Carbon Dioxide Emission Trapping Through Carbon Capture and Storage Technique

Maham Imtiaz[1], Sahiba Memon[1], Siddiqa Soomro[1]

[1]*Institute of Environmental Engineering and Management, Mehran-UET, Jamshoro, Pakistan*

***Abstract*: The extreme raise level of carbon dioxide emissions in past is due to combustion of fossil fuels. It creates the drastic changes in the environment. The extreme high level of emissions from the industries, power plants and burning of fossil fuels for the electricity generation can creates the adverse impacts on the living things. The substitute energy source is not valuable for the reduction of the emissions. The carbon capturing and storage is a procedure to reduce the emissions of carbon dioxide from the atmosphere. Carbon capture and carbon storage is the only method to reduce the climate change. The CCS plays very important role in decreasing the greenhouse gases emissions. It is estimated that it can reduce 80 to 90 % of the gases from the power plants. The technology consists of the three steps. Capturing the carbon dioxide from the source, and separate the gas from the flue gases, transport the gas through the pipe lines, ships, road tankers and underground immunization of the carbon dioxide. The aim of this paper is to determine the CCS technologies to elude the carbon dioxide emissions from the atmosphere and create the carbon free environment. The IPCC authorize this technology and this technology has several different benefits.**

***Keywords*: CCS, IPCC, Carbon Dioxide.**

I. INTRODUCTION

Economical growth is the main reason for the increasing demand of the energy, so it is visible that there is an increase demand of the fuel, however, sufficient use of the fuel produce the large amount of the CO_2 and effect on the plant, marine ecosystem and human beings. It is estimated that the atmospheric CO_2 increases more than 39% from the past century. It is also predicted that without climate change mitigation policies GHG emission will increase by 25 to 90% in 2030 from the 2000 year, So it is necessary to reduce the CO_2 from the atmosphere, CCS is a chain in which carbon first capture then separate from the flue gas then transport to the safe storage site .The purpose of this paper is to discuss the several technologies that are used in the CCS chain for the removal of the CO_2 from the atmosphere

II. REDUCE THE GLOBAL CLIMATE CHANGE BY USING SEVERAL APPROACHES

Countries using different approaches to reduce their carbon dioxide emissions

- Expand the energy efficiency and improve management and protection of energy.
- Usage of more renewable energy like wind, solar and hydro energy.
- Increase the tree planting.
- Use low carbon fuels like hydrogen, natural gas or nuclear power.
- Carbon dioxide capture and storage.

Table. 1.

Approaches	*Sector*	*Advantages*	*Disadvantages*
Usage of low carbon fuels	Alternative of coal fuel by using natural gas for energy generation.	Helpful to produce low sulphur dioxide emissions.	Cost of the natural gas if higher than the cost of coal fuel.
Usage of renewable energies	Wind, hydro and solar energy are highly usable.	Helpful to produce clean energy with no GHG emission or low toxic gas.	Production of energy from the renewable energy are most costly than the coal production.
Increase the tree planting.	Useful in all countries	Natural source to produce co2 from the trees.	It requires land space for the tree planting and none of the other application can applied
Expand the energy efficiency.	Useful in industrial and profit -making areas.	Save energy from 10 to 20% by using this approach.	It requires more energy saving installations
Carbon capture and storage	Used in large emission source for Co2 reduction.	Reduce co2 emission by 85-90%	This chain is expensive, Every sector do not adopt this chain because of their economic situations.

Table 1 discuss about the area where the approaches applied, their advantages and disadvantages. Each approach has its own benefit and some approaches reduce the carbon dioxide from the emission source like low carbon fuel and clean coal technology. It is unbelievable that to select a particular approach can sufficiently touch the IPCC goal of the Co2 reduction like 50-85% in 2050 so therefore need to select a matured approach for the reduction of carbon dioxide (85-90%) from large emission source. CCS is a technology that is used to reduce the carbon dioxide from the large emission source by (85 -90%) like industries, power plants. This approach consists of three steps, first step is capturing Co2 from the source (flue gas), transported, then two options either store it permanently or take advantage of it, and monitoring of Co2.

III. TECHNOLOGIES FOR CAPTURE OF CO2 FROM THE COMBUTION PROCESS

Co2 is a toxic gas, colorless and odorless, it is difficult for humans to identify the gas present in the atmosphere. Co2 is naturally present in the atmosphere 0.04% or 404 ppm and it varies from season to season about 6 ppm range. Commercially Co2 produced from the combustion process so it is necessary to identify the plant for the combustion process and fuel ,After identify the plant then select the carbon capture technology to reduce the Co2.[1]. The three main technologies are use for capture the Co2 post combustion, pre combustion and oxygen -fuel combustion

A. Post Combustion

The major key of post combustion is to separate the Co2 from flue gas. In a coal- fired industries, coal is used for electricity generation, coal is used as a fuel with air in a boiler to move a turbine for the electricity generation. The flue gas consists of N2 and CO2, post -combustion capture technology is considered as the viable for reducing the Co2 from the flue gas, however it is not applicable for large power plants. This technology depends on solvent scrubbing in which using amine solvents. Solvent scrubbing requires a chemical solvent use for purification of Co2, chemical solvent react with co2 in the flue gas and reproduce at high temperature for storage. It is estimated by the US national energy laboratory that the cost of electricity would increases32-65% by using the post-combustion technology in gas and coal-fired plants [2] [5]\

B. Pre Combustion

Pre -combustion is a process in which the fuel is treated before going into the combustion chamber. It is suitable for integrated gasifier combined cycle (IGCC) power plants. It is contributing in higher efficiency and helpful for the reduction of the cost of pollutant emission control. In a pre-combustion chamber fuel reacts with either syngas or oxygen and generate the synthesis gas (H2,CO2 and Trace), then the syngas reacts with water -gas shifted reactor Co converts to Co2 and the concentration of Co2 and H2 increases by 40 to 55% respectively. Co2 can be removed through the chemical absorption process and a physical process. After removal of Co2, Hydrogen gas is purified and can be used for the electrical and thermal power. Hydrogen is considered as save energy. [2][5]

C. OXYGEN FUEL COMBUSTION

Oxygen -fuel combustion use fuel and oxygen rather than air, for the combustion process. It reduces the load of nitrogen gas from flue gas. Oxygen is used to reduce the nitrogen content and other pollutants from the flue gas such as So2, particulates and water can remove from the electrostatic precipitator but the Co2 concentration in flue gas is very high (it depends 80-98% which fuel is used) .This method is suitable but it consumes a lot of oxygen and results as a high cost [2] [5].

Table 2 compares the three combustion process for Co2 removal with their application area and also their advantages and disadvantages.

Co2 capture process	Application area	Advantages	Disadvantages
Post -combustion	Coal and gas fired power plants.	It is suitable for retrofit in industrial power plants and using of amine solvent in industries has experience of 60 years[2]	Need for more absorbers and solvents contributing to the high cost .it is limited of large scale industries[2]
Pre- combustion	Gasification power plants	This process captured the co2 90-95%, it is the most valuable for capturing the co2 and the hydrogen obtained from this process can transported and stored.[2]	It needs a chemical plant which is expensive, so need of the high cost and need of gas scrubbers.[2]
Oxygen fuel combustion	Coal and gas fired power plants	It captured the co2 100%[2]	It requires high energy ,need of more electricity for the plant and need of pure oxygen[2]

III. TECHNOLOGIES FOR THE SEPARATION OF THE CO_2

This segment characterize the separation technologies of CO_2.These technologies isolate the gas from the flue gas, so this segment describe about the absorption, adsorption, cryogenic distillation and membrane separation.

A. Cryogenic Distillation

This process is used to remove the CO_2 from the flue gas by using distillation. Distillation is a process used to isolate gas or liquid mixture through partial vaporization and condensation, but for CO_2 removal, The flue gas accommodate the CO_2 and freeze CO_2 up to (-100 to -135 Celsius) isolated from other light gases and shrink by giving pressure up to 100-200 ATM .It is estimated that CO_2 could be reborn by Cryogenic distillation up to 90-95% of the flue gas [3].

B. Absorption

In this process CO_2 is removed through a solvent used in a chemical absorption processes ,the important chemical absorption is aqueous amine solutions, such as monoethanolamine (MEA), activated methyl diethanolamine (aMDEA) or hot potassium carbonate solution. Monoethanolamine (MEA) is the best solvent used for post-combustion processes for capturing the CO_2, gives 90% efficiency. Some other sorbents are also helpful for capturing the CO_2 such as piperazine and anion-functionalized .However, piperazine is now taking the attention because volatility of piperazineis higher than the Monoethanolamine (MEA) and it is pricey. [4]

C. Adsorption

Adsorbent is a process in which molecules are stuck to another substance, in a same way adsorbent technique is used to isolate the CO_2 gas from the flue gas.CO_2 is separated through a solid Sorbent from the surface. For the selection of the sorbent the main principal is high selectivity and regeneration. The CO_2 which is adsorbed it can be reborn by fluctuating the temperature and pressure. The fluctuating of the pressure for CO_2 recovery can have efficiency 85% for power plants and recovery of CO_2 by increasing the temperature using steam injection and hot air. The regeneration time of temperature is higher than the Pressure [5]

D. Membrane Separation

Membrane separation is a technology only allow to pass the CO_2 from the membrane and prevent other ingredients of the flue gas. It consists of a composite polymer, this technology also helps to remove the other gases like Nitrogen, oxygen and CO_2 from the natural gas. Its efficiency is estimated by the two researchers from 82-88%.The main difficulty in implementing this technology ,it impaired by the flue gas conditions like pressure and small concentration of the CO_2.[5]

IV. TRANSPORTATION OF THE CO_2

When the CO_2 isolate from the flue gas, the main task is to transport the CO_2 to the safe storage site or for the industrial application. The other hurdle is to choose the right transportation for the Co_2 which is dependable, safe, and economically beneficial for the carbon capture project. The transportation of the CO_2 depends on the volume of the CO_2 that's why different modes of the transportation are available like pipelines, road tankers and ships. A study on the CCS transportation shows that the CO_2 transportation from the ship tanker is more beneficial than the pipelines with a cost from 20 to 30 USD /tones [5]

The pipeline is considered as the useful method for the transportation of the huge volume of the CO_2 for onshore and it is competent way. The main use of the pipelines is to transport the CO_2 in the power plants, which lifetime is 23 years, and for the small period of time road tankers are practicable. The cost of the road tankers transportation varies with provincial economic conditions. It is necessary for the CO_2 that useable temperature and pressure should be balanced under the CO_2 supercritical encircle like above 32 Celsius and 72.9 ATM. The common range of pressure for the CO_2 transportation through the pipeline is lie 85 to150 bar and for temperature from 13 to 44 Celsius[5]

A presences of dirtiness in the CO_2 can cause a dangerous issue because their existence can change the pressure and temperature in the pipeline and existence of water higher than the 50 ppm may cause the forming of corrosion problems. An EOR is the projects who used pipelines for the transportation of CO_2. A new study suggests that in onshore project pipelines are hidden in trenches in 1m deep and offshore pipelines also use trenches for protection from a fish and fortunately the rate of accidents is very low for the CO_2 transportation but for the protection of the environment these pipelines have to be monitored [5]

V. APPLICATION OF THE CO2

The obtained CO_2 can be reused in industries, agriculture and energy production .China produced the ammonia and urea using the capture CO_2 from the power plants. CO_2 can also be used in refrigerators, food sector.CO_2 can be utilized for mineralization, it is a process in which capture CO_2 reacts with mg/CA and formed the stable carbonates.

A. Geological Storage Of The CO_2

The geological storage of the huge quantity of the CO_2 is considered as the viable because it reduces global warming. A common geological site can carry millions tons of CO_2 by different physical and chemical mechanism. It is necessary for the selection of the geological site considered the general requirements such as thickness, porosity, permeability of the rocks for the storage of the CO_2 also economic conditions and socio-political conditions will also involve for the site selection [5]

B. Coal Bed Storage

Methane can be recovered by the injection of the CO_2 into the deep coal bed which captured in the porous structure of coal, This process allows to the CO_2 to store in the voids of the coal when the trapped methane comes outside ,and this method currently working on China, USA ,Australia[5]

C. Saline Aquifer For The CO_2 Storage:

Deep saline aquifers are considered as the viable way for the storage of the CO_2,Deep aquifers below at 700 to 1000 m deep from ground level generally store high salinity , these aquifers have no financial value but can be used to store the captured Co_2 .This technology is technically beneficial and no adverse effect on the Environment[5]

D. Storage Of CO2 In The Oceans:

The Ocean covers 70 % of the Earth's surface, and produced about 38,000 Gt of carbon and adopt carbon from the atmosphere at a rate of 1.7 GT annually and produced at a same time 50-100 GT carbon, but inserting the larger amount of the CO_2 can affect the pH of water, it reduces the pH of water and causing acidification. This ocean acidification will reduce the biodiversity of the ocean [5]

VI. LEAKAGE OF THE CO2

The two feasible methods for the CO_2 leakage is the transportation of the CO_2 and storage area. A study has been organized to identify the effect of the CO_2 dispersion in the atmosphere like dispersion model is used to determine the atmospheric condition and its effect on the environment, while in contrast to leakage from the geological storage is more complicated situation, there are two typical leakages from the geological area through Caprock and permeable pathways. A Caprock is slow it takes thousands of years, However permeable pathways is faster than Caprock, due to the leakage of the CO_2 it causes effects on the plants ,marine ecosystem and human beings so it is necessary to monitor the CO_2 from both sources[5]

VII. CONCULSION

This CCS chain is used to meet the GHG emission reduction and CCS is densely reduced the CO_2 from the atmosphere, But every country has different economical conditions for the adoption of this chain. This paper is reviewed about CO_2 capture, separation, transportation of the CO_2 .The capture of Co_2 depends on the plant and fuel and in separation method absorption is the best method due to its efficiency and low cost and for the transportation of the CO_2 pipeline is considered as the viable method because it can help to transport the huge volume of the CO_2. It is necessary to monitor the source of the leakage of the CO_2, geological storage of the CO_2 is a complex situation so it necessary to monitor the geological storage of the CO_2.

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