Thermal-Economic Modeling and Optimization of Gas Engine Driven Heat Pump Systems

Sepehr Sanaye* Mahmood Chahartaghi

Energy Systems Improvement Laboratory (ESIL)
Department of Mechanical Engineering
Iran University of Science and Technology (IUST)

Abstract

Gas Engine driven Heat Pump (GEHP) modeling and optimization are presented in this paper. The heat pump cycle modeling included compressor, condenser, evaporator, expansion valve, as well as a gas engine to drive the compressor. To validate the modeling output results, they were compared with experimental results and acceptable difference percent points were obtained and reported.

To optimal design of GEHP, the total annual cost (sum of operating and investment costs) was defined as the objective function in terms of technical and economic parameters of the system. Genetic algorithm optimization technique was used to obtain the design parameters at the minimum total cost of the system. Eight design parameters of the system (the condenser and evaporator pressures in cooling and heating modes, the inlet air mass flow rate to the indoor and outdoor heat exchangers and the gas engine rotational speed in cooling and heating modes) were selected. The values of design parameters for a case study were obtained and reported when the total annual cost of the system was minimum. Furthermore at that system optimal design point, the investment and operating costs were found to be 64.23% and 35.67% of the total cost, while the fuel consumption of gas engine were 0.956 and 0.658, and COP of GEHP were 1.61 and 1.64 in cooling and heating modes respectively. Then the variation of optimum design parameters in various cooling and heating loads was studied. Finally, the sensivity analysis and change in design parameters with change in the fuel price and investment cost was performed.

Keywords: "Gas engine driven heat pump", "vapor compression refrigeration cycle", "gas engine", "thermal-economic modeling", "optimization", "genetic algorithm"

* Corresponding author: Sepehr Sanaye, Energy Systems Improvement Laboratory, Mechanical Engineering Department, Iran University of Science and Technology, Narmak, Tehran, Iran, 16488,
Tel-Fax: +98-21-77240192
E-mail address: sepehr@iust.ac.ir