

THE FUTURE IS GREEN

HTS provides these coils to various OEMs involved in the manufacture of cold vending machines and display cases for leading beverage brands worldwide, reducing the volume of atmosphere-harming refrigerants. In addition to CO2, HTS also offers alternative solutions that use other natural refrigerants such as propane and isobutane.

"The development of the manufacturing equipment to build such heat exchangers in high volume has changed the face of refrigeration and laid the foundation for further use of ultra-low-GWP refrigerants in the future," says Nigel Cotton, MicroGroove Team Leader at the International Copper Association. "The copper industry is committed to developing environmentally friendly refrigeration technology, especially technology that optimizes the use of natural refrigerants!"

REFERENCES

1. Amy Larkin, "Environmental Debt: The Hidden Costs of a Changing Global Economy," New York: Palgrave McMillan, 2013.
2. "Refrigerants, Naturally!" is a global, non-profit initiative of companies in the food and drink, food service and consumer goods sectors. For more information, see www.refrigerantsnaturally.com.