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Critical analysis of a biogas powered absorption system for climate change mitigation

S. Anand · A. Gupta · S. K. Tyagi

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Abstract The importance of biogas as a renewable alternative is being studied because of an increase in the cost of conventional fuels. The present article suggests a numerical study of a biogas powered NH_3–H_2O absorption refrigeration system where biogas is used to heat the water which serves as an energy input to generator of an absorption system. A computational model has been developed for the analysis which involves the determination of effect of generator temperature on various performance parameters, i.e., exergy losses in the different components, $COP_{cooling}$, $COP_{heating}$ and the exergy efficiency. The results indicate that $COP_{cooling}$ and $COP_{heating}$ lies in the range of 0.159–0.33 and 1.16–1.33, respectively, whereas exergetic efficiency lies in the range of 0.29–0.80 for the same variation in generator temperature ranging from 50 to 70 °C. The highest exergy loss is found in the generator while the lowest is found in the condenser and it is also found that with an increase in the evaporator as well as absorber and condenser temperature, the COP increases and decreases, respectively. The effect of ambient temperature on exergy loss in the different components is also studied. Exergy analysis is an excellent tool to pin point the losses in the system due to irreversibility which are the basis for the further improvement in the system components.

S. Anand (✉) · A. Gupta
School of Energy Management, Shri Mata Vaishno Devi University, Katra 182320, Jammu and Kashmir, India
e-mail: anandsanjeev12@gmail.com

S. K. Tyagi
Sardar Swaran Singh National Institute of Renewable Energy, Kapurthala 144601, Punjab, India

Keywords Absorption refrigeration system · Biogas · Exergy analysis · Coefficient of performance · Exergetic efficiency

Abbreviation

EES Engineering equation solver

List of symbols

Variables

COP	Coefficient of performance
$\dot{m}$	Mass flow rate (kg/s)
h	Enthalpy (kJ/kg)
S	Entropy (kJ/kg K)
$\dot{Q}$	Heat flow (kW)
P	Pressure (bar)
T	Temperature (K)
$\dot{W}$	Power consumption (kW)
Ξ_x	Exergy (kW)
1–10	Different state points in a system
PR-valve	Pressure reducing valve

Greek symbol

η Efficiency (dimensionless)

Subscripts

A, abs	Absorber
C, cond	Condenser
G, gen	Generator
E, evap	Evaporator
p	Pump
i, in	Inside
o, out	Ambient, outside