microgroove™ Update

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

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Presented by *THE NEWS* and *Appliance Design*.

Speaker: John Hipchen, President, Exel Consulting Group

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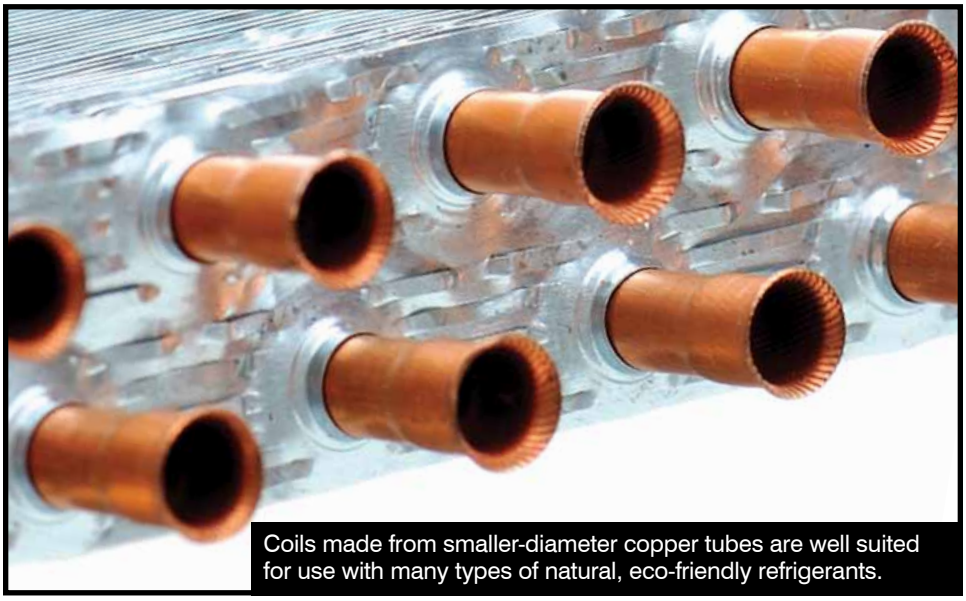
NATURAL REFRIGERANTS PERFORM BEST WITH MICROGROOVE TECHNOLOGY



Coils made from smaller-diameter copper tubes are well suited for use with many types of natural, eco-friendly refrigerants.

Natural refrigerants such as carbon dioxide and propane are fast becoming more attractive to OEMs and end-users for ACR and heating applications as technology advances.

Also known as R744, carbon dioxide is used as a refrigerant in a growing number of applications ranging from vending machines and refrigerated supermarket display cases to ice-skating rinks. Another natural refrigerant under consideration for use in air conditioner systems is propane, which is also known as R290. Propane is an eco-friendly hydrocarbon (chemical formula C_3H_8) with outstanding thermodynamic properties that make it well suited as a refrigerant for residential air conditioners.

The advantages of copper tubes in these applications include high thermal conductivity, corrosion resistance and strength. Smaller diameter copper tubes have even higher burst strengths and they allow for lower overall refrigerant volumes.

Copper is a proven technology with a well-established supply chain, including a network of trained installers with the know-how to ensure safety and reliability.

More on R744

In the transcritical refrigeration cycle pioneered by Gustav Lorentzen in the late eighties, the thermodynamic process after the compressor does not condense the gas into a liquid but merely cools the gas. Hence, the heat exchangers for this step are

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called "gas coolers" rather than condensers. Technological improvements with respect to high-pressure compressors, high-pressure expansion valves (HPEVs) and other components such as controls, pipework and heat exchangers have contributed to the feasibility of R744 as an eco-friendly refrigerant. A comprehensive 492-page Handbook details the science and technology of R744, including components such as compressors and heat exchangers [1]

More recently, researchers from LU-VE S.p.A. in Uboldo, Italy, presented a paper about heat exchangers for R744 applications at the International Congress of Refrigeration in Prague [2]. Their gas cooler tubes were made of a copper alloy and the evaporator coil was an off-the-shelf design made of copper tubes. This example highlights the trend toward smaller diameter tubes. Further improvements in heat transfer could be obtained using inner-grooved tubes.

For R744 as a refrigerant, gas cooler pressure is very high, typically in the range of 120 bar and burst pressure ratings may be several times higher. Maximum working pressures for the evaporation step in the transcritical cycle are less, typically in the 45 to 60 bar range. Traditional heat exchanger coil technology with copper tubes is well suited for both the gas cooler and the evaporator in R744 applications. The main requirement is that the thickness of the tube wall and header should be sufficient to withstand the high pressures. Interestingly, burst pressure increases as tube diameter decreases, so smaller diameter tubes would be especially appropriate for R744 applications.

More on R290

For propane (R290), the pressure requirements are much less. Perhaps the only drawback of propane is its flammability so the volume of refrigerant needs to be minimized compared to the room air volume to be cooled; and certain safety features must be included in the product designs.

In a recent study supported by ICA, a three-dimensional distributed parameter model was used for simulation and a knowledge-based evolution method (KBEM) optimizer was applied to optimize air conditioner heat exchangers with smaller diameter tube. Refrigerant charge was dramatically reduced using smaller diameter tubes. The experimental results confirmed the simulation results, demonstrating that smaller diameter copper tubes are suitable for developing safe room air conditioners with R290.

"Key technologies are maturing for bringing products with eco-friendly refrigerants to the marketplace," says Nigel Cotton, Global OEM Team Leader for ICA. "Smaller diameter copper tubes are an excellent match for many of these new refrigerants."

MicroGroove uses simple and familiar techniques well-known to manufacturers. The process is flexible and versatile because it does not require investment in complex brazing furnaces, and yet it results in superior products.

References

[1] "Natural Refrigerant CO2," a handbook edited by Walter Reulens, ATMOsphere 2009. Master Module 8 on "Components" was written by Professor Ezio Fornasieri *et alia* of the University of Padova. Compressors are described in Section 8.1 (pp. 348-382) and heat exchangers are described in section 8.2 (pp. 383-410) of the Handbook, available online free of charge as a PDF here: www.atmosphere2009.com/files/NaReCO2-handbook-2009.pdf

[2] Stefano Filippini and Umberto Merlo, "Air Cooled Heat Exchangers for CO2 Refrigeration Cycles," IIR 23rd International Congress of Refrigeration, August 2011, Paper 295.

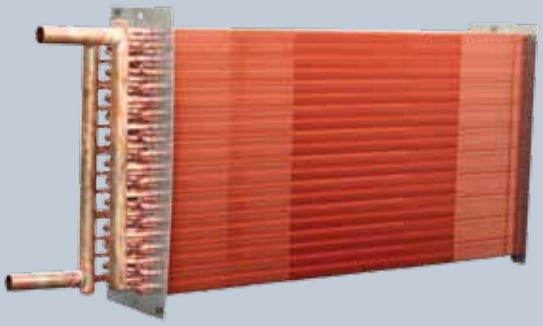
IN THE SPOTLIGHT

ANTIMICROBIAL MATERIALS

OEM companies such as the Chinese air-conditioning giant Chigo and Hydronic in France have already developed all-copper products expressly for their antimicrobial properties.

The use of all copper coils is not new but their use expressly to inhibit the growth of fungi and bacteria is a recent development that is expected to be an important factor in the development of innovative air conditioning and refrigeration products.

Bio build up on the coil may be reduced by using all copper coils, helping to maintain high levels of energy efficiency for longer times and avoiding energy efficiency drop off over time.



This ground-breaking antimicrobial copper coil air handling unit will harness the antimicrobial properties of copper in hospital applications. It is made in Europe by French manufacturer Hydronic in association with Centre d'Information du Cuivre, Laitons et Alliages (CICLA).