

Numerical analysis and experimental investigation into the performance of a wire-on-tube condenser of a retrofitted refrigerator

Abstract

The present paper discusses (a) the analysis of a wire-on-tube condenser under varying operating conditions of free convection using FEM, and (b) experimental verification of the performance of two wire-on-tube condensers in a retrofitted domestic refrigerator using refrigerant R-134a. The study is motivated by the desire to investigate if the wire-on-tube condensers used in R-12 based refrigerators could be used in a modified refrigerator using R-134a refrigerant. Experiments were conducted in a climate chamber under controlled and varying ambient temperatures and mass flow rates to determine the locations where phase change occurs and the degree of subcooling achieved. In terms of initial and final phase change point locations the predicted results agree with the experimental results to within $\pm 10\%$. The analysis and the experiments also lead to the information about the adequacy of the number of tubes for complete condensation of the refrigerant vapour under given operating conditions. The methodology can be used as a design tool for the design of wire-on-tube condenser of a small refrigerator as well as the suitability of specific decommissioned condensers for use in a retrofitted refrigerator. It also indicates that R-12 based refrigerators using wire-on-tube condensers retrofitted with R-134a compressor and refrigerant deserve and warrant further studies for adoption.

Keywords — Household refrigerator, condenser, survey, experiment, heat transfer, free convection, R-134a, CFD