Solar-Coal Hybrid Power Plant: Techno-economic Analysis

By

Noor Habib Khan
01-244132-041

Master of Sciences

In

Electrical Engineering (Power)

Department of Electrical Engineering
Bahria University,
Islamabad-Pakistan
FALL 2015

CERTIFICATE OF ORIGINALITY

I certify that the intellectual contents of the thesis

"Solar-Coal Hybrid Power Plant: Techno-Economic Analysis"

is the product of my own research work except, as cited properly and accurately in the acknowledgment and references, the material taken from any source such as research papers, research journals, books, internet, etc solely to support, elaborate, compare and extend the earlier work, Further, this work has not been submitted previously for a degree at this or any other University.

The incorrectness if the above information, if proved at any stage, shall authorize the university to cancel my degree.

Signature:_____. Dated:_____.

Name of the Research student: _____.

Bahria University, Islamabad

Solar-Coal Hybrid Power Plant: Techno-economic Analysis

A Thesis Presented to

Bahria University, Islamabad

In partial fulfilment

Of the requirement for the degree of

MSEE (Power)

By

Noor Habib Khan

01-244132-041

FALL 2015

Solar-Coal Hybrid Power Plant: Techno-economic Analysis

A Masters of Sciences Thesis submitted to the Department of Electrical Engineering as a partial fulfilment of the requirement for the award of Degree of MSEE (Power).

Name	Enrolment Number
Noor Habib Khan	01-244132-041

Supervisor

Name of Supervisor	Dr. Waseem Qaiser Awan
Designation	Deputy Engineering Advisor (Power)
Department	Ministry of Water and Power Islamabad

September, 2015

Final Approval

The thesis titled

Solar-Coal Hybrid Power Plant: Techno-economic Analysis

By

Noor Habib Khan
01-244132-041

Has been approved
For the Bahria University, Islamabad

External Examiner: _____

Dr. Waseem Qaiser,

Deputy Engineering Advisor (Power), Ministry of Water and Power Islamabad.

Supervisor: _____

Dr. Ali Shami

Department of Electrical Engineering, Bahria University Islamabad Campus

H.O.D: _____

Dr. Najim-Ul-Hasan

Department of Electrical Engineering, Bahria University Islamabad Campus

Declaration

I **Noor Habib Khan Registration # 01-244132-041** hereby declare that I have produced the work presented in this thesis, during the scheduled period of study. I also declare that I have not taken any material from any source except referred to wherever due that amount of plagiarism is within acceptable range. If a violation of HEC rules on research has occurred in this thesis, I shall be liable to punishable action under the plagiarism rules of the HEC.

Date: _____ Signature of Student:

_____

Noor Habib Khan

01-244132-041

Certificate of Completion
of
Thesis Work

This is to certify that **Mr. Noor Habib Khan** Enrollment No. 01-244132-041 has successfully completed his research thesis, titled **Solar-Coal Hybrid Power Plant: Techno-Economic Analysis** under my supervision. The thesis meets the scholarly standards as set by Bahria University, Pakistan.

Date: _____ Supervisor

_____

Dr. Waseem Qaiser Awan
Deputy Engineering Advisor
Ministry of Water and Power
Islamabad

Dedicated to

My Respectable Parents

and

Sweet Siblings

ACKNOWLEDGEMENTS

*In the name of **ALLAH**, Most Merciful, the most beneficent and the most gracious and countless salaam to **Holy Prophet Muhammad (Peace be Upon Him)**. Prior to anyone else, all gratitude and praises are due to the almighty **ALLAH**, who gave me health to achieve this goal.*

It is difficult to overstate our gratitude to our supervisor, Dr. Ali Shami, Assistant Professor, Bahria University Islamabad and Dr. Waseem Qaiser, Deputy Engineering Advisor (Power), Ministry of Water and Power Islamabad. Their sage advice, insightful criticism, sympathetic attitude, enthusiastic supervision especially during experiment work and patient encouragement aided me to write this thesis and let me to face every problem with smiling and fruitful attitude.

I would also like to thanks my dear father and mother who pray for me all the time to achieve the desire goal. I also want to thank specially Dr. Waseem Qaiser who helped and provided facilities to complete my thesis.

Last but not the least, a very warm thanks to my respectable parents as well as my sweet siblings for their continuous encouragement, unconditional love, and guidance. They always provided me support, helped me succeeded and instilled into me the confidence, and valuable suggestions for my studies and character.

NOOR HABIB KHAN
ENROLLMENT# 01-244132-041

ABSTRACT

Electricity is the basic need of this era and power demand is rising over the worldwide day by day. There are many factors, which are influencing the energy market, so the energy system is becoming more and more complex. Four core challenges is needed to be addressed whenever to install a power plant; reliable power supply, economic efficiency, resources efficiency and environment protection. The main problem in the power system after generating the electricity is to maintain the continuity of the system according to the continuous changing demand. Whenever the variation in load occurred, the continuity of the system is disturbed so as the efficiency. Pakistan is currently depending on costly fuels and share of cheap energy resources (solar + wind and others) is negligible, which results in huge energy costs and badly affects the economic growth of the country. In the research, a solar-coal hybrid system is proposed which provides the facility to sort out these problems. The Integration of solar energy in existing or new fossil power plant makes the system reliable; cost effective, efficient and environmental friendly. The concept of using solar energy is to provide directly to the heat feed-water heating system or independently that helps in reducing of fuel (coal) consumption along with its associated penalties in terms of CO_2 and also improved the overall efficiency of the system. For using this concept of generation, two options will be discussed in this work. In the first option, solar heat is directly provides to the feed-water heating system and in the second option is to using solar and coal power plant as an independently source which integrated together and provides the overall output but the mainly focuses on the first method of generation. The calculations of the research are based on 100 MW solar-coal hybrid power plant. The Pakistan solar data has been analyzed and on the basis of results design of solar field proposed to get integration with coal fired 100 MW power plant.

List of Figures

List of Tables

List of Abbreviations

DNI	Direct Normal Irradiation (W/m^2)
SCA	Solar Collector Assembly
GHGs	Green House Gases
CDM	Clean Development Mechanism
AC	Alternating Current
CO_2	Carbon Dioxide
L.P	(Low Pressure Turbine, Feed-water heater)
H.P	(High Pressure Turbine, Feed-water heater)
CSP	Concentrated Solar Plant
PV	Photovoltaic
MWt	Megawatt Thermal
RE	Renewable Energy

Contents