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Exergoeconomic performance optimization for a combined cooling, heating and power generation plant with an endoreversible closed Brayton cycle

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ABSTRACT

Finite time exergoeconomic performance of a combined cooling, heating and power generation (CCHP) plant composed of one endoreversible closed Brayton cycle and one endoreversible four-heat-reservoir absorption refrigeration cycle is investigated by using finite time thermodynamics. Heat conductance distribution among hot-, cold-, thermal consumer-, generator-, absorber-, condenser- and evaporator-side heat exchangers and compressor pressure ratio are optimized by taking the maximum profit rate as objective. Numerical examples show that there exists a sole group of optimal heat conductance distribution among hot-, cold-, thermal consumer-, generator-, absorber-, condenser- and evaporator-side heat exchangers and an optimal compressor pressure ratio which lead to the maximum profit rate. The effects of design parameters on the optimal performance of the CCHP plant are discussed.

1. Introduction

In recent years, a great deal of attention has been paid to energy and environmental problems. For this theme, a plant which is energy saving and environmental friendliness is what people chases for. The combined cooling, heating and power generation (CCHP) plant is a system that makes full use of different forms of energy (including cooling, heating and power generation) on the basis of energy cascade utilization principle. It has an excellent cycle performance, a higher energy integrated utilization rate, and a lower CO_2 emission in exhaust gas. Therefore, people begin to pay a great deal of attention to it.

Analyses and optimizations have been carried out in order to investigate the optimal performances of various cogeneration plants by using finite time thermodynamics [1–9]. Bojic [10] and Sahin et al. [11] analyzed the annual worth [10] and optimal exergy output rate performance [11] of an endoreversible Carnot cycle cogeneration plant by optimizing the heat conductance distributions between the hot- and cold-heat exchangers, respectively. Yilmaz [12] and Atmaca et al. [13] investigated the performance of an endoreversible [12] and irreversible [13] Carnot cycle cogeneration plant by taking exergy output rate as objective, and made some performance comparisons among energy utilization factor, artificial thermal efficiency and exergy efficiency. Erdil [14] analyzed and optimized the exergy output rate and exergy efficiency performance of an irreversible Carnot cycle cogeneration plant with heat resistance, heat leakage and internal irreversibility. Ust et al. [15] investigated the optimal exergy density performance of an irreversible Carnot cycle cogeneration plant and compared the optimal exergy density performance with that of the exergy output rate. Yilmaz [16]

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