

Study on the Integration Schemes and Performance Comparisons of Different Integrated Solar Combined Cycle-Direct Steam Generation Systems

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Abstract : The integrated solar combined cycle (ISCC) system has a series of advantages such as increasing the system power generation, reducing the cost of solar power generation, less pollutant and CO₂ emission. In this paper, the parabolic trough collectors with direct steam generation (DSG) technology are considered to replace the heat load of heating surfaces in heat regenerator steam generation (HRSG) of a conventional natural gas combined cycle (NGCC) system containing a PG9351FA gas turbine and a triple pressure HRSG with reheat. The detailed model of the NGCC system is built in ASPEN PLUS software and the parabolic trough collectors with DSG technology is modeled in EBSILON software. ISCC-DSG systems with the replacement of single, two, three and four heating surfaces are studied in this paper. Results show that: (1) the ISCC-DSG systems with the replacement heat load of HPB, HPB+LPE, HPE2+HPB+HPS, HPE1+HPE2+ HPB+HPS are the best integration schemes when single, two, three and four stages of heating surfaces are partly replaced by the parabolic trough solar energy collectors with DSG technology. (2) Both the changes of feed water flow and the heat load of the heating surfaces in ISCC-DSG systems with the replacement of multi-stage heating surfaces are smaller than those in ISCC-DSG systems with the replacement of single heating surface. (3) ISCC-DSG systems with the replacement of HPB+LPE heating surfaces can increase the solar power output significantly. (4) The ISCC-DSG systems with the replacement of HPB heating surfaces has the highest solar-thermal-to-electricity efficiency (47.45%) and the solar radiation energy-to-electricity efficiency (30.37%), as well as the highest exergy efficiency of solar field (33.61%).

Keywords : HRSG, integration scheme, parabolic trough collectors with DSG technology, solar power generation

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