Optimal Design of Gas Turbine CHP Plant with Preheater and HRSG

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Abstract

Located in the South of Iran, Jiroft Paper Mill Company requires an integrated combined heat and power plant, which can provide 50 MW of electric power and 100 ton/hr saturated steam at 13 bars, to produce paper from an adjacent eucalyptus forest. The plant is comprised of an air compressor, combustion chamber, air pre-heater, turbine, as well as a heat recovery steam generator (HRSG). The design parameters of the plant were chosen as: compressor pressure ratio (r_c), compressor isentropic efficiency (η_{AC}), gas turbine isentropic efficiency (η_T), combustion chamber inlet temperature (T_3), and turbine inlet temperature (T_4). In order to optimally find the design parameters a thermoeconomic approach has been followed. An objective function representing the total cost of the plant in terms of dollar per second, was defined as the sum of the operating cost related to the fuel consumption, and the capital investment for equipment purchase and maintenance costs. Subsequently, different parts of the objective function have been expressed in terms of decision variables. Finally, the optimal values of decision variables were obtained by minimizing the objective function using sequential quadratic programming (SQP). The influence of changes in the demanded power and steam on the design parameters have also been studied for 40, 50, 60, and 70 MW of net power output, and 100, 120, 150, ton/hr of saturated steam mass flow rate. Finally the sensitivity analysis of change in design parameters with change in fuel or investment cost was performed

Keywords: Thermoeconomic Optimization, Gas Turbine Cycle, CGAM Problem, Exergy Analysis

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