

Performance Evaluation and Development of Empirical Model for Hermetically Sealed Reciprocating Compressor

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ABSTRACT

The compressor is one of the major components of an air conditioning or refrigerating systems and has an important effect on system energy efficiency. A detailed thermodynamic model of a compressor is extremely complex due to inherently complicated structure of compressor and refrigerant flow pathways along which heat transfer and pressure vary substantially and rapidly. Also these models requires large sets of unknown parameters to characterize the complicated refrigerant flow, heat exchanges, effects of oil plus data on geometry and heat transfer characteristics of internal parts.

The present work is aimed at performance evaluation of HFC-134a small hermetic reciprocating compressor at design and off design conditions and to develop a simple empirical model based on experimental results to represent the performance of the compressor. For this purpose detailed experiments were carried out on compressor calorimeter at 15 different operating conditions (evaporator temperature ranging from -23.3°C to -12.2°C and condensing temperature ranging from 45.2°C to 54.4°C) on compressor calorimeter. These test results were analyzed to calculate the compressor capacity, mass flow rate and EER of the compressor. Computer program was prepared for that purpose. Properties of the refrigerant were calculated by using NIST's REFPROP (Version 6) software. Then for these 15 data points an equation in a multivariable form was fitted by using MATLAB (Release 12) software.

Thus simple model was developed to represent the performance of compressor as a function of evaporating and condensing temperature only. After that one more test was carried out by choosing any arbitrary temperature (in this case $t_e=-13.5^{\circ}\text{C}$ and $t_c=51.5^{\circ}\text{C}$) for verifying the validity of model. It was found that model developed predicted compressor capacity and mass flow rate within $\pm 1.1\%$ and $\pm 2.8\%$ accuracy respectively. Then by using these equations compressor performance maps were developed. It was also found that model interpolates and extrapolates reliably. These equations are useful to industries for system simulation.

Keywords: Hermetic compressor, compressor calorimeter, compressor cooling capacity, EER.