Carbon Capturing Technology

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ABSTRACT

Humans have liberated more than two thousand gigatons of carbon dioxide into atmosphere, since the Industrial revolt took place. (A gigaton is a billion metric tons.) There is a sturdy cover of air around our planet. This thick air-tight blanket captures the heat of the earth we find today. CO2 is the main greenhouse gas which controls the temperature of atmosphere. Since 1880, due to increasing carbon percentage in atmosphere Earth temperature is increased by 2° Fahrenheit. If we don't change anything, the effects of climate change as forest fires, the stifling heat waves, and sea level rise will continue to become severe. Here's the big, important thing about CO2: this is a greenhouse gas. That means CO2 in the atmosphere works to trap heat near Earth. It helps the Earth to hold on to some of the energy it receives from the Sun so that all the energy that comes from it does not return to space. If it were not for the effects of global warming, the oceans would be extremely solid. Earth would not be as beautiful a planet blue and green as life. Therefore, CO2 and other greenhouse gases are good to a certain level. As increase in CO2 concentration can help plants to grow faster. But CO2 is so good at trapping heat from the Sun, that even a small increase in CO2 in the atmosphere could cause the Earth to warm up even more. Currently we're using some techniques as Bioenergy with Carbon Capture and Storage (BECCS), Direct Air Capture, Carbon Mineralization, and Ocean-based Concepts. But these are not very cost effective. For instance, direct air capture costs about $94-$232 per metric ton. It's not very productive, some researchers have found the way to convert CO2 into useful fuel. The purified carbon could also be used to make methanol, carbon nanofibers, or diesel fuel. But again, fuel formed this way is expensive than naturally available resources. It can cost around $94 and $232 per metric ton. Here is the possible solution to minimize this cost in our report. So, that we may get a sustainable environment for future generations at least possible cost.

Keywords: BECCS, Carbon Mineralization, Ocean based concepts.

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INTRODUCTION

Carbon-capture technology has gained popularity in the recent years due to its versatility of applications, and its potential to mediate some of the more pressing large-scale issues such as global warming and the depletion of the fossil fuel supply from the earth's crust, that serve as the primary source of energy supply and power generation in many states such as China and India, particularly in the developing states where the facilities of renewable energy are not or cannot be utilized to maintain a stable economy. The procedure of carbon-capture is relatively simple, yet effective. The carbon dioxide emissions trapped at the source and are isolated and stored underground. This method, hence, reduces carbon emissions from propagating in the atmosphere. The stored carbon dioxide can be used for multiple purposes, such as mineralization of elemental carbon as a convenient source of fuel, uses in the fertilizer industries and steel mills, or perhaps the most important use of all – the synthesis of hydrogen gas, which is a 'clean' fuel; which is to say that upon combustion it does not emit any harmful substances, as the only product of hydrogen combustion in open air is water vapors, and the combustion of hydrogen also yields one of the highest combustion enthalpies that can be utilized in industrial applications. According to the article by Jillian Ambrose published in September 2020, the International Energy Agency (IEA) claims that the implementation of carbon-capture technology can reduce carbon dioxide emissions by roughly 20%, while reducing the resource utilization in tackling the climate crisis by up to 70%. This technology also allows us to generate power with no negative emissions, and that it was also observed that the power plants equipped with this technology are more efficient in generating power, and moreover this method also provides for a sustainable energy source. Not only that, but power plants can also save on their assets by implementing these methods. For example, saving costs of repair and maintenance owing to the damage and accumulation of waste material in the power plants that may lead to gradual corrosion or whittling of the structural components which can ultimately compromise the functionality of the power plant altogether, and costs of a constant supply of fuel. By implementing carbon-capture technology, we would also be reducing the eventual water pollution as well, that is a result of transferring industrial wastes to the nearby water bodies, as per the usual practices of the conventional power plants. Such practices adversely impact the river and marine life in general and may also lead to an increase in the greenhouse factors in the water bodies. If we were to tackle the global warming crisis without the invaluable aid by implementation of the carbon- capture technology, it would have inferred that we would stop using fossil fuels permanently, which is not feasible on a global scale, as majority of the world's power generated is through fossil fuels. Despite renewable sources of energy becoming popular in the recent years, fossil fuels still satisfy more than half of the power demands, and if it were to stop altogether the economies throughout the world would crash, and many industries would cease to function, especially those that have a higher demand for power. Even if we were to switch to renewable energy resources completely, it would be inefficient. For instance, hydro-electric power cannot be harnessed if there is not a large enough water body that can provide a large enough water pressure as to move the turbine for power generation. Similarly, tidal powers cannot be harnessed in a landlocked country, and solar and wind powers are dependent on weather of the region, and are hence, inconsistent.

Effects of Changing the Carbon Cycle

To date, about 55 percent of the extra carbon dioxide emitted into atmosphere has taken up by land plants and ocean over time about 45 percent is still in the atmosphere. Eventually, the earth and the oceans have taken over on top of some carbon dioxide, but about 20 percent can stay in the atmosphere for many thousands of years. Changes in the carbon cycle affect each reservoir. Excess carbon in the air warms the planet and helps plants on earth grow faster. Excess carbon in the sea makes the water too acidic, putting marine life at risk.

Atmosphere

It is important that more carbon stays in the atmosphere because it is Carbon Dioxide the most important gas for global warming.

Carbon dioxide, methane, and carbon monoxide gases absorb most of the energy - including the infrared-energy (heat) emitted by the Earth - and then release it. Re-emitted energy moves out in all directions, but some return to Earth, where it is hotter. Without greenhouse gases, the earth would freeze -18 degrees Celsius (0 degrees Fahrenheit). With a great amount of greenhouse gases, the Earth would be similar to Venus, where the temperature of atmosphere is around 400 degrees Celsius. Because scientists know the long distances for each greenhouse gas and the atmosphere, they can calculate how much each gas contributes to the warming of the planet. Carbon dioxide causes about 20 percent of the global warming effect; water vapor by about 50%; and clouds account for 25 percent. Some are caused by small particles (aerosols) and small greenhouse gases such as methane. Figure 1 shows the atmospheric carbon dioxide concentration measured in Hawaii.

The concentration of water vapor in the air is controlled by global warming. Warmer temperatures absorb more water from the oceans, increase air masses, and lead to higher humidity. Cooling causes water vapor to condense and fall as rain or snow. Carbon dioxide, on the other side, keeps gas at the much wider range of atmospheric temperatures than the water. Carbon dioxide molecules provide initial greenhouse heating needed for maintenance of the water vapor's concentration. As concentration of carbon dioxide decreases, Earth cools, some water vapor falls into atmosphere, and global warming is reduced caused by the water vapors. Similarly, as carbon dioxide levels rise, air temperatures rise, and more water vapor evaporates into the atmosphere - which in turn increases the greenhouse heating to the top. While carbon dioxide contributes less to effect of heat than normal water vapors, scientists have discovered that carbon dioxide is a gas that sets the temperature of atmosphere. Carbon dioxide regulates the amount of water vapors in the atmosphere and thus the magnitude of the greenhouse effect. The concentration of carbon dioxide has already caused the planet to heat up. At the same time as greenhouse gases continued to rise, temperatures inside the earth have risen by 0.8 degrees Celsius (1.4 degrees Fahrenheit) since 1880. This increase in temperature is not all the warming we will see in terms of the current concentration of carbon dioxide. Greenhouse temperatures do not occur immediately because the oceans absorb heat. This means that the earth's temperature will rise by at least another 0.6 degrees Celsius due to the carbon dioxide already present in atmosphere. The rate at which temperatures rise above that depends on how much carbon dioxide will be emitted in the future.

Ocean

About 30 percent of the carbon dioxide emitted by humans is released into the. oceans by direct chemicals Mixing of carbon dioxide into the sea creates carbonic acid, which increases the acidity of the water. Or rather, a slightly alkaline

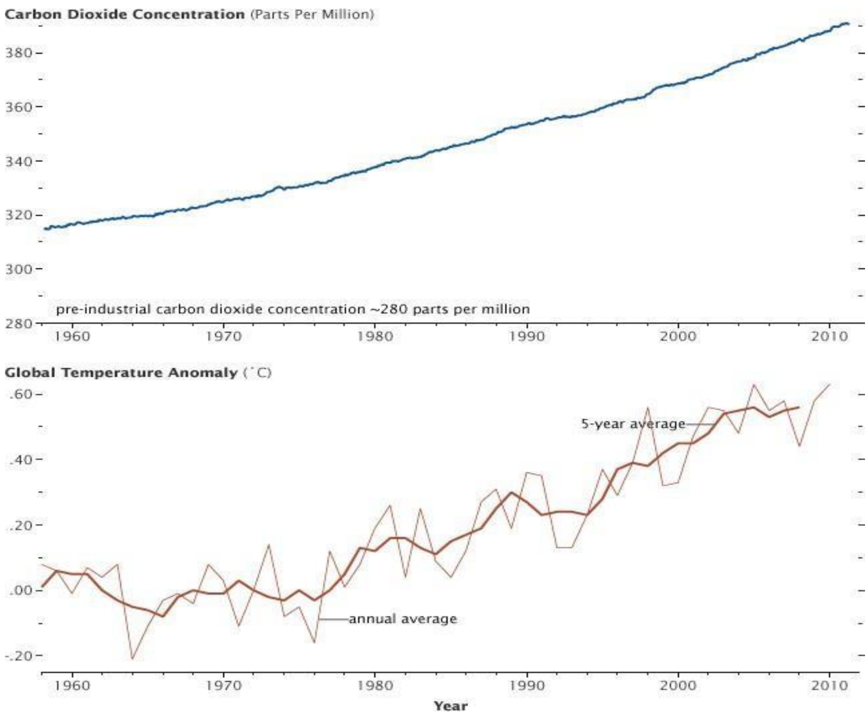

Figure 1: The atmospheric carbon dioxide concentration measured at Hawaii, makes a steady increase since 1957. At the same time temperatures in the earth's surface rise due to the heat being absorbed by the extra Carbon Dioxide and increased filtering of water vapor.

See becomes less alkaline. Since 1750, the pH of the ocean surface has dropped by 0.1, a thirty percent change in the acidity. Ocean acidification affects seafood in two ways. First, carbonic acid reacts with carbonate ions in water to form bicarbonate. However, those same carbonate ions are what coral-producing shells need to create calcium carbonate shells. With less carbonate available, animals need to use more energy to build their shells. As a result, the shells eventually become thinner and more fragile. Second, the more acidic the water, the better the soluble calcium carbonate. Over time, this reaction will allow the oceans to absorb excess carbon dioxide because more acidic water will dissolve more rocks, release more carbonate ions, and increase the sea's ability to absorb carbon dioxide. In the meantime, more acidic water will melt the carbonate shells of marine organisms, making them more porous and fragile. Warm seas - a product of tropical heat production - can also reduce the number of phytoplankton, which thrives in cool, nutritious water. This can reduce the ocean's ability to absorb carbon from the atmosphere in a faster carbon cycle. On other side, carbon dioxide is useful for plant growth and phytoplankton. The increase in carbon dioxide can increase growth by composting those few species of phytoplankton and marine plants (such as seaweed) that absorb carbon dioxide directly from the water. However, many species are not helped by the increasing availability of carbon dioxide.

Land

Plants on earth have absorbed about 25 percent of the carbon dioxide emitted by humans. The amount of carbon dioxide they take up varies greatly from year to year, but in general, the world's plants have increased the amount of carbon dioxide they absorb since 1960 (Moreno-Camacho et al., 2019). Only some of these increases has taken place as a direct result of gasoline emissions. Since the more carbon dioxide is available for photosynthesis, plants can grow much. This increased growth is known as carbon fertilization. Models predict that the plants can grow somewhere from twelve to seventy six percent if the carbon dioxide in air is increased to double, as long as there is nothing else, such as water shortages, that prevents their growth. The scientists don't know that how much carbon dioxide increases the plant growth in real world, since the plants require more carbon dioxide to grow. Plants also need the water, light of sun, and the nutrients, more specifically nitrogen. If a plant does not have one of these things, it will not grow no matter how many other necessities there are. There is a limit to the amount of carbon dioxide that can be released into the atmosphere, and that limit varies from region to region. To date, carbon dioxide emissions seem to increase the plant growth until plant reaches the limit of the amount of water or the nitrogen available. Another change in carbon dioxide is the effect of land use decisions. Agriculture is becoming more dynamic, so we can grow more food on less land. At higher and higher altitudes, abandoned fields return to the forest, and these forests store more carbon dioxide, both in wood and in the soil, than in crops. In many areas, we prevent carbon dioxide from entering to the atmosphere by usage of extinguishing wildfires. This allows the wood (which retains carbon) to form. All of these land use decisions help plants absorb man- made carbon from the Northern Hemisphere. In tropical areas, however, forests are cleared, often by fire, and this emits carbon dioxide. Since 2008, deforestation accounted for about 12 percent of all carbon emissions. Significant changes in the earth's carbon cycle are likely to result from climate change. The carbon dioxide increases the temperature, increases the growth time and increases the humidity. Both of these factors have led to further plant growth. However, warmer temperatures also put pressure on the plants. During the long, warm growing season, plants need a lot of water to survive. Scientists are already finding evidence that plants in the Northern Hemisphere are slowing down their summer growth due to global warming and water scarcity. Dry, water-stressed plants are also at greater risk of fire and pests as the growing season lasts longer. In the far north, when global warming is taking its toll, forests are already beginning to heat up, releasing carbon dioxide and vegetation into the atmosphere. Tropical forests can also suffer from severe drought. With less water, tropical trees slow down their growth and absorb less carbon dioxide, or they die and emit carbon dioxide stored in the air. Heat due to the increase of the green-house gases can “bake” soil, increasing the rate at which carbon seeps out from the other areas. This is especially troubling in the far north, where frozen soil - permafrost - is melting. Permafrost contains a rich deposit from plant sources for thousands of years because colds reduce rot. When the soil warms up, the natural decay and carbon - which is a form of methane and carbon dioxide - enters the atmosphere. latest research presumes that the permafrost in Northern Hemisphere contains more than 1,672 billion tons (Peta gram) of the organic carbon (The National Academies Press, 1992). If only 10 percent of the solvent were dissolved, it would emit enough carbon dioxide to raise the temperature by 0.7 degrees Celsius (1.3 degrees Fahrenheit) by 2100.

Methods to Utilize Carbon-dioxide

After we have stored the carbon dioxide by suitable means, it is also important to utilize it in an appropriate way in order to avoid storage issues for the gas, while simultaneously boosting economic growth. Some of the most effective and practical means to do so are discussed in detail below.

Manufacturing Processes

Carbon-dioxide can be chemically decomposed into its elements by catalytic action, such as plasma-assisted dissociation that is performed in presence of argon, and oxides of nickel and titanium (Lettenmaier et al., 1982). Once the value-added products are obtained from the conversion, the resulting chemicals are used to manufacture a variety of chemicals, such as urea which is used extensively in the fertilizer industry, methanol which can be used as an efficient source of energy along with syngas, which a mixture of gases primarily consisting of carbon monoxide and hydrogen gas. Syngas can either be used as a clean alternative to fossil fuels, or as a raw material for the production of liquid fuels such as dimethyl ether, synthetic diesel and methanol (Carlisle et al., 2016). Another application of this would be in the synthesis of polymers, which are strong and durable, and can be used as construction materials in buildings, or added to the body of the car to improve the durability. Fuels pertaining to this field of study have recently gained popularity, and have the potential to address a huge market, since they do not pose adverse effects on the environment, while simultaneously provid-ing more energy than the conventional fuels. Nonetheless, the current utilization of such fuels is heavily damped due to financial constraints, where despite carbon dioxide fuels utilizing 1 to 4 Gt carbon dioxide a year, cost up to $670 per ton (Bolinger et al., 2014).

Construction

Carbon dioxide can be used to cure cement, or in the manufacture of the aggregates. This enhances structural stability, and stores some carbon dioxide for the long run, while also holding the potential to displace the conventional cement which was emission intensive. Another important use is in the production of carbonates, which are used in construction sites, such as marbles. By crushing rocks such as basalt, and spreading them out on the land, we can easily produce the required carbonates with the help of the atmospheric carbon dioxide at an accelerated pace (Folger et al., 2017). This could also improve the crop yields significantly, if practiced on agricultural lands, by providing a variety of important nutrients to the soils, such as carbonate ions, potassium, zinc and calcium from the ores, and the like.

Fuels

Carbon dioxide can be used to enhance the oil yield from the well. By injecting the carbon dioxide into the oil well, one can increase the production of oil, which maximizes the extraction efficiency, for a low cost. By using this enhanced oil recovery method, we can inject and store more carbon dioxide than the amount that would be produced as the final product after the combustion of oil as fuel. Carbon dioxide can also be used to supply bioenergy via carbon- capture by growing trees, as the timber in the woods could potentially store this gas. Energy can be produced through operators, and the emissions undergo a process of sequestration to make the process environmentally friendly. Sequestration is the process of forming coordination complexes, usually of an ion, in order to neutralize the effect of the particular compound, without having to remove them from the solution or the mixture, as it can often become a tedious task that utilizes resources inefficiently **(**Carbon Capture Program, 2016). This technique is also used in order to store the carbon dioxide in the soil. Not only does this remove the carbon dioxide from the atmosphere, but it also leads to a boost in the agricultural yield of the crops, and provides nutrients to the soil that can further boost the crop quality.

Solar Powered Carbon-Dioxide (CO2) Conversion

This technology contains a photo-electrochemical cell made of the thin metal oxide films. It uses the sunlight (especially ultraviolet (UV), visible and Infrared (IR) components) and inexpensive compounds of titanium dioxide to react. The device can be used to absorb carbon dioxide produced in the industrial processes before being released into in the atmosphere and converts it into useful fuel such as methane. These devices can be shipped to commercial market with the low production costs and building materials. They can be made compact & efficient also can be used for the sensor and detector applications. We can modify greenhouse gas carbon dioxide (CO_2) into gasoline through solar energy, thin-film devices. Small Metal oxide films are coated to produce a photoelectron-chemical cell which gets power by solar-energy. By converting CO_2 into gasoline before being released into the atmosphere technology can reduce the effects of fossil fuels burning. The world's greatest source for a brighter future. This is new the nanomaterial film device offers low cost, made of facile how to sell technology to sustainable energy in the market. Most importantly, it leads to zero carbon by recycling C02 in fossil fuels resources. This is accomplished by using solar energy to convert C02 in highly compact device.

CONCLUSION

Increasing amount of CO2 is harmful for all species. Even, if we stop carbon release from all sorts of resources, it'll still take thousands of years to recover back to its form. What we can do is to capture carbon from the atmosphere. Various techniques and methods are used such as BEECS, Direct air capture, Carbon mineralization and ocean-based concepts. But these are very less cost effective. We need billions of dollars to implement this. The other more productive way to remove carbon is its conversion. This can be done by directly converting industries carbon to fuel like methane. This is done by using the sunlight power. It's way much effective. It does require budget but we can get a bi-product as fuel. We should do all possible steps to save our environment as tree planting and less plastic usage. As it's everyone's obligation to work for a sustainable environment for future generations.

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