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An Overview Idea on Carbon Sequestration

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Abstract: **Carbon sequestration is still a challenging problem for us. It leads the greenhouse effect or climate change. The sustainable growth of any country required to minimize the emission of Carbon dioxide by capturing, storing or reuse of atmospheric carbon dioxide and altering the raw material of the process. Carbon capture and sequestration is an area with great potential. The technologies of carbon sequestration mainly based on the prevention of CO_2 emissions into the atmosphere and the removal of CO_2 in the atmosphere. There are mainly three ways namely energy efficiency, lower carbon fuels and carbon sequestration to reduce the emission of Greenhouse gas (GHG). Now a Carbon Sequestration process is a promising path to control the green house gases effect. This paper emphasized an overview of the Carbon Sequestration and concentrates on innovative sequestration concepts for longer-term solutions. It describes long term storage of CO_2 or other forms of carbon to either mitigate or defer global warming and avoid dangerous climate change.**

Keywords: **Carbon dioxide, GHG, Carbon sequestration, reuse of atmospheric carbon dioxide, Terrestrial Sequestration, Geologic sequestration, ocean Sequestration.**

1. INTRODUCTION

Carbon sequestration is the process of capturing, separation and storage or reuse of atmospheric carbon dioxide [1]. The technologies of Carbon sequestration mainly based on the prevention of CO_2 emissions into the atmosphere and the removal of CO_2 in the atmosphere along with reduction in Greenhouse gas emissions. It describes long term storage of CO_2 or other forms of carbon to either mitigate or defer global warming and avoid dangerous climate change. It has been proposed as a way to slow the atmospheric and marine accumulation of greenhouse gases, which are released by burning fossil fuels [2]. Carbon dioxide is naturally captured from the atmosphere through biological, chemical or physical processes and may be as a pure by product related to petroleum refining or from flue gases from power generation [3]. Permanent artificial capture and sequestration of industrially produced CO_2 using reservoirs, ocean water, subsurface saline aquifers, aging oil fields or other carbon sinks.

2. METHOD FOR CARBON SEQUESTRATION

There are the following methods used for carbon sequestration.

1. Chemical Processes: CO_2 can be removed from the atmosphere by chemical processes, and stored in the stable carbonate mineral forms. This is known as carbon sequestration by mineral carbonation or mineral sequestration. In this process, CO_2 form stable carbonates with magnesium oxide or calcium oxide. These reactions are slightly more favorable at low temperatures [4]. The reaction rate can be made faster at higher temperatures or pressures or by pre-treatment. CO_2 naturally reacts with peridotite rock in surface exposures of ophiolites. It has been suggested that this process can be enhanced to carry out natural mineralization of CO_2 [5-6].

$CaO + CO_2 = CaCO_3$

$MgO + CO_2 = MgCO_3$

Cement manufacture releases large amounts of carbon dioxide, but recently developed cement types from Novacem [7] can absorb CO_2 from ambient air during hardening [8]. The amount of CO_2 captured averaged 60-65% of the carbonaceous CO_2 and 10-11% of the total CO_2 emissions [9]. Klaus Lackner proposed an artificial tree to remove carbon dioxide from the atmosphere using chemical scrubbers [10].

3. BIOLOGICAL PROCESSES

Carbon sequestration through biological processes affects the global carbon cycle known as biological sequestration. Peat bogs are a very important carbon store. By creating new bogs, or enhancing existing ones, carbon can be sequestered [10]. Reforestation is the replanting of trees on marginal crop and pasture lands to incorporate carbon from atmospheric CO_2 into biomass [11]. For this process to succeed the carbon must not return to the atmosphere from burning or rotting when the trees die [12]. To this end, the trees must grow in perpetuity or the wood from them must itself be sequestered, e.g., via biochar, bio-energy with carbon storage (BECS) or landfill. Short of growth in perpetuity, however, reforestation with long-lived trees (>100 years) will sequester carbon for a more graduated release, minimizing impact during the "carbon crisis" of the 21st century. Wetland soil is an important carbon sink; 14.5% of the world's soil carbon is found in wetlands, while only 6% of the world's land is composed of wetlands [13]. Globally, soils are estimated to contain approximately 1,500 giga tons of organic carbon to 1 m depth, more than the amount in vegetation and the atmosphere [14-15]. Modification of agricultural practices is a recognized method of carbon sequestration as soil can act as an effective carbon sink offsetting as much as 20% of 2010 carbon dioxide emissions annually. Carbon emission reduction methods in agriculture can be grouped into two categories: reducing and/or displacing emissions and enhancing carbon removal. Some of these reductions involve increasing the efficiency of farm operations (i.e. more fuel-efficient equipment) while some involve interruptions in the natural carbon cycle. Also, some effective techniques, such as the elimination of stubble burning can negatively impact other environmental concerns (increased herbicide use to control weeds not destroyed by burning). There are three primary means to reduce CO_2 emissions associated with energy production without reducing economic output:

- Improve the efficiency of energy conversion and end-use processes.
- Shift to lower-carbon-content fuels (including non carbon sources, such as renewable energy and nuclear power).
- Sequester the carbon released in energy production.

To reduce GHG emissions effectively and economically, we must be prepared to use all three of the above methods.

4. TERRESTRIAL SEQUESTRATION

Terrestrial ecosystems include both vegetation and soils containing microbial and invertebrate communities, recognized as major biological "scrubbers" for CO_2. Terrestrial sequestration can be enhanced in four ways:

1. Reversing land-use patterns
2. Reducing the decomposition of organic matter
3. Increasing the photosynthetic carbon fixation of trees and other vegetation
4. Creating energy offsets using biomass for fuels and other products

It is defined as either the net removal of CO_2 from the atmosphere or the prevention of CO_2 emissions from leaving terrestrial ecosystems. The terrestrial biosphere is estimated to sequester large amounts of carbon about 2 billion metric tons annually. The total amount of carbon stored in soils and vegetation throughout the world is estimated to be roughly 2 trillion metric tons [9]. Hence, even a small change in the CO_2 flows could amount to large additional amounts sequestered. Enhancing the natural processes that remove CO_2 from the atmosphere is thought to be one of the most cost-effective means of reducing atmospheric levels of CO_2, and forestation and deforestation abatement efforts are already under way. The multiple benefits of terrestrial sequestration is in the form of improved soil and water quality, better wildlife habitats, increased water conservation ete.

5. GEOLOGIC SEQUESTRATION

There are a variety of potential geologic sequestration options for long-term storage. This is not really a new concept. For example, CO_2 is currently injected into more than 70 operating oil fields to enhance oil production[29]. The idea of that storage of CO_2 is a desirable goal. The storage potential of these geologic options is enormous, possibly measured in trillions of metric tons. This is many times larger than total worldwide energy-related CO_2 emissions, estimated at about 22.3 billion metric tons of CO_2 in 1999 [29]. Deep saline reservoirs may be the best long-term underground storage option. Such reservoirs normally are too salty to provide potable water supplies and are generally hydraulically separate from more shallow reservoirs and surface water. Depending on the reservoir, injected CO_2 would displace the saline water, with some of the CO_2 dissolving, some reacting with the solids, and some remaining as pure CO_2. Preliminary hydro geologic and geochemical modeling showed that there is enormous potential for CO_2 sequestration in the Midwestern United States, especially in the Mt. Simon Sandstone in the Illinois Basin [29-30]. This capacity appears to be sufficient for storing emissions for several decades or more. However, the modeling also indicated that local factors, such as formation thickness, permeability, injectivity, and geochemistry, significantly influence the technical feasibility and cost-effectiveness of this technology.

6. OCEAN SEQUESTRATION

The world's oceans may be a large potential sink for anthropogenic CO_2 emissions. However, because the oceans play such an important role in sustaining the biosphere, any potential changes to these ecosystem functions must be carefully and thoroughly considered.

The CO_2 quickly combined with water to form a block of ice like hydrate. It is expected that the hydrate would dissolve very slowly, which would minimize local concentration effects.

One method is to transport the liquid CO_2 from shore via a pipeline and to discharge it from a manifold lying on the ocean bottom, forming a rising droplet plume. Another method is to transport the liquid CO_2 by tanker and then discharge it from a pipe towed by the moving ship. Still another approach is to inject the CO_2 as deeply as possible in order to maximize the sequestration efficiency. One such idea is to inject the liquid CO_2 to a sea-floor depression, forming a stable "deep lake" at a depth of about 4000 m.

7. CHEMICAL AND BIOLOGICAL FIXATION AND REUSE

The goal of CO_2 utilization is to design chemical processes that can convert CO_2 to useful and durable products that have reasonable lifetimes. Whereas storing CO_2 can mitigate the GHG problem, converting CO_2 to useful products can create additional economic and environmental benefits. Three possible end uses include particulate carbon in composite materials and construction materials, CO_2 as a feedstock for production of plastics, and carbon to create soil amendments. Advanced chemical processes might lead to unique sequestration technologies or to improvements in our understanding of chemistry that will enhance the performance of other sequestration approaches.

8. CO_2 SEPARATION AND CAPTURE

The idea of capturing CO_2 from the flue gases of power plants did not originate with GHG concerns. Rather, it initially gained attention as a possible source of supply of CO_2 especially for use in enhanced oil recovery (EOR) operations. In EOR, CO_2 is injected into oil reservoirs to increase the mobility of the oil and, thus, the productivity of the reservoir. Similar opportunities for CO_2 sequestration may exist in the production of hydrogen rich- fuels (e.g., hydrogen or methanol) from carbon-rich feed stocks (e.g., natural gas, coal, or biomass). Roughly one-third of the United States' anthropogenic CO_2 emissions come from power plants as a byproduct [20]. Now days, all commercial plants to capture CO_2 from power plant flue gas use processes based on chemical absorption with a monoethanolamine (MEA) solvent. The process was modified to incorporate inhibitors to resist solvent degradation and equipment corrosion when applied to CO_2 capture from flue gas. Also, the solvent strength was kept relatively low, resulting in large equipment and high regeneration energy requirements (21). Therefore, CO_2 capture processes have required significant amounts of energy, which reduces the power plant's net power output. Many advanced methods are also under development, such as adsorbing CO_2 on zeolites or carbon-bonded activated fibers and then separating it using inorganic membranes [22]. However, none have been applied at the scale required as part of a CO_2 emissions mitigation strategy, nor has any method been demonstrated for a broad range of anthropogenic CO_2 sources.

9. REDUCING EMISSIONS OF CO2

The accurate use of fertilizers, less soil disturbance, better irrigation, and crop strains bred for locally beneficial traits and increased yields and efficiency generally reduces emissions. In practice, most farming operations that incorporate post-harvest crop residues, wastes and byproducts back into the soil provide a carbon storage benefit. All crops absorb CO2 during growth and release it after harvest. The goal of agricultural carbon removal is to use the crop and its relation to the carbon cycle to permanently sequester carbon within the soil. This is done by selecting farming methods that return biomass to the soil and enhance the conditions in which the carbon within the plants will be reduced to its elemental nature and stored in a stable state. These are the following methods for CO2 stored:

- Use cover crops such as grasses and weeds as temporary cover between planting seasons
- Concentrate livestock in small paddocks for days at a time so they graze lightly but evenly. This encourages roots to grow deeper into the soil. Stock also till the soil with their hooves, grinding old grass and manures into the soil.
- Cover bare paddocks with hay or dead vegetation. This protects soil from the sun and allows the soil to hold more water and be more attractive to carbon-capturing microbes.
- Restore degraded land, which slows carbon release while returning the land to agriculture or other use.

Agricultural sequestration practices may have positive effects on soil, air, and water quality be beneficial to wildlife, and expand food production. The effects of soil sequestration can be reversed. If the soil is disrupted or tillage practices are abandoned, the soil becomes a net source of greenhouse gases. Typically after 15 to 30 years of sequestration, soil becomes saturated and ceases to absorb carbon. This implies that there is a global limit to the amount of carbon that soil can hold [20]. Many factors affect the costs of carbon sequestration including soil quality, transaction costs and various externalities such as leakage and unforeseen environmental damage. Because reduction of atmospheric CO_2 is a long-term concern, farmers can be reluctant to adopt more expensive agricultural techniques when there is not a clear crop, soil, or economic benefit.

10. REDUCTION OF CARBON BY MARINE ECOSYSTEM

Ocean iron fertilization is an attempt to encourage phytoplankton growth, which removes carbon from the atmosphere for at least a period of time [19-21]. Natural iron fertilization events (e.g., deposition of iron-rich dust into ocean waters) can enhance carbon sequestration. Sperm whales act as agents of iron fertilization when they transport iron from the deep ocean to the surface during prey consumption and defecation. The iron rich feces cause phytoplankton to grow and take up more carbon from the atmosphere. When the phytoplankton dies, some of it sinks to the deep ocean and takes the atmospheric carbon with it. By reducing the abundance of sperm whales in the Southern Ocean, whaling has resulted in an extra 2 million tonnes of carbon remaining in the atmosphere each year [24]. Ian Jones proposes fertilizing the ocean with urea, a nitrogen rich substance, to encourage phytoplankton growth. Australian company Ocean Nourishment Corporation (ONC) plans to sink hundreds of tonnes of urea into the ocean to boost CO_2-absorbing phytoplankton growth as a way to combat climate change. In 2007, Sydney-based ONC completed an experiment involving 1 tonne of nitrogen in the Sulu Sea off the Philippines [32].

11. CONCLUDING REMARKS

There are no technologies still efficient to control the emission of carbon dioxide and capture totally it. It leads the green house effect or climate change. The sustainable growth of any country required to minimize the emission of Carbon dioxide by capturing, storing and altering the raw material of the process**.** Carbon capture and sequestration is an area with great potential. Its potential benefits for our energy systems and our global environment are too great. It is the prime time to focus on advanced research & development for achieving break-through in carbon sequestration at lower cost, efficient and safety. A better under-standing of the basic processes and new chemistry and bioprocessing approaches is needed.

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