WASTE HEAT UTILIZATION IN WHITE CEMENT PLANTS THROUGH STEAM-ORGANIC CASCSDE RANKIN CYCLE

By

Aly Mahmoud Khater

A Thesis Submitted to the
Faculty of Engineering at Cairo University
In Partial Fulfillment of the
Requirements for the Degree of
MASTER OF SCIENCE
In
Chemical Engineering

FACULTY OF ENGINEERING,
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Under the Supervision of

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Title of Thesis:

Waste heat utilization in white cement plants through steam-organic cascade Rankin cycle.

Key Words:

Waste Heat Recovery; energy efficiency; White Cement Industry; Cascade Rankin Cycle; Organic Rankin Cycle.

Summary:

This study is concerned with utilization of waste heat liberated from a white cement plant in order to increase energy efficiency. Steam Rankin cycle was compared with steam-organic combined Rankin cycle (cascade organic Rankin cycle). This comparison depended on both thermodynamic and economic calculations.

Thermodynamic comparison was based on the net power generated, thermal efficiency and irreversibility. Economic comparison was based on total project capital cost and rate of return. This study aimed to maximize the net power generated, thermal efficiency and rate of return; and to minimize irreversibility and capital cost. Three (SRC) and three (S-ORC) different schemes were suggested to recover waste heat from waste streams. Aspen HYSYS v9.0 was used to simulate suggested schemes. Iso-penate and its different isomers- n-penatne, cyclo-pentane, spiro-pentane and 2, 2-dimethylpropane- were selected as working fluids for steam-organic combined Rankin cycle.

Disclaimer

I hereby declare that this thesis is my own original work and that no part of it has been submitted for a degree qualification at any other university or institute.

I further declare that I have appropriate acknowledged all sources used and have cited them in the references section.

Name: Aly Mahmoud Adel Aly Ibraheem Khater

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Dedication

For my father; the only person encouraged me to finish this work.

Acknowledgments

All praise is due to Allah alone for the grace and success He granted me till I completed this work.

And many thanks to my respected professors who supervised my study: Prof. Dr. Ibrahim Mohamed Ismail, Dr. Ahmed Soliman and Dr. Tamer Samir for their valuable advice, support and encouragement.

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Nomenclature

H	Specific Enthalpy [kJ/kg]
I_{tot}	Total Irreversibility [kW]
m^{o}	Mass Flow Rate [kg/S]
P_{net}	Net Power [kWh]
P_c	Critical Pressure [bar]
Q_{in}	Amount of Heat Input [kW]
S_{gen}	Entropy Generation Rate [kW/K]
T_c	Critical Temperature [K]
T_{Sur}	Surrounding Temperature [K]

Latin

η_{th}	Thermal Efficiency

Abbreviations

GDP	Gross Domestic Product
Mtoe	Million Tons of Oil Equivalent
ORC	Organic Rankin Cycle
SRC	Steam Rankin Cycle
S-ORC	Steam-Organic Combined Rankin Cycle
WHR	Waste Heat Recovery

Subscripts

I	I^{th} Component of The System