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Testing and formation of a carbon dioxide absorbing organic material

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Abstract: This study focuses on the development of a material and mechanical equipment to combat the harmful effects of carbon dioxide (CO_2) on the environment.Carbon is a significant greenhouse gas that contributes to global warming and makes up 0.03% of the makeup of the air. Industrialization has led to a rapid increase in CO_2 levels, which adversely affects human health, plants, animals, and the environment. To address this issue, we innovated a material that not only absorbs CO_2 but also releases oxygen into the atmosphere. We also designed a mechanical equipment that provides optimal conditions for the material to work efficiently. Using a combination of organic components and trial-and-error experimentation, we created a material that effectively absorbs CO_2. We then integrated this material into a mechanical device that purifies air by filtering out CO_2 and releasing pure air back into the atmosphere. The device was tested using an MQ 135 sensor, which quantitatively measured the reduction in the amount of carbon in the air. Our results show that this innovative approach to controlling carbon has great potential for reducing the impact of greenhouse gases on the environment.

Keywords: Carbon sequestration, Organic material, photosynthesis, Direct Air Capture.

I.INTRODUCTION

The atmosphere of the Earth is made up of air. It is made up of a variety of gases, including water vapour and 78% nitrogen, 21% oxygen, and 1% other gases. Air composition varies from location to location; for example, carbon dioxide levels are higher in polluted areas due to higher emissions of this gas.Even though CO_2 constitutes only a small fraction of the air we breathe (0.03%), it is a key contributor to global warming due to its heat-trapping properties (Intergovernmental Panel on Climate Change, 2014).Human activities like deforestation, land clearing, and burning of fossil fuels release large amounts of CO_2 into the atmosphere, which contributes to climate change. Carbon-based molecules are the fundamental building blocks of life. The majority of the carbon atoms in materials containing carbon mix with two oxygen atoms during combustion to form CO2, a powerful greenhouse gas that accelerates global warming. A significant environmental concern of our day is climate change, which is largely caused by rising atmospheric concentrations of greenhouse gases like carbon dioxide (CO2). Concerns have been expressed regarding the long-term viability of our planet's ecosystems and human cultures due to the rapid rise in CO2 levels brought on by human activities like the combustion of fossil fuels(IPCC, 2018).

Carbon sequestration is a promising method to capture, secure and store carbon dioxide from the atmosphere in solid or dissolved form to reduce global warming. There has been a growing interest among researchers and scientists to develop materials and devices that can directly capture carbon dioxide from the atmosphere. These technologies are known as Direct Air Capture (DAC). They have the capacity to remove carbon dioxide from the atmosphere at a large scale. Our idea focuses on tackling the issue of carbon emission at a smaller scale at least for now. Our approach involved the use of organic components to create a material that absorbs CO_2 from the air and releases oxygen back into the atmosphere. We also designed a mechanical device that provides optimal conditions for the material to work efficiently, with the goal of purifying the air by filtering out CO_2 and releasing pure air back into the atmosphere. The various components chosen for building the material is independently unique in its nature and cable of absorbing carbon.

II.LITERATURE REVIEW

PremnathMurge et al. [1], centred on the creation of rice husk adsorbents for the removal of CO2 from a flue gas stream. Several pre-treatment procedures, such as desilicalization, chemical activation, and K2CO3 impregnation, were used to prepare the adsorbents. A fixed-bed reactor was utilised to assess the adsorbents' ability to collect CO2 after thorough physico-chemical characterisation of the adsorbents.
M B Noor Mohammed et. Al [2], this study looked into the neem (Azadirachta indica) plantation's potential to store carbon. A 10-year-old neem plantation's biomass and carbon stock were estimated in this study under various diameter classes. This study underlines the value of sustainable agroforestry techniques for reducing climate change and shows how neem plantations can act as carbon sinks.
Swastik Paul et al. [3], this study investigates the potential of algae as a raw material source for a circular bio-economy that can diversify inputs and cut carbon dioxide emissions. The article examines generic approaches for systems mediated by macroalgae and microalgae and provides an overview of carbon capture technology.
Seethalakshmi K.K et. al [4], due to their robust growth and adaptability, research suggests that bamboos can play a significant role in carbon sequestration. It is a good choice for long-term carbon sequestration due to its special growth capability and fast regeneration after harvest.
Capotosto Augustine et. al [5], the study found that lithium peroxide can effectively be used as an air revitalization material for oxygen supply and carbon dioxide removal.
AngomSarjubala Devi et. al [6], In Mizoram, India, scientists investigated the capacity of two common bamboo species—Bambusatulda and Dendrocalamuslongispathus—to store and sequester carbon.
Zhao Mu Qiu et. al [7], this study thoroughly examined the ability of banana plants cultivated on western Hainan Island, China, to store carbon and sequester carbon dioxide. Bananas are a good example of a large annual herbaceous plant with substantial carbon storage and CO2 sequestration potential that can help to slow global warming.

III.METHODOLOGY

3.1 Preparation of the material

The detailed methodology for the preparation of the material will be discussed here. Our material is formed of organic matter: rice husk, haulm, bamboo husk, banana trunk, neem leaves, aloe vera, bagasse and corncob. We start by cleaning all the dirt and dust from the materials. We cut the bamboo husk and bagasse into more finer pieces and the banana trunk into small circular pieces. Rice husk is already in powdered form so we don't do any kind of changes in its structure. Taking corn, we remove all of its kernels and grind the corncob into finer pieces. Now all of these are dried to remove any kind of moisture. On the other hand, neem leaves are grinded into a thick paste and the inside of aloe vera is also grinded to form a slimy juice. Once we arrange all the materials, we take each of the material and measure them in the weighing machine. In a medium sized bucket, initially we take 25 gm of rice husk ,25 gm of corncob,50 gm of haulm and 60 gm of bamboo husk. Mix it thoroughly. In a separate beaker we take 50 gm of neem paste, 100 gm of aloe vera and 50 gm of organic glue. Mixing it properly, we pour the mixture in the bucket and mix the contents of it thoroughly. Simultaneously, we take another 25 gm of neem paste ,50 gm of aloe vera and 30 gm of glue and after mixing it thoroughly add into the contents. of the bucket. Now we take another 25 gm of neem paste, 50 gm of aloe vera and 30 m of organic glue. After we add that into the bucket, we mix it nicely. After checking the consistency of our mixture, we take a casting mould of 40 cm x 30 cm. Spreading our mixture in the mould in the form of a rectangular sheet we brush 24 gm of aloe vera and 25 gm of glue above it. Compressing the material to form a sheet, we leave we leave the casting to get dry. Create another similar sheet with the exact same dimension.The organic matter such as neem leaves, bamboo trunk, rice husk are good carbon absorbing sources. Aloe vera along with absorbing carbon also acts as a

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binder with the organic glue. We use 135 gm of organic glue which acts as a binder to bind our components and also keeps the material hydrated.


Fig 3.1 BananaFig 3.2 Neem

Fig 3.3: Casting Sheet

3.2 Setting up of the device

We needed a mechanical machinery to fit the smart material in and further increase its efficiency. The mechanical device is an easy set up that we made to allow the entry and exit of air through our smart material. Components:

1. Diffuser
2. Air filter
3. Activated charcoal filter
4.Smart material
5. Fins
6.Exhaust

We make our prototype outer casing using plywood. It is rectangular box opened at each end. Thermocol layer is added in the inside of plywood. The upper layer though is joined using pin hinge hence we can open and close it according to our need. One open end of the box is now fitted with diffuser or nozzle type set up which we achieve using cardboard. We now join the exit of the diffuser with an air filter. Further layers of detachable activated charcoal filter and smart material is added. We use tubes to make fins. End of each tube is held together by thermocol sheet. A minimum of 30 tubes is added. The exhaust fan is fitted at the end which is run by the help of a 12 V, 1.5 DC motor and DC adapter of 12 V and 2 A. We can also use solar panels to make our system more energy efficient. Air enters our system through the diffuser and passes through an air filter. The filtered air then enters the layer of activated charcoal to remove any further impurities. The purified air then enters the third layer which is our smart material. Here the carbon gets absorbed and the air now less in carbon enters our fins. Fins are positioned in an average distance. Inside of each fin is sprinkled with a dash of lithium peroxide to further absorb any carbon that may have remained in the air. The oxygen rich air now leaves the system through the exhaust.

Fig 3.4: Mechanical Set up

IV.RESULT

We used MQ 135 sensor with Arduino to measure the level of Carbon Dioxide in ppm. The various results so obtained helped us to calculate the efficiency of the device. Any apparatus that detects an occurrence or a change in the environment and converts it into an electrical signal that can be analysed and computed is a sensor. One sort of MQ gas sensor used to identify, quantify, and keep track of a variety of airborne gases, including ammonia, alcohol, benzene, smoke, carbon dioxide, etc. is the MQ135 air quality sensor. It uses 150mA while running on a 5V supply. With the help of Arduino UNO ,we connect the sensor and set up our code to detect carbon dioxide in Arduino IDE.

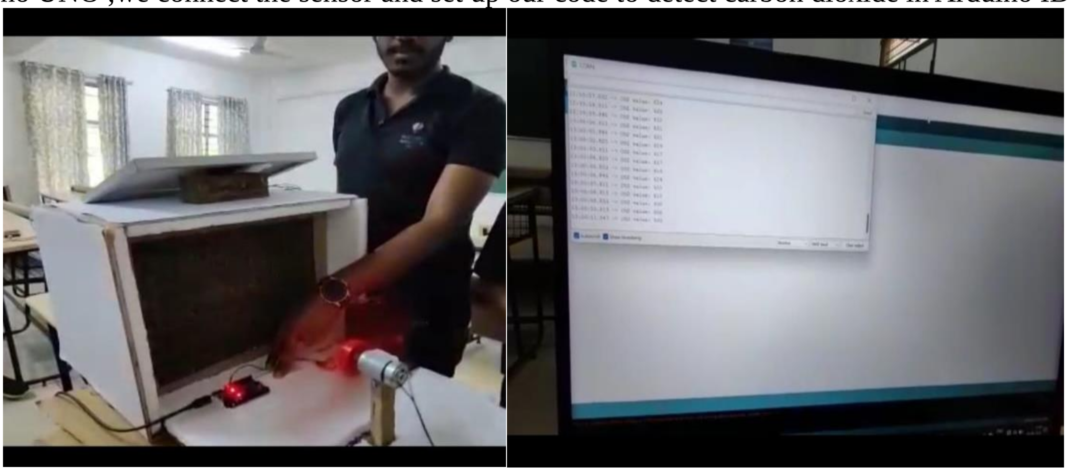

Fig 4.1: Mechanical Set up

Table 1: With Organic Material			
03:45 PM-03:50 PM			
Sr. No	Outside (ppm)	Inside (ppm)	Efficiency
1	807	760	5.824039653
2	806	756	6.203473945
3	808	752	6.930693069
4	805	752	6.583850932
5	808	748	7.425742574
6	808	748	7.425742574
7	806	730	9.429280397

8	806	730	9.429280397
9	806	728	9.677419355
10	808	727	10.02475248

Table 2: With Organic Material			
06:30 PM-06:40 PM			
Sr . No	Outside (ppm)	Inside (ppm)	Efficiency
1	793	765	3.530895334
2	791	762	3.666245259
3	791	760	3.91908976
4	792	760	4.04040404
5	791	758	4.17193426
6	791	755	4.551201011
7	792	756	4.545454545
8	792	755	4.671717172
9	795	753	5.283018868
10	794	752	5.289672544

Table 3: With Water Sprinkled on the Material			
01:00 PM-01:10 PM			
Sr . No	Outside (ppm)	Inside (ppm)	Efficiency
1	660	616	6.666666667
2	644	594	7.763975155
3	658	594	9.726443769
4	666	556	16.51651652
5	644	523	18.78881988
6	646	523	19.04024768

Table 4: With excess Water Sprinkled on the Material			
02:00 PM-02:10 PM			
Sr. No	Outside (ppm)	Inside (ppm)	Efficiency
1	652	624	4.294478528
2	653	624	4.441041348
3	657	624	5.02283105

Table 5:With 30 ml Water Sprinkled on the Material			
02:00 PM-02:10 PM			
Sr. No	Outside (ppm)	Inside (ppm)	Efficiency
1	652	624	12.294478528
2	653	624	11.928000121
3	657	624	12.02283105

Calculating overall efficiency in each case:
EFFICIENCY = [((OUTSIDE – INSIDE) ÷ OUTSIDE) × 100]

1. TABLE 1
   Overall Efficiency = $\frac{5.82+6.20+6.93+6.58+7.42+7.42+9.42+9.42+9.67+10.02}{10}$ = 7.9
2. TABLE 2
   Overall Efficiency = $\frac{3.53+3.66+3.91+4.04+4.17+4.55+4.54+4.67+5.28.\ +5.28}{10}$ = 4.37
3. TABLE 3
   Overall Efficiency = $\frac{6.66+7.76+9.72+16.51+18.78+19.04}{6}$ = 13.08
4. TABLE 4
   Overall Efficiency = $\frac{4.29+4.44+5.02}{3}$ = 4.58
5. TABLE 5
   Overall Efficiency = $\underline{12.29+11.92+12.02}$ = 7.9

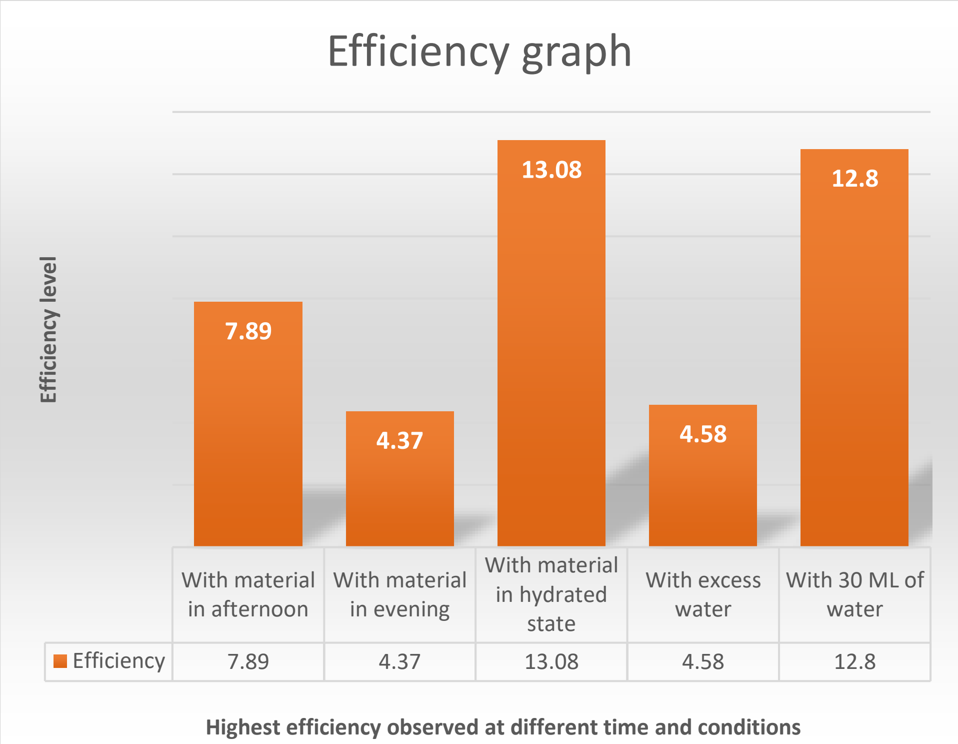

Fig 4.2: Efficiency Graph

Comparing the collected data, we come to know that the efficiency was obtained highest in the day time when the material was in the hydrated state. So, ensuring proper lighting and water all the times can help further increase the efficiency. Lot more work and research must be done to obtain greater results.

V.CONCLUSION

The major advantages of our device are that it is cost effective, completely biodegradable and it is an independent material. Since, the material is completely made of organic matter hence the material starts decomposing after approximately three weeks. This material can now be used compost in the field. We aim to install the device in houses, offices, school, corporates, malls, relatively smaller establishments. But once we could come up with a way to make this device heat resistant, this will be very useful in industries and power plants where there is excess release of carbon dioxide. The limitations that we have across are that it has a lesser time span, works in smaller scale and becomes expensive if we consider to use chemical for further enhancement.Testing of the device showed that a lot of further work must be done in order to increase the effectiveness of the device. Although the output is there but a lot of work must be done to increase the work output further.

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