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Awais Ahmed, Khaled Khodary Esmaeil, Mohammad A Irfan, Fahad Abdulrahman Al-Mufadi

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## Design Methodology of Organic Rankine Cycle for Waste Heat Recovery in Cement Plants

Awais Ahmed<sup>a</sup>, Khaled Khodary Esmaeil<sup>a,b</sup>, Mohammad A Irfan<sup>a,c</sup>, Fahad Abdulrahman Al-Mufadi<sup>a</sup>

<sup>a</sup> Department of Mechanical Engineering, Qassim University, KSA.

<sup>b</sup>Mechanical Power Engineering Department, Faculty of Engineering, Tanta University, Egypt. <sup>c</sup>Department of Mechanical Engineering, University of Engineering and Technology, Peshawar, Pakistan.

> Corresponding Author: Mohammad A Irfan (<u>mairfan@qec.edu.sa</u>) PO Box 6677, College of Engineering, Qassim University, Saudi Arabia

### Abstract

An organic Rankine cycle (ORC) is similar to a conventional steam cycle energy conversion system, but uses organic fluid, such as refrigerants and hydrocarbons, instead of water. A renewed research interest in ORC focuses on its progressive adoption as a premier technology for converting low and medium temperature i.e.  $80^{\circ}C < T < 300^{\circ}C$  heat resources into power. Available heat resources are solar energy, geothermal energy, biomass products, surface seawater, and waste heat from various thermal processes. This study presents a design methodology for an ORC. The design is conducted based on the actual data from a local cement factory. The working fluid directly affects the efficiency of the cycle. The fluid choice is fundamental for a good cycle performance because the optimal thermos physical properties depend on the source temperature. This study illustrates the results of an organic Rankine cycle combined with a gas turbine to convert the gas turbine waste heat into electrical power. The R134a working fluid is chosen for the design. Consequently, approximately 1 MW power can be generated using an ORC. Exergy analysis is performed using actual data from the industry, showing that most of the exergy loss is in the working part of the turbine.

NOMENCLATURE						
ORC	Organic Rankine cycle	NTU	number of transfer units			
Q	heat rate (kW)	f	Darcy coefficient of friction			
h	enthalpy (kJ/kg)	L	length (m)			
m	mass flow rate (kg/s//)	W	work done (kW)			
U	overall heat transfer coefficient	Re	Reynolds number			
	$(kW/m^2.K)$	E	exergy (kJ)			
А	area (m <sup>2</sup> )	115	base fluid viscosity $\left(N \stackrel{S}{\longrightarrow}\right)$			
D	diameter (m)	μ <sub>b</sub>	$\mu_{\rm b}$ base find viscosity (N. $m^2$ )			
K	thermal conductivity of pipe (W/mK)	$\mu_{\mathbf{w}}$	fluid viscosity at the wall of pipe $\left(N, \frac{S}{m^2}\right)$			
NuD	Nusselt number	Subscripts				
Pr	Prandtl number	g	gas			
μ	dynamic viscosity $(N.s/m^2)$	i	inlet			
ρ	density (kg/m <sup>3</sup> )	1	liquid phase			
V	velocity (m/s)	0	outlet			
λ	parametric length of tube (m)	cold (c) fluid at cold side				
So	transverse tube spacing (m)					

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