**University Laboratories Measure Performance of Low-GWP Refrigerants Inside of MicroGroove Tubes, Says Copper Alliance**

*Prediction accuracy of simulations depends upon the accuracy of laboratory experiments*

**New York, New York (30 September 2016)** – According to the Copper Alliance, simulation software for the design of heat exchanger coils is becoming more accurate thanks to laboratory experiments performed by researchers from around globe.

The accuracy of simulations depends upon the reliability of correlations for both airside heat transfer and refrigerant-side heat transfer. Research results from many laboratories around the globe are used to develop these correlations. Ultimately, the prediction accuracy of simulations depends upon the accuracy of laboratory experiments. Performance simulations require predictive correlations for a variety of inside-the-tube enhancements (i.e., microfins) including correlations for tubes with low- and ultra-low GWP refrigerants inside smaller diameter copper tubes.

Seminal research was performed at the Institute of Refrigeration and Cryogenics of Shanghai Jiao Tong University. Now laboratory research results are also available for new low-GWP refrigerants in smaller diameter copper tubes. In particular, laboratory experiments on MicroGroove tubes were conducted at the University of Padova, Padova, Italy [1, 2]; Tokyo University of Marine Science and Technology [3]; and Kyushu University, Fukuoka, Japan [4].

According to the Padova group, in reference to previous research in this field, “literature about smaller diameter microfin tubes (i.e., inner diameter lower than 6 mm or so) is poor if compared with larger tubes.” They aptly dubbed these “mini microfin-tubes” in contrast to traditional (larger diameter) microfin tubes. These researchers measured flow boiling heat transfer and pressure drops inside copper tubes with internal enhancements [1]. In this first paper, the copper tubes had an outer diameter (OD) of 5 mm and the refrigerant was R134a. The saturation temperature was 10 °C. The vapor quality was varied from 0.1 to 0.95; the mass velocity from 100 to 800 kg/m2s; and heat flux from 15 to 90 kW/m2.

As expected, the dominant mechanisms are convective boiling at low heat fluxes, and two-phase forced convection at high heat fluxes. The authors concluded that the results highlight the promising heat transfer capabilities of mini microfin tubes during flow boiling. Looking forward, they state that “additional heat transfer measurements with different tube diameters, different helical geometries, and different type of refrigerants are surely needed.”

In a second paper, the Padova group also measured flow boiling heat transfer and pressure drop for an ultralow-GWP HFO1234ze(E) refrigerant inside smooth tubes having an OD of 4 mm [2]. The heat transfer coefficients for the HFO was similar that of HFC134a at the same operating conditions but the pressure drops were 10 to 25 percent higher for the HFO. According to these authors, the heat transfer measurements confirm that HFO1234ze(E) is a very promising low-GWP candidate for HFC134a replacement.

The Tokyo research measured pressure drops and evaporative heat transfer coefficients for R32 refrigerant passing through 4 mm OD copper tubes with a broad range of internal enhancements, including “microfin” heights of 0.1 mm and 0.2 mm [3]. Measurements were made at saturation temperature of 15 °C with mass velocity ranging from 50 to 400 kg/m2s and heat flux from 5 to 20 kW/m2.

Meanwhile, the Kyushu group measured heat transfer coefficients for mixtures of R32 with HFOs [4]. This research is especially important because it provides performance data for different compositions of the refrigerant mixtures. “Temperature glide” is known to compromise performance in R32/HFO mixtures compared to single components (i.e., R32 or HFO alone). The Kyushu results provide predictive correlations including the effects of microfins for these refrigerant blends, which are likely to play an important role in future air conditioning and refrigeration systems. The microfins in the 4-mm diameter copper tubes had heights of 0.26 mm.

“MicroGroove smaller-diameter tubes deliver higher efficiencies with less materials usage,” says Nigel Cotton, MicroGroove Team Leader for the International Copper Association. “The key to higher efficiencies is the inside-the-tube heat transfer coefficient.”

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