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A Parametric Study on Exergy and Exergoeconomic Analysis of a Diesel Engine based Combined Heat and Power System

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ABSTRACT

This paper presents exergy and exergoeconomic analysis and parametric study of a Diesel engine based Combined Heat and Power (CHP) system that produces 277 and 282 kW of electricity and heat, respectively. For this purpose, the CHP system is first thermodynamically analyzed through energy and exergy. Then, cost balances and auxiliary equations are applied to subsystems. The exergoeconomic analysis is based on specific exergy costing (SPECO) method. Finally, a parametric study is used to show the effect of ambient temperature on important energy, exergy and exergoeconomic parameters of the CHP system. Also, effects of change in compressor pressure ratio and turbine inlet temperature on these parameters are investigated in different environment temperatures. The results show that increasing ambient temperature increases the work output, heating power and exergoeconomic factor and decreases the exergetic efficiency and cost of exergy destruction. Increasing compressor pressure ratio leads to increase in the work output, heating power, exergetic efficiency, and exergy destruction cost and exergoeconomic factor of the CHP system in all environment temperatures. Also increasing turbine inlet temperature decreases the work output, exergetic efficiency and exergoeconomic factor, while increases the heating power as well as exergy destruction cost in all environment temperatures.

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NOMENCLATURE

A	heat transfer area (m^2)	$y^*_{D,k}$	component exergy destruction over total exergy destruction
c	cost per exergy unit ($/kJ)	Z	capital cost of a component ($)
$\dot{C}$	cost rate ($/s)	$\dot{Z}$	capital cost rate ($/s)
e	specific exergy (kJ/kg)	**Subscripts**	
$\dot{E}$	exergy rate (kW)	0	dead (environmental) state
f	exergoeconomic factor	a	air
h	specific enthalpy (kJ/kg)	ch	chemical exergy
$\dot{m}$	mass flow rate (kg/s)	D	destruction
P	pressure (bar)	e	outlet
Q	rate of heat transfer (kW)	f	fuel
R	gas constant (kJ/kg K)	i	inlet
s	specific entropy (kJ/kg K)	j	jth stream
T	temperature (K)	k	kth component
$\dot{W}$	power (kW)	L	loss
X	mole fraction	ph	physical exergy
$y_{D,k}$	component exergy destruction over total exergy input		

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