**Smaller Diameter Copper Tubes Rapidly Cool Supercritical R744 in Gas Coolers**

*MicroGroove Coils Support Ecofriendly R744 Refrigeration Applications*

**New York, New York (15 November 2018) --** According to the International Copper Association, heat-exchanger coils made with smaller-diameter copper tubes and aluminum fins offer significant performance advantages in ecofriendly R744 refrigeration systems.

The term “gas cooler” rather than “condenser” is employed in these applications because the refrigerant does not liquefy as it passes through the gas cooler heat exchanger. Rather it enters and exits the gas cooler as a supercritical fluid (SCF) which is a state above the critical point with respect to temperature and pressure. A SCF does not have distinct liquid or gas phases. The gas cooler reduces the temperature and enthalpy of this SCF but does not condense it into a true liquid. The SCF can travel rapidly through a tube as though it were a gas. It may be a hundred times denser than the gas with a viscosity an order of magnitude smaller than the viscosity of the liquid. Close to the critical point, small changes in pressure or temperature result in large changes in density.

[The terms “subcritical” and “supercritical” refer to the state of the refrigerant; the term “transcritical” refers to the thermodynamic cycle in which the refrigerant passes between the supercritical and subcritical states.]

In a transcritical refrigeration cycle, the enthalpy of the refrigerant is reduced in the gas cooler at a constant high pressure in the state of a supercritical fluid (SCF). In this state, CO2 has a very low viscosity even under high pressures so 5-mm tubes can be used with little increase in pressure drop. Furthermore, the relatively high density of the SCF contributes to a high transfer coefficient at high mass flow rates.

Performance was compared for heat exchanger coils using MicroGroove copper tubes (5-mm) versus conventional (9.52 mm) copper tubes for designs of similar capacity, design pressure and footprint.

Smaller-diameter copper tubes reduced tube weight by 35 percent, fin weight by 21 percent, and internal volume by 45.5 percent compared to conventional tubes, with resulting similar performance. The smaller diameter tubes had an outer diameter of 5 mm (0.197”) and wall thickness of 1 mm (0.040”); the conventional-diameter tubes had an OD of 7.94 mm (5/16”, or 0.3125”); and wall thickness of 1.24 mm (0.049”). See Table.

Gas coolers for R744 transcritical refrigeration systems are now being supplied in North America and Europe for numerous industrial and commercial applications, including supermarkets. New technologies involving booster compressors, cascaded heat exchangers and multiple ejectors to expand range of climates and applications for R744 refrigeration systems.

“MicroGroove is an excellent match for R744 applications,” says Nigel Cotton, MicroGroove Team Leader for the International Copper Association. “Tube suppliers and coil makers are collaborating on the construction of large gas coolers using smaller diameter tubes. They are filling the demand for these ecofriendly products on every continent.”

The Copper Alliance will exhibit MicroGroove for R744 applications at the ATMOsphere Europe Conference, Lago di Garda, Italy, from November 19-21, 2018.

For more information, visit 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.

**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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| --- | --- | --- | --- | --- |
| CO2 Gas Cooler | Unit | **5 mm tube** | **5/16” Tube** | **Ratio****(percent)** |
| Capacity  | BTU/h(kilowatt) | 43,000 (12.6) | 43,000(12.6) |  |
| Design Pressure | PSIA(MPa) | 1005(68.4) | 1005(68.4) |  |
| Coil Size | inch X inch(mm x mm) | 18 x 37(46 x 94) | 18 x 37(46 x 94) |  |
| Rows |  | 4 | 4 |  |
| Fin Density | fins / inch | 15 | 12.5 |  |
| Tube Pattern | inch x inch(mm x mm) | 0.75 x 0.45(19 x 11.4) | 1. x 0.625

(25 x 15.9) |  |
| Tube Material |  | copper | copper |  |
| Tube OD | Inch(mm)  | 0.197(5.0)  | 0.3125(7.94) |  |
| Tube Wall | Inch(mm) | 0.040(1.0)  | 0.049(1.25) |  |
| Tube Weight | pounds(kg) | 24.5(11.1) | 37.7(17.1) | 65 |
| Fin Material |  | aluminum | aluminum |  |
| Fin Thickness | inches(mm) | 0.0039(0.10) | 0.0045(0.114) |  |
| Fin Weight | pounds(kg) | 7.5(3.4)  | 9.5(4.3) | 79 |
| Total Internal Volume | liter | 1.2 | 2.2 | 54.5 |