Cairo University

SIMULATION AND DESIGN IMPROVEMENT of IGCCS FOR ENERGY-EFFICIENT AND REVAMPING OPPORTUNITIES

By

Dalia Amer Ahmed Ali

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, CAIRO UNIVERSITY
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Under the Supervision of

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Approved by the
Examining Committee

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Title of Thesis:

Simulation and Design Improvement of IGCCs for Energy-Efficient and Revamping Opportunities.

Key Words:
Coal Gasification, Entrained Flow gasifier Model, Heat integration for IGCC unit, Improvements on IGCC unit, Revamping of an existing natural gas power plant.

Summary:

Increased Consumption of Crude oil and NG results in a large deficit in the supply and a huge rise in their prices, hence it is necessary to make an efficient use of the available non-renewable resources of energy such as coal, NG, etc. IGCC acts as the best available technology to use low quality or contaminated energy sources like coal or oil. The main objective of this study is simulating gasifier and improving the state of the art IGCC designs via decreasing the plant energy consumption and increasing the plant thermal efficiency.

Acknowledgments

I would like, first, to express my deepest appreciation for the technical guidance and support given by my research advisors, Prof. Fatma Ashour and Dr. Mamdouh Gadalla. I would like to thank Prof. Mohamed Shahir and Prof. Ehab Abadir for being my examination committee.

Dedication

I would like to dedicate this work to my parents and my husband engineer Ahmed El-Ashmawy for their continuous guidance, encouragement, prayers, love and support throughout my life.

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Nomenclature

Ad: Additional Heat Exchanger Area

Ae: Existing Heat Exchanger Area

ASU: Air Separation Unit

CP: Specific Heat

DCOALIGT: Density of Coal model

FBCB: Fluidized Bed Combustion Boiler

GT: Gas Turbine

HCOALGEN: Enthalpy of Coal model

HE: Heat Exchanger

HEN: Heat Exchanger Network

HRSG: Heat Recovery Steam Generator

IGCC: Integrated Gasification Combined Cycle

LHV: Lower Heating Value

MCP: Heat Capacity Flow rate

NG: Natural Gas

O&M: Operating and Maintenance

O/C: Oxygen/Carbon

PCCB: Pulverized Coal Combustion Boiler

PR-BM: Peng-Robinson with Boston–Mathias alpha function

PROXANAL: Proximate Analysis

PT: Pinch Temperature

S/C: Steam/Carbon

S/O: Steam/Oxygen