



Cairo University

**A NEW PROCESS TECHNOLOGY FOR
CAPTURING/CONVERTING CO₂ INTO LIQUID
FUEL MEOH**

By

Wafaa Mohamed Gomaa Mohamed

**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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Carbon Dioxide; Methanol; Simulation; Global Warming; Energy Integration.

Abstract:

This work throws the light on the environmental problems caused by carbon dioxide accumulation in the atmosphere, together with the energy crisis and the rapid depletion of the fossil fuels. Also, this effort proposes the solution for both problems by presenting new approach for capturing/converting CO₂ into liquid fuel methanol.

The new approach seeks to reduce both, the fossil consumption and atmospheric CO₂ by recycling secondary CO₂ as a carbon source instead of using natural gas. Three models are suggested for converting carbon dioxide present in the large- scale flue gases streams emitted from electric power plants into liquid fuel methanol. Our work considers the CO₂ balance for the new technologies proposed taking into account all CO₂ flows from/to the environment.

Three new process technologies are developed and modeled for converting CO₂ streams into methanol. The total cost of equipment and utility for all processes are compared. The energy targets as well as the CO₂ emissions (balance) are determined. Heat integration is performed on the best selected process technology.

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Dedication

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Nomenclature

A_i : Kinetic model constant
ATR: Auto-Thermal Reformer
 B_i : Kinetic model constant
CCS: CO₂ Capture & Storage
DEA: Di Ethanol Amine
GDP: Gross Domestic Product
GHG: Green House Gases
GTCC: Gas Turbine Combined Cycle
HEN: Heat Exchanger Networks
ICI: Imperial Chemical Industries
IEA: International Energy Agency
IGCC: Integrated Gasification Combined Cycle
IPCC: The Intergovernmental Panel on Climate Change
 K_{eqi} : Thermodynamic equilibrium constant
 k_i : Kinetic model constant
LTMS: Low Temperature Methanol Synthesis
MDEA: Methyl Di-Ethanol Amine
MEA: Mono Ethanol Amine
NG: Natural Gas
NHV: Net Heating Value, (kJ/kg)
 P_i : Partial pressure of component i
PRSV EOS: Peng-Robinson-Stryjek-Vera Equation of State
PSA: Pressure-Swing Adsorption
 r_i : Rate of reaction in relation to component i
T: Temperature
TSA: Temperature-Swing Adsorption
 α : The ratio of the molar masses of carbon dioxide and carbon