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An overview on the carbon capture technologies with an approach of green coal production study

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ABSTRACT

Coal will still be a significant component of power generation for years to come, and carbon dioxide capture systems will be the essential feature of clean coal in the future. Those who promise to deliver low carbon dioxide capture costs are committed to the pipeline and future systems. So far, many methods of carbon dioxide capture have proved costly and energy-hungry based on coal system additives. Besides, it is continually moving other industries to effectively utilize the amount of carbon present in carbon dioxide and move toward carbon capture and reuse, which is marketed ready for carbon dioxide, but it has different requirements on product quality. This paper aims to review the methods of carbon capture technologies and develop an optimal method for the green coal combustion process using the Energy and Exergy Analysis. According to the results of this paper, the Chemical Looping Combustion is the most suitable method for this process, and with the coal, powerplants using CLC technologies, the Green Coal target can be made real.

1. Introduction

Climate change is one of the shreds of evidence of global warming, which is contributing to the global average global warming. This is due to the increase in greenhouse gas in the atmosphere. Carbon dioxide is a significant component of greenhouse gases. Industry processes are the leading cause of CO2 influx [1]. It absorbs more than burning carbon oil. Greenhouse gas is also triggered by natural disasters such as agriculture and livelihoods. The mechanism of nature is the capture of CO2 in the atmosphere to maintain the biosphere balance. Greenhouse gas emissions are on the rise compared to the early industrial revolution[2]. This is due to the use of fossil fuels, heat generation, logistics, and transportation. Coal is mainly used in the energy sector and consumes 70% of the Indian economy. India's economic growth is expected to accelerate to around 600,000 MW by one by 2030 [3]. Carbon dioxide emissions are reduced to reduce global warming. Nuclear energy, water energy, fossil fuels, coal require a lot of energy generation, but coal and coal combustion technology efficiently and cleanly need to reduce CO2 emissions. General Chat Chat Lounge Occupancy and storage technology is used to reduce greenhouse gas emissions by capturing CO2 gas from the available levels [4].

Carbon capture and capture is a physical process that involves the capture and storage of CO2. Carbon capture technology is used to reduce CO2 emissions in the atmosphere. The CCS integrated system follows this process, absorbing CO2 and separating it from other gases. Then they do this by cleaning, pressing, and moving the space. CO2 is inserted into the geological surface of the reservoir or stored in the ocean[5]. This review focuses on the analysis, study, and evaluation of the importance of CCG technology to reduce global warming with economic implications for reducing GHG emissions. The primary purpose of CCS research with the energy sector is to understand the potential of these technologies. The power sector is used to clarify the

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conditions necessary for the creation of technology [6]. The purpose of CCS technology is as follows: It improves the efficiency of planting with the latest technologies to reduce carbon dioxide emissions using capture technology. Carbon dioxide is captured and separated by gas flow through a combustible gas compound. The captured CO2 is delivered to the underground reservoir. Carbon dioxide is stored in underground filtration pools, saltwater, and reservoirs. Carbon dioxide is stored in potential areas of the country[7]. The capture mechanism is used for the storage process. It is essential to ensure storage security. The primary purpose of CCS technology is to reduce the amount of CO2 in the environment. Carbon dioxide has been stored in safe places for hundreds of years using fossil oil at cheap rates[8].

There are three primary sources of CO2 release. They come from power plants, natural gas, and industrial gas. The essential CO2 gas emissions occur in power plants. This CCS technology is used to reduce CO2 emissions. Former combustion is used to collect gas from coal combustion flows and is discharged into geography [9].

1.1 Carbon transportation

Therefore, this method is used to protect the gases from entering the atmosphere. It uses pipeline processing for carbon transfer. Transfer the relationship between carbon storage and storage. It uses a piping process for carbon transfer. This pipeline method is used to transport long distances from gas [10]. Liquid, gas, and solid are the three conditions of carbon transfer. Liquid and gaseous carbon are transported using commercial-scale scales such as pipelines, boats, and tanks. The best method is to use boats to transport gas[11]. There are four types of boats used for this transport. These four types of reservoirs are used to transport liquid carbon from significant sources such as ammonia plants[12]. Boats then transport this liquid carbon to the coastal distribution terminals [13].

1.2 Carbon Sequestration

Carbon sequestration is an essential step in this technology. This carbon release in the atmosphere is protected by this step. At this stage of the capture, the carbon captured is stored in a geological site. From an economic point of view, the best places for carbon storage of non-heated stones, deep salt formations, oil refining and gas refining (EOR or EGR), and oil/gas fields are vacated. Many techniques are used to store carbon in storage tanks [14].

1.3 Potential sources of GHG emissions

According to the Indian Ministry of Energy, there are five components in India: west, east, north, south, and northeast. Coal is found in central, eastern, and southern parts of India. The lignin is found in large power plants and the southern hemisphere. Lignin is essential for development in the northeast and northern regions to produce more energy. Coffee technology is used to improve power generation. At this time, there is also a need to maintain GHG emissions for environmental protection. [10]. "The energy sector is the largest source of greenhouse gas emissions. In terms of electricity, fossil-fuel power plants supply electricity. This is a large part of greenhouse gas emissions that affect the environment. Following are solutions to reduce greenhouse gas emissions" [15],

- reducing waste and timely maintenance is an effective way to increase the efficiency of power plants
- abandoning old plants and use new technologies
- Establishment of loads from fossil fuel plants to power plants as renewable energy
- Carbon capture technology can be used for future power plants

2. Carbon Capture technologies

All current CO2 capture methods are based on combustion methods and include pre-combustion technology, oxy-combustion, and post-combustion regression technology. In the post-combustion system, CO2 is extracted from flow gas using gas separation technology. In the pre-combustion system, oxygen is removed from the air and used for combustion, releasing almost pure CO2 as flue gas. Both methods are expensive and technically sophisticated. Energy requirements reduce the impact of conversion in coal-fired plants.

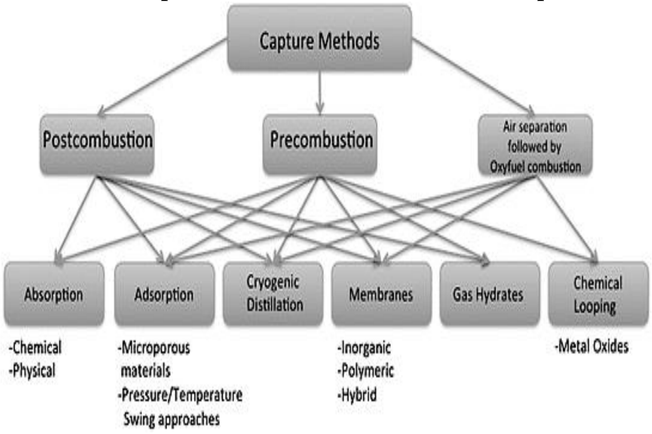


Fig. 1. the carbon capture technologies [13]

Pre-combustion: Pre-combustion capture refers to the removal of CO2 from coal before burning. For example, the gasification process produces a mixture of H2 and CO2 abundant gas[14[. CO2 can then be separated and synthesized with H2-rich oil. Due to the high concentration of CO2, pre-combustion filing is usually more efficient, but the cost of the final gasification process is often more expensive than traditional powdered coal power plants [1].

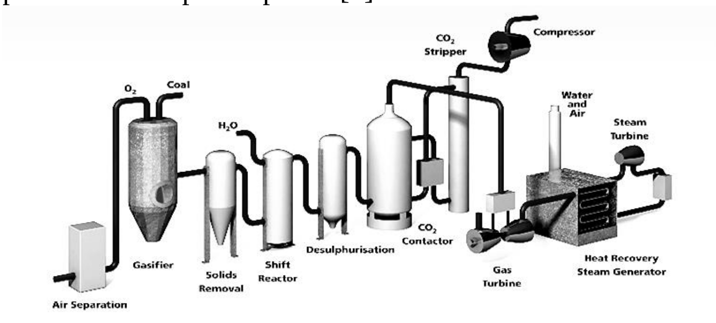


Fig. 2. The pre-combustion carbon capture schematics [14]

Oxygen-combustion: Oxygen combustion is one of CCS's most promising and cost-effective technologies for new coal. In this process, high purity carbon dioxide flow is created by burning the oil in a nitrogen-free atmosphere [15]. Traditional oxygen acts rely on pure oxygen provided by air separation units (ASUs). This is usually based on the cryogenic dislocation of the air, a process that requires air to cool to 173 degrees Celsius. These severe operating conditions make ASU systems relatively expensive to build and operate [2].

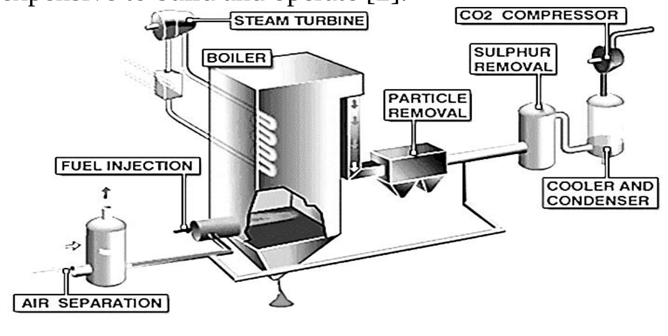


Fig. 3. The Oxy-combustion carbon capture schematics [15]

Post-combustion: Post-combustion capture (PCC) uses a chemical solution to remove CO2 from conventional power plants (gas or coal) gases. The solvent, generally the amine solvent, binds to CO2 [16]. The CO2 solution is separated and warmed by the remaining ether gas. Heat is released from relatively pure CO2 and is ready for pressure and separation or reuse. The solution is refrigerated and reused. The process has an energy penalty that is estimated to be around 30% of plant production [3].

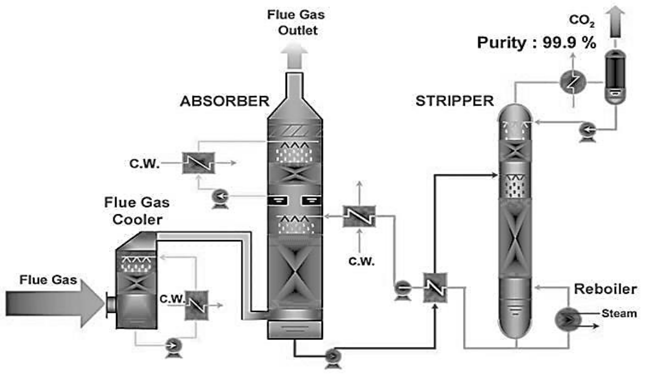


Fig. 4. The Post-combustion carbon capture schematics [16]

Table 1. The Carbon capture technologies

Capture option	Separation technology	Method	Applications	Ref.
Pre-conversion	Absorption by physical solvent	• Selexol, rectisol	Power plants (IGCC)	[4]
	Absorption by chemical solvents	•Amine-based solvent, e.g., monoethanolamine (MEA)	Ammonia production	[5]
	Adsorption by porous organic frameworks	• Porous organic frameworks membranes	Gas separations	[7]
Post-conversion	Absorption by chemical solvents	• amine-based solvent, e.g., monoethanolamine (MEA), diethanolamine (DEA), and hindered amine (KS-1) • Alkaline solvents, e.g., NaOH and $Ca(OH)_2$ • Ionic liquids	Power plants; iron and steel industry; cement industry; oil refineries	[11-12]
	Adsorption by solid sorbents	• Amine-based solid sorbents	No application reported	[15]
		• Alkali earth metal-based solid sorbents, e.g., $CaCO_3$		[11]
		• Alkali metal carbonate solid sorbents, e.g., Na_2CO_3 and K_2CO_3		[7]
		• Porous organic frameworks – polymers	Power plants	[17]
	Membrane separation	• Polymeric membranes, e.g., polymeric gas permeation membranes	Power plants; natural gas sweetening	[16]
		• Inorganic membranes, e.g., zeolites		[15]
		• hybrid membranes		[8]
	Cryogenic separation	• Cryogenic separation	Power plants	[9]
	Pressure/vacuum swing adsorption	• Zeolites	Power plants; iron and steel industry	[10]
		• Activated carbon		[11]
Oxy-fuel combustion	Separation of oxygen from the air	• Oxy-fuel process	Power plants; iron and steel industry; cement industry	[14]
		• Chemical looping combustion	Power plants	[16]
		• Chemical looping reforming	Power plants; syngas production and upgrading	[12

3. Chemical Looping combustion method (CLC)

The concept of a chemical ring was introduced in the 1950s, but during the 1990s, when the Tokyo Institute of Technology revived the process, it almost was forgotten and both researched and experimented with the process, carrying out various oxygen carriers[5]. Chemical Looping combustion is one of the most promising technologies for solid fuels. Chemical Looping combustion allows the capture of CO2 without the need for an air separation unit or absorption process. Chemical Looping combustion is very similar to oxygen burning fuel, but there is no direct connection between air and fuel[7]. Oxygen is extracted from the air, then oxygen is mixed with coal or hydrocarbon oils and produces carbon dioxide or carbon dioxide and water vapor-rich gas. Figure 5 shows a schematic diagram of a simple coal-fired CLC process, in which two filtered bed reactors (CFBs) are connected to form a loop[8].

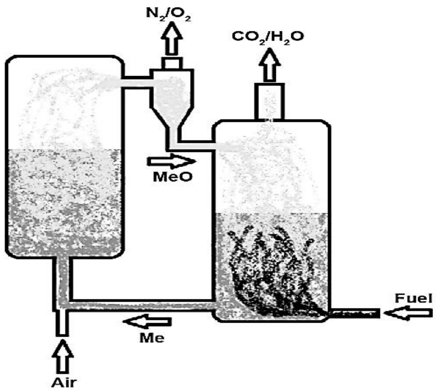


Fig. 5. The CLC carbon capture reactor [19]

In its first form, the chemical ring contains an air reactor and a fuel reactor. Usually, these reactors are made of interconnected metal beds. The oxygen carrier is split between two reactants. This oxygen carrier is usually made of metal and is easily oxidized, such as Fe, Ni, or Cu[19]. Figure 5 shows the oxygen carrier as Me, and the oxidized form of the carrier is shown as MeO. In the air (or oxidant) Me reactor is placed in a fluidized bed with air as the fluidizing agent. At high temperatures (700 to 900 ° C), I react with the presence of oxygen in the air to analyze the heat production of MeO[20]:

$$2\mathrm{Me} + 0_2 \rightarrow 2\mathrm{MeO} \quad (1)$$

The solid (MeO) is then separated from N2 and transferred to the fuel (or reducing) reactor. (MeO) reacts with either coal or hydrocarbon fuels in the oil reactor produces CO2 and H2O up to 900 g while reducing (MeO) to (Me) reactions[23]:

$$2\mathrm{MeO} + \mathrm{C} \rightarrow 2\mathrm{Me} + \mathrm{CO_2} \quad (2)$$

And in the case of hydrocarbon fuel:

$$MeO + H2 \rightarrow Me + H_2 0 \quad (3)$$

(Me) is then transferred to the air reactor for a repeat of the process. In an air reactor, a Solid oxygen carrier collects oxygen from the air through the oxidation reaction to create a solid oxide and release nitrogen. This chemical reaction is external and releases heat into the air reactor [2]. The hot particles containing warm oxygen are transferred to the fuel reactor. Once they are here, they release oxygen and convert the combustion gases of the coal sector to oil [24].

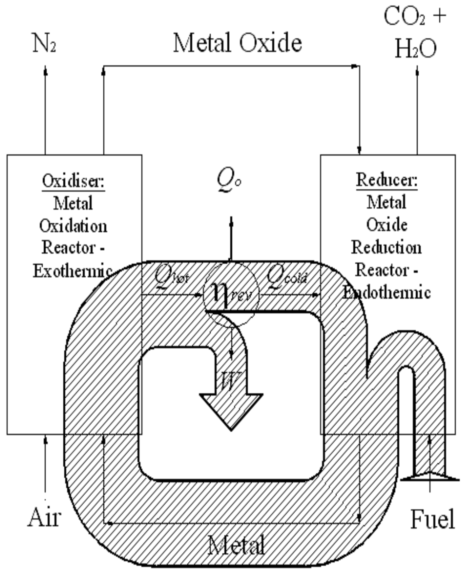


Fig. 6. The CLC carbon capture process [22]

The static carrier provides the heat needed to convert the oil. This separation and oxygen delivery phase occur at temperatures close to the heat of the fuel. As a result, it reduces the heat penalty flow. After heat and oxygen release into the fuel reactor, the oxygen carrier is repeated to the air reactor for recovery. The solid carrier rotates during the two reactors and repeats during oxidation-reduction or "chemical loop [25]."

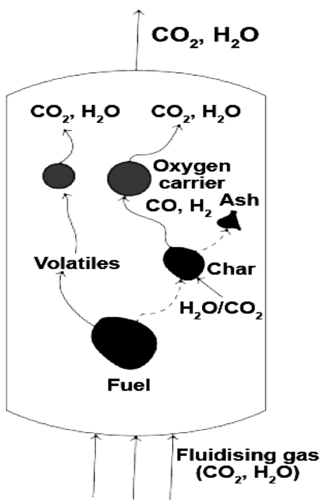


Fig. 7. The reaction in the fuel reactor [12]

The oxidation reaction is always external, while the reduction reaction can be done externally depending on the carrier and the nature of the fuel. However, the values of reaction (1) and (2) are the same as for conventional burns. Therefore, the CLC process has no direct cost or energy penalty for CO2 concentration [5]. This idea is reliable and flexible and is offered for other products as well. By contrast, the number of solid oxygen carriers compared to the coal given to the oil reactor, high-quality units (CO, H2, and other light carbon) are used as raw materials for petrochemical/refinery as well as power generation processes. It can be produced as [2]. Energy comes from the flow of hot gases. There are several options to consider[26]:

• Direct use of hot gas in the type of gas turbine operation:

In this process, hot gas (especially nitrogen) from oxide in a flow gas turbine (electric wheel) is used to generate direct power and to power compressor pumps. It can be combined with a steam turbine from a reducing reactor in a kind of hybrid operation[27].

• Standard or supercritical operation under normal fever:

In this setting, boiler tubes can be installed inside the reactors, and the normal steam cycle occurs. As an alternative, a separate heat separator/boiler may be located outside the reactors[28].

3.1 Processing of CLC coal

Most of the CLC's research has focused on gasoline oils such as natural gas and units because it requires minimal systems, and little development has been done on solid fuels. However, interest in solid fuel CLC systems has increased, with several prototypes evident in the literature. Some pre-combustion advancements require screw gasification, but several upgrades use direct combustion of coal using CCC. The use of an oil reactor for solid fuels is usually a type of bedrock that meets the requirements of the CLC process[29].

In the case of solid fuels such as coal or biomass, the reaction gas is much more complicated than gas or even liquid fuels. One way to process solid oil through CLC is first to perform the external oil refining in the fuel and then process the compositions using CLC gas. Since it requires an external gasification unit and ASU to produce oxygen for partial damage, it is questionable if an alternative option is economically feasible. Instead, the oil can be fed directly to the reactor with metal oxide particles. The oil here is confined to a large part of the gas, which is made of portable and solid charcoal, as shown in Figure 7[30].

In parallel, the proportional fraction, which is mainly composed of CO, H2, and CH4, shows direct reaction with oxygen. Carrier particles. The cricket components are carbonated in the presence of steam and carbon dioxide and produce CO and H2 according to reactions 4 and 5[31].

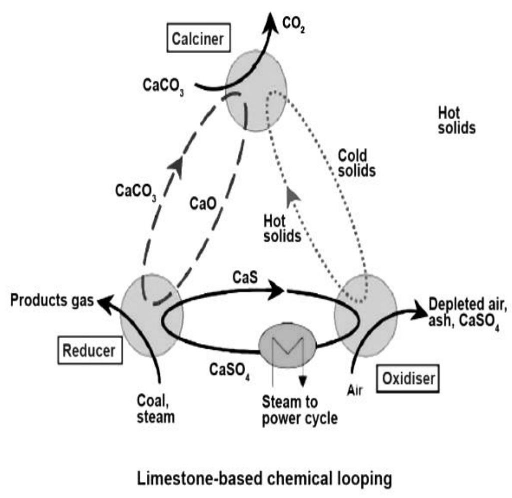
$$Char\ (mainly\ C) + H_2O \rightarrow CO + H2 \qquad (4)$$

$$Char\ (mainly\ C) + CO_2 \rightarrow 2CO \qquad (5)$$

CO and H2 should react to the result of these reactions (1) with oxygenated products wholly oxidized. Reactions (4) and (5) do not directly contain oxygenated particles [32].

Static fuels constitute the remainder of the character that cannot directly react with the oxygen carrier after the release of mutations that may react directly to the oxygen carrier[33]. The rest of this character gets gasped, for example. With fever, the horn produces. Cricket degassing is a slow process, which means that an oil reactor needs a design that provides sufficient residence time to prevent char particles from going into the air reactor[34]. In order to achieve high volatility exchange, fatigue at the oil interface must be provided to allow a fine bond between the bedding material and the particles [35].

It is especially interesting that experiments on the use of oleumite, oxide scales, and unprocessed iron with oxygen as an oxygenator indicate that relatively inexpensive materials can be firmly adsorbed with heavy oil. Be used for LC [33].



Schema 1. the illustration of the chemical looping process[32]

3.2 Oxygen carrier

The activity of a chemical ring system depends on the oxygen carrier. In all cases, this process involves redox. An oxygen carrier is usually made of metal that can quickly produce an oxide that is easily degraded. The carrier cycles through the reflectors at a permanent base and requires stable mixing and stable performance over a large number of periods[36]. This technology has been successfully demonstrated in several continuous units using cheap and readily available metal oxides. Most materials are made of raw materials, but natural raw materials and industrial waste have also been used successfully[37]. There are a significant number of different production technologies among manufactured goods.

One of the advantages of the system is to make readily available metal oxide suitable [38]

- Metal oxidants

Iron (manganese), manganese (copper), copper (nickel), and nickel are all successful oxygenators in the pure metal oxide[39].

- Mixed metal oxides

Research has shown that the use of mixed oxides, either as natural minerals or as chemical / mechanical mixing tablets, can achieve optimal performance for some types of oils. Ilmenite (FeTiO3) is the most suitable titanium oxide iron as an oxygen carrier. Iron/nickel compounds are commonly used[40].

- Oxygen carrier combination

The basis of CLC technology is finding oxygen particles that are sufficiently reactive to the oil and still have high mechanical stability in most redox periods. OC requirements are a stable activity over a different period. The oxygen carrier body composition affects both the reaction rate and the efficiency of the circulatory system used in CLC. The cargoes were shot in the oxide state (figure 7)[38].

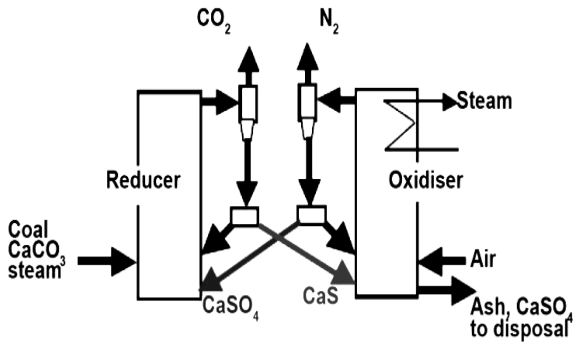


Fig. 8. LCL system for coal combustion [37]

To increase oxygen carrier reactivity and stability, the pure metal oxide is combined with various inactive support materials that act as potential adhesives to increase the reactivity of the active phase and possibly as an oxygen ion conductor[39].

Besides, it potentiates the passive bond mechanism and oxygen carrier absorption resistance. Common ingredients include magnesium zirconium oxide (MgZrO2), alumina (Al2O3), titanium dioxide (TiO2), magnesium oxide (MgO), silicon dioxide (SiO2) or magnesium aluminate (MgAl2O4) [9]. The Um, alumina, is often used as a support material. The particles are passed through metal oxides on.-Al2O3 particles[39].

Alstom has developed a CLC system based on aluminum and ilmenite. Studies show that Limestone's chemical loop technology has a lower cost potential for producing electricity from coal-based CO2. The LCL loop is shown in Figure 8. The main reactions are[40]:

Air reactor (oxidizer)

$$CaS + 2O_2 \rightarrow CaSO_4 + Heat \tag{6}$$

Fuel reactor (reducer)

$$C_{fuel} + CO_2 + Heat \rightarrow 2CO \tag{7}$$

$$2CO + CaSO_4 \rightarrow CaS + 2CO_2 \tag{8}$$

Alstom has been developing chemical loop technology for more than a decade and has developed a Limestone LCL system to operate a 3 MW test plant on a thermal basis, and this is a chemical loop reaction. The ring confirms performance and capacity[41]. The system uses a high-cost, low-cost chamber as an oxygen carrier, built on the company's CFB technology, and uses traditional materials and production techniques. Technical and economic assessments show that power generation systems based on chemical loops have the potential to reduce CO2 electricity costs. The company plans to improve technology by 2025 with the ultimate goal of producing 100 MW of power [42].

Studies have shown that Cycladic boiler island equipment is smaller than a fluoride circulation bed for the same production power, which requires a significant reduction in construction volume and overall weight [43].

- Reconstruction Potential

- Alstom predicts that CCC combustion units can be cheaper than adding combustion burn captures to existing computer booths. There are two options[44]:

- Use CLC as a gas burner to produce hydrogen present in the boiler

- Replace the existing boiler with a CLC-based boiler and store the equipment on a power island[45]

- Chemical ring combustion through hydrothermal substitution

The combination of CLC and hydrothermal processes facilitates the storage of CO2 in the chemicals used. These chemicals can be stored in ambient conditions and do not require the transfer of CO2 to the field of biological resources [46].

3.3 Conceptual modeling of the method performance

The analytical performance of the carbon capture systems is described in the tables below:

Table 2. the performance factor of the NDCL plant[47]

Factor	Formula
The Energy performance plant	$\eta_{Gross} = \frac{W_{gross}}{m_{fuel} * LHV_{fuel}} * 100$
hydrogen efficiency	$\eta_{H_2} = \frac{LHV_{H_2}.m_{H_2}}{m_{fuel} * LHV_{fuel}} * 100$
Carbon capture efficiency	$\eta_{CO_2} = \frac{CO_{2,i} - CO_{2,o}}{CO_{2,i}}$
specific carbon dioxide emission	$E_{CO_2} = \frac{m_{CO_{2emit}}}{W_{net}}$
the annual CO2 emissions rate	$\varepsilon_{fCO_2} = \frac{m_{CO_{2emit}}}{3.6 * E_{chf}}$
The exergy efficiency of the plant	$ExE = \frac{\xi_{H_2}.LHV_{H_2}.m_{H_2} + \xi_{FA}.LHV_{FA}.m_{FA}}{Electricity\ consumption}$

Table 3. the thermodynamical exergy, Energy and environment, the economic model of the CCPP

Description	Equation
Power consumption in Air compressor	$W_{AC} = m_a(h_2 - h_1)$
Power generation in Air turbine	$W_{GT} = m_g(h_3 - h_4)$
HRSG thermal model	$m_g Cpg(T_a - T_b) = m_{wHP}(h_u - h_t)$
Efficiency ratio of the steam cycle	$\eta_{ST} = (\frac{W_{ST,act}}{W_{ST,is}})$
Pumping system performance ratio	$\eta_{pump} = (\frac{h_{15,is} - h_{24}}{h_{15} - h_{24}})$
Exergy balance	$Ex_Q + \sum m_i ex_i = \sum m_e ex_e + Ex_w + Ex_D$
Exergy equation	$ex = ex_{ph} + ex_{ch}$
Physical exergy	$ex_{ph} = (h - h_0) + T_0(s - s_0)$
Chemical exergy	$ex^{ch}{}_{mix} = \sum X_i ex^{ch} + RT_0 \sum X_i \ln X_i$
Exergy of the fuel	$\zeta = \frac{ex_f}{LHV_f}$

The systems modeled using the concepts mentioned in the tables 2 and 3, and the summary of each analysis mentioned in the schema below[48]:

C Chemical analysis
- Chemical performance
- Product energy and mass rates
- Ecological analysis

E Energy analysis
- Energy modeling
- Energy performance
- Energy optimiztion

E Exergy analysis
- Exergy stream rates
- Exergy performance ratio
- Exergoeconomic analysis

To expand the scope and generality of this method, some aldehydes were used as the substrate in this reaction. The results were summarized in Table 2[49]. In continuation of our studies, we triggered to synthesize tris-(bis coumarinyl)methane using POImD (Figure 1).

All of the compounds summarized in Table 2 were characterized by spectroscopic methods (IR, HNMR, and CNMR) and elemental analysis. So, all of the synthesized compounds are new. They were prepared from pyrazolecarbaldehydes that most of them are not commercially available material. Our experiments also indicated that after five successive runs, recycled ionic liquid showed no loss of efficiency concerning reaction time and yield (Table 3)[50].

4. Results and Discussion

4.1. General

Table 4 compares the three CO2 capture technologies mentioned above. Former combustion is mainly applied to coal power plants, while both combustion and oxygen fuel combustion is used in coal and gas. Post-combustion technology is currently the most mature process for CO2 capture [51], [52]. On the cost side, Gibbins and Chalmers compare these three technologies for gas and coal-fired power plants (Table 5). They reported that for coal-fired plants, pre-combustion technology avoided the lowest cost of one tonne of CO2, while post-combustion technologies and oxy-oil technologies had similar costs. However, for gasoline-fired plants, the cost per tonne of CO2 avoided after combustion was nearly 50 lower than the other two captured technologies[53]. Besides, the capture of CO2 after combustion is usually the least feasible option, with energy fines of about 8% and 6% for coal and gas power plants, respectively [54].

Table 4. Con and Pros of the different CO_2 capture technologies[55].

Capture process	Application area	Advantages	Disadvantages
Post-combustion	Coal-fired and gas-fired plants	Technology is more mature than other options. It can be easily converted to existing plants [45].	Low CO2 concentration affects the capturing efficiency.
Pre-combustion	Coal-gasification plants	Higher CO2 concentration increases absorption efficiency. The sufficiently advanced and commercially available technology is required in some industrial sectors. Possibility to remove existing plants [46]	The issue of heat transfer and heat-related degradation efficiency using hydrogen-rich gas turbine oils requires high parasitic regeneration currently. There is currently not enough experience with several gasoline manufacturers in the market. High investment and operating costs for current emissions systems;
Oxyfuel combustion	Coal-fired and gas-fired plants	The highest concentration of CO2, which increases the absorption efficiency. The available air separation technology reduces the amount of gas needed to treat it, hence the need for smaller boilers and other [47]equipment.	High-efficiency drop and energy penalty; cryogenic O2 production is expensive. It can be a severe problem.[48]
Chemical looping combustion	Coal-gasification plants	CO2 is the main combustion product that combines with N2, thus preventing the separation of high-energy air [49].	The labor process is still in development and has insufficiently extensive operating experience [50];

Table 5. comparing the performance factors of different carbon capture methods for a 500MW powerplant

Fuel type	Parameter	Capture technology				
		No capture	**Post-combustion**	**Pre-combustion**	**Oxy-fuel**	**CLC**
Coal-fired	Thermal efficiency (% LHV)	44.0	34.8	31.5	35.4	**62.42**
	Capital cost ($/kW)	1410	1980	1820	2210	**2951**
	Electricity cost (c/kWh)	5.4	7.5	6.9	7.8	**5.3**
	Cost of CO_2 avoided ($/t CO_2)	–	34	23	36	**24**
	Exergy efficiency (%)	35.2	28.81	26.32	25.41	**61.31**
	Carbon utilizetion potential (MWth/MWe)	-	-	-	-	**1.42**
	Carbon Capture efficiency(%)	-	88	84	87	**94**
Gas-fired	Thermal efficiency (% LHV)	55.6	47.4	41.5	44.7	**68.98**
	Capital cost ($/kW)	500	870	1180	1530	**3274**
	Electricity cost (c/kWh)	6.2	8.0	9.7	10.0	**6.5**
	Cost of CO_2 avoided ($/t CO_2)	–	58	112	102	**105**
	Exergy efficiency (%)	45.8	41.44	37.90	36.97	**72.77**
	Carbon utilizetion potential (MWth/MWe)	-	-	-	-	**1.68**
	Carbon Capture efficiency(%)	-	83	79	81	**89**

4.2. Carbon dioxide Transfer

There are several types of transferring CO2 to the storage area after collection and separation. From a storage perspective, large quantities of CO2 are transported efficiently through pipelines. However, the cost of this transportation depends on operating conditions, coastal locations, and the size and composition of the pipelines [59]. The IPCC According to him, the cost of transporting from one source to a site is estimated at 1-8 $/tCO2 in the km pipeline. The published report suggests that as long as the distance between the primary source pool and the reservoir pool is less than 300 km, transportation may not incur high costs on the CCS project [60]. During the recording process, impurities (for example, N2, O2, and Ar), which are often mixed with CO2, may cause additional costs for storage and decrease storage capacity. Therefore, they must be removed before injection [33]. Besides, in order to reduce capacitance and hydration, CO2 moisture must be separated, which can incur additional costs [61]. Subsequently, supercritical CO2 was suppressed to a density of about 900 kg-3. The transfer of CO2 to liquid CO2, which appears as supercritical, is more effective due to its low density and relatively high-pressure drop per unit length [30]. Therefore, the operating cost of a storage project must be considered and evaluated in the early stages before the injection begins[51].

4.3. Carbon dioxide Storage

Choosing a storage site for the CCS project is done by assessing the adequacy of the pool and site. Only oil and gas reservoirs, deep sandstone and deep carbonate water, stone beds, and salt beds are permanent pools often targeted for the CO2 fixation method. In comparison, active or excluded oil and gas reservoirs and deep reservoirs have been identified as the best CCS sites for large CO2 mitigation [12,20], [35], [36], [37], [38], [39], [40], [41], [42], [43], [44], [45]. The advantages and disadvantages of this geological structure are listed in Table 6 [61].

Table 6. Cos and Pros of each carbon storage type[61]

Geological medium	Advantage	Disadvantage
Unminable coal seams	•Large capacity •Enhanced methane Production	•High cost •Not available in all-region
Mined salt domes	•Custom design •Storage integrity	•High cost •Not available in all regions
Deep saline aquifers	•Large capacity •Widespread availability	•Unknown storage integrity
Active or depleted oil and gas reservoirs	•Proven storage integrity •Enhanced hydrocarbon recovery •Established infrastructure	•Not available in all regions •May not be available for immediate injection •Multiphase flow complications associated with residual hydrocarbon

During and after injection, CO2 monitoring should be performed to ensure that the injection fluid is transported to the storage area and removed. Monitoring is a measure of mitigation to evaluate tank behavior during and after an injury[62]. To date, there are surface and sub-surface monitoring techniques that achieve important measurements such as injection speed, composition, and pressure/temperature change on the surface[63]. Pressure/heat measurements are also used to adjust injection wells/monitors to adjust the storage modules and to predict the maximum injection speed with storage capacity [64]. Time-lapse (4-D) earthquake measurements appear to be a valid method for evaluating CO2 column migration in the Sleeper and Sanguine Coast industrial-scale projects [43]. If valuable data on earthquakes is not obtained due to budget constraints, it may be helpful to provide additional information on the situation density, and the amount of water analyzed [65]. Geological monitoring techniques using non-photographic and refractive tracking timers may be a good tool for explaining the quantities of physical and geochemical changes on Earth, but these are usually not effective for earthquake data. [66]

The economic potential of CCS is a major concern that should be considered based on the technical costs of planning and operations [41,42]. These costs can be further divided into several categories, including CO2 separation, transportation (especially with compressors and pipelines), and injection. High concentrations of CO2 can cause health problems and increase health and safety risks [67]. The contaminated phase produces an acidic solution during CO2, which raises the problem of corrosion and degradation for the storage water. Supracyclic CO2 should be evaluated with and without impotence because impurities can alter their physical properties and transport. Besides, the types of impacts, their composition and quantity may have a significant impact on the pressure distance, compressor strength, and pipeline capacity [40].

4.4. obstacles of the Carbon capture development

The CCS constraints for approval are divided into three categories. They are [66]:

- Financial constraints
- Technical constraints
- Administrative disruption
- Other obstacles

Financial constraints include higher capital costs and higher energy fines. Institutional constraints do not meet the general development objectives. These include non-manufacturing costs that do not contribute to sustainable development. Technical barriers to trade indicate high sources of CO2[68]. It is used for recording technologies but is not standard for large-scale sources specifies the sink and its capacities. Technical constraints have some persistent problems, and these issues are active in many parts of the world. Technical constraints are used to determine the probability and cost of emitted gas and oil. It selects the coordinates and outlines of the dots and their sources [20]. Other barriers include[53]:

- Financial
- Regulatory
- Storage
- Acceptance

The stock is used for leak detection and carbon calculations. Monitoring is used to establish the EU and to provide CCS for European trade[63]. Large-scale CCS deployment is a major obstacle in the World. It does not have the technology and geologic bypass data that can be installed in power plants, and their sources are of efficiency, capacity, and location. Implementing CCS involves things like increasing power consumption and generating electricity [64]. One of the biggest barriers to CCS in the World is the lack of electricity and electricity. Worldwide, CO2 storage uses advanced oil refining and is one of the most attractive options for CCS deployment. In this usage method, CO2 storage costs are reimbursed by accumulated revenue[55].

In the oil sector, it has been stated by stakeholders, and there are very few oil fields that are partially destroyed to promote oil recovery [21]. Improving oils based on acceptable properties of oils that are not suitable for all purposes. The implementation of CCS illuminates the old plants using re-recording equipment. Previous plants will change the length of time the source is made[47].

These barriers are used to access financial institutions such as the Asian Development Bank and the World Bank, and so on. Prerequisites are endorsement, monitoring, and measurement [65]. The requirements depend on the specific CCS cleaning. Special CCS exemptions from governmental agencies and the Department of Energy over settlement requirements. Widespread CCS deployment requires the best infrastructure and specialist human resources available in Globe[48]. The CO2 Storage Monitor ensures accurate CCS implementation and precise monitoring. This oversight requires techniques and scale development ideas, and it is introduced to Global partners. There are several obstacles to legal issues related to CO2 leakage, land acquisition, and groundwater pollution. CO2 deployment and large-scale transport are permitted through CCS deployment in World [54].

4.5. Reforms in Indian Politics to Implement CCS (Case study)

India is the third-largest consumer of coins in the world. Coal accounts for 62% of the country's electricity distribution. About 75 percent of the coal is sent to India to help generate electricity, while the remaining 25 percent is used as a part of steel, dams, and fertilizers. Given India's growing coal footprint, which also contributed to the demand for development power, the Indian government supports the creation of nine additional mega projects[55]. It has a screw-driven volume of about 36 GWof while specifying the mandatory chance for CCS review. CO2is emissions increased to 123 tonnes, partly due to the wide range of sources suitable for CO2 [55]. In 2000, the 25 largest carriers accounted for about 36% of the total CO2 national concentration, indicating the possible presence of various valuable CCS opportunities. As a non-annexed country to the UN Framework Convention on Climate Change (UNFCCC), India has agreed to publish the Greenhouse Gas Index (GHG), which is still under the GHG emissions target. There is no need to end the Kyoto Protocol[66]. India faces various professional and administrative obstacles to the way CCS is used, eliminating coal inventions as an important aspect for a larger environmental change perspective [67]. To address these problems, the Legislature has developed a roadmap for developing clean coal technology (CCT) that aims to promote clean coal and support the invention of strategies. Besides, the CCRD (Coal Research and Development) Center has been established by the industry[67]. The CBP (Capacity Communication Program) is predicted to have more advanced technology in CCS. Besides, India participated in various international efforts to drive development and disseminate CCS development. India joins CSLF's Carbon Efficiency Leadership Countries[56].

4.6. Climate Change Conference of Paris 2015

COP-21 was held in Paris on November 30, 2015. The agreement states that there are at least 55 countries that should represent 55 percent of greenhouse gases. One hundred seventy-four countries signed the agreement on April 22, 2016[68].

The main purpose of the conference is to reduce global warming by emitting greenhouse gases. At past climate conferences, countries have signed a global agreement to agree on a blueprint. These agreements are called INDCs. INDCs are used to reduce global warming as well as to reduce greenhouse gases [22]. The outcome of this conference is important for reducing greenhouse gas emissions. According to the document, members agreed to reduce carbon emissions worldwide to reduce global warming. In the deal, island states such as Seychelles, the Pacific Ocean, and the Philippine Sea coast strongly mentioned that they would increase greenhouse gas emissions at sea level. They have been targeted to reduce the temperature from 2 ° to 1.5 ° C [23].

5. Conclusion

Reducing CO2 emission without CCS reduces CO2 emission. BAU aims to reduce CO2 emission by more than 40%. Maximum CO2 reduction in the power sector occurs using the clean coal technology deployments shown in Figures 9, 10, and 11 for 2011, 2021, and 2031, respectively. It has the highest accuracy of recorded and recorded atmospheric CO2 concentration and changes in atmospheric composition over time [69]. CO2 emission is caused by fossil fuels because these are the CO2 source material. It mainly involves deforestation, soil degradation, and land clearing for agriculture[24]. Greenhouse gas emissions focus on minimizing greenhouse gas emissions. This will increase environmental awareness and regulation. The following chart describes the micro CO2 segment for 2011, 2021, and 2031 [57].

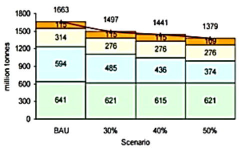


Fig. 9. The CO2 emission for 2011 [20]

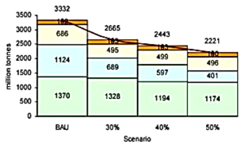


Fig. 10. The CO2 emission for 2021 [20]

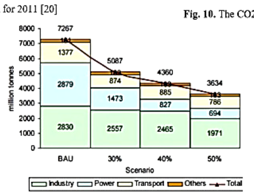


Fig. 11. The CO2 emission for 2031 [20]

The electricity sector has the best opportunity to run CCS and is used to increase the uptake of clean coal technology by 10GW at BAU [70]. Energy technologies Energy also increases CCS development opportunities. The division of power and energy consists of various units such as energy policy, oil, coal, and power. This survey raises growing concerns about the environment and energy and ensures energy security [71]. Energy technologies Energy policy is evolving in energy policy, encompassing commercial, and non-commercial energy sources. This includes natural gas, oil, power, and coal [25]. Figs 12, 13, and 14 describe the power generation technologies in 2011, 2021, and 2031, respectively [58].

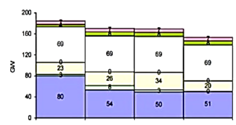


Fig. 12. Tech. for power generation in 2011 [20]

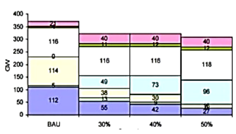


Fig. 13. Tech. for power generation in 2021 [20]

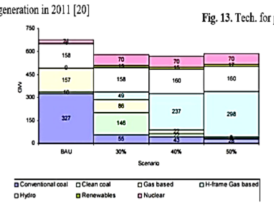


Fig. 14. Tech. for power generation in 2031 [20]

Energy-related CO2 emissions also reduce carbon emissions [72]. It considers the only CO2 related to energy and analyzes the distribution of COCO2 distribution related to the energy sector. The CCS in the energy sector predicts the amount of energy consumption. It uses baseline scenarios, blue map scenarios, and the emission rate is over 40% [26], as shown in Figure 15. The BLUE Map scenario provides 14 Gt CO2 / year if the CCS is implemented; otherwise, the forecast is 62Gt CO2 / year [73].

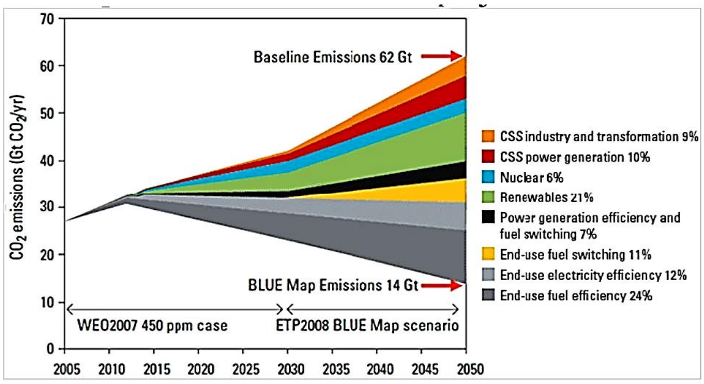


Fig.15. CO2 emission based on energy level [27]

As a case study, the Indian government's contribution to the accumulation of CO2 and other greenhouse gases from the atmosphere due to incorrect combustion of fossil fuels with a significant amount of fuel supply is significant [74]. Hybrid infrastructures and internal reserves are based on energy sources such as wind, solar, and biomass that need to be improved at the first level and CCS's alignment with coal plants [75]. Clean coal technologies and CCSs are the mainstream media that can be useful for achieving carbon targeting and implementing carbon dioxide production processes. CCS completes CO2 emission reductions in the electricity sector and measures energy efficiency [76]. CO2emission is expected to reach more than 55% of the global total in India. CCS uses three technologies, such as pre-combustion recording, post-ignition combustion recording, and oxy-combustion recording, including combustion prevention and suitable combustion options for India due to their flexibility and retrofit capability [77]. Fossil fuels are available. The fired plants have the main impediment to energy punishment, which can be reduced by integrating the solar power generation system with the combustion process [48, 78].

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