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Numerical investigation of capillary tube-suction line heat exchanger performance

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Abstract

This paper presents the numerical results of the effect of different parameters on the performance of capillary tube-suction line heat exchangers (CT-SLHX), including condensing and evaporating temperatures, degrees of subcooling and superheat, tube diameter, tube length, and refrigerant flow inlet quality. The heat transfer rate from the capillary tube to the suction line has been simulated for two environmentally friendly refrigerants, namely HFC-134a and HC-600a. The simulation model also postulates the situation where heat may be transferred from capillary tube to the ambient air, before entering the CT-SLHX.

Keywords: Non-adiabatic capillary tube; Suction line heat exchanger; Simulation model; Two-phase refrigeration flow; Heat transfer

1. Introduction

Optimizing a capillary tube-suction line heat exchanger is desirable for the designers of household vapour compression refrigeration systems in order to improve the system performance. The capillary tube is a 1–6 m long tube of drawn copper with an inside diameter generally from 0.66 to 2 mm, which connects the outlet of the condenser to the inlet of the evaporator. Most commonly

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Nomenclature

A	cross sectional area (m^2)
C_p	specific heat ($kJ/kg \cdot K$)
D	diameter (m)
dz	elemental tube length (m)
F	enhancement factor (–)
f	friction factor (–)
G	mass flux ($kg/s\,m^2$)
g	acceleration due to gravity (m/s^2)
h	specific enthalpy (kJ/kg)
I	difference (–)
k	conductivity ($kW/m\,K$)
M	molecular weight (–)
$\dot{m}$	mass flow rate (kg/s)
Nu	Nusselt number (–)
p	pressure (Pa)
Pr	Prandtl number (–)
$\dot{q}$	heat transfer rate (kW)
q_F	heat flux (kJ/m^2)
Re	Reynolds number (–)
S	suppression factor (–)
T	temperature (K)
U	overall heat transfer coefficient ($kW/K\,m^2$)
v	specific volume (m^3/kg)
w	width of solder joint (m)
x	refrigerant quality (–)
α	heat transfer coefficient ($kW m^{-2} K^{-1}$)
θ	inclination angle (deg)
ρ	density (kg/m^3)
δ	solder joint thickness (m)

Subscripts

amb	ambient
c	capillary tube
cond	condenser
crit	critical
evap	evaporator
j	solder joint
l	liquid phase
o	outside
p	pool boiling