**Internal Surface Enhancements Boost Efficiency of Smaller Diameter Copper Tubes, Says International Copper Association**

*Inner Fins Boost Heat Transfer and Reduce Materials Usage*

**New York, New York (December 23, 2014)** – According to the International Copper Association, internal surface enhancements, or “inner fins” on tubes, substantially increase internal heat transfer coefficients (HTCs) of smaller diameter copper tubes in evaporator and condenser coils as well as gas coolers.

“Internal surface enhancements are beneficial in small-diameter copper tubes,” says Nigel Cotton, MicroGroove Team Leader for the International Copper Association. “Recent research proves microfins are effective down to 5 mm and even smaller diameters.”

Internal surface enhancements can more than double HTCs compared to smooth tubes. They are effective in evaporator coils, for which nucleation of vapor bubbles in the liquid refrigerant is paramount; and in condensers, for which the heat transfer across the boundary layer of the liquid refrigerant strongly influences the condensation HTC. By reducing the thickness of the boundary layer, the inner fins change the character of the flow from laminar to turbulent, thereby mixing the refrigerant and increasing the HTC.

It has also been demonstrated that internal enhancements can improve the performance of gas coolers for CO2 (*i.e.*, R744) refrigeration systems, where the refrigerant does not condense into a liquid.

“Surface enhancements increase heat transfer allowing for even less materials usage,” says Cotton. “MicroGroove technology refers to the combined effects of smaller diameters and enhanced inner surfaces. These features separately and together dramatically lower the HTCs.”

ICA member companies who supply tubes for ACR applications use a variety of internal surface enhancements to improve HTCs with minimal pressure drop penalty, depending on the tube application and its method of fabrication. For example, for tubes made by the roll-and-weld method of fabrication, various cross-hatch patterns can be embossed on the rolled copper strip prior to welding. These patterns include shallow cross-hatch, deep cross-hatch, V-shaped herringbone patterns and other proprietary patterns. Variables include the tube outer diameter, mean wall thickness, groove width and groove depth as well as the angle the groove makes with the wall of the copper tube.

Another common pattern is the helical tube enhancement, which can be introduced into the internal surfaces when tubes are extruded. This method of surface enhancement has been in use since the 1990s on larger diameter copper tubes and it continues to be widely employed in the case of smaller diameter copper tubes.

At the most recent IIR Gustav Lorentzen Conference on Natural Refrigerants, members of the research staff at the LU-VE Group discussed the merits of inner fins for use with propane and CO2, respectively, in papers titled “Design and analysis of R290 high capacity air to water heat pump with finned tube heat exchanger of small diameter” by E Navarro-Peris *et alia* (Paper 159); and “Latest development of air cooled heat exchangers for CO2 applications” by S. Filippini *et alia*. (Paper 18).

Another example of recent research on HTCs is a paper titled “Influence of Oil on Heat Transfer Characteristics of R410A Flow-Boiling in Conventional and Small Size Microfin Tubes” by Haitao Hu *et al.* which was presented at the 2014 Purdue Conferences (Paper ID 2347).

Additional research papers on HTCs are tabulated in the Technical Literature webpage section of microgroove.net. For more information, visit [www.microgroove.net](http://www.microgroove.net). Join the MicroGroove Group on LinkedIn to share your ideas about research directions and product development. [www.linkedin.com/groups/Microgroove-4498690](http://www.linkedin.com/groups/Microgroove-4498690).

**About ICA**

The International Copper Association, Ltd. (ICA) is the leading organization for promoting the use of copper worldwide. ICA’s mission is to promote the use of copper by communicating the unique attributes that make this sustainable element an essential contributor to the formation of life, to advances in science and technology, and to a higher standard of living worldwide. Visit [www.copperinfo.com](http://www.copperinfo.com) for more information about ICA.

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