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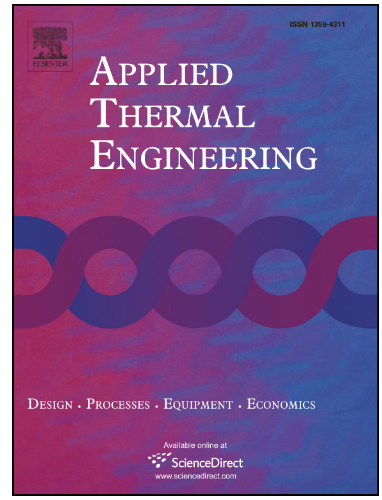

Research Paper

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Solar driven ORC-based CCHP: Comparative performance analysis between sequential and parallel system configurations

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Abstract：

Overall energy efficiency remains a large and unexploited resource in combined cooling, heating, and power systems driven by solar energy. This study aims to explore the configuration effects on such systems using parabolic trough collector and organic Rankine cycle (ORC) technologies. The configurations are concisely clarified into sequential and parallel connections, in which a single-effect absorption chiller and a heat exchanger are considered for cooling and heating, respectively. A comprehensive assessment framework is proposed by establishing the thermodynamic performance, system size, and economic models. Under reasonable thermodynamic boundary conditions, the optimal operational parameters are obtained via a Pareto frontier solution for such a system, with an ORC of 200 kW. Promising technical solutions and enhancement potential are justified and quantified by means of system simulations and comparison on the annual time scale.

Keywords: Configuration; Combined cooling, heating, and power; Energy cascade utilization; Organic Rankine cycle; Solar thermal energy

Nomenclature

Symbols		*Subscript*	
A	area, m^2	abs	absorber
A_a	aperture area of solar collector, m^2	ACH	absorption chiller
c	specific heat capacity, J/kg	atm	atmospheric
C_g	geometric concentration ratio, -	amb	ambient
d_e	equivalent shell diameter, m	Cond	condenser
d_i	inner diameter of tubes, m	el	electrical power
d_o	outer diameter of tubes, m	ev	evaporation
f	friction factor	eva	evaporator
F_e	dirt degree of collector's mirrors, -	ex	superheating
g	specific gravity, m/s^2	Exp	expander
G_b	direct solar irradiance, W/m^2	g	saturated vapor condition
h	specific enthalpy, J/kg	HE	heat exchanger, -
ΔH	enthalpy drop, J/kg	HS	heating system
K	incident angle modifier, -	i	inside fluid of HE
IC	investment cost, $	id	inside dirt of HE
l	length, m	in_oil	inlet of oil
$\dot{m}$	mass flow rate, kg/s	l	saturated liquid state