

**CO₂ CAPTURE FROM A POST-COMBUSTION PROCESS
INVOLVING A NOVEL HYBRID ADSORBENT-ABSORBENT
SYSTEM**

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JULY, 2022

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SYSTEM**

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**A DISSERTATION SUBMITTED TO SCHOOL OF POSTGRADUATE
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CHEMICAL ENGINEERING IN THE DEPARTMENT OF CHEMICAL
ENGINEERING, COLLEGE OF ENGINERRING, 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.

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DECLARATION

I, **VERSHIMA, DENEN ASHIEKAA (12CF013587)**, declares that this research was carried out by me under the supervision of Dr. Samuel E. Sanni of the Department of Chemical Engineering, College of Engineering, Covenant University, Ota, Nigeria. I attest that this dissertation has not been presented either wholly or partially for the award of any degree elsewhere. All sources of data, and scholarly information used in this dissertation are duly acknowledged.

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Signature and Date

CERTIFICATION

We certify that this dissertation titled “**CO₂ CAPTURE FROM A POST-COMBUSTION PROCESS INVOLVING A NOVEL HYBRID ADSORBENT-ABSORBENT SYSTEM**” is the original research work carried out by **VERSHIMA, DENEN ASHIEKAA (12CF013587)** in the Department of Chemical Engineering, Covenant University, Ota, Ogun State, Nigeria under the supervision of Dr. Samuel E. Sanni of the Department of Chemical Engineering. We have examined and found this research work acceptable as part of the requirements for the award of the degree of Master of Engineering in Chemical Engineering.

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DEDICATION

This dissertation is dedicated to God Almighty.

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All the praise and adoration belong to GOD Almighty for my existence and for his mercy over me.

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LIST OF ABBREVIATIONS

ANG	Associated Natural Gas
CCS	Carbon capture and storage
CNG	Natural gas vehicles
COP21	21st Conference of Parties
CI	Climate impact
CST	Concentrated solar thermal energy
DEA	Diethanolamine
DIPA	Diisopropylamine
GDP	Gross domestic product
GHG	Greenhouse gasses
Gt	Gigatonne
GO	Graphene oxide
IL	Ionic liquids
KMnO ₄	Potassium permanganate
MEA	Monoethanolamine
MN	Methylammonium nitrate
MOF	Metal-organic framework
Mt	Megatonne
PN	Propylammonium nitrate
PVA	poly(vinyl alcohol)
PCC	Post-combustion capture
PAMAM	Poly(amidoamine)
SFSI	Strategic Fuel Substitution Initiatives in Nigeria
UNFCCC	United Nations Framework Convention on Climate Change

ABSTRACT

Due to the global menace caused by carbon emissions there have been concerted efforts by researchers to search alternative ways of curbing issues arising (environmental pollution, health related diseases, risks to aquatic life etc.) from such emissions. In today's world, CO₂ has become one of the major gaseous pollutants that has attracted significant interest as a result of man's consistent use of energy from fossils and other human activities. The traditional ways of controlling carbon emissions are not very efficient and somewhat expensive, hence the need to search alternative solutions. The research is aimed at capturing carbon from a post-combustion using an adsorbent- absorbent system. Graphene oxide was synthesized using a modified hummers method. Ionic liquids (methylammonium nitrate and propylammonium nitrate) were synthesized by dissolving ammonium chloride in methanal and propanal. Cellulose acetate membrane was then synthesized using the casting method. The cellulose acetate membrane was doped with the ionic liquids and graphene oxide for carbon capture. Ca(OH)₂ solution was prepared to test for the presence of CO₂ in the experimental process. A combustor- adsorber -desorber system was fabricated to capture CO₂ in a post-combustion process. The combustible material used was Napier grass. 600 g of Napier grass was fed into the system and heated at 400 °C. At the exhaust pipe of the adsorber, the bottle containing the Ca(OH)₂ solution was fitted in order to confirm if the flue gas leaving the system contains CO₂ and the amount of CO₂ leaving the process. This helped to determine the amount of CO₂ captured by the system. The experiment was monitored for 50 minutes and at 10-minute intervals, a syringe was used to draw out 25 cm³ samples for analysis. The maximum adsorption capacity recorded for the 30 wt.% GO - 20 wt.% PN - membrane was 1.32753 ($\frac{mol.CO_2}{dm^3.membrane}$) which was considerably high compared to that in literature. The results showed carbon capture efficiency of 80 % for the membrane doped with ionic liquids/graphene oxide. These results confirmed the possibility of using the membrane doped with ionic liquids/graphene oxide for efficient and effective carbon capture.

Keywords: *Adsorption; Biogas; Biomass; Carbon capture; Membrane-Ionic liquid system; Post-combustion*