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ALGAE POWER

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Abstract

No one can deny that the water crisis in Egypt is a really significant problem that we aim to completely solve and reduce its negative impacts. Our challenge this semester is specifically related to the huge water consumption of the agricultural field that is mainly due to the irrigation process. After a lot of research, we chose to work on the biological treatment of the agricultural wastewater using the chlorella algae so as to maintain a renewable source of water that can be then used again in the irrigation process. Our solution was chosen according to specific design requirements which are efficiency, low cost, safety, eco-friendly and finally simplicity. We were very careful to achieve all of these design requirements in our prototype and also when applying on the large scale. We applied the primary treatment to the wastewater sample. Then, we started our main treatment process using chlorella algae, working on 1 liter of water adding to it 100g of algae according to a standard scale which is 1:10. The final results were really promising and impressive. According to the standards of the used water in irrigation in Egypt, we have reached the best results that the pH scale of the treated sample was 7.1, the BOD was 5.1 and the COD was 10. Also, our solution's efficiency reducing the ratio of the heavy metals and simple elements is 63.5%, which is very suitable for the water to be used again in the irrigation process. This is in addition to the biomass produced from our treatment process which can be then used in many fields especially the agriculture one, as it can be used as a fertilizer that can fix any type of soil and make it rich in many elements. According to these results, we can conclude that our chosen solution can be very effective in solving our grand challenge.

Introduction

We all know that Egypt is confronting a lot of grand challenges that greatly affect its progress. Some of these grand challenges are arid areas, urban congestion, energy production, recycling of garbage, pollution and many others. Our challenge this semester is related to the improvement of the use of water especially in improving the agriculture field. This is because the agricultural field including the irrigation process among the others consume the most of the water available resources which is 82% and as we all know that water is mainly essential to all the aspects of life such as: health care, education, energy economic production, social activities and many others.

It was a must for us to work hard aiming to find a solution in order to save water by reducing the amount of water loss in the agricultural field or by treating and recycling waste water so as to be used in the irrigation process. Prior solutions have already been tried that are somehow efficient, but expensive or have other disadvantages to be applied on the large scale. One of the prior solutions was drip irrigation which allowed water to drip slowly to the roots of plants to minimize evaporation. Another solution was in treating water by bacteria that it grows and feed on ammonia, but water would need another phase of treating after it so it can get rid of heavy metal so it was an expensive way. After searching more, we decided to work on Algae and specially chlorella because it's cheap, common to find, reproduce quickly and it get rid of ammonia and heavy metals in water so all our design requirements are applied to this solution. We can calculate its efficiency be comparing the results of water analysis before and after purification. In addition to that it will help us to solve another problem which is soil pollution and improving agriculture that there will be a bioproduct from purification process can be used as a fertilizer and fix any type of soil then we can plant in it trees or oilseeds. Geology helped us so much in the project that we knew because of it what are the steps of water treating and what are the pollutants of water so we can find a solution can get rid of all of them.

Materials & Methods

Materials	picture	cost
Chlorella algae (~ 100 gm)		31 L. E
Air pump		From lab
Centrifugal machine		From lab
2 Plastic bottle (1L)		Recycled bottles

Table 1

1. At first, we searched for places where we can get agricultural irrigation wastewater and then we brought 2 L from El-Qanater agricultural water bank.
2. We then applied the first primary treatment process that involves the settling process which is the process of removing large pieces of debris and any other large solids.
3. Then, we sent one liter of them to be analyzed in the laboratory so as to be able to compare our results after treatment with it and we then started to work on the other liter of water.
4. We then started to apply our main treatment process using the Chlorella algae. We used 100g of algae to treat 1 liter of water and it was a very suitable scale which is 1 : 10 (100 gram of algae per 1 liter of water).
5. We put the water with the algae in a plastic bottle. Then, we expose the bottle to a source of light (light bulb) so as to provide the algae with a suitable medium to start the photosynthesis process and therefore reproduce quickly .

figure 1

6. We then used the air pump and put it in the bottle so as to quickly stir the water with the algae and therefore rapid its reproduction.
We also closed the bottle with a piece of cotton so as not to be affected with any external environmental factor.
7. We then left it for 4 days and in the forth day we used the centrifugal machine to detach liquid water from the solid algae.

figure 2

8. Then a sample of our treated water was sent to be analyzed.

- At last, we were able to compare the results of the first analysis with the second one to make sure that we have achieved our first design requirement which is the efficiency (water quality).
- Also as an addition, we brought a glass box and we put in it sand soil (that reassembles dessert soil). We then add the algae biomass which is the byproduct of our treatment process to it. This is because it works very well as a fertilizer and can be used to fix any soil the thing that made our solution more efficient especially in the agricultural field.

Results

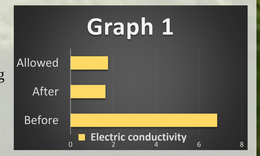
Test plan

After analyzing the water sample, We started our test plan by adding 100g of chlorella algae to 1 liter of water, we mixed them and then we put the air pump in the bottle and closed it by a piece of cotton to avoid any effects form the environmental factors, then exposed the bottle to a source of light so as to provide the suitable medium for it to reproduce by photosynthesis process and we then left it for 4 days. After that we used the centrifugal machine to separate water from solid algae and then we sent the water to be analyzed ,so that we can compare our final results with the results of the first analysis and see if our finals results are suitable and match to the standards of the irrigation water in Egypt.

Results

After comparing the final water analysis results by the first one, we found that our efficiency in reducing heavy metals and simple elements was 63.5%.

The water conductivity after treating became 1.633 "shown in graph 1".



And about heavy metals by its own we have reduced it by 58.8% and simple elements by 67.69% as shown in table 2 , from previous mentions, we found that our results are suitable to be used as irrigation water according to the standards of the irrigation water in Egypt.

As the pH of water after purification is 7.1, and the COD is 10 ppm, the BOD is 5 ppm, which are perfect results for the irrigation water.

	Before	After	Efficiency
Total N	42 ppm	28 ppm	33.3%
K	60 ppm	11.5 ppm	80.8%
Ca	160 ppm	50 ppm	68.75%
Mg	141 ppm	26.5 ppm	81.21%
Na	500 ppm	128 ppm	74.4%
Average	-	-	67.69%

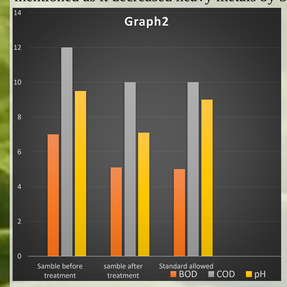
Table 2

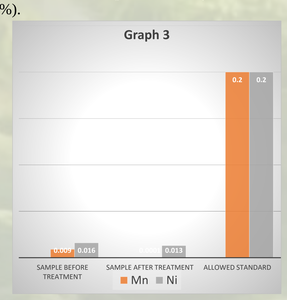
Analysis

We all know that water is the vein of life, it is the reason of any civilization as it is the main reason for sustainability. So far as result of the improper use of water in many fields especially the agricultural one (irrigation process) which consumes about 82% of Egypt's fresh water, it's expected that Egypt would suffer hard from the water scarcity in the next few years, which will result in horrible disasters in all the branches of life, agriculture will collapses and so will industry, trading and as a result the whole economic system in Egypt will fall. Therefore, our solution was chosen after a lot of research aiming to solve this problem depending on the use of the Chlorella algae. We were very careful to ensure the all of our determined design requirements and especially our main two (the efficiency and the cost) will be achieved. In our result according to the opposite graph (2) which compares between the ratio of the heavy metals before and after applying our treatment with algae, we find that the ratio decreased by 58.8% . We could test all our design requirements through the following steps: -

1- Efficiency was tested by comparing the results of the first water analysis and the second one and we found that:

• According to the heavy metals and the BOD, COD, pH analyses, the ratio changed positively, that before treating it's ratio wasn't suitable to the standards of the irrigation water in Egypt (clear in graph 2), but after treating the ratio became acceptable and very suitable (as mentioned as it decreased heavy metals by 58.8%).





• In small elements analysis, we found after comparing that the average efficiency was 67.69%. In addition to reaching good results that match for suitable electric conductivity.

2- Cost was tested by calculating the money needed to construct our prototype, that was only 31L.E for the whole project. Also, when applying on the large scale, we would need only the centrifugal machine and the air pump. For the Chlorella algae, it is already common in nature as it grows naturally in fresh water.

3- It's a safe, eco- friendly and simple idea.

figure 3

In order to achieve these accurate results we had to follow some rules, laws and ordered procedures which are: -

1- We had to apply the first primary treatment process that involves the settling process which is the process of removing large pieces of debris and any other large solids." according to what we have learned in geology"

2- We sent the irrigation wastewater sample to the lab to be analyzed at the same day in which we brought it, so that we would have the results that are very closer to the results of the wastewater sample itself, if we delayed, bacteria would have been reproduced and many ratios would have been changed.

3- When we started adding the algae on water and mixing them, we followed the 1:10 scale, so that each liter of water will be purified with 100g of algae, which was one of the main reasons why our solution is very low-cost and high efficient.

4- After that, we had to expose the bottle to any source of light ,so it can be in a medium that allows for it to be reproduced by photosynthesis (as we have studied before in biology) ,and we put the air pump in the bottle so as to quickly mix the molecules and therefore the water purification process will occur much faster.

Learning Transfer :

1- In Geology, we have leaned a lot about water, its cycle, its natural recourses and its danger pollutants and how to reduce each of them, which helped us a lot with our project. We also learned about the treatment process of water and its ordered phases that we have followed in our methods of treatment.

2- In chemistry, we learned about the filtration process and it's different ways "by EDTA, Resins" , we have also learned how to measure the pH of water using the pH meter, the TDS which helped us to know if this water is suitable for irrigation process or not.

Conclusion

In conclusion, the water crisis in Egypt requires our hard work in order to be able to maintain sustainability for the coming generations. Our project will make a difference and limit the impacts of this problem, by providing a new renewable source of water that we have produced from treating agricultural wastewater using chlorella algae that it is naturally grown in fresh water. We concluded that algae can greatly remove heavy metals, carbons and ammonia from water with efficiency of 58.8% with heavy metals and 67.69% with simple elements, and in general it reduced both of them by 63.5%, and it also gives a normal ratio of BOD, COD and pH. In addition to the biomass produced from the treatment process that can be then used as a fertilizer to improve the agricultural soil and also used in many other fields. In fact, our project has achieved all of our determined design requirements and more as:

- Its efficiency: as depending on the water analysis, the water quality after treatment, compared to the determined standards, is very suitable to be used in the irrigation process.
- Its low cost: that it can be afforded by anyone and by Egypt on the large scale.
- It is a safe, simple, and an eco-friendly one that it does not produce any harmful gases or toxins.

Not only that, but also by comparing our solution to the prior solutions which we searched before, we would find that algae are the most effective way to treat water as it doesn't need many phases to be applied in the treatment process treat. On the other hand, most of the prior solutions need many more phases of treatment that makes it much more expensive to be applied on the large scale and as a result it isn't so effective to be applied, so our solution is a really perfect way to solve our problem.

Recommendation

There are many other things that could be applied in the future in our project, so we recommend anyone that aims to improve our project to:

□· Make use of the biomass produced from the purification process and reuse it to perform another function such as following: -

1.Using it as an animal feeding after triturates it, if the ratio of heavy metals in algae is small.

2.Using it to produce bio fuel- that will help solving the energy crisis in Egypt.

□· Combine the treatment process with a complete closed irrigation system that can save our new produced source of water. This irrigation system could be the drip-irrigation system as it saves about 70% of water used in the irrigation process by reducing the rate of the vaporization process. To increase the system's efficiency we can use mulch" which can be rice straw" and put it on the soil to efficiently decrease the rate of vaporization. We can also use DHL sensor to detect the humidity of the soil so as to start the irrigation process only when it is needed.

□Search for chemicals that could be used in the BG medium of the chlorella algae in order to increase its rate of reproduction.

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