International Journal of Engineering

Journal Homepage: www.ije.ir

TECHNICAL NOTE

Thermodynamic Analysis and Optimization of a Novel Cogeneration System: Combination of a gas Turbine with Supercritical CO_2 and Organic Rankine Cycles

H. Nami*, F. Mohammadkhani, F. Ranjbar

Faculty of Mechanical Engineering, University of Tabriz, Tabriz, Iran

PAPER INFO

Paper history:
Received 04 August 2016
Received in revised form 30 September 2016
Accepted 11 November 2016

Keywords:
Combined Cycle
SCO_2
Organic Rankine Cycle
Energy
Exergy
Optimization

ABSTRACT

Thermodynamic analysis of a novel combined system which is combination of methane fired gas turbine cogeneration system (CGAM) with a supercritical CO_2 recompression Brayton cycle (SCO_2) and an Organic Rankine Cycle (ORC) is reported. Also, a comprehensive parametric study is performed to investigate the effects on the performance of the proposed system of some important parameters. Finally, a thermodynamic optimization is done to maximize energy and exergy efficiencies. The results showed that, the energy and exergy efficiencies are maximized at particular compressor pressure ratios and the values depend on the operating parameters of the system. Energy and exergy efficiencies are determined to be 85.33% and 54.18%, respectively, for the proposed system under the base condition. Moreover, the parametric study showed that in addition to the operating parameters of the system, ambient temperature has also an important effect on the system performance as energy efficiency increases and exergy efficiency decreases with the ambient temperature increment.

***doi**: 10.5829/idosi.ije.2016.29.12c.00*

ACRONYMS

AC	Air compressor
AP	Air preheater
CC	Combustion chamber
COND	Condenser
C1	Compressor 1
C2	Compressor 2
GT1	Gas turbine 1
GT2	Gas turbine 2
HRSG	Heat recovery steam generator
HTR	High temperature recuperator
HE1	Heat exchanger 1
HE2	Heat exchanger 2
LTR	Low temperature recuperator
ORCT	Organic Rankine cycle turbine
ORCP	Organic Rankine cycle pump

Nomenclature

$\dot{E}_i$	Exergy rate [kW]
e_i	Specific thermomechanical flow exergy at state i [kJ/kmol]
e_{ch}	Specific chemical exergy [kJ/kmol]
e_{ph}	Specific physical exergy [kJ/kmol]
h	Specific enthalpy [kJ/kmol]
LHV	Lower heating value [kJ/kmol]
$\dot{n}$	Molar rate [kmol/s]
P_i	Pressure at state i [bar]
r_p	Pressure ratio [-]
$\overline{R}$	Universal gas constant [kJ/kmol.K]
s	Specific entropy [kJ/kmol.K]
T_i	Temperature at state i [K]
$\dot{W}$	Produced or consumed power by components [kW]

Greek letters

ε	Exergy efficiency [%]
$\eta_{is,C}$	Isentropic efficiency of compressor [%]
$\eta_{is,GT}$	Isentropic efficiency of gas turbine [%]
$\eta_{is,P}$	Isentropic efficiency of pump [%]
η	Energy efficiency [%]

*Corresponding Author's Email: *h.nami@tabrizu.ac.ir* (H. Nami)

Please cite this article as: H. Nami, F. Mohammadkhani, F. Ranjbar, Thermodynamic Analysis and Optimization of a Novel Cogeneration System: Combination of a gas Turbine with Supercritical CO_2 and Organic Rankine Cycles, International Journal of Engineering (IJE), TRANSACTIONS C: Aspetcs Vol. 29, No. 12, (December 2016)