Post-Combustion Carbon Dioxide Capture

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Abstract— Many industries, industrial power plants, are burning fossil fuels, they are coaling to get their energy while releasing flue gas into the air. Global warming causes greenhouse gas emissions and causes several environmental and social impacts. The capture of carbon dioxide from exhausted flue gas is essential to keep a cleaner environment better. So, capturing or avoiding the formation of dust, NO_x, SOx, and CO_2 is the central part of the industry, due to environmental and health reasons. There are three methods of capturing CO_2 from the flue gas, and one of them is post-combustion capture. Otherwise, there are five options to capture CO_2. Chemical absorption is widely applicable in industry, and effectively. That captured CO_2 stored some industries and again used that to improve their efficiencies and use them for relevant works.

Index Terms— Absorption, Alkanolamines, Amines, Biodiesel, By-Products, Carbon-Dioxide, Chemical-Absorption, Coal, Crude-Oil, Efficiency, Emission, Formation, Fossil-Fuel, Flue-Gas, Global-Warming, Greenhouse gas, Liquid-Vapour, Oxy-Fuel Combustion, Pre-Combustion, Post-Combustion,

1. INTRODUCTION

The atmospheric green-house gases cause the effects of global warming and climate change to increase. Because of the thermal power plants, industries, vehicle emissions, and other methods significantly grow CO_2 emission to the atmosphere. Coals and fossil fuels are significant sources of income, and this leads to considerable emissions of flue gas. Carbon Capture and Storage (C.C.S.) is a method of reducing CO_2 emissions from flue-gas emissions that captures CO_2 and transports it to storage sites for storage of post works [1]. In the future, the consumption of coal and fossil fuel will increase to overcome the drastically increasing demand for energy. Therefore, it is essential to shift to renewable energy sources shortly. Until that, C.C.S. has been the most viable option for continuing the process of development and industrial production [1]. There are three mains mechanisms for CO_2 capture, and Fig 1 is representing.

1) Pre-Combustion
Pre-combustion capture refers to the removal of CO_2 from fossil fuels before combustion. So we consider air and fuel.

2) Post-Combustion
Do not mind air, fuel. Already carries out the process of combustion and the end of the CO_2 gas combustion process with other gases. We would then be considering how to capture that CO_2 [2].

3) Oxy-Fuel Combustion
The combustion of oxy fuels is one of the leading technologies considered for capturing CO_2 from C.C.S. power stations. It is involved burning the fuel With almost pure oxygen, rather than air [2]. Some portion of the flue gas is pumped back into the furnace/boiler to handle the flame temperature.

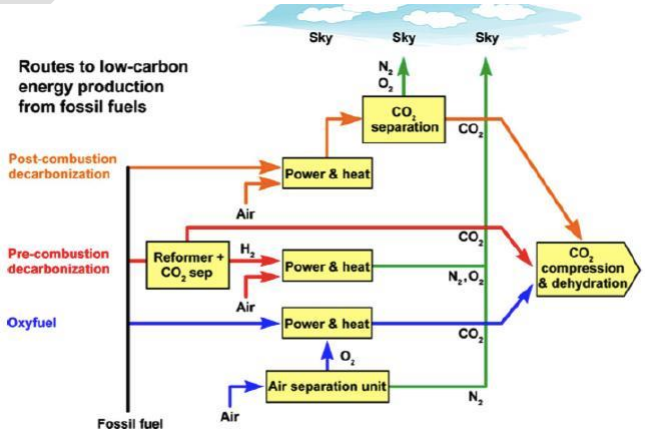

Fig 1. CO2 Capture And Sequestration

❖ Only we consider post-combustion process to capture CO_2 in this paper.

2. CO_2 GAS EMISSION IN THE WORLD

There are primary ways to emission CO_2 to the atmosphere.

- **Transportation (Vehicle Emission)**
  The transportation contributes for the greater proportion of greenhouse gas emissions. Carbon dioxide emissions from transport stem primarily from fossil fuel burning for our cars, trucks, ships, trains and aircraft. More than 90% of the fuel used for transportation is based on petroleum, which mainly comprises gasoline and diesel.

- **Industries**
  The cement industry is the primary industry which generates a substantial volume of CO2. Because the concentration of CO2 is consist of the flue-gas industry 14-33 per cent. There are two ways in which CO2 emissions such as carbon reaction combustion with oxygen and calcium carbonate by-product separated as calcium-oxide (clinker) and CO2 gas are present [3]. Underneath is the equation,

$$CaCO3 \rightarrow CaO + CO2$$

- **Electricity Power plants**
  The second-largest share of greenhouse-gas emissions is generated by electricity production. Around 63 per cent of our electricity comes from fossil fuel burning, mostly coal and natural gas. Therefore, CO2 emission also increased due to the demand for power.

- **Deforestation**
  Forests keep large quantities of carbon in stock. The trees and other plants absorb carbon dioxide as they grow from the atmosphere. It is transformed into carbon and stored in the branches, leaves, trunks, roots and soil of the plant. Stored carbon is emitted into the atmosphere when forests are cleared or burnt, mainly as carbon dioxide.

- **Population**
  The climate change disruption due to the buildup of human-generated carbon dioxide in the atmosphere will be the most significant known threat to the planet's ecology and biodiversity in the decades to come. People all over the world start tackling the problem by reducing carbon emissions by reducing consumption and improving technology.

3. REASONS FOR CAPTURE CO_2 AND POST-COMBUSTION CAPTURE METHODS

In the modern world, many factories manufacture most different kinds of goods for people, and companies do their manufacturing operation. However, specific factories that do their manufacturing process release the waste gas to the atmosphere. Examples for these sectors would recognize power plants with fossil fuel bases, cement factories, steel production, fossil fuel industries being burned. Including these sectors, the primary adverse environmental impact of releasing "greenhouse gases." The effects of greenhouse gasses adversely impact the environment at large. It can be shown to be a harmful effect of greenhouse gases, climate change, air pollution, such as heating the Earth. Furthermore, when it comes to greenhouse gases, CO_2, CH_4, N_2O, water vapour, ozone, C.F.C. such as. One of the leading gases is a CO_2 can be identified. Much of the CO_2 gas was emitted by factories before, and CO_2 gas released could be collected to reduce emissions. So many businesses in the industrial world have used the process of obtaining carbon dioxide during combustion. Equally, the CO_2 extracted can be used for beneficial purposes [4,5, 6].

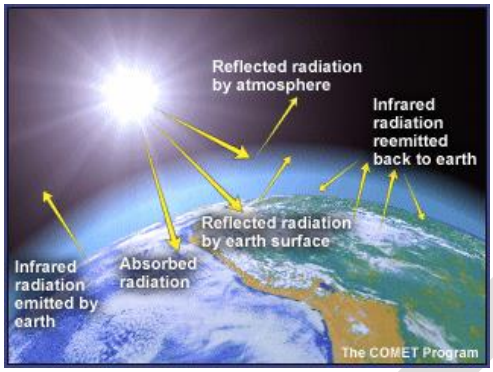

Fig. 2. Radiation absorption and emission by greenhouse gases [7].

4. POST-COMBUSTION CO_2 CAPTURE

There are many industries in the modern world, likewise doing their works and producing their products. However, in the present big issue is the release of carbon dioxide (CO_2) to the atmosphere by some factories. Coal plant, gas plant, cement plant, the aluminium plant can be shown as carbon dioxide emitting industry. Industries, therefore, use it in new technology, and they have their focus in their work for sustainable growth. Hence, carbon dioxide trapping techniques can be used in manufacturing. There are three principal methods of capture. Suppose they are the method of capturing carbon dioxide Pre combustion, the process of capturing carbon dioxide Oxy-fuel combustion, the process of obtaining carbon dioxide post-combustion. However, mostly used post-combustion carbon dioxide capture method of these three methods and it can be defined as merely after the combustion and carbon dioxide capture system. Likewise, the purpose of recovery of carbon dioxide after combustion has 05 primary processes [2].

1) Chemical absorption

Through this various method, "chemical absorption" is the most efficient form of carbon dioxide capture. CO_2 can be removed from flue gas streams by this method in the industry. Chemical absorption relies on the reaction of the absorbent liquid, which is usually an aqueous Alkanolamines solvent, to CO_2. An absorber receives the CO_2-laden feed gas at the bottom and a watery or non-aqueous solution from the top to selectively absorb CO_2 in a countercurrent fashion in this method. After most CO_2 is absorbed, the flue gas is released into the atmosphere. Then final solution rich in carbon dioxide sent to the regenerator and separated the CO_2. The last move is to compress and return the extracted carbon dioxide gas to storage. The most crucial solution in chemical absorption is al Alkanolamine. Likewise, chemical absorption of post-combustion carbon dioxide capture system has Important factors for solvent selection. Whether they are the absorption capacity, the absorption rate, the absorption heat, the stability and volatility of the solvent, the price of the water and the toxicity, accordingly, Alkanolamine solution can mainly be classified as primary amine and secondary amine when viewed. Monoethanolamide (M.E.A.), dialkylamine (D.G.A.) are used as the primary amine. Diethanolamine (D.E.A.) occurs as a secondary amine. However, M.E.A. is mostly used in industry in post CO_2 capture. These sectors are such as "Coal plant, Gas plant, cement factory,

and aluminium factory." And so on will reveal the physical properties as follows of the solvents of both "M.E.A. and D.E.A." [1][2]. Those parameters are showing Table below.

Table 1: Solvents of both M.E.A. and D.E.A. [1]

Specification	MEA	DEA
Chemical formula	C_2H_7NO	C4H11NO2
Amines category	Primary	Secondary
Molecular weight [g/mol]	61.08	105.14
Density [g/cm^3]	1.012	1.090
Boiling point[°C]	170	217

Fig 3 may show a basic design of a process flow scheme for the post-combustion chemical absorption procedure.

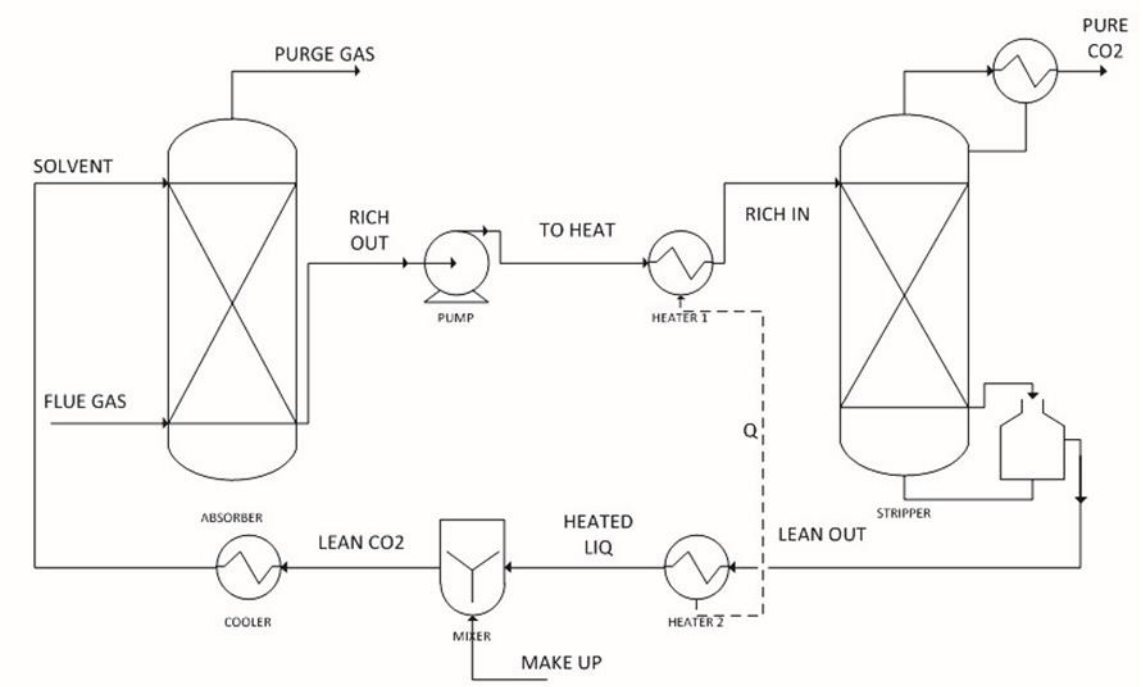

Fig 3. Process flow diagram of post-combustion chemical absorption [1].

2) Physical absorption

When considering the post-combustion carbon capture system, "physical absorption" is another essential method. Pressure and major temperature factors consist of this method. The mixture's vapour-liquid equilibrium determines the amount of CO_2 the solvent absorbs. Therefore, physical absorption processes are especially important Suitable for the treatment of gas streams which are

rich in CO_2 [8].

3) Membrane separation

The simple meaning of membrane separation is the technology which separates materials selectively through pores and gaps in a continuous structure's molecular arrangement. In this system, mixed gas feeding and purified gas exiting can co-occur. Membrane selectively permeates the desired components and retains the unwanted, which results in gas mixtures being separated in Carbon sequestration and storage processes, before subsequent transport and storage, CO_2 must be separated from the exhaust gas streams. That is the effective carbon capture solution [8]. Fig 4 represents that membrane separation below.

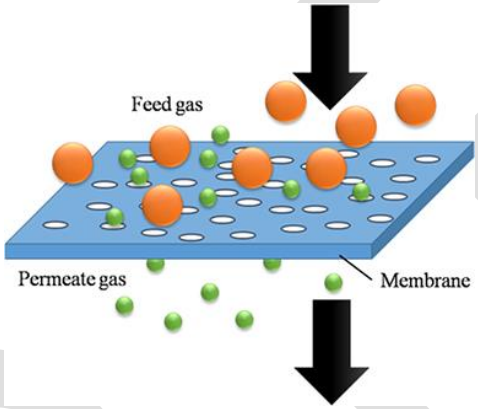

Fig 4. The schematic of membrane separation for binary gas mixtures [9].

4) Cryogenic separation

The cryogenic separation process of CO_2 capture as flue-gas dries through the emitting line and cools flue gas from existing systems. Compresses it modestly, cools it to a temperature slightly above the point where CO_2 forms a solid, expands the vapour to cool it further, precipitates a quantity of CO_2 as a solid which depends on the final temperature, pressures CO_2, and heats the CO_2 and the remaining flue gas by refrigerating the gases come in. The result is CO_2 in a liquid phase and flux of gaseous nitrogen. The efficiency of CO_2 capture depends above all on the pressure and temperature at the end of the expansion cycle and most useful methods in the process of carbon dioxide separation [8].

5) Adsorption

The natural sense of the adsorption is a carbon dioxide separating the flue gas line from the other flue gas. As adsorption, therefore, different materials were used, such as a mixture of lithium hydroxide, zeolite and water (mixture pellet) [9].

5. STORAGE METHODS OF CO_2 AFTER CAPTURED

Captured carbon dioxide is then conveyed for secure storage by pipeline or ship. Millions of tons of carbon dioxide are already transported by road tankers, crafts, and pipelines annually for commercial purposes. Then, there are three main ways to store Captured CO_2.

1) Storage

1.1) Geo Sequestration.

The method of store captured Earth's underground CO_2 up to a specific limit is in the deep geological formation. Some spaces are available, and those places inject Captured CO_2 into the sedimentary rock for permanent storage.

- ✓ Old oil fields
- ✓ Gas fields
- ✓ Saline Formation
- ✓ Unminable coal seams

1.2) Ocean Storage

Deep ocean water is considered as the bottom of the ocean storage method, which injects CO2 into the bottom of the ocean as liquid formation. Injected CO_2 make out like a lake at the bottom of the sea, avoiding because of the density.

1.3) Mineral Storage

When extracting coal from the ground, the form of mineral carbonates is then a space in coal mines is there. So captured CO_2 can inject those spaces to fill and close permanently.

2) Enhance Oil Recovery (E.O.R.)

Because of under-ground pressure, we can simply carry out fossil fuels first due to significant bottom-of-the-earth demand for force. The strength of oil well is diminishing when we extract oil. So we cannot take more and more oil out of the remaining part of the oil. So we can obtain well CO_2 injected with high pressure into the oil. Then strength is developed, and we can extract more and more crude oil. After the oil is attained over time, it can be permanently shut down with full CO_2 filling.

3) Chemical Feedstock

Too many industries use CO_2 in gas, liquid, solid or supercritical form (raw material).

Beverage carbonation is the process of dissolving CO_2 gas with drinks that have an acidic flavour and an exciting mouth sensation. Soft drink, beer and wine industries are mainly used.

Algae cultivation also processes the use of CO_2 to grow / Cultivate algae and increase its productivity considerably. We can use those algae to extract oil like algal oil, and it can be used to produce algae products like biodiesel, for example.

Cultivated algae → Extract oil → Produce the Biodiesel.

- ❖ So, Better to use CO_2 as a chemical feedstock then captured CO_2 will be used in the same industry to produce or implement something useful.

6. CONCLUSION

The rapid increase of anthropogenic CO_2 from various energy and industrial areas in the atmosphere is

the primary contributor to global warming and associated climate change. Therefore, different methods of capture post-combustion are developed to recover CO_2 from point sources and are chemical and physical absorption, separation of membranes, cryogenic distillation and adsorption. The technological problems associated with the processes mentioned above changed the focus to using solid sorbents ready and willing from affordable CO_2 by-products based on lignocellulosic. The approach still has certain restrictions/disadvantages to it. It is evident from this study that chemical activation leads to beneficial CO_2 adsorption outcomes. Due to its low energy and capital requirements, P.S.A. is a useful alternative for CO_2 capture, combined with the ability to operate over a wide range of conditions of temperature and pressure. Post-combustion technologies offer excellent potential for reducing CO_2 emissions in the short future since they can be retrofitted to existing fossil fuels, coal-fired power plants and can also be applied to other industrial CO_2 emissions.

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