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Dynamic Performance Comparison Of R134a and R1234yf Refrigerants for a Vapor Compression Refrigeration Cycle

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ABSTRACT

Machines like air conditioners and refrigerators, which cause significant energy consumption in countries around the world, are widely used in industry and residences. Analyzing and studying the behavior of these machines with computer simulations can optimize performance of them. In this study, thermodynamic modelling and dynamic simulation of a vapor compression refrigeration cycle is handled. R134a and R1234yf are used as the primary fluid and water is used as the secondary fluid in the refrigeration cycle. R1234yf is a refrigerant, which has low Global Warming Potential (GWP) and Ozone Depletion Potential (ODP) and is recently has been begun to use as a substitute of R134a. In this study, dynamic behaviors of these two refrigerants are examined in a vapor compression refrigerant cycle with fixed operating conditions. Finite Difference Method is utilized for the modelling of the evaporator and condenser and Gungrr-Winterton and Travis et al. correlations are used for the modelling of the evaporation and condensation proccesses respectively. Orifice equation is utilized for the modelling of the expansion valve and modelling of the compressor is carried out by first dynamically simuating the heat transfer between the gas and surroundings until the gas reaches to compression chamber and after that the polytropic compression process in the chamber. For the realization of the dynamical simulation, refrigerant fluid mass flow rate is applied to the system as step input. Response of the system to the input is observed with transient p-h and coefficient of performance (COP) diagrams. The results showed that COP is started off with the values of 2.079 for R134a and 1.711 R1234yf, reached the maximum points of 2.577 for R134a and 2.02 for R1234yf, then slowly declined with fluctuations. In the p-h diagram, due to temperature rise of inner walls of the evaporator and condenser, condenser outlet and compressor inlet enthalpy values started off with 395,945 kJ/kg and 231,714 kJ/kg for R134a, 361,557 kJ/kg and 230,750 kJ/kg for R1234yf, then approached to the saturation curve with time and reached the values of 393,957 kJ/kg and 233,808 kJ/kg for R134a, 359,547 kJ/kg and 231,917 kJ/kg for R1234 yf.

Keywords:
Refrigeration cycles; Dynamic Simulation; System Modelling; Thermodynamics; Global Warming Potential

INTRODUCTION