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Thermoeconomic analysis of a CHP-based dual-purpose power plant

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ABSTRACT

China faces severe water shortages due to the rapid growth of population and fast development of the economy. Especially in northern coastal cities where China's population and economy are concentrated, the poor water condition has become a critical constraint factor for socio-economic development in the long run. A combined heat-and-power (CHP)-based dual-purpose power plant with low-temperature multi-effect distillation (LT-MED) is a viable answer to the problem for this zone. This paper presents an economic analysis of it based on the cyclical function method, the equivalent enthalpy drop theory, and the analytical theory on steam turbines in off-design working conditions. By solving the matrix calculation models of the cyclical function method and the equivalent enthalpy drop theory, the thermal generating efficiency, the heat and power generation rate (HPGR) and the electricity-equivalent consumption rate (EECR) are analysed to explore the effect of extraction for desalination on the CHP system and the energy cost for water production. The study indicates that utilizing surplus heating extraction load in summer for desalination improves thermal generating efficiency and HPGR of extraction and reduces the fuel cost for water production. It is also shown that EECR is more accurate to evaluate the performance of the desalination process than GOR that is widely used to evaluate the performance of desalination process. It is concluded that the CHP-based dual-purpose power plant is a suitable way to economically provide fresh water resource in northern coastal zone of China.

Keywords: Combined heat-and-power; Dual-purpose power plant; Equivalent enthalpy drop theory; Cyclical function method; Electricity-equivalent consumption rate; Desalination

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