

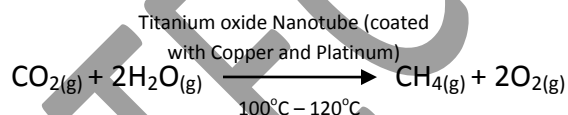
Recycling Of Carbon Dioxide (CO₂) To Fuel; A Solution To Global Warming

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ABSTRACT

In our world today, global warming has been a threat to the life of plants and animals, with carbon dioxide (CO₂) being a major cause of this alarming threat. As a result, scientists, technologists and engineers have been working over the years to reduce the release of this harmful gas into the atmosphere.

Conversion of CO₂ to gaseous fuel (Methane gas) requires a number of steps; the first being separating CO₂ from mixture of exhaust gases, which can be done by using the Pre combustion Carbon Capture technique or Post combustion carbon capture technique. The captured CO₂ will then be reacted with water vapour i.e. steam and the mixture would be passed through a pack of nanotubes coated with copper and platinum at a temperature of about 100°C-120°C operating at atmospheric pressure to hasten the production of methane gas (CH₄)



The methane gas produced can then be used at homes and industries. This would not only reduce the emission of CO₂ into the atmosphere, but also release more oxygen gas.

Keyword: Carbon dioxide (CO₂), Methane gas (CH₄), Fuel, Recycle, Hydrogen, Amine, Water vapour i.e. steam, Nanotube, Pollution, Carbon capture.

1.0 INTRODUCTION

Fuels are widely used for various purposes. They power the truck that deliver products to our communities, the buses that take us to school and work, the agricultural equipment use in farms and power plants.

Unfortunately, the exhaust from these fuel engines contains substances that pose a risk to human health as well as the well-being of plants and animals and the entire atmosphere.

When fuel is burn in these engines (Generator sets, vehicles, plant machineries etc.), the main gas produced are carbon dioxide (CO_2), carbon monoxide (CO), nitrogen oxide and Steam.

For over thousands of centuries now, plants convert water, sunlight, and carbon dioxide into sugars in a process known as photosynthesis. Carbon dioxide being one of the major causes of global warming is removed from the atmosphere during the process of photosynthesis because its presence in the atmosphere is not good for terrestrial animals in the environment, aside from this, if this toxic gas should move into the stratosphere layer of the atmosphere, they damage the ozone layer. In the course of industrialization in recent century, thousands of these trees and plants are being cut down for industrial purposes, thereby leading to lots of this harmful gases wander freely in the atmosphere.

Owing to the number of road users in the world, the exhaust from motor-vehicle is taken into consideration with large amount of CO_2 being emitted into the atmosphere every day, contributing to global warming and climate change.

What can we do? This is a common question that crosses our mind. For about a century, a chemical method known as the Fischer-Tropsch process has been utilized to convert Hydrogen gas (H_2) and carbon dioxide (CO_2) to liquid fuels under high pressure from (1-100) times atmospheric pressure and temperature ranging from 100-300 degree celsius.

2.0 CARBON CAPTURE TECHNOLOGY

The source of man-made carbon dioxide emission is from fossil fuel energy power plant.

There are two main steps to recycling CO_2 to fuel;

- a. Carbon Capture i.e Trapping and separating CO_2 from a mixture of flue gases
- b. Recycling the captured CO_2 to usable fuel

Trapping and separating CO_2 from a mixture of flue gases

Carbon is gotten from power plant and vehicles in three basic ways

- i. Post-combustion carbon capture
- ii. Pre-combustion carbon capture

iii. Oxy-fuel combustion carbon capture

2.1 POST COMBUSTION CARBON CAPTURE

This refers to capturing carbon dioxide from flue gas after the fossil fuel (e.g., coal, natural gas, or oil) has been burned.

Post-combustion CO₂ capture is primarily applicable to conventional natural gas and pulverized coal-fired (PC) power generation. In a typical PC power plant, fuel is burned with air in a boiler to produce steam, which drives a turbine to generate electricity. The boiler exhaust, or flue gas, consists mostly of nitrogen (N₂), and CO₂. Separating CO₂ from this flue gas stream is challenging for several reasons:

- CO₂ is present at dilute concentration (typically 13 to 15 volume percent for PC power plants and 3 to 4 percent for natural gas-fired plants) and at low pressure (slightly above atmospheric); thus, a large volume of gas has to be treated.
- Trace impurities (e.g., particulate matter, sulfur dioxide [SO₂], nitrogen oxides [NO_x]) in the flue gas can degrade sorbents and reduce the effectiveness of certain CO₂ capture processes.
- CO₂ is captured at low pressure. Compressing it from atmospheric to pipeline pressure (about 2,000 psia) will incur a large auxiliary power load on the overall power plant system

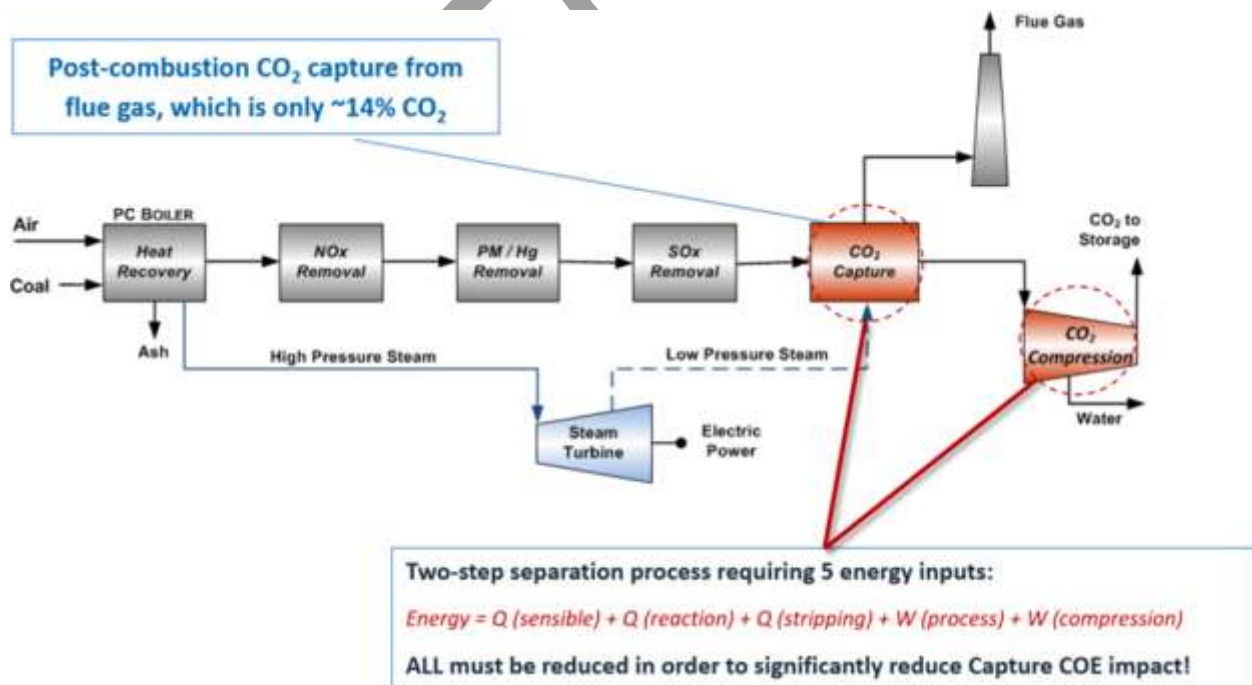


Fig. 1 Post-combustion carbon capture

2.2 PRE-COMBUSTION CARBON CAPTURE

Pre-combustion CO₂ capture related to a gasification plant is pictorially depicted below. In gasification reactions, the amount of air or oxygen (O₂) available inside the gasifier is carefully controlled so that only a portion of the fuel burns completely. This “partial oxidation” process provides the heat necessary to chemically decompose the fuel and produce synthesis gas (syngas), which is composed of hydrogen (H₂), carbon monoxide (CO) and minor amounts of other gaseous constituents. The syngas is then processed in a water-gas-shift (WGS) reactor, which converts the CO to CO₂ and increases the CO₂ and H₂ mole concentrations to about 40 percent and 55 percent, respectively, in the syngas stream. The gases in the flask will naturally begin to rise, so a chemical called **AMINE** would be poured from the top. The amine binds with the CO₂, falling to the bottom of the flask, next the amine/CO₂ mixture is heated. The CO₂ rises to the top for collection and the amine drops to the bottom for reuse.

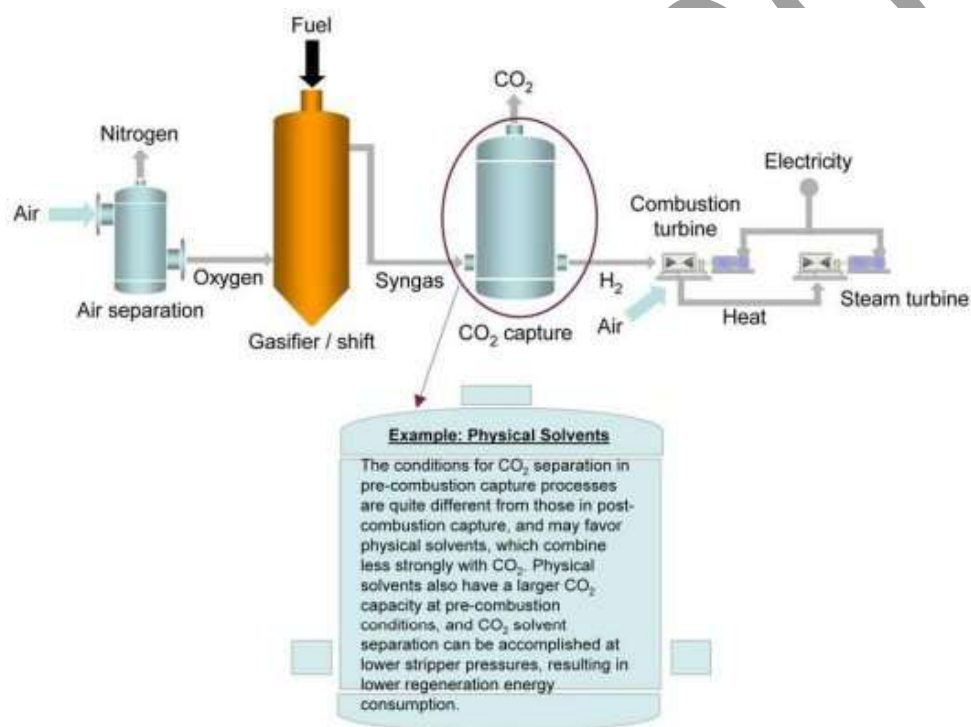


Fig. 2 Pre-combustion carbon capture

2.2.1 ADVANTAGES OF PRE-COMBUSTION OVER POST-COMBUSTION

- Pre-combustion produces a higher concentration of CO₂ compared to post-combustion.
- Pre-combustion can prevent 80-90 percent of a power plant emission from the atmosphere.
- The hydrogen gas produced during Pre-combustion can likewise be used as fuel as shown in fig.2 above
- Pre-combustion is lower in cost.

2.3 OXY-FUEL COMBUSTION CARBON CAPTURE

The power plant burn fossil fuel in oxygen. This results in a gas mixture comprising mostly of steam and carbon dioxide. The steam and carbon dioxide are separated by cooling and compressing the gas stream. The oxygen required for this process increases cost. Oxy-fuel combustion can prevent 90% of a power plant emission from entering the atmosphere.

3.0 METHODOLOGY (Recycling the captured CO₂ to fuel)

CATALYST

The required catalyst is Titanium oxide nanotube coated with copper and platinum.

3.1 PROCEDURE

- To convert CO₂ to fuel, the most effective Carbon Capture technique used is the Pre-combustion carbon capture technique is used.
- The mixture of carbon dioxide and water vapour i.e. steam is passed through a pack of titanium oxide nanotubes coated with copper and platinum to hasten the production of methane gas (natural gas).
- The product i.e. methane is then stored and use as fuel when the need arises.

The chemical equation for this process is given below;

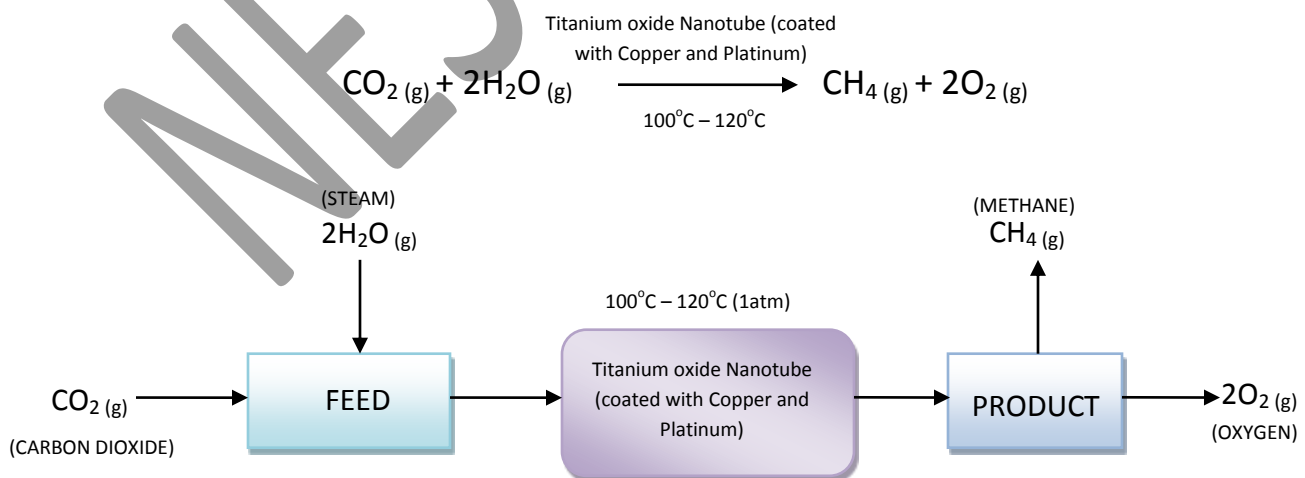


Fig. 3 Flowchart showing the process of conversion of Carbon dioxide to Methane

3.2 LIMITATION OF STUDY

Instability; the methane gas produced is somewhat unstable, making it prone to explosion if the methane comes in contact with oxygen, this is because methane is a highly flammable gas.

The methane gas contains a number of impurities even after the refining process has been put in place. As a result, when compressed for use as fuel, these impurities can become corrosive for metal parts

4.0 SIGNIFICANCE OF STUDY

- **Reduction of Pollution:** The presence of these unwanted substances in the atmosphere has been a great deal, they cause air pollution and water pollution. If a person is exposed to much carbon monoxide gas, it combines with haemoglobin in the red blood cell to form a stable compound known as carboxyl-haemoglobin. This compound prevents the transportation of oxygen in our body. A person will die from lack of oxygen when one-third of the haemoglobin in the body is combined with carbon monoxide, not that they only pose as threat to terrestrial lives alone, they also pose as threat to aquatic lives; the CO₂ and CO that are being released into the atmosphere dissolve in rivers and lakes as well as rain to form acidic solutions such as hydrogen trioxocarbonate IV (H₂CO₃)



- **Cost Benefit:** With the success of this experiment, fuel users won't have to keep buying fuels for their engines since the exhaust from the fuel in their engines can be recycled to generate more fuel.
- **Development of Novel Technology:** As a result of this experiment technologists can build a compartment for the reaction to take place in our vehicle, power generator sets etc.
- **Promote the growth of New Industries:** New industries will emerge as a result of the new technology in the market and thereby reduce the rate of unemployment in the country.
- **Reduce dependence on Crude Oil:** Since the fuel used can be recycled over and over again, the need to extract and refine crude oils will become limited.
- **Production of more Oxygen:** The process yields two moles of oxygen gas as byproduct for every unit mole of methane produced.

5.0 CONCLUSION

It is seen that the need to convert CO₂ to fuel is a paramount one, because it's cost effective and play a great role in reducing the rate of global warming in our society and the world at large.

With more study, CO₂ will not only converted to gaseous fuel such as gasoline, but also to liquid fuel; imagine the possibility of being able to recycle the fuel in your vehicle, whereby you don't have to worry about fuel bills every time.

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