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Analysis and Optimized Design of a Packaged Liquid Chiller

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Abstract : The purpose of this work is to develop a physical simulation model for the purpose of studying the effect of various design parameters on the performance of packaged-liquid chillers. This paper presents a steady-state model for predicting the performance of package-Liquid chiller over a wide range of operation condition. The model inputs are inlet conditions; geometry and output of model include system performance variable such as power consumption, coefficient of performance (COP) and states of refrigerant through the refrigeration cycle. A computer model that simulates the steady-state cyclic performance of a vapor compression chiller is developed for the purpose of performing detailed physical design analysis of actual industrial chillers. The model can be used for optimizing design and for detailed energy efficiency analysis of packaged liquid chillers. The simulation model takes into account presence of all chiller components such as compressor, shell-and-tube condenser and evaporator heat exchangers, thermostatic expansion valve and connection pipes and tubing's by thermo-hydraulic modeling of heat transfer, fluids flow and thermodynamics processes in each one of the mentioned components. To verify the validity of the developed model, a 7.5 USRT packaged-liquid chiller is used and a laboratory test stand for bringing the chiller to its standard steady-state performance condition is build. Experimental results obtained from testing the chiller in various load and temperature conditions is shown to be in good agreement with those obtained from simulating the performance of the chiller using the computer prediction model. An entropy-minimization-based optimization analysis is performed based on the developed analytical performance model of the chiller. The variation of design parameters in construction of shell-and-tube condenser and evaporator heat exchangers are studied using the developed performance and optimization analysis and simulation model and a best-match condition between the physical design and construction of chiller heat exchangers and its compressor is found to exist. It is expected that manufacturers of chillers and research organizations interested in developing energy-efficient design and analysis of compression chillers can take advantage of the presented study and its results.

Keywords : optimization, packaged liquid chiller, performance, simulation
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