Turning Up the Cool Factor in **HVAC Systems**

Designers simulate flow through microfin tubes to analyze the effectiveness of heat exchangers.

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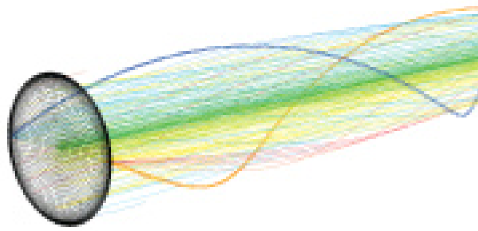


Pathlines of the particle flow inside the microfin tube colored by particle ID

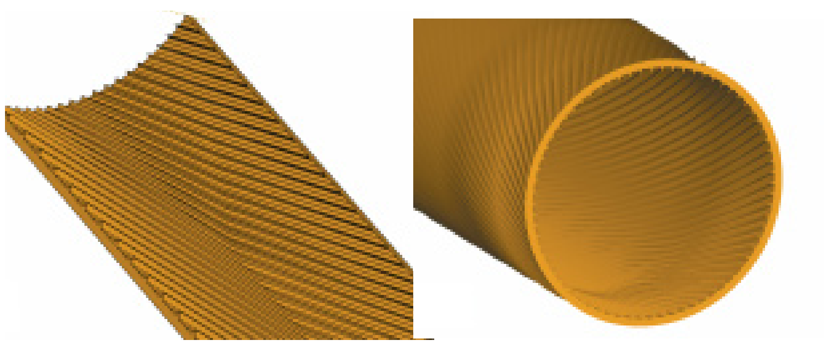
Manufacturers in the heating, ventilation and air conditioning (HVAC) industry are constantly looking for ways to enhance the heat transfer capabilities of their systems. In refrigeration and air conditioning systems in particular, the cooling fluid absorbs heat from the surrounding air by a process known as direct expansion evaporation. Heat from the surrounding air (the “hot” fluid) is thus transferred to the evaporating coolant via the walls of the metal tubes through which the coolant flows.

At the O.Y.L. R&D Centre in Selangor, Malaysia, designers have been analyzing coolant flow through microfin tubes within the evaporators. The microfins themselves are raised ridges less than one millimeter high that twist around the interior of the tubes in the pattern of a helix. The advantages of such tubes are that they increase the surface area that is available for heat transfer while causing a relatively small decrease in pressure. Tubes with microfin walls have been proven to be more effective in refrigeration and air conditioning systems compared to tubes with smooth walls.

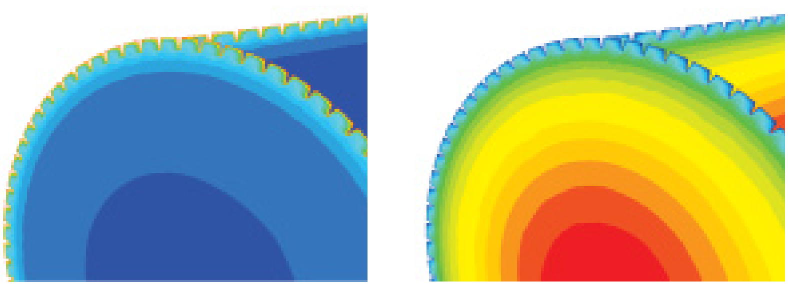
Using the FLUENT computational fluid dynamics (CFD) software package, O.Y.L. successfully simulated the flow of water inside a microfin tube. A constant heat flux was applied at the tube wall to provide the heating. Due in part to a tangential velocity component, the flow inside a microfin tube is relatively complex and involves swirl. The Reynolds stress model (RSM) was therefore chosen to model this turbulent flow. Only the length of one full helical revolution of the fins inside the tube was modeled because the flow was expected to repeat periodically. The inlet and outlet of the tube were thus set to have periodic boundary conditions.

The simulations showed that a swirling flow developed inside the microfin tube and became more significant near the wall region. Swirling flows enhance heat transfer in the tube, but at the same time also increase the pressure loss due to friction when compared to the smooth tube. The temperature and velocity profile of the microfin tube not only varied in the radial and longitudinal directions, but also in the tangential direction.

Both the friction factors and heat transfer coefficients calculated from the CFD results were validated with the experimental results obtained by O.Y.L. researchers in a previous study, and were within 15 percent of the measured values. The FLUENT models were thus able to predict the heat transfer and pressure drop performances with satisfying accuracy and serve as a very useful tool to analyze the flow inside a microfin tube. ■



Close-up views of microfin tube geometry including a cutaway section (left) and a full cross section (right)



Close-up view of contours inside a microfin tube, temperature (left) and velocity (right)