Algae And Wastewater Reuse

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Abstract

The Egyptian nation confronts several issues, that construct barriers to reach the desired target, which is accomplishing sustainable development goals (SDGs) and the optimum for the nation. Capstone projects attempt to solve these challenges and barriers by the usage of scientific research, innovation and creativity. The pollution of air, water, and soil, and Managing and increasing the sources of clean water, which are two antiparallel issues, have immense effects on the economy of the nation. Agricultural practices are one of the problems Egypt suffers from. The irrigation process leads the government to use myriad amounts of water. So, the resulted water is wasted and polluted. Therefore, Algae has been utilized as a shredder to these barriers; as its high efficiency in absorbing chemicals from water during the photosynthesis process and increasing the fertility of the soil, also its low-cost because it is widespread. Thus, the decision was to use Chlorophyta algae on the Egyptian soils and reuse the water in the irrigation process again. The prototype simply simulates the process, that was adjusted to eliminate pollution in water and soil, in addition to working as a fertilizer for the soil. The design requirements, which are inexpensiveness, eco-friendliness, and high-water quality are selected based on the solution's test plans and results, the obtained results revealed the ability of the project to achieve the design requirements. In general, the Chlorophyta algae solution for restricting the wasted and polluted water is the effectual futuristic solution in the irrigation process for the agricultural areas.

Introduction

Egypt suffers from major issues that frustrate it to keep pace with development. However, the economical grand challenges that confront Egypt are pollution and the wasting of clean water resources, which are two analogous challenges. They occurred in Egypt because of pursuing the old traditional harmful practices and the squandering of the sources of clean water, that is 55.5 billion cubic meters as a fixed Nile quota. Thus, in this semester's capstone project, restricting pollution and improving the clean water resources challenges is the crux clue. Irrigation for the agricultural areas, which constitutes only about 3 percent of the total area. The Irrigation process is from the old traditional practices, is an intersection between the two challenges due to the wasting of water and the high pollution percentage in the excess water in the irrigation process. That can be edited merely. Furthermore, myriad of prior solutions, that work on removing the contaminants for the agricultural areas to get the clean product, and less polluted and less wasted water. For instance: Removal of chemicals from wastewater by Bio-electrochemical denitrification, which removes nitrates from water by reverse osmosis, ion exchange, electro-dialysis, and activated carbon adsorption. Inaddition, it is highly efficient, eco-friendly, and works on emitting less polluted water but it's a high cost and harsh application. While another prior solution, that is the usage of algae, which absorbs the chemical contaminants, that enters the water as nitrates and phosphates while the photosynthesis process and has no carbon footprints in the eco-system, and it works as a fertilizer for the soil. This idea is accomplishable, low-cost, and eco-friendly, which obeys the design requirements. After the searching journey, the determination was the algae will be the used idea with suitable design requirements which are inexpensiveness, eco-friendliness, and high-water quality. Hence, the prototype simulates all details in the irrigation process for the agricultural areas. Moreover, the results from test plans are satisfying to ensure that the solution is successfully exiting less polluted water with fewer chemicals percentage.

Figure 1 represents Chlorophyta Algae

Materials

Name	Quantity	Cost	Usage	Photo
wooden box	1	70 L.E	Representing the agriculture area	
water ppr pipe	27	5 L.E	To drainage the farmland through it.	
soil	4kg	.....	The farmland	
Motor	1	.....	Powering the device of irrigation	
switch	1	5 L.E	Control the device of irrigation	
bottle cap	3	.....	Making a small fan to spread the water	
Water hose	3m	3 L.E	Suctioned and distributed water	
Battery	1	3 L.E	Give energy to the motor	

Methods

1- We prepared a box from wood with 38cm length, 27cm width, and 17cm height. To represent the area of agriculture. figure(2)

2- We put a plank of wood at 28cm of the length of the box. To split the box into two parts. The first part is a simulation of the farmland and the second part is the simulation of the canal which it's used for drainage and irrigation of the farmland.

3- We made a circular hole in the plank with a radius of 2cm to put a 27cm water PPR pipe in it and across the area of the farmland. This pipe has small holes in it to be the source of drainage for farmland. (The way of agriculture drainage), figure (3).

4- We make a device to irrigate the farmland by using some simple materials. First, we get the small motor and affixed it in one bottle cap. Second, we made a shape of a fan by another bottle cap and put it in the motor. Third, we close the first bottle cap with another. Finally, we made two holes in the final shape and put a water hose in each one. And first water hole is connected with the canal and the second is connected with the farmland. Same as the figure (4). This device is used to transfer the water from the canal to the farmland. (The way of agriculture irrigation)

5- To make the water applicable again, we used algae. The function of algae is to absorb all the nutrients and pollutants in water. We planted the algae in the canal to be grown. And our device suctioned the water with algae to distribute and spread out them on the farmland. The farmland will irrigate with clean water and benefit from algae as fertilizers.

Figure 2 The Box

Figure 3 The pipe

Figure 4 the device

Test plan

1-We get the wasted water from Egyptian agriculture drainage.
2-We divided the water into 4 beakers and each beaker with 250 ml of water.
3- We measured the TDS and PH of each beaker and record them as the results before modifying.
4-We get some amount of life algae which is green algae. Then we weight it and put specific different masses in each beaker.
5- We kept it for one week in a good place and after that, we separated the algae from the water. Finally, we measured the TDS and PH of each beaker after the purification of water.

Our prototype is only a simulation of the farmland and irrigation and drainage process.it represents the way that we used the algae to purification the water and reuse it in irrigation again. Finally, our prototype is matched all the design requirements. Because we didn't affect the water quality, our materials are very simple, available, and little cost, the prototype is ecofriendly and the project has high efficiency and it is equal TDS efficiency is 60.54% and PH efficiency is 100%.

Figure 5 testing PH sample 3

Figure 6 testing TDS sample 3

Results

We made four samples of water and measured TDS and PH for each sample three times before and after adding algae and we get the average of it to make our result more accurate. After that we measured the efficiency of TDS and PH by the following equations

The efficiency of TDS= $\frac{\text{old TDS}-\text{new TDS}}{\text{old TDS}} \times 100$

The efficiency of PH= $\frac{\text{PH of new water}-\text{PH of old water}}{\text{PH of old water}-\text{PH of normal water}} \times 100$

Sample no.	TDS before	TDS After (by cover)	TDS After (Without cover)	Efficiency(by cover)	Efficiency(by cover)
Sample 1	687	326	338.6	52.55%	50.70%
Sample 2	691	399.3	421.3	42.21%	39.03%
Sample 3	690	272.3	289	60.54%	58.12%
Sample 4	688	442.6	491	35.65%	28.63%

Table 3 PH results

Sample no.	PH before	PH After	Efficiency
Sample 1	8.05	7.2	80.95%
Sample 2	8.04	7.3	71.15%
Sample 3	8.01	7	100%
Sample 4	8.00	7	60%

Table 2 TDS result

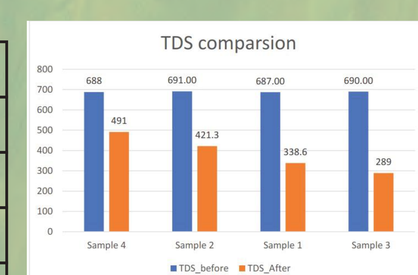

Figure 7 TDS comparison

Sample no.	Algae mass	Water volume
Sample 1	300.38 gm	350 ml
Sample 2	277.4 gm	320 ml
Sample 3	418.76 gm	550 ml
Sample 4	194.43 gm	270 ml

Table 1 Samples_ Algae mass

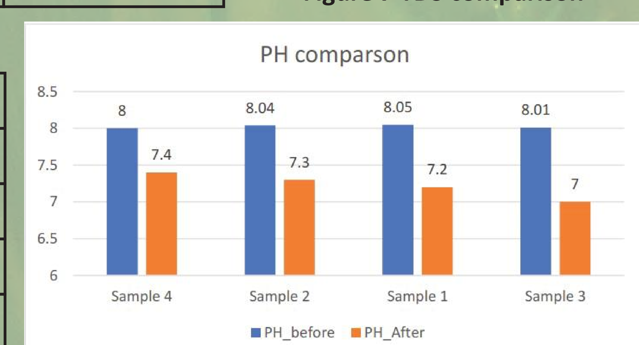

Figure 8 PH comparison

Analysis

Many grand challenges face Egypt every day and increased among years like pollution, lack of water sources, recycling. For this, our project is working on increase the water quality by little cost on the country. So, we used algae to absorb all the chemicals, nutrients, and phosphates from drainage water. This will make the water applicable again and farmers can reuse it.

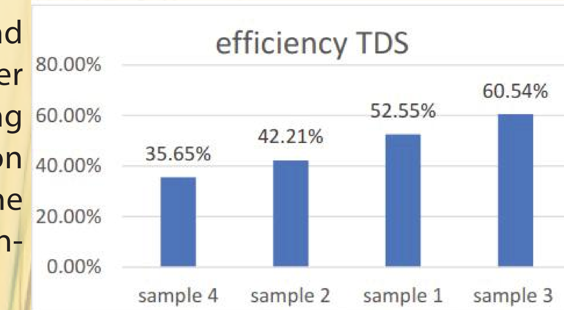

Figure 9 TDS efficiency

We chose algae because it is a natural plant in our life,very cheap, and available on any land. We make the test plan on our project on four samples of water each sample with a varied number of algae. After one week, we split the algae from water and measured the TDS and PH of the water.

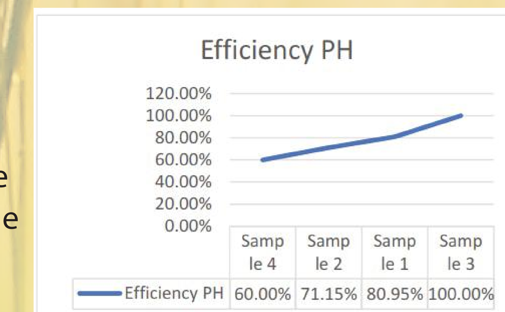

Figure 10 PH efficiency

After examining data of the test plans from the four samples, our solution accomplished the three main design requirements which are, inexpensiveness, eco-friendliness, and high-water quality. Subsequently fixing all problems we confronted by altering the egregious algae and preparing the water samples, the highwater quality design requirement's efficiencies were calculated in the following fig. (9, 10). So, the pH test on the samples, which reached an efficiency of 100%, besides, the TDS test, which has an efficiency of 60.54%. This means that the number of lgae is inversely proportional to the TDS and PH test same as fig. 11&12.

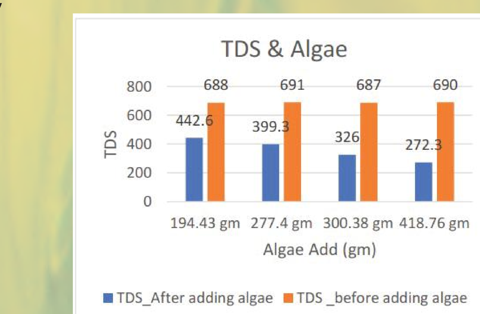

Figure 11 TDS relative to Algae mass in each sample

These results showed that the solution can unravel the overusing water in agricultural practices during the irrigation process. Thus, it can be an answer key for the pollution of soil, water, and air, besides, improving and increasing the sources of clean water. Since these two grand challenges have antagonistic relations. In our prototype, we used simple materials and all of them are available. This makes our project little cost. The project is applicable to achieve it in the real life. Bcause all the materials are available on large scale.

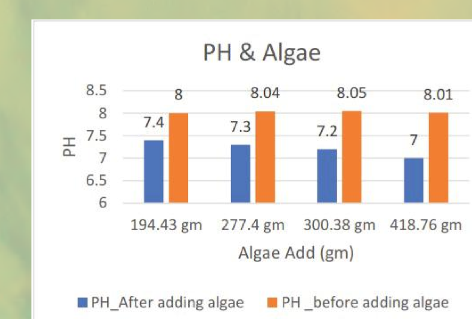

Figure 11 PH relative to Algae mass in each sample

Learning Transfer

subject	Code	How it is useful for us
Chemistry	CH.2.01	Quantitative analysis to define the pollution in the water and each concentration to work on water quality. Especially, we used TDS and we measured it by ppm. Resins and EDTA. We took these as examples to know what the mechanism of purification of water is and how we will reuse the water by editing the process or adding something
Chemistry	CH.2.02	We learned about water and its properties. This helped us to know the effect of the solutes on the physical or chemical properties of water
Geology	ES.2.02	We used the factors that affect the water quality to define our solution.
English	EN.2.01	Thesis statement and how to write it to summarize a paragraph and to get the most important points.

Conclusion

In inference, the aimed goal was achieved at the end of the road. And the solution pursues the targeted design requirements. Also, its test results and analysis showed, that its efficiency for both, the pH scale for water and the TDS amount, were outstanding each one estimated to be 100% and 60.54% respectively. These efficiencies were figured out to be the suitable sufficient majority percentages; in restriction the pH scale to be in between (7.0-7.4), moreover, in the elimination of exceeding and mischievous dissolved chemicals and solids in water by range (289-491 ppm). Therefore, Chlorophyta algae confine the pollution and improve the water quality, besides, working as a natural fertilizer for the soil. However, other solutions' tests and analysis were gathered from the research journey, for instance, the Bio-electrochemical denitrification method and compared it with our tests, analysis, and even strengths and weaknesses. Consequently, the choice was that Chlorophyta algae not only because of its efficiency but also because of its eco-friendliness and inexpensiveness.

Recommendations

If the agriculture wastewater has a huge number of heavy metals, we recommended using a Rose Nile to reduce this amount to the normal range. But one of the disadvantages of Rose Nile is that it evaporates around 1 liter per day of water. We can also substitute Green Algae (Chlorophyta) with Azolla that can clean water. Microalgae-derived products have multi-functional properties in agriculture, facilitating nutrient uptake, improving crop performance, physiological status, and tolerance to abiotic stress. Thus, we suggest using this type of algae instead of Green algae hence, we do not have the axis to use it. As we know, there are many types of soil, but we focus on this project in Clay soil, so we also recommend using the type of soil.

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