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Thermodynamic Analysis of New Cogeneration Cycle Based on Gaynarje Hotspring

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A B S T R A C T

Gaynarje spring is one of the hottest springs in the world and is located around Meshginshahr in northwest of Iran. Because of the water at temperature of 82 ºC, it is not appropriate to use this mineral water for swimming and bathing. In this study, in addition to lowering the water temperature to the appropriate swimming temperature (29 ºC), the hot water is used for power and natural gas production in a combined cycle based on Organic Rankine Cycle (ORC) and LNG cold. The proposed configuration has been studied thermodynamically and optimized for important performance parameters. For this purpose, mass, energy and exergy equations were developed for components and the whole system. Also, performance parameters were calculated. For achieving the best results, several working fluids are examined for the ORC. According to the obtained results R245fa as an ORC working fluid has the best performance from the thermodynamic viewpoint. Also, for optimum condition of the cogeneration cycle, net output power, natural gas production, thermal and exergy efficiencies were calculated to be 524.9 kW, 1.352 kg/s, 24.11 and 48.99%, respectively. The parametric study is also indicated that the performance parameters have optimum values with respect to the evaporator temperature.

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NOMENCLATURE

$\dot{E}$	Exergy rate (kW)	$\dot{W}$	Power (kW)
h	Specific enthalpy (kJ/kg)	**Greek Symbols**	
LNG	Liquefied Natural Gas	η_{ex}	Exergy efficiency (%)
$\dot{m}$	Mass flow rate (kg/s)	η_{th}	Thermal efficiency (%)
ORC	Organic Rankine Cycle	**Subscripts**	
P	Pressure (kPa)	Ev	Evaporator
$\dot{Q}$	Heat transfer rate (kW)	P	Pump, product
T	Temperature (°C), Turbine	PP	Pinch point

1. INTRODUCTION

Nowadays, the demand for energy and electricity in the industrial, commercial and service sectors has increased, which has led to an increase in fossil fuel consumption [1-5]. This trend leads to environmental pollution and energy shortages. In order to avoid these effects, many studies have recently been conducted on the use of low-grade heat sources, including geothermal energy source [6,7]. Fallah et al. [8] performed a comparative analysis on single, double, and triple-flash, dry steam and different Organic Rankine Cycle (ORC) configurations for power generation from geofluid temperature of 230 ºC. They showed that the triple-flash system produces more power compared to the single and double-flash from the thermodynamic viewpoint while the dry steam cycle is the best cycle from thermoeconomic point of view. A new configuration of integrated single and double-flash with modified Kalina is proposed by

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