the microgroove™ advantage

Economical, Eco-Friendly Copper Tubes

Smaller, MicroGroove™ tubes make possible smaller, more efficient heat exchanger coils ... and hence air conditioners and refrigerators with high energy-efficiency.

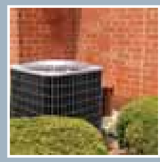
Coils made with this new technology weigh less and take up less space. They use less refrigerant and can also operate at higher pressures. The cost effective copper fabrication processes and assembly techniques are proven and familiar to suppliers and manufacturers. Corrosion resistant, durable and dependable, copper tubes provide long life, reliable performance and recyclability.

New commercial and residential air-conditioning and refrigeration products based on small diameter copper tubing are already changing the game.

COPPER
International Copper Association, Ltd





Available from a range of suppliers.
For more information visit:
www.microgroove.net

Small Tubes of Copper Yield Major Advantages

Air-conditioning and refrigeration product designers worldwide realize that small tube copper yields major benefits. The MicroGroove™ advantage could be summed up as follows:

- Higher performance can be obtained using the same weight of fin and tube materials and less refrigerant volume.
- Equivalent performance can be obtained using less tube material, less fin material, less refrigerant and hence less overall system size and weight.

The competitive advantages are compelling: Less material usage, less refrigerant and smaller system size are just a few. To fully understand small tube copper technology and its potential to increase profits, it is worthwhile to examine the overall design of heat exchanger coils as well as the physical properties of small tube copper.

Maximizing Performance

The design goal is to maximize performance and minimize materials usage. The amount of tube material is determined by the tube circumference, length and wall thickness.

What then are the advantages of small tubes?

One advantage is the reduction in tube volume and hence refrigerant volume. Tube volume is proportional to the tube radius squared while the inside tube surface area is directly proportional to the tube radius.

Another advantage is that the tube wall thickness can be reduced for small diameter tubes without compromising the operating pressure. The reduction in tube wall thickness results in an additional weight savings. For example, if the average tube wall thickness is reduced from 0.32 mm to 0.24 mm then tube weight is reduced by one-quarter.

Finally, heat transfer increases markedly for small diameters. This effect can be measured with careful laboratory experiments and is expressed in terms of local heat transfer coefficients. A higher heat transfer coefficient allows for the same performance to be realized with less surface area; hence less tube, less fin and less refrigerant; and also less coil size and weight.

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Heat Transfer Coefficients

Heat transfer can be represented by diagrams similar to simple electric circuit diagrams. The inverses of the heat transfer coefficients are analogous to electrical resistances; heat transfer rates analogous to currents; and temperature differences to voltages. For coil designs, there are three components of "thermal resistance."

1) **Inside Tube.** Convection and conduction heat transfer from the refrigerant to the inside tube wall

2) **Through the Tube.** Conduction heat transfer through the tube wall

3) **Outside Tube.** Conduction heat transfer through fins and convection heat transfer from fins and tubes to ambient air. Radiation heat transfer typically can be ignored.

The rate of heat transfer from the refrigerant to the tube wall increases remarkably as the tube diameter shrinks. In the circuit analogy, the increase in local heat transfer coefficient is equivalent to a drop in the "inside tube" thermal resistance. In other words, tube diameter has a major effect on the local, inside tube, heat transfer coefficient.

Tests on Tubes

ICA recently sponsored laboratory measurements of heat transfer coefficients and pressure drops for small tube copper. This essential research was conducted at the Institute of Refrigeration and Cryogenics at Shanghai Jiao Tong University (SJTU) in Shanghai, China.

As an example, tests with a common refrigerant were run on various small diameter copper tubes with enhanced (microgroove) inner surfaces and with smooth inner surfaces. The laboratory test results bear out the prediction of high inside-tube heat transfer coefficients for tubes with small diameters and enhanced inner surfaces.

More information about these experimental test results is available at www.microgroove.net.

Designing Coils

Several OEMs are using MicroGroove research results to simulate coil designs. They have already brought new products to market in Asia, Europe and the USA. Heat exchanger engineers and OEM design engineers interested building heat exchangers and air conditioning and refrigeration products in small tube copper should visit www.microgroove.net to follow the latest developments and contact ICA about this game-changing technology. ■