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THE GREEN GOBLIN

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***Key words*:** purification / Air / Pollution / CO2 / Chlorella / Wasted materials

Abstract

Among the many grand challenges facing Egypt, recycling garbage and waste for economic and environmental purposes, Deal with population growth and it is consequence ,reduce and adapt to the effect of climate change ,and work to eradicate public health issues and diseases . Our project will directly address these concerns by focusing on innovative ways of air filtration. The polluted air in Egypt is critical and highly affects both the public health and the environment. We are going to propose a one-faced approach which is filtering the air biologically. THE GREEN GOBLIN contains Chlorella vulgaris is a form of green algae. It is also known for its ability to absorb CO_2, while it simultaneously enhances nitric oxide production responsible for improving vascular health. The chlorella absorbs about 4 ppm of CO_2 in 1 minute, it also absorbs faster when it moves in our system that designed from 4 bottles of chlorella above each other and the water pump keeps the chlorella flows. Our result taken in consideration to ensure the success of our project is decreasing air pollutants by 41.1%, and reach filtration and analysis time, taking 10 minutes in an air sample volume of 800 ml beside to sustainability and efficiency of the prototype.

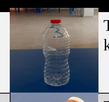
introduction

Egypt faces several challenges related to air pollution, industrial, and urban factors. The air pollution is caused by gases that exists from cars, factories wastes that are burned which increase the percentage of CO_2 in the air, also a lot of our day activities pollutes the air. HEPA filtration system is a type of pleated mechanical air filter. The acronym means (high efficiency particulate air) filter. Its advantage is that it can filtrate pollutants and remove at least 99.97% of dust, pollen, mold, bacteria and any other airborne as Carbon dioxide particles with a size of 0.3 microns (µm). And about its disadvantage is that it is limited Particulate so there are some polluted particles go through the filter causes many harms for human. The GREEN GOBLIN which is our system that depends on Chlorella vulgaris will absorb the CO_2 as a nutrition for it, and producing O_2 as it makes photosynthetic process, this way is the safest way of filtration for human and environment from our opinion as it does not depend on harmful chemical reaction that emits any gas or using any harm rays as: UV, Gamma, or X-rays in filtration. Chlorella can absorb CO_2 when it dissolves in the water. so, we pump the polluted air through the solution to make CO_2 dissolves in this solution so, the Chlorella can absorb it, also it should absorb at least 20% of the CO_2 of air sample ranges from 650 to 1500 ml in time range maximum 10 minutes, using waste recycled materials in constructing the system to be safe for human and all living organism's health, decreasing the cost of the air filtration systems, and increase the efficiency of the system's mechanism to prevent any particles from passing through the system without filtration.

Fig.1

Materials

Table.1 of materials

items	image	Function	quantity	sources
Bottles		To put the algae and to keep the algae	4	Waste materials
silicon		To connect horses between bottles	1	Out school
Chlorella Vulgaris		Used to purify the air from Co2	4	Research center
Hoses transfer		For attaching water bottles	3	Waste materials
Water pump		To push water in our system	1	Recycled materials
Pipe solution		To push Co2 in our project	4	pharmacy
syringe		To push Co2 in our project	4	pharmacy

Methods

After getting the materials for our prototype, surely our team utilized waste and recycled materials in the construction to preserve the environment, and of course, with the fulfillment and observations of the rubric that met design requirements :

- 3D model of the prototype was designed using blender to imagine the final shape before constructing the prototype.
- The system was constructed using wood to ensure the stability of the prototype with 4 levels for each bottle that is full of the chlorella.

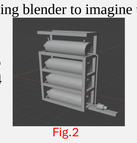


Fig.2


Fig.3

- Then, the bottles were fixed one above the another and connect them using isolating tubes With keeping space in each bottle about 200ml to give total of 800ml of air inside our system.
- After that, the tubes were inserted in the bottles, adding silicon between the tubes and the bottles to ensure that the water & gas will not leak that would affect its efficiency.
- Water pump was connected to the first and the last bottles to transfer the water from lower bottle to the upper bottle to complete the cycle of chlorella solution and ensure that the polluted air would pass through all the solution to absorb the maximum amount of CO_2.


Fig.4


Fig.5

- (MQ-135) sensor was used by connecting it to the Arduino and coding it to measure the amount of the pollution in the air.
- CO_2 was prepared by adding $Na_2CO_3 + 2HCl \longrightarrow 2NaCl + H_2O + \mathbf{CO_2}\uparrow$ which is the pollutant that would be inserted in the system.
- Finally, the filtered sample that passed through the Chlorella was inserted in the sensor to ensure that the system decreased the percentage of the CO_2 by 20%.

Test plan

➢ **Absorption:**

- 20% of the pollutant must be absorbed about from the air.

This will be done by pumping CO_2 directly into the Chlorella Vulgaris to dissolve in the solution and be absorbed using syringe.

➢ **Time of absorption:**

-This amount of carbon dioxide must be absorbed in about 10 minutes.

This will be tested by measuring the initial concentration and then the final concentration of CO_2 and calculate the time frame of 10 minutes using timer.

➢ **sensor:** Concentration of CO_2 must be measured before and after filtration using the (**MQ-135 sensor**)

Results

After finished prototype, we tested the prototype.

The results were as follow:

Negative result:

1.first the mechanism of the prototype wasn't stable and leaking of the air and chlorella solution , and this was effect negatively on the efficiency of pumping the water and passing it through the system.

Solution: the problem was solved by using strong base.

2.Exposure to light, the first test was in closed place that did not expose to light so, the readings were not satisfying that it absorb about $\frac{180-159}{180}$ =12% of CO_2.

Solution: the problem was fixed by exposing the solution to source of light.

Positive result:

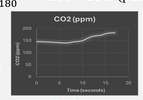
- **After making sure that the problems of stability,** leaking and light were fixed completely, we tested the prototype by using MQ-135 sensor that it detects the pollution in the air and to pump CO_2 that we prepared it in lab as shown in Graph.1 directly in front of the sensor.

Our trails:

First trail: the readings were 180 ppm of carbon without filtration and then after filtration it reached to 152 ppm . We calculated it and find that the efficiency of the carbon absorption was $\frac{180-152}{180} \times 100 = 16\%$ (percentage of CO2)

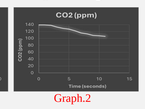
Second trail: the readings were 180 ppm of carbon without filtration in normal air and then after filtration it reached to 144 ppm, and it was $\frac{180-144}{180} \times 100 = 20\%$ (percentage of CO_2), that it achieved the design requirements.

Third trail: this trail as shown in Graph.2 was the best trail as 180 ppm of Normal air with CO_2 pollution and it reached to 106 ppm after filtration of CO_2 and it was = $\frac{180-106}{180} \times 100$= 41% of pure air with decreasing the concentration by 41% (percentage of CO_2)



Graph.1

→The reading of amount of Co2 before filtration
Absolute error = ±5



Graph.2

→The reading of amount of Co2 after filtration
Absolute error = ±3

Table.2 shown in Graph.1

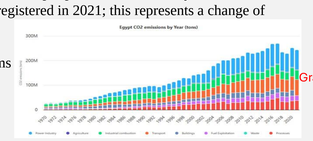
CO_2(ppm) ±5	146	146	145	144	143	142	140	141	145	147	150	159	167	170	173	179	179	180
Seconds	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17

Table.3 shown in Graph.2

CO2 in ppm ±3	140	139	138	133	129	127	122	116	113	109	108	106
Seconds	0	1	2	3	4	5	6	7	8	9	10	11

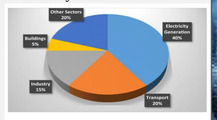
Analysis

- Egypt has a huge problem dealing with CO_2. As the percentage of CO_2 increases every year. In 2022, Fossil CO_2 Emissions 265,961,280 tons. CO_2 emissions increased by 6.54% over the previous year, representing an increase by 16,318,820 tons over 2021, when CO_2 emissions were 249,642,460 tons. CO_2 emissions per capita in Egypt are equivalent to 2.40 tons per person an increase by 0.11 over the figure of 2.25 CO_2 tons per person registered in 2021; this represents a change of 5.0% in CO_2 emissions per capita.



Graph.3

- Here is how to solve these problems eco-friendly to purify the air and decrease the percentage of pollutants like the living organisms based on the pollutants that can be exploited to purify the air like (Chlorella vulgaris), this type of algae is one of the best solutions to purify the air from carbon dioxide gas (CO_2) because it depends mainly on the CO_2 as a source of nutrition and producing O_2 as it makes photosynthetic process, In addition to it is eco-friendly and does not harm the living organisms. Also, it can adapt with any environment does not need specific standards. So, purifying the air from CO_2 will solve many problems such as global warming that affect the two poles negatively and harming the living organisms.
- The designed solution to purify these pollutants is using this type of algae (Chlorella vulgaris) as a biofilter where the polluted air passes through it using water pump to ensure that the air will pass through all the solution to absorb the maximum amount of the CO_2. We could use our method in areas with high concentrated CO_2. So, our team based on essential testing results and calculations several times to get the most accurate results with precise and intensity with some scans about polluted areas

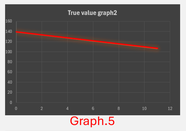


Sources of CO_2 emissions in Egypt in 2018
Graph.4

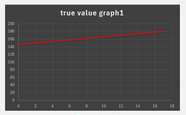
- **About the variables that we achieved:**
  1.filtration of the air by Chlorella Vulgaris
  2.Eco-friendly and safe for environment
  3.low in its cost by using waste materials

Advantages of constructing prototype:
- **Purifying the polluted air naturally.**
- **Eco-friendly(Safe for Environment)**
- **Constructed by wasted materials (Costless).**
- **Biologically not using any chemicals**.

Disadvantages of constructing prototype:
- **Need specific environment.**
- **Need permanent source of electricity.**
- **Chlorella is not safe after death**



Graph.5



Graph.6

The laws

We used the following laws in constructing and testing:

- **Number of moles** $= \frac{mass}{molarmass}$
  To determine the grams of hydrochloric acid and sodium carbonate that needed to prepare CO_2.
- **percentage of CO_2 :**
  $= \frac{\text{concentration of } CO_2 \text{ before} - \text{concentratiof } CO_2 \text{ after}}{\text{cocentration of } CO_2 \text{ before}} \times 100$
- **Absolute Error of sensor readings:** error percentage; we did a linear graph as shown in graph 5 and 6 satisfy the first and last number of the graph, The formula for linear function is **ax + b** , (0,140) and (11,106) By plugging the first point the b will be 140 Doing the same with second point; 11a + 140 = 106 so a will be -3 Now the equation will be -3x + 140 ,Now trying other points and get the highest error possible.
  Absolute Error = | Observed Value − True Value | =|129 – 126|= ± 3 and same in the other graph.

Learning transfer

Table.4

Subject	Connection
Math (lo1)	**Algebraic functions helped us to make an equation to calculate the efficiency of the system.**
Chemistry (lo1)	**Quantative analysis demonstrated the units of the concentration of CO_2 and various ways to measure it.**
Earth science (lo1)	**Water cycle gave us the idea about doing a closed system where the inputs = outputs.**
Physics (lo1)	**the concept of gravity and inverse square law helped to understand the relation when the air follows against the gravity and with it.**
English	**Different Vocabularies for the environment of water.**

Conclusion

In that project, a Carbon dioxide-based air purifier is constructed. We have worked to solve the problem of polluted air and decreasing the percentage of the carbon dioxide gas (CO_2) that leading to increase the global warming and also harmful for living organisms, and we have done our best to give the best solution to purify the air from the carbon dioxide gas (CO_2) and produced purified air with less percentage of (CO_2) from it using wasted material to be safe for human and environment, eco-friendly and costless. Our project is applicable, which will enable the country to get benefit from its beneficial aspects. We have done our best in building the prototype, starting from choosing the materials to finalize the prototype and test it. So, after the results we have gained from the test plan and have analyzed it, we are able to say that our project is a successful project, shows its simplicity in the design, and meets the design requirements which is decreasing at least 20% of carbon dioxide (CO_2) in 10 minutes. If it wanted to be applied on the large scale, it only requires a place with a high percentage of carbon dioxide gas (CO_2).

Recommendation

For developing on our project here are the main points to focus on achieving them:

- Increasing the amount of chlorella solution used as it will increase the rate of absorbing the CO_2 in the solution resulted in an increase in the concentration of the chlorella.
- Using plower to pump the air faster to decrease the time of CO_2 absorption in the solution.
- Construct the prototype vertically to make the air go down through the solution resulting from the effect of the pressure on the air column.
- Adding another filter like a chemical filter to absorb another pollutant non- CO_2 not depending only on one type of pollutant.
- Using a tighter storing system to store the purified air in, preventing it from leaking out to the pollutant air and giving more efficient readings in the MG-811 sensor.
- Using the frame made of glass because the chlorella vulgaris needs sunlight or light 12 hours per day.

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