

Proposal of Efficient Technique for carbon Capture and its Transportation – A Review

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ABSTRACT: The increasing global temperature, the expanding worldwide temperature, increment in the population development, Increment in the utilization of non-renewable energy source has made the industries to understand that there is a need to lessen the emission of ozone harming substances. CO₂ being a stand out amongst the most essential, it is a need to decrease its discharge. Carbon capture is the procedure used to capture CO₂ in the environment. Carbon storage & capture (CCS) is as of now possible at plant scale utilizing a scope of advances. This paper portrays in short the diverse sources like power plant, Transport, forest fires and so on., the innovations utilized for carbon capture diminishes its discharge into air. This paper likewise examines the techniques utilized for extraction of CO₂ through flue gas & transportation of CO₂ with secured capacity. The capture strategies would include catch from power plants since huge measures of flue gas is discharged from these sources. It is more viable to catch CO₂ from well springs of extensive outflow than circulated discharge, for example, autos, house emissions and so forth., The extraction and detachment process is only expulsion of CO₂ from vent gas by means of gasification or improving, through ignition with oxygen, by retaining CO₂ gas and so on., or, in other words to fluid or straightforwardly infused underground as per its geo-sequestration. The favourable circumstances and drawbacks of carbon are likewise talked about. The extraction of CO₂ from air could give a feasible and practical option in contrast to changing the transportation framework to non-carbonaceous fuels. This paper discusses different sources, separation technologies, carbon capture techniques, transportation & storage.

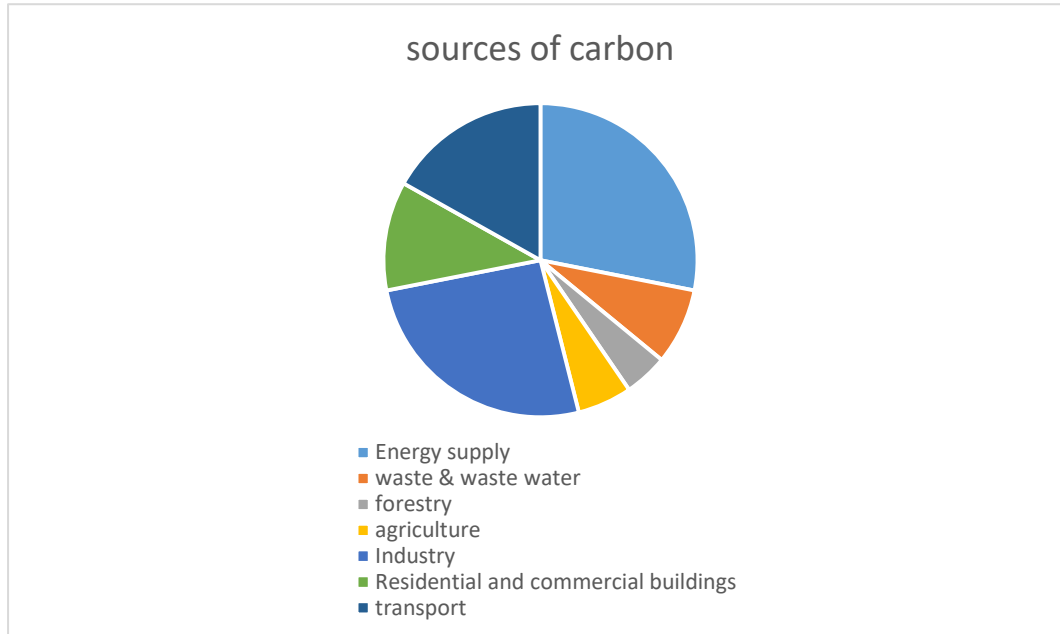
KEYWORDS: carbon capture, storage, transportation, post and pre combustion, absorption, adsorption.

I. INTRODUCTION

Due to industrialisation the demand for energy has increased tremendously. This increase in energy lead to the exploitation of natural resources like coal, oil and natural gas. These sources of energy played a pivotal role in industrial revolution. But the use of these fuels has adverse impacts on environment and they lead to the increase in emissions of carbon dioxide which is a greenhouse gas. As a result, global warming is increasing. At this rate the effect on climate would be catastrophic which is why actions are to be taken to control the emissions of carbon dioxide. In order to control these emissions, we have two options. First one is to search for alternate fuel that has less impact on environment. Second one is to control or capture the emissions of carbon dioxide in atmosphere. Carbon-Capture is the method of capturing & storing carbon emitted from fossil fuels after burning them and preventing them from entering the atmosphere. As carbon has adverse effects on ozone, it is important to prevent it by entering atmosphere by collecting and storing it safely so that it can be used for other purposes. Carbon capture can be done by the usage of solvents, cryogenics, membranes & sorbent materials.

II. SOURCES OF CARBON

There are wide range of sources that contribute to the emission of carbon, Which includes natural and man-made sources.



III. CO₂ CAPTURE TECHNOLOGY

CO₂ capturing is very effective at initial source (i.e. natural gas processing, large fossil fuel, biomass, energy plants, fossil fuel based hydrogen production plants, synthetic fuel plants, crude oil refineries, petrochemical plants & industries that emit CO₂).

Organisms that produce ethanol during fermentation gives out pure form of CO₂ which can be pumped underground.

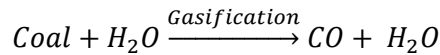
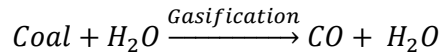
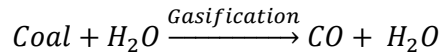
Capturing CO₂ from coal fired thermal power plants is more economical than plants of natural gas as coal fired plants has huge quantities of emission. CO₂ present in the gas that should be transported will lead to corrosion of pipelines and there is a definite need to separate it before the gas is being transported.

There are three technologies used for carbon capture:

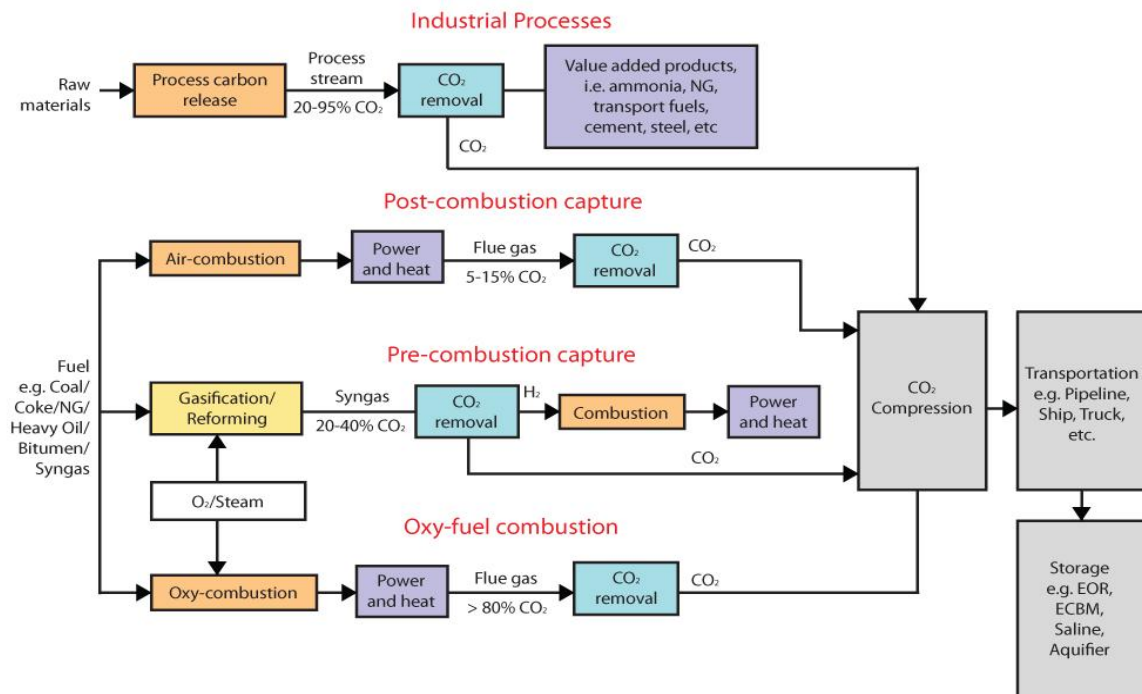
- Post Combustion
- Pre Combustion
- Oxy fuel Combustion

Post Combustion: This is the process of capture of CO₂ after the combustion has taken place. (L D. M, 2004). Post combustion is method is more preferred since it can retrofit the power plants that are already in use. The technology has proven effective at a small scale at a recovery rate of 800t/day (TF,2007). CO₂ is removed from flue gas before it enters atmosphere in this process. Flue gas mainly consists of nitrogen and CO₂. It is facilitated by adding traps or filters that are attached to the chimney or smoke stacks. The CO₂ captured is then compressed & stored. This method is most feasible because in a short period of time, all the fossil fuel power plants can be retrofitted with many proposed technologies.

Pre combustion: This is the process of removing carbon before sending it for combustion. Fuel is converted to CO₂ and Hydrogen through the process of reforming or gasification. The coal is partially oxidised for the production of fuel in gaseous state as a mixture of CO and H₂ to form syngas or synthesis gas. This gas is then processed through shift-conversion reaction where more hydrogen and CO₂ are produced. The CO₂ That is formed is captured and stored while H₂ can be used in gas turbines or fuel cells.



Oxy Fuel Combustion: In this process oxygen is used to separate CO₂. Pure oxygen from air is separated and sent to the unit of energy conversion and then it is combined with flue gas from recycle stream (high in CO₂ concentration). Due to this combustion occurs and pure CO₂ stream is produced. The product is free from nitrogen and sulphur dioxide. N₂ & SO₂ are removed using adsorption techniques from exhaust. Then the product i.e., Pure CO₂ is compressed and transported for permanent storage. The advantage of this method is that there is no emission of nitrogen which is why the equipment related to control of nitrogen oxide is not necessary.



IV. SEPERATION TECHNIQUES

This section gives the brief explanation of methods that are mostly used for separation of CO₂ from flue gas before transportation and storage. Technologies or methods used are absorption, adsorption, cryogenic distillation, membrane separation, Microbial separation (Y, 2008).

Absorption: Absorption used solvent for the removal of CO₂ from the stream of flue gas. The solvent used or absorbent is recovered by stripping or it can be regenerated by heating and depressurization. Absorption is the most commonly used technique for removal of CO₂. The efficiency depends upon the absorbent used and other process parameters. Monoethanolamide (MEA), potassium carbonate (K₂CO₃) and di-ethanolamine (C, 1995). The solvent will be in contact with the stream of flue gas. Then the stream of CO₂ rich solvent is sent for stripping to get pure CO₂ which can be used for industrial process.

Adsorption: Unlike absorption process, this separation technique uses solid sorbents which provides a large surface area for the absorption of required component. high regeneration ability and high selectivity are the characteristics of a good sorbent. Sorbents used for adsorption includes zeolites, molecular sieves, hydrotalcites, activated carbon, lithium zirconate and calcium oxides. The sorbent adsorbs the CO₂ at high pressure which in-turn releases it under low pressure

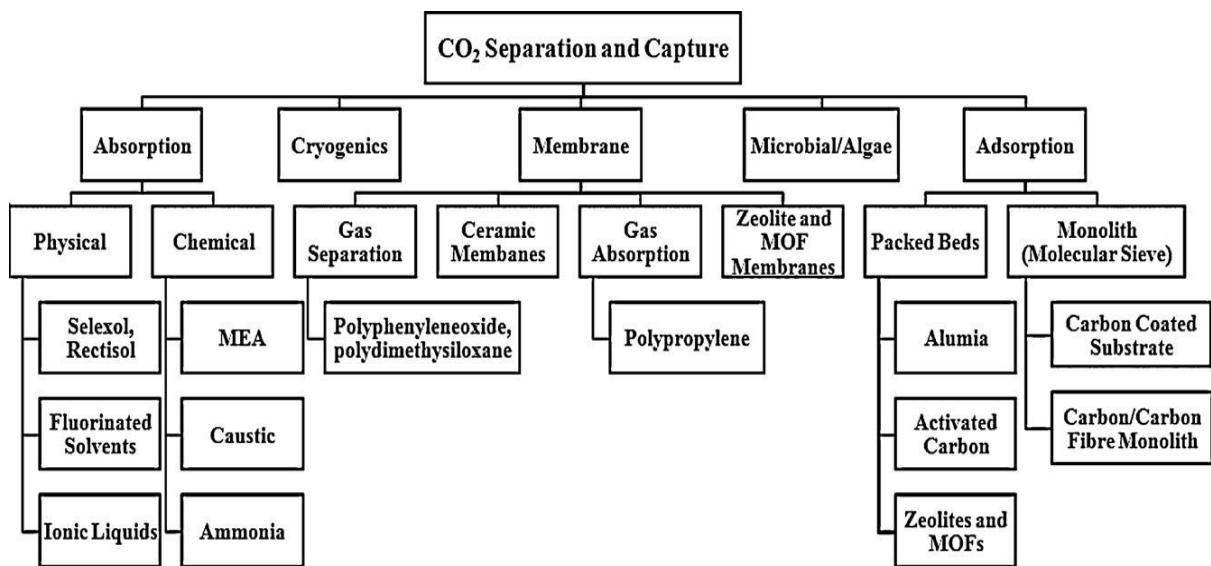


to release CO₂ for transport and storage. The used adsorbent can be recovered or regenerated by the system of Temperature-Pressure swing.

Cryogenic Distillation: This process is similar to normal distillation but this is carried out at low temperatures and high pressure as it is used for the separation of gases due to relative volatility unlike the conventional method which is used for separation of liquids. Flue gas with CO₂ is cooled to a temperature of de-sublimation which is -110⁰C to 140⁰C. After that the solidified Carbon dioxide is segregated from light gases and is compressed at a pressure of 150-2100 atm. In this method 95% of flue gas can be recovered as CO₂ (L D.M., 2004). This process consumes lot of energy as it has to be carried out at low temperatures and high pressure.

Membrane Separation: Membrane separation process or in other terms it is called as filtration process, uses a membrane layer that stops other components except CO₂ from passing through it. Membrane is the most important part of this method and it is made by bonding a layer of thin selective composite polymer to another thick non-selective layer which acts as support and is of less cost. The separation rate depends upon the flow pattern of feed to the membrane, its pore size, temperature and pressure at which it is operated (Rackley SA 2010),

Microbial Separation: This process uses the microorganisms that consume CO₂ to separate it from the existing stream. These micro-organisms consume CO₂ and produce starch and oxygen or convert them into energy. The most commonly known micro-organisms for this separation process are chlamydomonas (green-algae), synechococcus (cyanobacteria), Rhodovulum sulfidophilum (bacteria), chlorella (micro-algae).



V. TRANSPORT OF CO₂ & it's STORAGE

CO₂ that is captured has to be transported in order to store it in the secured storage places. The transportation is either by pipes, road tankers or ships. Pipes and ships are used for long distance transportation while tankers and pipes for short distances. Tankers has been the safest mode of transportation over years.

The main aim of storage of CO₂ is reducing the level of its atmospheric exposure. There are many safe storage techniques of CO₂. The most used techniques are discussed below.



S.No	Storage technique	Description
1	Direct injection	Direct injection is the process of pumping CO ₂ into underground natural sinks with a capacity of several mega tonnes of gas over time
2	Oceanic Injection	It is a direct injection technique for storage of CO ₂ where the liquid CO ₂ is injected into water columns at an intermediate depth of 1000-3000m or a depth deeper than 3000m where the liquid CO ₂ is heavier than the surrounding water and drop to the oceanic bottom forming CO ₂ Lake. The usual storage period is hundreds of years.
3	Geological Injection	It is modified technique of oceanic injection but it has high rate of retention. The storage period is over thousands of years, even more when CO ₂ reacts underground resulting in carbonate minerals which reduces the amount the quantity of CO ₂ released into the atmosphere.
4	Enhanced Oil Recovery	CO ₂ is pumped in to the reservoir of oil so that it builds pressure in the reservoir and pushes oil to the surface. The gas is recovered and injected again until as much oil as possible can be extracted.
5	Coal Seams	It is another form of geological injection where abandoned or uneconomical coal seams are injected with CO ₂ . The gas gets adsorbed by the porous rocks and gets retained permanently. Huge quantity of Methane is often present in coal beds. Methane extraction is a value added process.

VI. PROS & CONS OF CARBON CAPTURE

Some of the advantages are the reduced emissions of CO₂ into the atmosphere. The separation process also helps in the capture of other greenhouse gases such as CH₄, NO_x, SO_x etc., so that they are not released into the atmosphere. And underground pumping of CO₂ helps in oil recovery. The hydrogen produced during the separation of CO₂ can be used as fuel for generating power.

Some of the disadvantages are that it is labour intensive and expensive. The recovery of CO₂ from oil is difficult. There is an effect of corrosion in pipe lines during the transportation of CO₂. Direct injection has a tendency to leak over time.

VII. CONCLUSION

- Studies that prove that the separation methods are effective at present, but they should be improved in future for high efficiency.
- Capture of CO₂ in coal based power plants is more effective and requires less capital.
- Pipeline transportation is the most effective and economical way for transporting CO₂.
- Adsorption is the effective way to separate CO₂.
- Cryogenic Distillation is effective in capturing CO₂ but this method is not used as it requires high energy.
- Membrane separation technique is not that effective as fouling of membranes takes place & damaged membranes has to be replaced which is not economical.
- Even though CO₂ can be used to build pressure in reservoirs for the removal of oil the method is not feasible as separation of CO₂ from the stream is another hideous task.

- Post Combustion technique is effective only in case of small quantities. When it comes to large quantities Pre-Combustion technique can be used.

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