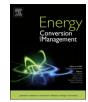
Contents lists available at ScienceDirect



Energy Conversion and Management



journal homepage: www.elsevier.com/locate/enconman

Comprehensive assessment of a multi-generation system integrated with a desalination system: Modeling and analysing



Esmaeil Arab Chadegani^{a,*}, Moslem Sharifishourabi^b, Fereshte Hajiarab^c

^a Department of Mechanical Engineering of Agricultural Machinery, Faculty of Agricultural Engineering and Technology, University of Tehran, Iran

^b Department of Mechanical Engineering, Faculty of Science and Engineering, Université Laval, Quebec City, QC G1V 0A6, Canada

^c Department of Physics, Faculty of Sciences, University of Isfahan, Iran

ARTICLE INFO

Keywords: Energy analysis Exergy analysis Exergoenvironmental analysis Reverse Osmosis desalination

ABSTRACT

A new system for providing multiple outputs from solar energy capture (multi-generation) is proposed. The main objective of the system is to supply electricity, heating, cooling, and water to the residential sectors. The proposed system uses solar energy as its source to integrate two Rankine Cycle, a single effect absorption system, an electrolyser unit and a Reverse Osmosis desalination system. The system employs, as a working fluid, a molten salt, for a parabolic trough solar collector cycle, and Lithium bromide-water as a working fluid in the absorption system. The main objectives of this research are firs to analyze the system through energetic and exergetic, then evaluate the system from environment point of view. The effects of various parameters on the system efficiency and production are evaluated and the results show that the overall energy and exergy efficiencies of the system are 33.52 and 20.69%, respectively. In addition, the results of the environment assessment shows that if the system works in an environment with a lower ambient temperature is more efficient.

1. Introduction

The growth of global energy demand causes an increase in carbon dioxide emissions [1]. A significant number of the environmental issues are due to the use of fossil fuels in buildings. It is estimated that 32% of the world energy supplies are used in buildings, including 8% in commercial buildings and 24% in the residential sector [2]. Therefore, it is worth concentrating on efforts to decrease building emissions. According to Fig. 1, the least attention is given to the use of renewable energies.

Due to the increase in energy consumption and to decrease the effect of greenhouse gases, the use of renewable energy is becoming more popular [4]. As a strong-growing alternative energy sources, renewable energy technologies have come out to supply green power generation for the future [5]. Solar is responsible for many novel approaches to reduce fossil fuels [6], because it is abundant, non-polluting and inexhaustible. Therefore, reduction of fossil fuels consumption has been done in numerous countries with enough daily solar radiation [7]. Also, it is cheap, renewable, and environmentally friendly [8]. Approximately 170,000 TW of solar radiation falls on the earth surface during a year [9].

The renewable energies, especially solar energy, have been used in some multi-generation systems. The previous studies have shown that multi-generation systems can play an important role in the reduction of emissions related to energy production [10]. Multi-generation systems that use renewable sources are practical to provide various needs of a public unit. Furthermore, they produce the power of clean energy with high efficiency [11]. The production of multiple outputs from one system improves the overall efficiency of the system [12]. Multi-generation systems with combination of two renewable energy sources can increase the overall efficiency of a conventional plant up to 70% by providing useful outputs such as cooling, heating (and hot water) [13]. Various studies have been conducted on multi-generation systems:

Khalid et al. [10] designed and evaluated a multi-generational system based on biomass and solar energy through energy and exergy analysis. Space heating, electricity, hot water, and cooling were the system outputs. Also, they studied the impacts of varying the main factors on the system. The overall energy and exergy efficiencies of the system were calculated to be 91.0% and 34.9%, respectively. The results showed that the system was more economic and efficient in comparison with running individually solar and biomass systems.

Sharifishourabi et al. [14] have proposed a multigeneration system to supply electricity, dry air, hot water, hydrogen, cooling and heating to the residential sectors. The system involved an ORC, a single effect absorption system, an electrolyser and a dehumidification system. The overall energy and exergy efficiency of the system have found to be 70

* Corresponding author.

E-mail address: es_arab@ut.ac.ir (E.A. Chadegani).

https://doi.org/10.1016/j.enconman.2018.08.011

Received 15 February 2018; Received in revised form 30 July 2018; Accepted 4 August 2018 0196-8904/ @ 2018 Published by Elsevier Ltd.

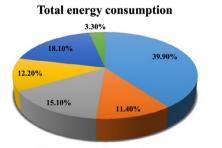
AbsTtemperatureAbsAbsroherFfilterABCAmmonia Rakine cycleFfilterBboilerDTGturbine generatorCOcondenserΔPtrans-membrane pressureCOPcoefficient of performanceAPtrans-membrane pressureGDcoefficient of performanceRRrecovery ratioddestructionρdensitySEASsingle effect absorption systemMmembrane perneability resistanceELEelectrolyzerAmmoniaarea of membraneELEelectrolyzerAmmoniaarea of membraneFImass flow rateCwmembrane rejection coefficientMWmolar mass of H2Rmembrane rejection coefficientP1pump1dffeed channelsP2pump3ReReynolds numberP3pump4ReReynolds numberP4pump4MNnumber of feed channelsP5entrosymotorLeadfilterQhat transfer rateScSchmidt NumberP4entrosymotorScSchmidt NumberP5entrosymotorScSchmidt NumberP6entrosymotorFainput exergy areaP6entrosymotorScSchmidt NumberP6entrosymotorScSchmidt NumberP7entrosymotorScSchmidt NumberP6entrosymotorScSchmidt NumberP	Nomenclature ε utilization factor				
AbsabsorberFfilterARCAmmonia Rankine cycleTGturbine generatorBboilerDnumber of RO trainsCOcondenserΔPtrans-membrane pressureCOPcoefficient of performanceAPtrans-membrane pressureCOPcoefficient of performancePdestructionddestructionPdensitySEASsingle effect absorption systemkmmembrane permeability resistanceEESEngineering Equation SolverAmmonia mass flow rateCwELEelectrolyzerAmmonia mass of H2RRmembrane rejection coefficientMWmolar mass of H2Rmembrane rejection coefficientORCorganic Rankine cyclekmassmass transfer coefficientPpressureDsdiffusivityP1pump1dfeed channel thicknessP3pump3Mmnumber of pressure vesselsQheat transfer rateScSchmid NumbergentropyHHWhigher heating valuehenthalpykmnembrane widthQheat transfer rateScScsenthalpykmexerge value coefficient rateggeneratorferexergenvironmental impact indexQheat transfer rateScScsenthalpyferexergenvironmental impact coefficientfabsorption evaporatorferexergenvironmental impact coe			Т	temperature	
Bboiler b_n number of RO trainsCOcondenser ΔP trans-membrane pressureCOPcoefficient of performanceRRrecovery ratioddestruction ρ densitySEASsingle effect absorption system k_m membrane permeability resistanceEESEngineering Equation Solver J_w volumetric permeate flow rateELEelectrolyzer A_{mem} area of membraneEnenergy $\Delta\delta$ trans-membrane osmotic pressure \dot{m} mass flow rate C_w membrane vall concentrationMWmolar mass of H2Rmembrane rejection coefficientORCorganic Rankine cycle k_{mass} mass transfer coefficientP1pump1dfeed channel thicknessP2pump2ReReynolds numberP3pump3N _{ch} number of feed channelsP4pump4Wmmembrane width \dot{Q} heat transfer rateScsentropyHHWhigher heating valuehentropy E_{xin} input exergy rateEVabsorption evaporator E_{xin} input exergy officientkxexergy d_{cii} exergoenvironmental impact coefficientfentropyHHWhigher heating valuehentropy d_{cii} exergy officienty of the systemfentropy d_{cii} exergoenvironmental impact coefficientfexergy d_{cii} <	Abs	absorber	F	filter	
COcondenser Δ^P trans-membrane pressureCOPcoefficient of performanceRRrecovery ratioddestruction ρ densitySEASsingle effect absorption system k_m membrane permeability resistanceEESEngineering Equation Solver J_w volumetric permeate flow rateELEelectrolyzer A_mem area of membraneenergy $\Delta\delta$ trans-membrane osmotic pressure \dot{m} mass flow rate C_w membrane wall concentrationMWmolar mass of H2Rmembrane rejection coefficientORCorganic Rankine cycle k_{mass} mass transfer coefficientPpressure D_x diffusivityP1pump1dfeed channel thicknessP2pump2ReReynolds numberP3pump3 N_{ch} number of pressure vesselsP4pump4NPnumber of pressure vesselsRentropyHHWhigher heating value \dot{Q} heat transfer rateScSchmidt Numbersentropy E_{xin} input exergy destruction rateEXexergy d_{ack} vorrall exergy destruction rateEXexergo denvironmental impact coefficient f_{ack} ggenerator f_{ack} exergoenvironmental impact coefficientfunmbr f_{ack} exergoenvironmental impact coefficientggenerator f_{ack} exergoenvironmental impact coefficient	ARC	Ammonia Rankine cycle	TG	turbine generator	
COPcoefficient of performanceRRrecovery ratioddestruction ρ densitySEASsingle effect absorption system k_m membrane permeability resistanceEESEngineering Equation Solver J_w volumetric permeate flow rateELEelectrolyzer A_{mon} area of membraneEnenergy $\Delta\delta$ trans-membrane osmotic pressuremmass flow rate C_w membrane wall concentrationMWmolar mass of H2Rmembrane rejection coefficientORCorganic Rankine cycle k_{mass} mass transfer coefficientPpressure D_s diffusivityP1pump1dfeed channel thicknessP2pump3Nchnumber of feed channelsP3pump4NPnumber of feed channelsP4pump4NPnumber of genesure vesselsR0Reverse Osmosis μ dynamic viscosityTturbine k_{con} reargy detruction ratesentropyHHWhigher heating valuehexergy d_{con} detruction rategexergy d_{con} veragoenvironmental impact factorEXexpansion valve1 f_{ei} exergoenvironmental impact coefficientFXparabolic trough solar collector θ_{ei} exergoenvironmental impact indexfparabolic trough solar collector θ_{ei} exergy subalibility indexfparabolic trough solar collector	В	boiler	b _n	number of RO trains	
ddestructionρdensitySEASsingle effect absorption system k_m membrane permeability resistanceEESEngineering Equation Solver J_w volumetric permeate flow rateELEelectrolyzer A_{mem} area of membraneEnenergy $\Delta\delta$ trans-membrane osmotic pressure \dot{m} mass flow rate C_w membrane vall concentrationMWmolar mass of H2Rmembrane rejection coefficientORCorganic Rankine cycle k_{mass} mass transfer coefficientPpressure D_z diffusivityP1pump1dfeed channel thicknessP2pump2ReReynolds numberP3pump3Nchnumber of pressure vesselsR0Reverse Osmosis μ dynamic viscosityTturbine W_m membrane width \dot{Q} heat transfer rateScSchmidt NumbersentropyHHWhigher heating valuehenthalpy \dot{E}_{xim} input exergy rateEXexpansion valve1 f_{eff} exergoenvironmental impact factorEX2expansion valve2 C_{ei} exergoenvironmental impact indexFYSCparebolic trough solar collector θ_{ei} exergo subinity factor η energy efficiency \dot{e}_{est} exergy subinity factor	CO	condenser	ΔP	trans-membrane pressure	
SEASsingle effect absorption system k_m membrane permeability resistanceEESEngineering Equation Solver J_w volumetric permeate flow rateELEelectrolyzer A_{mem} area of membraneEnenergy $\Delta\delta$ trans-membrane somotic pressure \dot{m} mass flow rate C_w membrane rejection coefficientORCorganic Rankine cyclekmassPpressure D_s diffusivityP1pump1dfeed channel thicknessP2pump2 Re Reynolds numberP3pump3Nchnumber of feed channelsP4pump4NPnumber of pressure vesselsR0Reverse Osmosis μ dynamic viscosityTturbine S_c Schmidt Numbersentropy E_{sin} input exergy ratekabsorption evaporator E_{sin} input exergy efficiencyEX2expansion valve1 f_{eil} exergoenvironmental impact factorC41expansion valve2 C_{eil} exergoenvironmental impact indexPTSCparabolic trough solar collector θ_{eil} exergoenvironmental impact index η energy θ_{est} exergy sustainability index	COP	coefficient of performance	RR	recovery ratio	
EESEngineering Equation Solver J_w volumetric permeate flow rateELEelectrolyzer A_{mem} area of membraneEnenergy $\Delta\delta$ trans-membrane osmotic pressure \dot{m} mass flow rate C_w membrane moll concentrationMWmolar mass of H2Rmembrane rejection coefficientORCorganic Rankine cycle k_{mass} mass transfer coefficientPpressure D_s diffusivityP1pump1dfeed channel thicknessP2pump2ReReynolds numberP3pump3Nchnumber of feed channelsP4pump4NPnumber of pressure vesselsR0Reverse Osmosis μ dynamic viscosityTturbine W_m membrane width \dot{Q} heat transfer rate Sc Schmidt Number s entropyHHWhigher heating valuehenthalpy \dot{E}_{xin} input exergy destruction rate Ex exergy d_{int} overall exergy deficiency of the systemEX1expansion valve1 f_{ei} exergoenvironmental impact factorEX2expansion valve2 G_{ei} exergoenvironmental impact indexPTSCparabolic trough solar collector θ_{ei} exergoenvironmental impact index η energy efficiency θ_{ei} exergy subability factor η energy efficiency θ_{ei} exergy subability index	d	destruction	ρ	density	
EESEngineering Equation Solver J_w volumetric permeate flow rateELEelectrolyzer A_{mem} area of membraneEnenergy $\Delta\delta$ trans-membrane osmotic pressure m mass flow rate C_w membrane wall concentrationMWmolar mass of H2Rmembrane rejection coefficientORCorganic Rankine cycle k_{mass} mass transfer coefficientPpressure D_s diffusivityP1pump1dfeed channel thicknessP2pump2 Re Reynolds numberP3pump4NPnumber of feed channelsP4pump4NPnumber of pressure vesselsR0Reverse Osmosis μ dynamic viscosityTturbine W_m membrane width \dot{Q} heat transfer rate S_c Schmidt Number s entropyHHWhigher heating valuehenthalpy E_{xin} iput exergy distruction rateEXexergs d_{ax} overall exergy efficiency of the systemEX1expansion valve1 f_{ei} exergoenvironmental impact factorEX2expansion valve2 G_{eii} exergoenvironmental impact indexPYSCparabolic trough solar collector θ_{eii} exergoenvironmental impact index η_{xi} energy efficiency θ_{eii} exergoenvironmental impact index	SEAS	single effect absorption system	k _m	membrane permeability resistance	
Enenergy mass flow rate $\Delta\delta$ trans-membrane osmotic pressure \dot{m} mass flow rate C_w membrane wall concentrationMWmolar mass of H2Rmembrane rejection coefficientORCorganic Rankine cycle k_{mass} mass transfer coefficientPpressureDsdiffusivityP1pump1dfeed channel thicknessP2pump2ReReynolds numberP3pump3Nchnumber of feed channelsP4pump4NPnumber of pressure vesselsR0Reverse Osmosis μ dynamic viscosityTturbine W_m membrane width \dot{Q} heat transfer rateScSchmidt NumbersentropyHHWhigher heating valuehenthalpy E_{xin} input exergy rateEXexergy η_{ex} overall exergy deficiency of the systemEX1expansion valve1 η_{ex} exergoenvironmental impact factorGgenerator ϕ_{ei} exergoenvironmental impact coefficientHXheat exchanger f_{ei} exergoenvironmental impact indexFYSCparabolic trough solar collector ϕ_{ei} exergoenvironmental impact index η_{v} energy efficiency ϕ_{ei} exergy subalility factor η_{v} energy efficiency θ_{eii} exergy subalility index	EES	Engineering Equation Solver		volumetric permeate flow rate	
\dot{m} mass flow rate C_w membrane wall concentrationMWmolar mass of H2Rmembrane rejection coefficientORCorganic Rankine cycle k_{mass} mass transfer coefficientPpressure D_s diffusivityP1pump1dfeed channel thicknessP2pump2 Re Reynolds numberP3pump3 N_{ch} number of feed channelsP4pump4NPnumber of pressure vesselsR0Reverse Osmosis μ dynamic viscosityTturbine S_c Schnidt NumbersentropyHHWhigher heating valuehenthalpy \dot{E}_{xin} input exergy rateEXexergy η_{ex} overall exergy efficiency of the systemEX1expansion valve1 f_{ei} exergoenvironmental impact factorEX2expansion valve2 C_{ei} exergoenvironmental impact indexGgenerator θ_{eii} exergoenvironmental impact indexPTSCparabolic trough solar collector θ_{eii} exergy stability factorHThydro turbine θ_{eii} exergy sustainability index η energy efficiency θ_{est} exergy sustainability index	ELE	electrolyzer	A_{mem}	area of membrane	
MWmolar mass of H2Rmembrane rejection coefficientORCorganic Rankine cycle k_{mass} mass transfer coefficientPpressure D_s diffusivityP1pump1dfeed channel thicknessP2pump2 Re Reynolds numberP3pump3 N_{ch} number of feed channelsP4pump4NPnumber of pressure vesselsROReverse Osmosis μ dynamic viscosityTturbine S_c Schmidt NumbersentropyHHWhigher heating valuehenthalpy \dot{E}_{xin} input exergy rateEVabsorption evaporator Ex total exergy destruction rateEX1expansion valve1 η_{ex} overall exergy deficiency of the systemEX2expansion valve2 C_{ei} exergoenvironmental impact factorGgenerator θ_{eii} exergoenvironmental impact indexPT5Cparabolic trough solar collector θ_{eii} exergoenvironmental impact index η_{v} energy efficiency θ_{est} exergy stability factor η_{v} energy efficiency θ_{est} exergy subaliability index	En	energy	$\Delta\delta$	trans-membrane osmotic pressure	
ORC Porganic Rankine cyclekmass kmassmass transfer coefficientPpressureDsdiffusivityP1pump1dfeed channel thicknessP2pump2ReReynolds numberP3pump3Nchnumber of feed channelsP4pump4NPnumber of pressure vesselsR0Reverse Osmosis μ dynamic viscosityTturbineWmmembrane width \dot{Q} heat transfer rateScSchmidt NumbersentropyHHWhigher heating valuehenthalpy \dot{E}_{xin} input exergy rateEVabsorption evaporator E_x total exergy destruction rateEX1expansion valve1 f_{ei} exergoenvironmental impact factorEX2expansion valve2Ceiexergoenvironmental impact coefficientGgenerator θ_{eii} exergoenvironmental impact indexPTSCparabolic trough solar collector θ_{eii} exergoenvironmental impact indexHThydro turbine f_{es} exergy stability factorHThydro turbine f_{es} exergy stability index	ṁ	mass flow rate	C_w	membrane wall concentration	
PpressureDsdiffusivityP1pump1dfeed channel thicknessP2pump2ReReynolds numberP3pump3Nchnumber of feed channelsP4pump4NPnumber of pressure vesselsROReverse Osmosis μ dynamic viscosityTturbineWmmembrane width \dot{Q} heat transfer rateScSchmidt NumbersentropyHHWhigher heating valuehenthalpy \dot{E}_{xin} input exergy rateEVabsorption evaporator \dot{Ex} total exergy destruction rateEX2expansion valve1 f_{ei} exergoenvironmental impact factorGgenerator Θ_{ei} exergoenvironmental impact indexPTSCparabolic trough solar collector θ_{ei} exergoenvironmental impact indexHThydro turbine ϕ_{est} exergy sustainability index η energy efficiency θ_{eit} exergy sustainability index	MW	molar mass of H2	R	membrane rejection coefficient	
P1pump1dfeed channel thicknessP2pump2ReReynolds numberP3pump3Nchnumber of feed channelsP4pump4NPnumber of pressure vesselsR0Reverse Osmosis μ dynamic viscosityTturbine M_m membrane width \dot{Q} heat transfer rate Sc Schmidt NumbersentropyHHWhigher heating valuehenthalpy \dot{E}_{xjn} input exergy rateEVabsorption evaporator Ex total exergy destruction rateEXexergy η_{ex} overall exergy efficiency of the systemEX1expansion valve1 f_{ei} exergoenvironmental impact factorGgenerator θ_{ei} exergoenvironmental impact indexPTSCparabolic trough solar collector θ_{ei} exergoenvironmental impact indexHThydro turbine f_{es} exergy subility factor η energy efficiency θ_{eit} exergy subility factor η energy efficiency θ_{eit} exergy subility index	ORC	organic Rankine cycle	k _{mass}	mass transfer coefficient	
P2pump2ReReynolds numberP3pump3 N_{ch} number of feed channelsP4pump4NPnumber of pressure vesselsROReverse Osmosis μ dynamic viscosityTturbine W_m membrane width \dot{Q} heat transfer rate Sc Schmidt NumbersentropyHHWhigher heating valuehenthalpy \dot{E}_{xjn} input exergy rateEVabsorption evaporator Ex total exergy destruction rateEXexergy η_{ex} overall exergy efficiency of the systemEX1expansion valve1 f_{ei} exergoenvironmental impact factorEX2expansion valve2 C_{ei} exergoenvironmental impact coefficientGgenerator θ_{ei} exergoenvironmental impact indexPTSCparabolic trough solar collector θ_{ei} exergoenvironmental impact indexHThydro turbine θ_{est} exergy sustainability index η energy efficiency θ_{est} exergy sustainability index	Р	pressure	Ds	diffusivity	
P3pump3Nchnumber of feed channelsP4pump4NPnumber of pressure vesselsROReverse Osmosis μ dynamic viscosityTturbine W_m membrane width \dot{Q} heat transfer rate Sc Schmidt NumbersentropyHHWhigher heating valuehenthalpy \dot{E}_{xin} input exergy rateEVabsorption evaporator Ex total exergy destruction rateEXexergy η_{ex} overall exergy efficiency of the systemEX1expansion valve1 f_{ei} exergoenvironmental impact factorEX2expansion valve2 \mathcal{O}_{ei} exergoenvironmental impact coefficientGgenerator θ_{ei} exergoenvironmental impact indexPTSCparabolic trough solar collector θ_{ei} exergoenvironmental impact improvementHXheat exchanger f_{es} exergy stability factorHThydro turbine q_{est} exergy sustainability index	P1	pump1	d	feed channel thickness	
P4pump4NPnumber of pressure vesselsROReverse Osmosis μ dynamic viscosityTturbine μ membrane width \dot{Q} heat transfer rate Sc Schmidt NumbersentropyHHWhigher heating valuehenthalpy $\dot{E}_{x_{in}}$ input exergy rateEVabsorption evaporator Ex total exergy destruction rateExexergy $de_{s,tot}$ overall exergy efficiency of the systemEX1expansion valve1 f_{ei} exergoenvironmental impact factorGgenerator ∂_{eii} exergoenvironmental impact indexPTSCparabolic trough solar collector ∂_{eii} exergoenvironmental impact indexHXheat exchanger f_{es} exergy stability factorHThydro turbine ρ_{est} exergy sustainability index	P2	pump2	Re	Reynolds number	
ROReverse Osmosis μ dynamic viscosityTturbine W_m membrane width \dot{Q} heat transfer rate Sc Schmidt NumbersentropyHHWhigher heating valuehenthalpy $\dot{E}_{x_{in}}$ input exergy rateEVabsorption evaporator Ex total exergy destruction rateexexergy $des.tot$ overall exergy efficiency of the systemEX1expansion valve1 f_{ei} exergoenvironmental impact factorEX2expansion valve2 C_{ei} exergoenvironmental impact factorGgenerator θ_{ei} exergoenvironmental impact indexPTSCparabolic trough solar collector θ_{eii} exergoenvironmental impact indexHXheat exchanger f_{es} exergy stability factorHThydro turbine θ_{est} exergy sustainability index	Р3	pump3	N _{ch}	number of feed channels	
Tturbine W_m membrane width \dot{Q} heat transfer rate Sc Schmidt NumbersentropyHHWhigher heating valuehenthalpy $\dot{E}_{x_{in}}$ input exergy rateEVabsorption evaporator Ex total exergy destruction rateExexergy $des.tot$ overall exergy efficiency of the systemEX1expansion valve1 f_{ei} exergoenvironmental impact factorEX2expansion valve2 C_{ei} exergoenvironmental impact coefficientGgenerator θ_{ei} exergoenvironmental impact indexPTSCparabolic trough solar collector θ_{eii} exergoenvironmental impact indexHXheat exchanger f_{es} exergy stability factorHThydro turbine g_{est} exergy sustainability index	P4	pump4	NP	number of pressure vessels	
\dot{Q} heat transfer rate Sc Schmidt Number s entropyHHWhigher heating valuehenthalpy $\dot{E}_{x_{in}}$ input exergy rateEVabsorption evaporator $\dot{E}x$ total exergy destruction rateExexergy $des.tot$ overall exergy efficiency of the systemEX1expansion valve1 f_{ei} exergoenvironmental impact factorEX2expansion valve2 C_{ei} exergoenvironmental impact coefficientGgenerator θ_{ei} exergoenvironmental impact indexPTSCparabolic trough solar collector θ_{eii} exergoenvironmental impact improvementHXheat exchanger f_{es} exergy stability factorHThydro turbine θ_{est} exergy sustainability index	RO	Reverse Osmosis	μ	dynamic viscosity	
sentropyHHWhigher heating valuehenthalpy $\dot{E}_{x_{in}}$ input exergy rateEVabsorption evaporator $\dot{E}_{x_{in}}$ total exergy destruction rateExexergy $des.tot$ overall exergy efficiency of the systemEX1expansion valve1 η_{ex} overall exergy efficiency of the systemEX2expansion valve2 C_{ei} exergoenvironmental impact factorGgenerator θ_{ei} exergoenvironmental impact coefficientPTSCparabolic trough solar collector θ_{ei} exergoenvironmental impact indexHXheat exchanger f_{es} exergy stability factor η energy efficiency θ_{est} exergy sustainability index	Т	turbine	Wm	membrane width	
henthalpy $\dot{E}_{x_{in}}$ input exergy rateEVabsorption evaporator \dot{E}_{x} total exergy destruction rateExexergy $\dot{d}_{ex,tot}$ overall exergy efficiency of the systemEX1expansion valve1 η_{ex} overall exergy efficiency of the systemEX2expansion valve2 C_{ei} exergoenvironmental impact factorGgenerator θ_{ei} exergoenvironmental impact coefficientPTSCparabolic trough solar collector θ_{ei} exergoenvironmental impact indexHXheat exchanger f_{es} exergy stability factorHThydro turbine θ_{est} exergy sustainability index	Q	heat transfer rate	Sc	Schmidt Number	
EVabsorption evaporatorExtotal exergy destruction rateExexergy des, tot overall exergy efficiency of the systemEX1expansion valve1 η_{ex} overall exergy efficiency of the systemEX2expansion valve2 f_{ei} exergoenvironmental impact factorGgenerator θ_{ei} exergoenvironmental impact coefficientPTSCparabolic trough solar collector θ_{ei} exergoenvironmental impact indexHXheat exchanger θ_{ei} exergoenvironmental impact improvementHThydro turbine f_{es} exergy stability factor η energy efficiency θ_{est} exergy sustainability index	S	entropy		higher heating value	
EVabsorption evaporatorExtotal exergy destruction rateExexergy des, tot overall exergy efficiency of the systemEX1expansion valve1 η_{ex} overall exergy efficiency of the systemEX2expansion valve2 f_{ei} exergoenvironmental impact factorGgenerator θ_{ei} exergoenvironmental impact coefficientPTSCparabolic trough solar collector θ_{ei} exergoenvironmental impact indexHXheat exchanger θ_{ei} exergoenvironmental impact improvementHThydro turbine f_{es} exergy stability factor η energy efficiency θ_{est} exergy sustainability index	h	enthalpy	$\dot{E}_{x_{in}}$	input exergy rate	
EXexergy η_{ex} overall exergy efficiency of the systemEX1expansion valve1 f_{ei} exergoenvironmental impact factorEX2expansion valve2 C_{ei} exergoenvironmental impact coefficientGgenerator θ_{ei} exergoenvironmental impact coefficientPTSCparabolic trough solar collector θ_{ei} exergoenvironmental impact indexHXheat exchanger θ_{eii} exergoenvironmental impact improvementHThydro turbine f_{es} exergy stability factor η energy efficiency θ_{est} exergy sustainability index		absorption evaporator	Ex	total exergy destruction rate	
EX1expansion valuelinitialEX2expansion value2 f_{ei} exergoenvironmental impact factorEX2expansion value2 C_{ei} exergoenvironmental impact coefficientGgenerator θ_{ei} exergoenvironmental impact indexPTSCparabolic trough solar collector θ_{eii} exergoenvironmental impact improvementHXheat exchanger θ_{eii} exergoenvironmental impact improvementHThydro turbine f_{es} exergy stability factor η energy efficiency θ_{est} exergy sustainability index				overall exercy efficiency of the system	
EX2expansion valve2 C_{ei} exergoenvironmental impact coefficientGgenerator θ_{ei} exergoenvironmental impact indexPTSCparabolic trough solar collector θ_{ei} exergoenvironmental impact indexHXheat exchanger θ_{ei} exergoenvironmental impact improvementHThydro turbine f_{es} exergy stability factor η energy efficiency θ_{est} exergy sustainability index		*			
Ggenerator θ_{ei} exergoenvironmental impact indexPTSCparabolic trough solar collector θ_{ei} exergoenvironmental impact improvementHXheat exchanger θ_{ei} exergoenvironmental impact improvementHThydro turbine f_{es} exergy stability factor η energy efficiency θ_{est} exergy sustainability index	EX2	expansion valve2			
PTSCparabolic trough solar collector θ_{eii} exergoenvironmental impact improvementHXheat exchanger f_{es} exergy stability factorHThydro turbine θ_{est} exergy sustainability index η energy efficiency θ_{est} exergy sustainability index		8			
HXheat exchanger f_{es} exergy stability factorHThydro turbine θ_{est} exergy sustainability index η energy efficiency θ_{est} exergy sustainability index					
HThydro turbine $θ_{est}$ exergy sustainability indexηenergy efficiency $θ_{est}$ exergy sustainability index		0			
η energy efficiency	HT				
ψ exergy efficiency			- 651		
	ψ	exergy efficiency			

and 53% respectively.

Almahdi et al. [15], developed a solar multi-generation system based on hydrogen production. In their system, three ORCs, two absorption systems, a heat pump and an electrolyzer were used. The system was able to generate 18.8 L/s of hydrogen. The overall energy and exergy efficiency of the system were determined to be 20.7 and 13.7%, respectively.

Ozturk and Dincer [16] studied a multi-generation system which produced hot water, heat, electricity, cooling, and hydrogen using renewable energy input. The system consisted of organic Rankine cycle, Rankine cycle, an absorption system, and an electrolyzer. Results showed that the exergy efficiency of the multi-generation system was higher than that of the sub-system efficiencies.

Islam and Dincer [17] developed and analyzed a combined solar and geothermal energy-based system for multi-generation purposes.



Coal = Natural Gas = Biofuels and waste = Electricity = Other: geothermal, solar, wind, heat, etc.
Fig. 1. Total energy consumption in 2014 [3].

The proposed system included two ORC power cycles, two thermal energy storage systems, a heat pump, an absorption chiller, and a drying system. They compared the system's energy and exergy efficiencies when it was working in multi-generation and single generation modes. The energy and exergy efficiencies were found to be 51% and 62%, respectively in multi-generation mode, whereas these efficiencies in single generation mode were in the order of 22% and 54%, respectively.

Hassoun and Dincer [18] assessed performance of a multi-generation system powered by an Organic Rankine Cycle which used solar energy as a prime energy source. The system developed to meet the demands of a net zero energy building such as electricity, fresh and hot water, heating, and cooling. The exergetic analyses showed that the overall exergy efficiency of the system was 44.67% and increased to 58.8% by multi-objective optimization.

Mohammadi et al. [19], evaluated a combined cooling, heating, and power system integrated with a wind turbine and compressed air energy storage system through energy and exergy analysis . The results showed that the system could generate 33.67 kW of electricity, 2.56 kW of cooling and 1.82 tonnes per day of hot water with an energy efficiency of 53.94%. Exergy analysis revealed that the highest amounts of exergy destruction belonged to the wind turbine, the combustion chamber, and the compressed air storage systems, respectively.

Ezzat and Dincer [20] evaluated a new multi-generational system through energy and exergy analysis. Their system consisted of a heat pump system, a single effect absorption chiller, a single flash geothermal system, thermal energy storage, a drying system, and a hot water system. The system had the overall exergy and energy efficiencies Download English Version:

https://daneshyari.com/en/article/7157744

Download Persian Version:

https://daneshyari.com/article/7157744

Daneshyari.com