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The Hematic Harvest

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Key Words: Blood – Organic Matter – lignin – Formaldehyde – Filtration

ABSTRACT

As it is known that Egypt faces many problems which called “Egypt Grand Challenges”, the grand challenge that should be solved in each semester's project is specifically the pollution of water (slaughter’s house wastewater), which was polluted by dangerous thing called organic compounds of blood. it's important to put a design for our prototype by stepping on a specific design requirement which is: extracting organic compounds and fats from blood in a closed system with salinity over then 1000 ppm, this prototype is fast in processing water, the prototype should be non-impediment, user and environmentally friendly. So, by these descriptions’ prototypes should be designed to extract organic compounds from blood by depending on any way, like extracting by a chemical reaction or by using filtration process. In our team, we have depended on filtration process to extract organic compounds from blood from four stages that have been ordered in two rows. First is for coagulating the blood to be pure water, second stage is for removing large particles, third stage which is lignin is for regulating the turbidity of the slaughter’s house wastewater and the fourth stage is for decreasing the dissolved oxygen. And after testing this prototype by using some sensors after filtering it by using some chemical like chloride; it's found that water have been filtered from organic compounds that were in it by ratio **82.5%**, so it's concluded that the project is a successful one and it can solve the Egypt’s problem which also faces a lot of other countries.

INTRODUCTION

In the past decades, Egypt issued 11 challenges (Egypt grand challenges) that aid in attaining the Sustainable Development Goals. The project primarily has the aim of formulating solutions for 5 of them, focusing on creating additional sources of clean water, improving waste disposal through recycling, and expanding the agricultural land in Egypt. These issues form the foundation of developing the country as they involve fundamental environmental and health challenges. Wastewater, for instance, would pose immense health hazard and ecological injury in case it was not handled carefully. This issue had to be managed urgently to avoid causing more damage. According to the capstone challenge, the project will design a sustainable water filtration system for rural communities that have a poor record of always having clean water accessible. These regions are particularly vulnerable, as they most commonly do not possess the infrastructure and resources to implement solutions on their own. There have been many initiatives to solve these problems. One of these was in Germany, which was driven by GI Aqua Tech, that harnessed nanotechnology to purify slaughterhouse wastewater. Another solution, proposed in Iran in 2022 by scientists at Zahedan University, used chemical and electrical coagulation techniques to solve similar wastewater issues. Both options were viable, but both had their problems.

After careful consideration of many past solutions and careful analysis of their advantages and disadvantages, design parameters for an alternative solution were determined. For instance, while nanotechnology was very effective, it was very expensive, making it unsuitable for widespread application within rural populations. On the other hand, coagulation technologies were too complex to upkeep, limiting their applicability within low-resource environments. Therefore, the novel design aims to incorporate the most beneficial components of these previous solutions while minimizing their constraints. The main aim of this project is to reduce the salinity of slaughterhouse wastewater to a value less than 500 ppm, reduce turbidity to an acceptable level, reduce the total organic carbon content, and eliminate the odor. A natural remedy was chosen to achieve these objectives, one that is primarily composed of coconut shells and salts such as copper sulfate. This choice was made with several factors in mind: coconut shells are affordable, readily available, and renewable, and copper sulfate can effectively disinfect, fulfilling the project design requirements in a better way. This solution using natural bases applies not just to the technical standards of wastewater treatment but also to ecological sustainability. The use of readily available recyclable materials doesn't just lower the ecological impact of wastewater but offers an efficient, cost-effective way of doing so. It also provides an opportunity to sell domestic industries and generate employment, benefiting both economic sustainability and environmental conservation. This is how we can overcome the wastewater problem in Egypt through recycled and natural products to formulate a long-term, sustainable change

MATERIALS


Amount: 1 Wooden Frame
Usage: To carry the whole components of the prototype.


Amount: 4 plastic containers
Usage: To carry the system or components for filtration of each stage.


Amount: 8 sticks
Usage: To stick components to the wooden frame.


Amount: 2 organza bags
Usage: To put the lignin and activated carbon inside them.


Amount: 1 Gauze Ribbon
Usage: To cover & protect bags and the inside of them.


Amount: 1 sheet of iron grid
Usage: To carry the gauze and to prevent something from going down.


Amount: 5 pumps
Usage: To pass the blood through the stages.


Amount: 25 jumpers
Usage: To connect the circuit with the components.


Amount: 2 H bridge drivers
Usage: To control the pumps


Amount: 1 Arduino Uno
Usage: To create the electronic project.


Amount: 1 TDS sensor
Usage: To measure the total dissolved solids in water.


Amount: 1 Turbidity sensor
Usage: to determine the concentration of suspended particles in a sample of water.


Amount: 40 grams of $NaOH$
Usage: To separate the acids from biomass.


Amount: 100 ml of H_2SO_4
Usage: To separate the acids from biomass.


Amount: 10 ml of CH_2O
Usage: To add cooh groups & make lignin insoluble in water.


Amount: 20 grams of Crashed Alum stones
Usage: Coagulation Enzyme


Amount: 20 grams of moringa seeds
Usage: Coagulation Enzyme


Amount: 1 sheet of Fiber grass
Usage: Physical Screen.


Amount: 50 ml of $CuSO_4$
Usage: Coagulating slaughter’s-house wastewater.

METHODS

Stage 1:

Filter Construction Substage 1: Coagulation and Initial Treatment Dissolved 50 g of copper sulphate in 1000 mL of water to make a 0.2 solution. Added 25 g of alum sulphate for coagulation. Added a small amount of moringa seed solution (Figure 1).

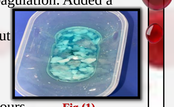


Fig.(1)

Physical Filtration Substage 2: Used a mesh made from organza fibers, coconut husks, activated carbon, and recycled fiberglass. Materials sewn into organza sheets (Figure2).

Chemical Filtration Substage 3: Used Lignin (Resin) Extracted lignin from 100 g of dried coconut husks in 250 mL of 0.1 M NaOH, heated at 60°C for 2 hours. Added 10 mL of 10% diluted H_2SO_4, stirred, settled, filtered, and washed lignin. Converted lignin into resin: Dried, dissolved in 100 mL water, heated at 60°C for 3 hours. Mixed with 10 mL formaldehyde to introduce carboxyl groups (COOH). Added 10 mL concentrated H_2SO_4 to introduce sulphate groups (SO_4^{2-}).Dried modified lignin(Figures 3 & 4).

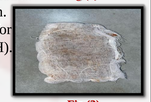


Fig.(2)

Disinfection Substage 4: Used sodium hypochlorite (NaClO) as disinfectant

Stage 2:

Prototype Construction: Built a wooden frame with two vertical levels (each: 40 cm x 20 cm x 20 cm).Placed four 1.2 L plastic boxes (two per floor).Installed filters in boxes (bottom left to top left, counterclockwise).Water pumped in a loop through the system. Fifth pump installed in top left box to release filtered water after 5 cycles.


Fig.(4)


Fig(3)

Stage 3:

Circuit Design Simulated: circuit in Tinker cad or validation. Installed Arduino board; connected VCC and GND lines. Connected two motor drivers to Arduino ,attached to frame. Linked four pumps to motor drivers for operation control. Final prototype included frame, filters, and circuit (Figure 5).


Fig.(5)

TEST PLAN:

1. Verify that the wooden frame (40 cm length, 20 cm width, 20 cm height) is stable, and all parts are securely assembled.
2. Ensure the four filters are placed in the correct order inside the plastic boxes, with proper alignment for water flow.
3. Run water through the prototype and confirm that it flows in the counterclockwise direction, passing through each stage.
4. Test the mesh screen (organza, coconut husks, activated carbon, fiberglass) to ensure it filters particles effectively with out leaks.
5. Check the modified lignin resin in the prototype for its ability to remove Na^+, Mg^{+2}, and Ca^{+2} ions from the water.
6. Verify that sodium hypochlorite (NaClO) is added correctly to the system and visually confirm the water's appearance after disinfection (clearer water, no visible contaminants).
7. Test each water pump to ensure they are working as expected, including the additional pump for water exit after the fifth cycle.
8. Confirm the Arduino and motor drivers correctly control the pumps by testing the circuit setup and connections.
9. Power on the system and monitor to ensure all components (frame, filters, pumps, circuit) work together to filter and circulate water.
10. Run the system continuously for several hours and check the water quality before and after filtration to ensure the system maintains performance.

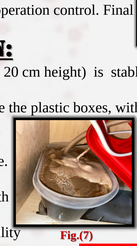


Fig.(7)


Fig.(6)

(Some photos of the test)

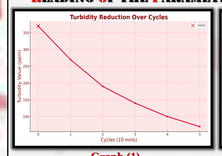
RESULTS

After a long time of research and theoretical work, it was the time for applying the test plan practically:

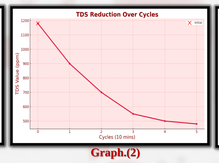
- **THE TOTAL ENERGY CONSUMPTION :**

System consumed about **79,200 joules** , or **22wh** per the **5 cycles** of purification.

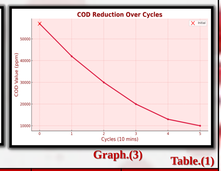
- **READING OF THE PARAMETERS PER EACH CYCLE:**



Graph.(1)



Graph.(2)



Graph.(3)

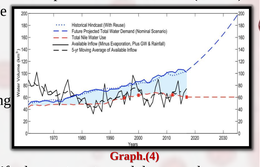
Table.(1)

Cycle No.	Initial	Cycle 1	Cycle 2	Cycle 3	Cycle 4	Cycle 5
Turbidity	370 ppm	270 ppm	190 ppm	140 ppm	100 ppm	70 ppm
Salinity	1180 ppm	900 ppm	700 ppm	550 ppm	500 ppm	480 ppm
COD	57,000 ppm	42,000 ppm	30,000 ppm	20,000 ppm	13,000 ppm	10,000 ppm

- **Turbidity:** decreased from **370 ppm** (Cycle 1) to **70 ppm** (Cycle 5).
- **Salinity:** dropped from **1180 ppm** to **480 ppm**.
- **Chemical Oxygen Demand (COD):** At the first cycle the COD percentage didn't reach the desired value, it reached only 20,000. We fixed that by adding more coagulants reduced significantly from **57,000 ppm** to **10,000 ppm**. The system consumed approximately **79,200 joules** per 5 cycle. Results demonstrate progressive improvement in water quality across all measured parameters over the **five 10-minute** treatment cycles. So, The prototype achieve the design requirements by these results.

ANALYSIS

- Egypt has long depended almost exclusively on the Nile River as its primary source of freshwater. This over-reliance has created significant challenges, particularly in the face of population growth, climate change, and upstream developments like the Grand Ethiopian Renaissance Dam (GERD). By focusing solely on freshwater sources mainly the Nile Egypt has overlooked the potential of alternative water sources such as desalination, wastewater treatment, and rainwater harvesting. This narrow focus has made the country vulnerable to water scarcity, placing stress on agriculture, industry, and daily consumption. Diversifying water resources and adopting sustainable water management strategies have become urgent priorities to ensure long-term water security for Egypt.



Graph.(4)

- Here is how to solve these problems eco-friendly to purify the wastewater and decrease the percentage of pollutants. We focused on treating slaughterhouse wastewater, which contains high levels of pollutants such as organic matter (blood, fat, manure), suspended solids (meat particles, hair), and nutrients (nitrogen and phosphorus). These contaminants can harm the environment and human health. Our eco-friendly treatment aims to reduce these pollutants and reuse the purified water for irrigation. This solution not only prevents pollution but also provides an alternative water source, helping reduce Egypt’s reliance on freshwater from the Nile.

- The designed solution to purify these pollutants is constructing a closed system consists of three stages (Physical, Chemical, Biological) each stage filter a specific pollutant as follow, firstly, the physical filter which consists of organza fiber which is very tiny to prevent the small particles to allow, activated carbon and activated coconut shell to remove the Suspended Solids or any large or small particles. Secondly, the chemical filter which consists of resins to remove metal ions like sodium, potassium and magnesium and thus reducing total dissolved salts. Finally, the biological filter which consists of crashed Alum stones, chlorin and moringa seeds to remove the Organic Matter which are the Blood, fat, flesh, and manure. So, our project is 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.

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

Advantages of constructing prototype:
- **Purifying the polluted water naturally.**
- **Eco-friendly(Safe for Environment).**
- **Constructed by wasted materials (Costless).**

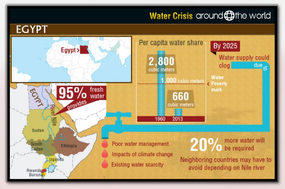


Fig.(8)

Disadvantages of constructing prototype:
- **Need specific environment.**
- **Require a lot of expensive sensors.**
- **Remains of waste are not safe for living organisms.**

THE LAWS

We used the following laws in constructing and testing:

- First law: **P = I x V**

(P) which is power in watts = **(I)** which is the Current intensity in amperes × **(V)** which is the electromotive force in Volts , We used it to calculate the power of the system to enter the wastewater, so the total power equals **12 watts** per **5 cycles** of the purification.

- Second law: **E = P x t**

(E) Which is energy consumption in joules = **(P)** which is the power that is calculated from the previous law in watts× **(t)** which is time in seconds , We used it to calculate the energy consumed in the system which equals **79,200 joules** which is also equals **22 wh** per the **5 cycles** of purification.

- Third law: **Efficiency= $\frac{In - Out}{In}$ x 100**

The **(In)** which is the initial of the second cycle which means the first cycle but the **(Out)** which is the final of the first cycle which means the second cycle so , We used this law to calculate the efficiency between every two cycles.

LEARNING TRANSFER

Table.(2)

SUBJECT	CONNECTION
ES.2.11	To understand the difference between the earth’s materials and choose the best materials to use.
MA.2.06	To understand the limits concept and to know the difference between its graphs and to know which one to use and we learned about continuity which helped controlling the system when it approaches its capacity limit.
PH.2.10	We studied how to calculate the power and Energy of system = I × V × T
CH.2.09	Redox reactions are about transferring the electrons. This concept aids team in doing coagulation process with utilizing Aluminum Sulfate
BI.2.08	The similarity between the menstrual cycle every 28 days for women and our water filter every 10 minutes.

CONCLUSIONS

After considering results and analysis, The main problem that the project solves which is reducing the amount of organic matters and fats in the blood so from our testing , we observed the amount of fats and organic matters that are precipitated is very large per each cycle as an evidence that the ratio of them is 82.5% over the cycles. We deduced that our prototype is a successful project as after testing it, we observed that the percentage of organic matters and fats that was in water have been decreased after filtering it. We understood that our prototype is very simple to be designed as all of materials that is needed to design this prototype is available by large amounts in the nature. We inferred that our prototype achieve all required solutions that we get from prior solutions from our searches. We observed improvement in the water quality per cycle and decreasing of the percentages of each parameter. So, We focused on treating slaughterhouse wastewater, which contains high levels of pollutants such as organic matter, these contaminants can harm the environment and human health. Our eco-friendly treatment aims to reduce these pollutants and reuse the purified water for irrigation.

RECOMMENDATION

After many researches on the properties of the solution, there are some recommendations that were found to help the solution be more affective and suitable and that were hard to do because of limitations, they are as following:

- Using more powerful water pumps to pump the water faster to decrease the time of pollutants absorption in the wastewater.
- Using sensors cheaper than the used as it quietly expensive.
- Using the frame made of glass because the wastewater needs sunlight or UV light 12 hours per day to fast the reactions.
- Stirring will help increase the rate of the reaction.
- Using composting will help more in filtering the bacteria and microorganisms.
- Make the process of removing filters easier to ensure sustainability.
- building places next to place of our prototype to stored cleaning water on it to increase the amount of water supplies and save it in right place.

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