GAS-TO-WIRE FOR UTILIZATION OF STRANDED ASSOCIATED GASES IN NIGER DELTA

OGUNLADE, STEPHEN KEHINDE
(20PCF02080)

JULY, 2022

GAS-TO-WIRE FOR UTILIZATION OF STRANDED ASSOCIATED GASES IN NIGER DELTA

BY

OGUNLADE, STEPHEN KEHINDE
(20PCF02080)
B.Tech. Chemical Engineering, Ladoke Akintola University of Technology, Ogbomoso.

A DISSERTATION SUBMITTED TO THE SCHOOL OF POSTGRADUATE STUDIES IN PARTIAL FULFILMENT OF THE REQUIREMENTS FOR THE AWARD OF MASTER OF ENGINEERING (M.Eng.) DEGREE IN CHEMICAL ENGINEERING IN THE DEPARTMENT OF CHEMICAL ENGINEERING, COLLEGE OF ENGINEERING, COVENANT UNIVERSITY.

JULY, 2022

ACCEPTANCE

This is to attest that this dissertation is accepted in partial fulfilment of the requirements for the award of the degree of Masters of Engineering in Chemical Engineering in the Department of Chemical Engineering, College of Engineering, Covenant University, Ota, Ogun State.

Mr Taiwo B. Erewunmi
(Secretary, School of Postgraduate Studies) **Signature and Date**

Prof. Akan B. Williams
(Dean, School of Postgraduate Studies) **Signature and Date**

DECLARATION

I, OGUNLADE, STEPHEN KEHINDE (20PCF02080) declare that this dissertation is a representation of my work, and is written and implemented by me under the supervision of Professor James Omoleye of the Department of Chemical Engineering, Covenant University, Ota, Nigeria. I attest that the dissertation has in no way been submitted either wholly or partially to any other university or institution of higher learning for the award of a masters' degree. All information cited from published and unpublished literature has been duly referenced.

OGUNLADE, STEPHEN KEHINDE

Signature and Date

CERTIFICATION

This is to certify that the research work titled **"GAS-TO-WIRE FOR UTILIZATION OF STRANDED ASSOCIATED GASES IN NIGER DELTA"** is an original research work carried out by **OGUNLADE, STEPHEN KEHINDE (MATRIC. No: 20PCF02080)** meets the requirements and regulations governing the award of Master of Engineering (M.Eng.) degree in Chemical Engineering from the Department of Chemical Engineering, College of Engineering, Covenant University, Ota, and is approved for its contribution to knowledge and literary presentation.

Prof. James A. Omoleye **Signature and Date**
(Supervisor)

Prof. Vincent E. Efeovbokhan
(Head of Department) **Signature and Date**

Prof. Kayode G. Latinwo
(External Examiner) **Signature and Date**

Prof. Akan B. Williams
(Dean, School of Postgraduate Studies) **Signature and Date**

DEDICATION

This research work is dedicated first and foremost to the God Almighty, the custodian of all wisdom, knowledge, and understanding, for His grace and favour throughout the duration of carrying out this research. Then to my family for their endless support and love.

ACKNOWLEDGEMENT

I am extremely grateful to the Board of regent of Covenant University. I would like to express my deepest gratitude to the Chancellor, Dr David O. Oyedepo. I would also like to acknowledge the entire management of Covenant University, starting from the Vice-Chancellor, Prof. Abiodun H. Adebayo and the Dean, School of Postgraduate Studies, Prof. Akan B. Williams for ensuring a research-driven institution.

I also appreciate the Head of the Chemical Engineering Department, Prof. Vincent E. Efeovbokhan, my supervisor Prof. James A. Omoleye, the departmental post graduate coordinator Dr (Mrs) Olayemi A. Odunlami, all Faculty and Staff of Chemical Engineering department for their support.

I would also like to acknowledge my employer – Dow Industrial Chemical Products Nigeria Limited, my immediate supervisor, Silvia Pena, former leaders (Edosa, Adriano, Lisa, Ahmed) and members of my Lagos team (Adebisi, Toby-Lade, Helen, Adejoke, Chucks, Pride, Augustina, Awele, and Anu).

My special appreciation goes to the managing director of Weam and Company Ltd – Sir Morgan Wereuche Amadi for allowing me to carry out the process simulation and cost estimation in his Port Harcourt office. I also like to appreciate Mr. Tamuno Amiesimaka and Theophile Megueptchie of the same organization for their support.

I also appreciate my post graduate colleague and friends –Denen Vershima, Sonia Nkongho, Temiloluwa Amoo, Oboroghene Olomukoro and Neza Ezekiel.

I would also like to appreciate the effort of my late parents Mr. and Mrs. Zacchaeus Ogunlade for their past financial support. My superior appreciation goes to my immediate family (Oluwatosin Ogunlade, Oluwatofunmi Ogunlade and Oluwanifemi Ogunlade) and my older siblings (Yusuf, Yinka, Jimoh, Fasilat, Emmanuel and John).

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

LIST OF ABBREVIATIONS AND SYMBOLS

MEA	Monoethanolamine
DEA	Diethanolamine
MDEA	Methyl diethanolamine
TEG	Triethylene Glycol
GTW	Gas-to-wire
MMSCF	Million Metric Standard Cubic Feet
MMscfd	Million Metric Standard Cubic Feet Per Day
GPM	US Gallon Per Minute
SCF	Standard Cubic Feet

ABSTRACT

Gas-to-wire system has been a promising technology to convert stranded gas to electricity in remote oilfield locations where there is no infrastructure to monetize the gas. The research work was carried out to design an optimized process system which includes process simulations, equipment sizing and cost estimations. The basis for the work is a 5.1 MMscfd (million standard cubic feet per day) of associated gas from an active gas flaring site in Niger Delta Nigeria. The inlet gas has a temperature of 35^{o}C, pressure of 66.5 barg, water content of 63.13 lb/MMSCF, water dew point of 40 ^{o}C and 3.97% molar concentration of CO_2. The gas-to-wire process route selected comprises acid gas removal, gas dehydration and a combined cycle system. ASPEN HYSYS V10 was used to produce a base case process simulation and sensitivity analyses to arrive at optimal process operating conditions which include for the acid gas removal unit: 8.70 m^3/hr of 28% weight strength of Diethanolamine (DEA) in aqueous solution, lean loading of 0.00757 (mol/mol), rich loading of 0.4310 (mol/mol), reboiler duty of 1.002 (lb Steam/Gallon Rich Amine) and 20number of absorber trays with 33% efficiency to obtain a treating gas specification of 15ppm of CO_2. For gas dehydration, 0.90 kg/hr recirculation rate of Triethylene glycol (99.8 % by mass) with 0.033 MMscfd of stripping gas injected into the reboiler was the optimal condition to dehydrate the wet from the amine gas treating unit gas to 0.7 lb/MMSCF water content and dew point of -7 ^{o}C using 4 absorber trays with 25% efficiency when the lean amine temperature is 40 ^{o}C. The combined cycle efficiency simulated has a net power of 27.5 MW and total thermal efficiency of 42%. The research work contributed process design data that can be used to make technical and investment decisions.

Keywords: Gas-to-wire, Process Simulation, Equipment Sizing, Costings.