Optimum Performance Improvements of the Combined Cycle Based on an Intercooler–Reheated Gas Turbine

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ABSTRACT

The performance enhancements and modeling of the gas turbine (GT), together with the combined cycle gas turbine (CCGT) power plant, are described in this study. The thermal analysis has proposed intercooler–reheated-GT (IHGT) configuration of the CCGT system, as well as the development of a simulation code and integrated model for exploiting the CCGT power plants performance, using the MATLAB code. The validation of a heavy-duty CCGT power plants performance is done through real power plants, namely, MARAFIQ CCGT plants in Saudi Arabia with satisfactory results. The results from this simulation show that the higher thermal efficiency of 56% MW, while high power output of 1640 MW, occurred in IHGT combined cycle plants (IHGTCC), having an optimal turbine inlet temperature about 1900 K. Furthermore, the CCGT system proposed in the study has improved power output by 94%. The results of optimization show that the IHGTCC has optimum power of 1860 MW and thermal efficiency of 59%. Therefore, the ambient temperatures and operation conditions of the CCGT strongly affect their performance. The optimum level of power and efficiency is seen at high turbine inlet temperatures and isentropic turbine efficiency. Thus, it can be understood that the models developed in this study are useful tools for estimating the CCGT power plant's performance.

KEYWORDS: combined cycle, gas turbine, intercooler, reheated, triple pressure, optimization

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