**MicroGroove Heat Exchangers Ready-for-Use in Residential Refrigerators**

*Smaller Diameter Copper Tubes Favored for Efficient Household Appliances*

**New York, New York (15 October 2018)** – According to the International Copper Association, Inc. (ICA), MicroGroove has played a key role in the development of refrigeration systems made with propane (R-290) and isobutene (R-600a). The long-awaited U.S. EPA Final Rule allows 150 grams (5.29 ounces) of propane or isobutane to be used in household appliances in accordance with the 2017 UL standard 60335-2-24. It was published on August 8, 2018 [Reference 1].

To quote from the Final Rule, “EPA previously required a charge size limit of 57 grams (2.01 ounces) for each separate refrigerant circuit in a refrigerator or freezer. The 2017 UL Standard 60335–2–24 specifies that the maximum charge size for each separate refrigerant circuit in a refrigerator or freezer must be no greater than 150 grams (5.29 ounces).”

In recent years, smaller diameter copper tubes have been successful in light commercial refrigeration equipment subject to the 150 gram use condition. Practically every major manufacturer of “reach in” cool display cases now offers models with propane or isobutane as a refrigerant.

The new ruling facilitates the use of ecofriendly refrigerants in household appliances. Smaller-diameter copper tubing (typically 5 mm) maintains or increases the efficiency and cooling capacity of such appliances while reducing the refrigerant charge to allowable levels. This new EPA ruling along with MicroGroove technology will speed up the adoption of ecofriendly refrigerants in household appliances.

**Motives for Switching to Isobutane**

The phasedown of HFCs by such regulations as the F-Gas regulations of the European Union, the SNAP process of the EPA and the Kigali Amendment to the Montreal Protocol contributed to renewed interest in low-GWP hydrocarbons such as propane and isobutane.

Yet it is the attractive physical properties of these refrigerants that have led to their quick adoption, once the regulatory hurdles in favor of hydrocarbons and against HFCs were in place. The excellent thermodynamic properties of propane and isobutane and the fact that they are readily available and affordable are important factors. Refrigeration systems that use isobutane as a refrigerant have high-efficiency and high-performance. They have proven their reliability in Europe, where isobutane has been used in refrigerators for many years.

Although R290 and R600a are classified as A3 flammable refrigerants, they are deemed safe to use when proper protocols are followed. They are not a drop-in replacement. The appliance components must be specifically designed for hydrocarbon refrigerants, they must comply with the charge limit of 150 grams, and they must be labeled with warnings.

Currently, a working group within the International Electrotechnical Commission (IEC) is developing a standard that would allow 500 grams of propane in refrigeration systems; in that case, even higher-capacity refrigeration system could use ultralow GWP hydrocarbon refrigerants.

**Technical Presentation on R-600a**

Recently, a presentation was given at the Herrick Conferences at Purdue University titled, “Optimization of MicroGroove Copper Tube Coil Designs for Flammable Refrigerants” (Paper ID 2532) [Reference 2]. The paper shows how Optimized Thermal Systems (OTS) optimized new designs of MicroGroove heat exchangers for residential refrigeration products made by Sub-Zero. The paper was presented by Yoram Shabtay, President of Heat Transfer Technologies, who assisted in this application. The slideshow presentation, which is available in the “Technical Literature” landing page of microgroove.net, includes Sub-Zero’s experimental verification of the Multiple Objective Genetic Algorithm (MOGA) simulation results. Performance could be maintained using only 57 grams of R600a refrigerant with smaller diameter tubes.

“Isobutane and MicroGroove copper tubes are an ideal match and together will play a key role in reducing the volume of F-gases released in the atmosphere from residential appliances,” said Nigel Cotton, MicroGroove Team Leader for the International Copper Association. “MicroGroove technology is uniquely suited for use with isobutane, particularly with respect to reduced refrigerant charge.”

The website www.microgroove.net includes additional data relating to heat exchanger design and manufacturing technology. It also includes links to the MicroGroove series of webinars. A technical literature section provides links to technical papers relating to laboratory experiments, tube circuitry optimization, fin design and manufacturing equipment.

**References**

1. Federal Register / Vol. 83, No. 153 / Wednesday, August 8, 2018 / Rules and Regulations pages 38969-

<https://www.gpo.gov/fdsys/pkg/FR-2018-08-08/pdf/2018-16773.pdf>

2. Nigel Cotton, Adam Rhoads, Anderson Bortoletto, Yoram Shabtay, “Optimization of MicroGroove Copper Tube Coil Designs for Flammable Refrigerants,” 17th International Refrigeration and Air Conditioning Conference at Purdue, July 9-12, 2018, Paper 2332.

<https://www.conftool.com/Purdue2018/index.php?page=browseSessions&search=2532>

**About ICA**

ICA brings together the global copper industry to develop and defend markets for copper and to make a positive contribution to society’s sustainable-development goals. Headquartered in New York, the organization has offices in four primary regions: Asia, Europe and Africa, Latin America and North America. Copper Alliance® programs and initiatives are executed in nearly 60 countries through its regional offices. For additional information please visit copperalliance.org.

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