Abstract

A numerical and experimental study was performed to predict the flow and thermal performance of a capillary tube that used in air conditioning and refrigeration systems. The governing equations of such flow include continuity, momentum and energy, in addition to (k- ε) model equations for turbulence in two dimensional. In the numerical study, the (CFD) technique was employed to model these equations using the finite volume method for a two-phase, two dimensional flow in the pipe. This model gives a filed distribution for velocity, temperature, pressure, density, and dryness fraction along the tube.

In the experimental part, an experimental rig was constructed using a split unite to measure the temperature and pressure along the capillary tube (1.02 m) and (1.63*10-3 m) inner diameter. These measurements were made for (R-22) refrigerant for different ambient temperatures.

It was concluded that the mass flow rate of (R-22) increases as the inlet temperature increases in capillary tube at constant pressure in evaporator for a fixed length and diameter of capillary tube. The experimental data were used to verify the numerical results. Other published works were also used for more verification of the computer code results including pressure, temperature, dryness fraction, velocity, and length for several refrigerants. The verification reveals that the present code can be used to predict the proper capillary tube length for each application depending on the system operating conditions.

The computer code was then applied to predict the flow and heat transfer along several types of capillary tube i.e. several lengths (2.5 m, 3 m, 3.5 m, 4 m), several diameters (1.24*10-3 m, 1.63*10-3 m, III 2.16*10-3 m, 3.05*10-3 m), several refrigerants (R-12, R-22, R-134a, R-407C), and for adiabatic and non- adiabatic tube.

In the adiabatic capillary results, the capillary tube length of (R-407C) was found to be shorter than that required for (R-22) by (29.6 %). It was also found that (R-22) vaporized later than its corresponding (R-407C). A similar conclusion was also found for (R-134a) shorter than (R-12) by (26.2 %).

The numerical results show also that the length of capillary tube has a large effect on its performance. When the length increases, the drop in pressure, temperature, and density increases, as well as the velocity and dryness fraction increases. The diameter of capillary tube was found to have a little effect on pressure, temperature, density, velocity, and dryness fraction because the applied range was small.