Hydroelectric Dynamitic Pressure-Induced Electricity Generating System

Group no. 23101

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Grade 10 – Semester 2 – 2022 / 2023

Keywords: Hydropower – Dynamitic system – Electricity generation – Water turbine

ABSTRACT

Egypt faces a myriad of problems, amongst which is an energy crisis, caused by the overdependence on fossil fuels and the lack of alternative energy sources, like wind, water and solar energies. Another problem is climate change which is propelled by global warming which is getting accelerating by the use of fossil fuels as the main energy source. The third problem would have to be Egypt's evermore increasing population. The global consumption of oil alone went from 74 million barrels per day in 1998 to 94 million barrels per day in 2021. This solution tries to provide a viable option for expansion in the renewable energy sector, which provide an alternative to fossil fuels, and help provide energy for the rapidly growing population of the World. This should hopefully slow down climate change. The main idea revolves around the premise of utilizing the kinetic energy of a running river to spin an electric dynamitic generator. This is achieved by using a turbine to catch some of the mechanical energy of the river and transfers it to a generator through the use of gears and a chain to power it. After the whole thing was built, it was high time that it gets tested. The test plan would start by passing water through the system from an ordinary faucet. Then an Avometer would collect different data about the produced electricity. The results came out, and the current has a voltage of 2.759 ± 0.001 volts on average and an intensity of 0.030 ± 0.001 amps after the thing was up and running. With further analysis it became clear that the average power of the system was 0.074 ± 0.003 J/s, and it is non-ohmic. When it comes to the efficiency of the system, it only managed to clock and efficiency of 14.1%, which is not ideal. All in all, the system did what it was meant to do, which was generate electricity from the flow of a river. The name of this project perfectly encapsulates its main aspects, which are that it generates electricity from water through a dynamo, and it depends on the pressure from the water than its potential energy.

INTRODUCTION

Egypt suffers from many problems. Amongst which is the overdependence on fossil fuels, which is global phenomenon and is shown in **(Fig. 1)**. This overdependence makes Egypt susceptible to energy crises, whether from plateauing production, logistical shortcomings, or sky-high prices. The second major challenge would be population growth, or, to be more precise, rapid population growth. A rapidly growing population requires more things, whether that is clothes, food, or electricity, all of which require ever more robust energy production. The third and fourth major problems actually result from the previous two, which are an increase in pollution and climate change. In brief, pollution is the addition of any foreign substances to an environment, and it almost always harms it and the wildlife that depends on it. Most of it comes from human activities like industrialization, thermal electricity generation, etc. While climate change is the change of the overall climate of a region due to pollution. This type of pollution revolves around an increase in greenhouse gases, like carbon dioxide and sulfur dioxide, by things like manufacturing goods, and a decrease in oxygen levels by things like deforestation. The fifth problem is poor land utilization, where almost 95% of Egypt is uninhabited, since a majority of the land is arid. The sixth problem has to do with a poor scientific environment that doesn't allow or encourage technological advancements or breakthroughs.

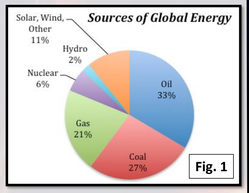


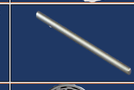
Fig. 1

A solution that solves some of the aforementioned problems is the generation of energy from the kinetics of water in the form of electricity. This solution has already been thought of and applied in real life. The most famous around the world are the Sihwa Lake Tidal Power Plant, the Three Gorges Dam, and the Aguçadoura Wave Farm. They are all very good at what they do. They generate clean, renewable electricity, they produce a tiny amount of greenhouse gases, they do this sustainably, and on top of all of that, they require very little maintenance. However, they all have some major drawbacks. The most notable thing about them is that they are massive projects that require lots of start-up funding. They harm the local marine wildlife, and they cause disturbances to the surrounding environment. They could also block or hinder shipping routes.

In order to improve these previously tried solutions, a source of water has to be found that doesn't have dense marine life in it, with the exception of microorganisms. The second of which would be to increase the conversion efficiency of the water's kinetic energy to electricity. The third thing is that the entire system has to not damage its surrounding environment.

This solution takes the best of both. As it takes the prior solutions and modifies them to make them match the newly implemented design improvements. The main idea of the solution is to generate energy from the flowing water of the Nile River by installing mechanical energy harnessing systems along its banks to generate electricity. The way that it works is that it uses the kinetic energy of the running water to turn a waterwheel, which is connected to an electric generator, or dynamo. This electricity then gets connected to the local grid. In order to check the viability of the solution, some design requirements were put in place, which are a voltage of at least 1.5 volts, a work capacity of one joule, and an efficiency of at least 75%. This project helps solve some of Egypt's grand challenges, like its overdependence on fossil fuels, by introducing alternative energy sources, rapid population growth; providing additional energy, reducing pollution, and preventing climate change, by staying away from fossil fuels.

MATERIALS

Items	Usage	Picture	Items	Usage	Picture
Blower-style motor fan	It will act as the turbine that changes the form of mechanical energy		Dynamo	It will generate AC electricity from mechanical energy	
Metal bar	It is the axle that will move the mechanical energy from the turbine to the dynamo		White LED	It will act as a visual indicator on whether or not electricity is being produced	
2 Ball bearing	It will be the thing the metal beam gets supported on		2 Metal sheets	It will be used to anchor the ball bearings and the axle with the turbine	
2 Wooden Planks	It is the frame that everything is going to be installed on				
Plastic reinforced sheet	It is going to be used to increase the surface area on which the water can push the turbine				

METHODS

I. Prepare the framework on which everything is going to be placed. The framework is going to be made out of wood. The dimensions of this framework aren't particularly important, because it only has to be able to house the other components of the prototype and make room for water to flow into the turbine.
II. Then, the metal bar is going to get attached to the blower-style fan, which is going to pass through the two ball bearings.
III. These ball bearings are going to be held on pieces of wood and held down by the two metal pieces that are going to get screwed on top of them.
IV. Place the gear on the end of the bar, and place it the parallel dynamo.
V. Connect a chain between the gear at the end of the bar and the dynamo's gear. A 3d model of the prototype can be seen in **(fig. 2)** and the actual prototype can be seen in **(fig. 3).**
VI. This dynamo is going to be hooked onto a small LED to visually show whether or not electricity is being produced, and this is the output of the system and doesn't have to strictly be a small LED.

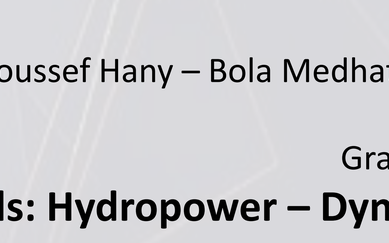


Fig. 2

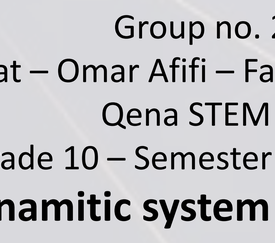
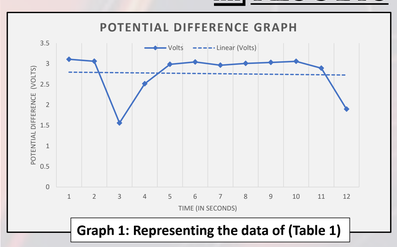


Fig. 3

Test Plan

And after the prototype was finished, it had to be put to the test. This could be done by passing water through the system and then measuring the potential difference, or volts, and the intensity of the current, or amps. This data is going to be measured through an Avometer connecting the two tips of it to the two strands of wire coming out of the electric generator. The water is going to come from a normal faucet to try to simulate the currents of a river. After the data is collected, it will get further analyzed to calculate the amount of work done, the instantaneous power and the efficiency.

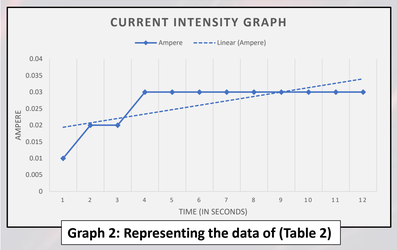
RESULTS



Graph 1: Representing the data of (Table 1)

Time (in seconds)	Potential difference
1 sec	3.107 ± 0.001 volts
2 sec	3.060 ± 0.001 volts
3 sec	1.558 ± 0.001 volts
4 sec	2.512 ± 0.001 volts
5 sec	2.985 ± 0.001 volts
6 sec	3.042 ± 0.001 volts
7 sec	2.963 ± 0.001 volts
8 sec	3.007 ± 0.001 volts
9 sec	3.031 ± 0.001 volts
10 sec	3.058 ± 0.001 volts
11 sec	2.891 ± 0.001 volts
12 sec	1.895 ± 0.001 volts
Average	2.759 ± 0.001 volts

Table 1



Graph 2: Representing the data of (Table 2)

Time (in seconds)	Ampere
1 sec	0.010 ± 0.001 amps
2 sec	0.020 ± 0.001 amps
3 sec	0.020 ± 0.001 amps
4 sec	0.030 ± 0.001 amps
5 sec	0.030 ± 0.001 amps
6 sec	0.030 ± 0.001 amps
7 sec	0.030 ± 0.001 amps
8 sec	0.030 ± 0.001 amps
9 sec	0.030 ± 0.001 amps
10 sec	0.030 ± 0.001 amps
11 sec	0.030 ± 0.001 amps
12 sec	0.030 ± 0.001 amps
Average	0.027 ± 0.001 amps

Table 2

ANALYSIS

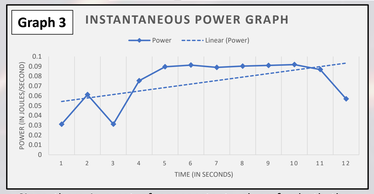
Egypt suffers from numerous problems, like pollution, climate change, lack of alternative energy sources. Pollution reduces life expectancy, increases infant mortality rates, spreads diseases, harm entire ecosystems, and reduce quality of life. Climate change increases the average temperature of the entire year, increases the frequency of natural disasters, and ruins natural environments. This affects Egypt as it endangers the many rare species that on its lands and its natural wonders. The overdependence on one type of energy source is not ideal, because if this source would get disturbed, disappear or become too expensive, then it would negatively affect the economy and the everyday citizen.

This solution helps address some the aforementioned challenges, where it would generate clean renewable energy, which would produce an alternative source of energy and no pollution what so ever and it wouldn't accelerate the climate change phenomenon. This would have tremendous payoffs for Egypt. It will reduce its dependence on fossil fuels, decrease the amount of pollution, and it would slow down the rate of major climatic change. It will also bring with it economic payoffs and social benefits.

No prototype is perfect, and this prototype is no exception; it has its own set of strengths and weaknesses. But it did manage to meet the design requirements. And as proof, it did generate a current that had a voltage of 2.759 ± 0.001 volts on average, which is a bit less than double the 1.5-volt design requirement. And the other design requirement was that the work capacity of the system would at least be one joule, which was not met as it only managed to clock about 0.89 joules, which will be shown later. When it comes to the number of amps the current possessed, it started out at 0.010 ± 0.001 amps, and then it would turn into the fixed value of 0.030 ± 0.001 amps. This prototype has a couple of pros. One of them being that it was able to generate electricity from the water coming out of a faucet at a normal pressure. It also met the design requirement of being simple to build, as it has lots of prebuilt parts and the setup process doesn't require highly skilled labor.

In order to further analyze this data, some other quantities have to be gotten. The first quantity is the instantaneous power, which describes how much work is happening per second, and it is shown in (Law 1), (Graph 3), and (Table 3).

Law 1: $\text{Power} = \text{Electric Intensity} \times \text{Potential Difference}$



Graph 3

Time (in seconds)	Instantaneous Power
1 sec	0.031 ± 0.003 J/s
2 sec	0.061 ± 0.003 J/s
3 sec	0.031 ± 0.002 J/s
4 sec	0.075 ± 0.003 J/s
5 sec	0.090 ± 0.003 J/s
6 sec	0.091 ± 0.003 J/s
7 sec	0.089 ± 0.003 J/s
8 sec	0.090 ± 0.003 J/s
9 sec	0.091 ± 0.003 J/s
10 sec	0.092 ± 0.003 J/s
11 sec	0.087 ± 0.003 J/s
12 sec	0.057 ± 0.002 J/s
Average	0.074 ± 0.003 J/s

Table 3

Since there is a set of nonconstant values for both the potential difference and the intensity of the electric current, the average of both of them has to be taken which equals 0.074 ± 0.003 Joules/second through **(Law 2)**, and the second thing that will be calculated the average power.

Law 2 $W = \bar{P} \times \sum t$

$\text{Work} = \text{average Power} \times \text{total Time}$

$\therefore W = 0.074 \times 12.0 = 0.89 \pm 0.04 Joules$

The second thing that will get calculated is the amount of work that the water source is doing, this could be done by calculating the velocity of the water, which could be gotten by knowing the volume flow rate through **(Law 3)**. The volume flow rate could be measured by seeing how long it takes to fill a liter bottle, and in this case, the liter bottle got filled in approximately in 3.2 s. The faucet had the diameter of 1.5 cm. Since the work was calculated, now the overall efficiency of the system can be calculated, by using the following law **(Law 4)**.

Law 3

$$\frac{Vol}{\Delta t} = Av \therefore v = \frac{Vol}{\Delta t \times A}$$

$$\therefore v = \frac{0.001}{3.2 \times \pi (0.75 \times 10^{-2})^2} = 1.77\ m/s$$

$$\sum Vol = Vol_{flow\_rate} \times \sum t = \frac{0.001}{3.2} \times 12 = 0.004\ m^3$$

$$\because m = \rho V = (1000)(0.004) = 4kg$$

$$\because E_{\text{Kinetic}} = \frac{1}{2}mv^2 = \frac{1}{2}(4)(1.77)^2 = 6.3J$$

The second useful to get quantity would be the resistance that the electric current faces as it passes through the electric circuit using Ohm's law **(Law 5)**, and it is shown in **(Table 4)** & **(Graph 4)**.

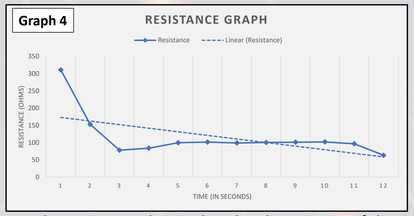
Law 4

$$Efficiency_{\%} = \frac{Output}{Input} \times 100 = \frac{0.89}{6.3} \times 100 = 14.1\%$$

Law 5

$R = V \div I$

$\text{Resistance} = \text{Potential difference} \div \text{Electric intensity}$



Graph 4

Time (in seconds)	Resistance
1 sec	311 ± 31 Ohms
2 sec	153 ± 8 Ohms
3 sec	77.9 ± 3.9 Ohms
4 sec	83.7 ± 2.8 Ohms
5 sec	99.5 ± 3.4 Ohms
6 sec	101 ± 3.4 Ohms
7 sec	98.8 ± 3.3 Ohms
8 sec	100. ± 3 Ohms
9 sec	101 ± 3 Ohms
10 sec	102 ± 3 Ohms
11 sec	96.4 ± 3.2 Ohms
12 sec	63.2 ± 2.1 Ohms
Average	103 ± 4 Ohms

Table 4

From the previous graph, it is clear that the resistance of the circuit is variable, and therefore, it goes against Ohm's law, which states that potential difference and the electric current intensity are proportional and that the resistance is constant. Therefore, this circuit doesn't follow Ohm's law and it is a non-ohmic circuit.

Learning transfer: Before the system was constructed a lot of thought was put into it. Form mechanics, the energy-work theorem was used, which is explains that energy is just a change in kinetic energy, which the premise of the system. From physics, the continuity equation and its applications, volume and mass flow rate, was used during the analysis to determine the velocity and mass of the water respectively, the properties of electric current, like voltage, intensity and resistance, along side with their respective laws, like Ohm's law and law of electric power, and also the way to hook up and use an Avometer were all taken from physics. From geology, the idea of hydroelectric power, the measurement of conversion efficient, and how to improve renewable energy through various modifications. From chemistry, the physical properties of matter, and how they affect things like durability and speed, which was very important during choosing the material of the turbine.

CONCLUSION

The prototype did meet two of the design requirements and almost meet the third one. To start, it produced, on average, about 2.759 ± 0.001 volts and, later, a constant 0.030 ± 0.001 amps. It, however, slightly fell short of one joule's worth of work, as it only outputted 0.89 ± 0.04 joules. The average power of the system was 0.074 ± 0.003 J/s. Unfortunately, the system is quite inefficient, as it only had an energy conversion efficiency of 14.1%. All in all, this prototype cost about 790 L.E. The Gorges Dam in China was the main inspiration of the project. Its idea of generating electricity, which was to utilize the flow of the Yangtze River to turn turbines to generate electricity, was used. However, this solution differs as it doesn't involve damming, which makes this solution way better to the surrounding environment and ecosystem. This solution is supposed to be a midway solution between these two ideas, which has some of the benefits of both.

RECOMMENDATIONS

Well, the project didn't always go according to plan. There were many obstacles in the way and many things that went south, and that is why there are some things to recommend to anyone who is going to try to construct this system whether a prototype or on a bigger scale and scope.

1. Since the project only managed to produce a current with an average voltage of 2.7, it is quite weak even for a prototype. So, if there were any attempts to try and reconstruct this system, a better and more robust dynamo should be chosen or a redesign of the way mechanical energy reaches the dynamo.
2. The prototype's current was not very intense only clocking about 0.03 amps, which is abysmal to say the least, and therefore a modification on the prototype has to happen so that the turbine either spins faster or with more power. This could be done by redesigning the fins of the turbine, or making the turbine lighter.
3. Lots of mechanical energy was lost in the gear-chain mechanism as friction and also it bottle-caped how fast the dynamo could spin, the solution to this would be to choose two pulleys instead of two gear and a smooth motor belt instead of a chain.
4. The efficiency of the whole design was only about 14.1% efficiency in the conversion between the kinetic energy of the water to the amount of work that the current can do. Therefore, a combination of all of the preciously mentioned recommendations should be implemented, in order to increase the efficiency of the system.

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ACKNOWLEDGMENT

It is high time to take a moment and thank all the people who have helped us turn a mere idea into reality. Especially the engineers, physicists, and electricians. And also to give the capstone teacher, Mr. Ahmed Abd El-Sattar, the grade 10 capstone leader, Mr. Mahmoud Abdullah, and the general capstone leader, Mr. Ahmed Abd El-Moez, special thanks for their efforts and help. And alas, also to wish the best for everyone.

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THE IDEAL CRANE

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Key words: Arid areas, Self-erecting crane, Stability And Low cost

Abstract

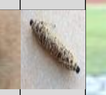
"Our survival depends on our ability to stay awake and adjust new ideas to face the challenge of change" So, No one can deny that Egypt has been suffering from many grand challenges, and we're trying to solve the problem of arid areas, 90% of Egypt is a desert land. there're many reasons that cause aridity such as: 1- long distances from oceans 2- the presence of dry descending air 3- lack of water and plant so the population is low there ,some examples of the arid areas : western desert, eastern desert , Sinai. there's another problem which is related to this problem which is " The Urban Congestion" this problem will be solved if we solve the problem of the Arid areas. So in our project we will use the Self-erecting Tower crane to make balance between the Arid Areas and the Urban congestion by building more residential areas . The proportional high efficiency to low cost was our most important design requirements for our personal prototype and we made many tests to modulate our prototype according to their results , So we altered it many times to meet all our design requirements until we achieved the entire requirements, we made a successful design.

Introduction

Through our capstone project we'll contribute to solve the misdistribution in Egypt's population through making balance among the population in Arid areas and in the large cities by building complex and residential buildings in the arid regions by the help of Self-erecting Tower Crane. As we found that most of Egypt's population concentrated in the Nile valley and Delta ,Egypt's population is still grows by approximately 1.5 million.
There are some prior solutions of this problem, one of them is "Family organization issues" this solution was applied in many countries to prevent the Urban Congestion from happening this solution worn in limiting the number of new born babies 2 or 3 at maximum, it has many good results as it organizes the society , the new born baby will have all of their rights ,it can also decrease the pollution and increase the care for the health. This solution was successful in many countries but it wasn't strong or active enough in Egypt because the government wasn't strict about it.
We will build these complex building in Al-Dabaa which is located in a semi-arid area , our solution depends on using the Self-erecting Tower Crane in moving the loads which we will use in building. We performed our project in physical model (prototype) which gives a preview of the whole project.

Materials& Methods

The prototype's Materials:

Foam card	Card board	Cutter	Glue	strings
				
2 foam cords	2 Card boards	1 cutters	1 kg Of glue	1 Meter Of strings

The design and the Prototype:

Methods

The first requirement we tested is the load resistance:
1-objective: load resistance requirements
2-materials: - piece of iron
- Meter tape
3-procedures:
1-we measured the distance between the ground and the prototype before putting any weight
2-we put a piece of iron (2.5 kg)and then measured the height
3-we put 5 kg of iron and measured the height again
4-Finally, we put 10 kg and then measured the height

The second design requirement we tested is using the given scale:
1-Objective: using scale requirements
2-Materials: Meter tape
3-Procedure: We measured the dimensions of the jip, base and the mast and recorded the results.

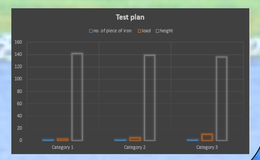
The third design requirements that the crane has high efficiency:
That was proved by keeping the weight on the hook of the crane for a long time and observed that if it was affected or not.

The last design requirements that the crane has low cost:
1-Objective: low cost requirement
2-Materials: Bathroom scale
3-Procedures: We measured the weight of the crane and it was 1200 g , that means we didn't use much materials.

Results

We reached these results after the test plan:
First: load resistance requirements
Results of self-erecting crane:
From observation, our crane was able to carry 10 kg, and will be in stable state, we put 10 kg of iron , and if we put more books the crane will be unstable.
So, we recommended that the load of it can be above 10 kg.

Number of piece of iron	Load (weight)	Height
0	0 g	145 cm(+1mm or -- 1mm)
1	2.5 kg	142 cm(+1mm or -- 1mm)
1	5 kg	139 cm(+1mm or -- 1mm)
1	10 kg	136 cm(+1mm or -- 1mm)
Average	5.8 kg	139 cm(+1mm or -- 1mm)



Second: using scale requirements
After measuring we found out that our crane's dimensions is:
Its height = 65 cm
Its base: 35cm x 45cm
Its jip: 35cm
"So we assured that it was built with the scale of 1/40 "
Third: low cost requirements
It had low cost and that's because when we measured it, we found out that the weight of the crane was 1200 g so that means we used a little amount of materials.

Analysis

Egypt faces many challenges which obstruct its development, we know that Egypt is able to solve this challenges by the help of its youth, That's why we aim to solve these challenges through smart modern solution. Our solution solves the problem of arid areas and reduce the population in the urban cities.

Results and analysis:

After finishing our prototype and testing it , we found out that it met the design requirements needed as:
1- is can carry 10 kg at the height of 1 meter from the ground.
2- it has low cost as its weight was 1200 g , that means we used a little amount of materials.
3- it was built with a scale of 1/40, and we assured that when we measured the length of the base , Tower and jip using the meter tape and found that it had dimensions of 35cm x 45cm for the base , 65 cm for the tower and 35cm for the jip.
4- it could bear the weight for a long period of time without being cracked or affected

Our solution:

After discussing the problem together and choosing the best solution for making balance between the arid areas and the urban cities we choose two types of crane by voting which are:

1- hammer head tower crane:

It's a modern form of balance, fixed to the ground and it give the best combination of height and lifting capacity, its often used in the construction of tall building .
Its lifting hook is operated by using electric motor.
"Although this type has many advantages, but it also has some disad which prevented us from choosing it " which are:
1- it has huge structure, since the major labor is intensive to install.
2- it can't be used by remote control so controlling it in the site is more difficult and tiring.
3- it requires balance to work and achieving balance is difficult.

2- self-erecting tower crane:

It's a type of tower crane as well, it's a remote controlled crane which can lift it-self from the ground by using jacks allowing the next section of the crane to be inserted at the ground level, it can be assembled without outside help or can grow together with the building ,it has a lifting capacity from 8 tons to 40 tons, it also called "Kangaroo" .
This type of cranes has many advantages, which are:
1- It operates in a very small footprint and can be erected near to the structure being erected.
2-It can erect it-self on site.
3-It can be more efficient by delivering materials to various locations on site in a short time, and the materials can be placed exactly where they are needed in typically under an hour.
4- It controlled by using remote control and this allows the operator to have sight of the load from the most appropriate position.
5- They increases the site productivity and shorten project duration .

The location:

We choose the place where the crane will work to build residential regions, we chose El-Dabaa(Arid area).

Building materials:

1. High strength low alloy(HSLA) it used in cranes designed to lift very heavy objects as it gives it high strength.
2. Electrical components include copper for wires.
3. The cables used to lift weights are made from steel wires.

Learning transfer:

1-Math the outcome of similarity and scaling as we constructed the physical model of the crane with the scale of 1/40 , we learned how to measure the dimensions of the crane with the given scale, we used sine & cosine low also trig functions to find the missing items.

2-Physics from the outcome of forces we knew how to put the crane in equilibrium while carrying the load and from the outcome of gravity we could know the force between the crane and the ground so we knew how much could the crane bear.

3-Chemistry the outcome of science and scientific method, we knew that we must have evidence on every explanation we perform and we knew how to reach the best solution by following the scientific method.

conclusions

Our conclusion about the test plan was great as we achieved all the design requirements : The given scale , stability , low cost and high efficiency ,As the results of he measurements was accurate so we achieved all the design requirements. Our prototype is stable and can bear more than 10 kg at the height of 1 meter , the prototype is quite light so we didn't use much materials , it could bear the load for a long period of time without being cracked, Also our crane is made according to the 1/40 scale of the real crane.

Recommendations

Finally we want to leave a message to those who will complete our project from where we stopped, the next step is to build the residential and complex building and give them advantages to attract people to live there and leave the urban areas. We want our crane to be used in building sky scrapers with high efficiency beside the aerial crane (only 31 one of this kind(aerial crane) exist in the whole world).

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ACKNOLEDGEMENTS

After thanking we would like to express our great appreciation to Mrs. Shimaa , Mr. Mohammed younis , Mrs. Eman Ali and Mr. Hossam
Also, we would like to thank Eng. Alaa , Eng. Bayoumi and Eng. Andro

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Econo House

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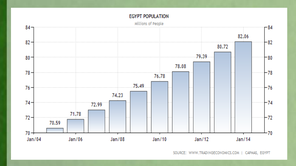
Keywords: Ventilation,Passive House, Insulation, and Atmospheric Water

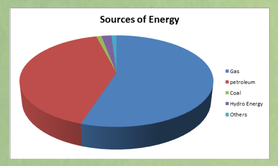
• Abstract

Nowadays, Egypt faces a lot of problems; some of them are related to housing. Egypt doesn't have a direct housing problem; it has a bad population distribution. This leads to other grand challenges like pollution, low electricity, slums and high costs of houses.
So, we followed the scientific methods to find solutions based on specific design requirements. Our solution is designing a house which is REQUIRED to be: comfortable, affordable and efficient. This house should provide water, electricity and food with alternate and clean ways. We named this house "The Econo-House". After hard work and a lot of research, we found out that using the Nanotechnology, the Passive House technique and some other techniques have wonderful results. First we tested the strength of the prototype. Then we tested its ability to maintain a suitable temperature.
After that we concluded that it achieved effective results.

• Introduction

The population in Egypt is increasing every day with an alarming rate (as in figure 1). Currently, there are many traditional methods already tried to solve this problem such as using normal bricks as the material of the building, using nonrenewable sources such as fossil fuel to generate the houses' electricity (as in figure 2) – which causes air pollution – and using pipes in order to provide houses with water; these pipes may pollute the water. That's why we started to think of a smart solution to this challenge.



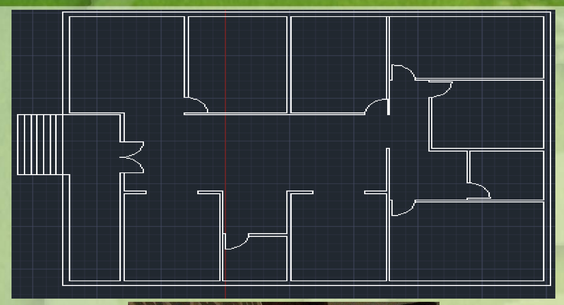


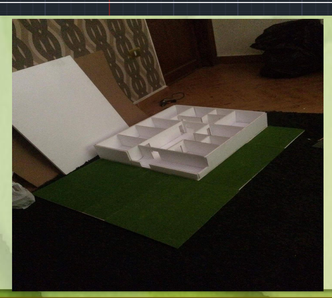
For the solution to be smart, the house should be self-cleaning, eco-friendly and affordable. Also, it must be provided with renewable sources of electricity. We discovered that Matrouh is the most suitable place for the previous conditions. In our solution, we depended mainly on the Passive House technique and the fifth generation of technology known as Nanotechnology. We are going to build our house using Nano concrete. The Nano coating method is used with the Nano glass as well as the Micro CHP and waves to generate electricity.
We can recycle water using techniques such as the grey water treatment technique. Micro CHP achieves other design requirements ,like efficiency and cost, better than other methods. Moreover, an atmospheric water generator is used to condense water vapor.
A prototype was made in order to test the strength of the design and heat insulation. We paid a lot of attention to constructing the prototype with cheap and suitable materials.

• Materials and Methods

Materials:
1-Foam boards 2-Cutter 3-Pencil 4-Rubber 5-Scissors 6-UHU Glue 7-T Ruler 8-Kanson 9-AutoCAD 2013
Methods:
First, we designed a 2D design for our prototype. Then, we used 1 :30 scale to build the prototype. After that we cut foam boards with cutter and we used the Uhu to fix them together to get a full building , then we moved to the test plan stage.

Test Plan
We wanted to test if the design requirements was met or not .
Errors were determined





• Results

Static load :

We put a certain number of laptops on the prototype to test its strength. (as in the following pictures)
As we put the laptops in the picture and the fire extinguisher we recognized that our prototype was capable to bear more than at least 15 KG because the fire extinguisher alone is full with 6 KG in it and one laptop is not less than 2.5 kg

• Analysis

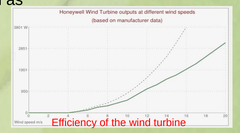
The results showed that our house met the design requirements as it has the ability to maintain temperature and to bear a static load on it .So we concluded that this design is better than a lot of other designs. Then we started to think of the grand challenges and how the house could interact with the environment where people should move from the crowded places to a new urban community in the untapped regions.

The Location:

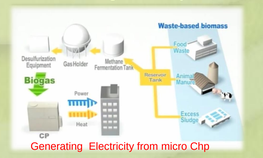
At the beginning of our capstone, we examined the map of Egypt to find a suitable place for our project and chose Marsa Matrouh for some reasons:
-It has enough wind speed to rotate our turbines.
-It is near the sea as we will use waves to generate electricity.
- The humidity there is quite high so we can condense sufficient water from the atmosphere.
- There is good transportation in this area.
-One of the negative results in the place is that it is so far from Cairo.

Electricity:

Three sources will be used in order to provide the house with electricity. These three sources are all renewable, cheap and clean as they don't harm the environment. These sources are:
-Generating electricity from waves.
-Using the Micro Combined Heat and Power (CHP) which uses the biogas.
-Generating electricity from wind.



Efficiency of the wind turbine



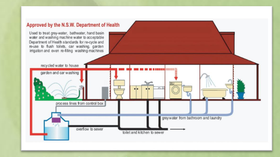
Generating Electricity from micro Chp

Generating Electricity from waves

Water

The Atmospheric Water Generator will be used in order to produce water in the house. This system converts water vapor into liquid pure water. In addition grey water technique will be used to recycle water that comes from wash hand basins, showers and baths, but not from kitchen or toilet. Moreover rain water will be gathered and recycled to make use of it.

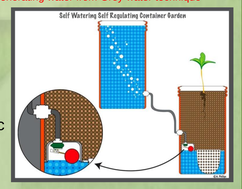
Generating water from AWG



Generating water from Grey water technique

Garden

Some crops – such as tomatoes, olives and potatoes - will be planted in the garden to achieve self-sufficiency. These crops will be watered by alternative techniques (Self- Watering).The organic wastes will be transformed into dry soil using the dry decomposition machine.

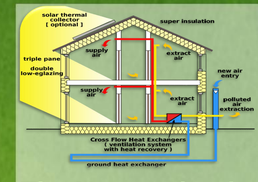


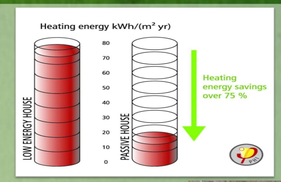
Self watering

The Passive House

The Passive House provides a good and continuous ventilation.
This technique will help:

-do without air conditioning.
-save 75% of heat energy



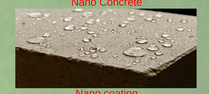


The Nanotechnology

We depend on the Nanotechnology in our project a lot:
Nano concrete: it is cheaper than normal brick, and it consists of a lot of components such as cement which is improved by the Nano silica (Sio2) that:
- Increases the strength of the cement.
- Increases the resistant to water penetration.

-Nano-coating: It makes the surface hydrophobic and repels water and this helps in the self-cleaning; it also Provides proper heat insulation.
-Nano-glass is a product of nanotechnology products with important properties like:
- Water repellency
- Self-cleaning.
- Protection from weather changes.
- Protection against ultraviolet rays.

Nano Concrete



Nano coating

Nano glass

• Conclusion and Recommendations

Conclusion:

After revising the results,analysing it and choosing solutions for the challenges we met in the house such as electricity,water and building materials we found out that our house met the design requirements we need to reach.
At last we want to say that the learning outcomes have helped us a lot such as:
-We used the Hooke's law from physics to graph the relation between the load we put on the prototype and the corresponding amount of shrinkage.
-We used Geography in determining the location of our house.
-We used statistics to collect data and make graphs.

Recommendations:

People who would like to follow the footsteps of this project should:
- Try to make the house more automated so that the disabled persons could dwell in the house easily.
- Use the desalination of water in providing water.
- Enhance power production with the usage of solar panels.

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• Acknowledgement

Thanks to: Eng.Muhammad Eid(our capstone supervisor) and Mrs.Mona (our capstone session teacher).

Special thanks to: Eng.Heba El Khedery

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QCWC

Menofia stem school

QUADRUPLE CYLINDER WATER COLLECTOR

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2020/2021 - 1st SEMESTER - GROUP 20102

KEY WORDS: WATER HARVESTING

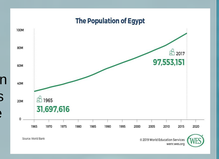
ABSTRACT

"There is no life without water"
Egypt has been trying to solve the main problems facing the country, such as pollution, recycling, public health, population growth and arid area. There are many things that can be used to solve these problems .One of these, rain water. There are many places which have a lot of rain water also most of these countries can't use the rain water. Collecting of rain water will help in solving many problems such as population growth and arid area. From the causes of population growth, is lack of water. Many people concentrated in many countries because there is water. Collecting of water, will provide many places for people .And that will reduce the population growth. Also, one of the factor which causes arid area is lack of water, so collecting of water, will help in solving the problem of arid area. We searched about prior solution and discussed the possible solution that may contribute to solve these problems. We selected possible solution and edited on it, to achieve our target to collect lots of water. We built our design with our amendments .In the end, we made test plane to make sure that our collector will achieve the target and it collected lots of water in few seconds.

INTRODUCTION

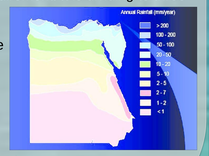
IN any time did you seat with yourself and ask why the water is the secret of the life? Follow, you will see the answer. Egypt is one of the countries that seeking progress, but there are many challenges that hinder Egypt's progress such as recycle garbage and but the most two grand challenges that faces Egyptian government are population growth and Arid area. First one is population growth; According to the statistics in 2020 the number of population is 102,334,404.

Most of this people are concentrated in less than 4% of the area of Egypt and more than 96% is desert, the problem of arid area is due to the dependence of the population concentrated in the Nile valley and delta and that make problems such as diseases and pollution so The Egyptian government try to solve this problems so They built new cities such as the new administrative capital of Egypt, floating bridges. The second is Arid Area and they are the areas that have law ability to produce crops.



The water is the secret of the life, so a new solution was chosen for these two problems .which is design a water harvesting. After deep researching and discussion the shape of the solution was select to meet design requirement. It is dividing to three parts.

Our scientific idea of the water harvesting is make a surface that can collect big amount of water. The surface is made of four trapeziums with a slope .and tube was made because it will prevent the water to reflect .Then the test plan was done for four times and it succeeded. Finally the water proof was use to make the inner of prototype more softly to collect more water in short time .so if our project is applied in real life it will be a good solution for the problems of arid area and population growth.



METHODS.

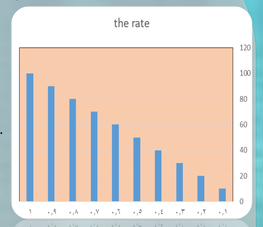
We work in professional method that skyrocket our productivity sticks:

1-at first, we draw our design in sketch up.
2-we made 2 squares whose side length = (40+0.5) (the length of the diameter of the circle that we needed to make the base and the upper circle.
3-we made in the upper circle smaller circle its diameter = (15-0.5) then we made a tube its height = (10 +1.5)
4-we stood the base (lower circle) with sticks that have special lengths to be sloped.
5-we connected the two circles with each other by the sticks.
6- We made two square and we draw two trapezium in each one Then we made four trapeziums with a high = (26), (26+0, 3), (26+0.5). (26+0.8). The length of the big bases = (59). (59+2). (59-1), (59-0.5) the length of the small bases = (25). (25+1). (25-0.5).(25+0.5)

7-we put in the tube a square its length (25-1cm) (the length of the lower base of the trapeziums) and on this square a circle its radius equal to the radius of the tube.

RESULTS

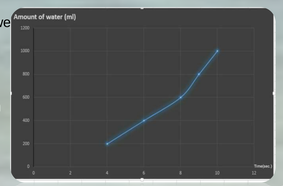
After we finish building our prototype we choose 2 from the design requirements to test it;
-The area of the prototype.
-The rate of water collection.



The area of the prototype.
Our target;
The area of our project should not exceed 0.36 meter squared.
How we tested it?
We uses learning outcome five math to calculate the area of the prototype.
As the shape of our prototype surface is squared.
We use the square area law that is (length side)*(length side).
So the area was (57+_0.2)*(57+_0.2)=(3249+_90.56)cm2.
The rate of water collection.
Our target;
-To collect maximum amount of rainwater in minimum time.
After hard working, making many mistakes, observing and learning from them we have added some modifications to our prototype. In each test plane, we recorded the results accurately.
To reach our mistakes and modify it.
We made three test plan are below.

Test plan	Results
1	80ml/second.
2	90ml/second.
3	100ml/second.

Test plane 1:
At first ,we find that water take a period of time to reach the base (the lower circle) so we thought that we should shorten the distance between the base and the upper circle as the velocity equals to distance divided by time.
Test plane 2:
After solving the first problem, we observed that the speed of the water sliding from the wood (sticks) is not enough when we searched for the reasons we found that the wood (sticks) is not farmed well with the water proof
We solved this problem by giving the prototype another layer of water proof.
Test plan 3:
After solving the previous problem we tested our prototype, we requirements and score the goal.
Then we modified it and collected 90ml/second.
After that we discovered another problem and solved it.
Finally we made another teat plane. the prototype collected 100ml/second and we made sure that we meet all the design requirements.



MATERIAL

ANALYSIS

Egypt is one of the countries that face challenges but the most two important challenges are population growth and arid area so the Egyptian environment try to solve them by built new cities and do projects in arid area such as land reclamation.
Solving these two problems was focused .so water harvesting was chosen as a solution to solve them. The goal is collecting the big amount of water in a small time it was a big challenges .After deep researching and discussion we select our prototype (water harvesting). It was designed in a shape that achieves the goal. Our project was started to design by us. The sticks were used to do it.

In the first: it's in a shape of cylinder. The base was made (the lowest circle) with a diameter equal (40+0.5). It was stood on sticks with a slope because the slope which water moving on it can be increases so that increasing acceleration that water moving because
(Acceleration ∂ = g sin an angle of slope)
We stood it on sticks with a slope .By using the trigonometry in math. We measure the angle of slope=

$$\sin^{-1}\frac{\text{opposite}}{\text{hypotenuse}} = 39/40.5 = 74^{\circ}\,21'\,27''$$

-It was made from three layers of sticks to be hard and bear the pressure above (project) and put them under the inclined circle Then the circle was painted with water proof (varnish) to make it softer). Another circle was made with the same diameter. Then the circle was connected by the sticks and it was made the shape of cylinder with a high (18 -0.5).
-Two squares were made and two trapezium were drawn up in each one Then four trapeziums was put was slope in all directions with a high = (26), (26+0, 3), (26+0.5). (26+0.8). The length of the big bases = (59). (59+2). (59-1),(59-0.5)the length of the small bases = (25).(25+1).(25-0.5).(25+0.5)
To made a tube, a circle with a diameter = (15-0.5) was cut from the upper base of cylinder .After that the sticks was put around the circle then the shape of tube was getting.
-The high of the tube =(10 +1.5).The tube was painted with water proof.
The tube connected the upper part to the cylinder .we saw that it difficult to put the four trapeziums up the tube so a square was made its length equals the length of the small base of trapeziums. Then a circle was drawn up on this square this circle was cutting. Then the square was put on the tube. The four trapeziums were put up the square.
-Finally the sticks was covered with iron paste and then to cover the error distance between the sticks to prevent water to enter into the sticks we put a layer of varnish which is the water proof has a chemical properties that it work as insulator for the water also we use it .finally a slot was made in a shape of circle in the cylinder with a diameter =3.5 for using water.
-There are many problems that we face through design the prototype:
The first: we decide to do the base of our prototype in a shape of cylinder and we decide to do a circle with a slope inside the cylinder because it will help in increase the speed of water and allow collecting more water in short time, but it was observed that the cost will be high. It was the first problem, but it was solved with a new idea.
The idea was changed before it was done. a circle was made and it was stood on the sticks that have special length to be sloped.

Second: Sometimes when the rainwater falls by down the water harvesting it will reflect. So we decide to make a tight tube between the upper part and the cylinder. it will prevent water to reflect.

The third: It is so difficult to put the four trapeziums on the tube because the base of it takes the shape of circle. This problem was solved by put a square that has the same length of the lower base of trapeziums.

Learning outcomes and connection:

Physics	In lo(1.01): By studying the concept of measurement errors that helps us to determine the percent of errors in the dimensions of water harvesting and also to choose the most accurate tools to prevent these errors. In lo (1.02): we studied "equilibrium and free body diagram" .it was helped in keeping the prototype stable.
math	We use trigonometry to calculate the angle of the slope.
Mechanics	In lo (1.01) :the concept of graphs was helped in doing data collection.

CONCLUSIONS

To sum up, after deeply searching, the prototype was finished, and the results were all set. So, we concluded the main ideas in our prototype in these points:

-The collector can help in solving the grand challenge of population growth and urban congestion by solving the capstone problem of collecting of rain water which is a main part in the grand challenge.

-the efficiency of the prototype is quite high as it collect water form 2 meter and the surface which collect water is 60cm*60cm.

-The cost of the prototype is as low as the it's equal 259L.E. The design of the collector makes it able to collect water in any direction.

-At last, I hope to see our idea of collector applied in the real world to help the people of Egypt.

RECOMMENDATIONS

-For the success of the idea, it needs some recommendations to be developed so, our recommendation is using another type of glue and the name of this glue is Titebond Wood Glue. -Titebond Wood Glue is wonderful and easy in use. -We want to use this type but it is very expensive. - Also, the surface can be made bigger, for collecting more water. -Students who would work on our design is to use marine paints as a waterproof for the collector, because after searching we discovered that they are the best and the most suitable for wood and they protect it from cracked and malfunction, but a marine paint has a high cost, so we could not use it as waterproof, because it did not follow the design requirements that require the bridge to have as low cost as we could. There are a lot of good marine paints. -The one that we recommended is "Rust-Oleum Marine Coatings Topside Paint". -It has outstanding weather resistance and water resistance. -In the end, Northwest coast will be the good place for the project, as it will achieve the required achievement and great affinity.
The scale factor:
The collector its length of the upper shape (square) = 59cm, then the area of it = 59*59=3481cm^2=0.3481m^2
When it done in the nature and grow up the area will be 70m^2. Then the scale factor= 70/0.3481=201.1
The prototype collect 50ml per second as it madden when it make in the natural it will collect 10054.6ml per second then the scale factor=10054.6/50=201.1

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ACKNOWLEDGMENTS

After Allah we want to thank our parents, school mates in grade11&12 and our teacher for helping us.

Special thanks for:

-Mr. Jalal (art teacher).

-Eng. Shukri (engineer of fabrication laboratory).

-Mr. Kamel (capstone leader).

-Mrs. Nadia & Mrs. Eman (capstone teacher).

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Electro Dust

STEM Gharbiya Grade 10 semester 2 2021/2022 19104

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Keywords: Cement battery - Cement kiln dust - Conductive metals - Galvanic cell - Redox reactions - Recycling

Abstract

Recycling garbage and waste for economic and environmental purposes, as well as producing alternative energy, is one of Egypt's major challenges. It was discovered that humans produce and discard massive amounts of waste every day, which has a significant negative impact on the environment. By-products are a type of waste, they are secondary products that are produced with the main product and are frequently discarded without use, harming the environment and increasing soil, air, and water pollution. Cement kiln dust is one of these environmentally harmful by-products; it pollutes the air as it is produced by cement factories while producing cement. Some solutions have been developed to convert worthless by-products into usable energy; the solution chosen, is to use cement kiln dust in the production of batteries that produce electric energy, thereby saving the environment from the pollution caused by cement kiln dust, and the potential energy and metals contained in cement kiln dust will be useful in storing and producing electric energy. The prototype will be created by combining cement kiln dust with metal powders, resulting in the formation of a cathode block and an anode block that will aid in electron transfer and the formation of electric energy. **After 30 days**, our prototype must achieve a design requirement of **0.003 W**. However, when the prototype was built and tested, it exceeded the listed design requirements of **0.011 W in 30 days**. After testing the prototype, several conclusions were reached, including the fact that the metals used in its construction aided in increasing the prototype's potential energy and providing a suitable medium for electron flow.

Introduction

Egypt confronts 11 grand challenges that must be addressed and solved. This semester's project aims to solve one of them which is recycling garbage and waste for economic and environmental purposes and producing alternative energy from it. Massive amounts of garbage are produced every day by humans, these wastes have multiple negative impacts on the environment**.** An example of waste that can harm the environment are by-products. By-products are the secondary product that is produced from the manufacturing process without a use. The problems of throwing by-products into the environment without use are increasing the soil, air, and water pollution and wasting a large amount of potential energy. An example of by-products is cement kiln dust, which is the by-product of cement production. Egypt is ranked 14 on the list of cement-producing countries, with an annual output volume of around 60 million tons. (Hafez, 2019). This massive production produces a huge amount of cement kiln dust which pollutes the environment. Solving this problem will require finding usage for by-products and turning it into usable energy. One of the prior solutions is recycling steel slag to cement. Steel slag is a by-product produced in a variety of forms during the steelmaking process. It is used as an ingredient in the cement composition used in building constructions. This kind of cement has a low cost but on the other hand, because of the long initial setting time, this cement is not recommended for emergency or repair work. The second prior solution is Cement batteries developed by the Chalmers University of Technology in Sweden (Emma Qingnan Zhang & Luping Tang, 2021, p. 1). Cement can be a good carrier for electrons because of the metals in it. Using cement as a medium for the battery is a good solution for having renewable energy like electric energy, as it can store energy 10 times more than lithium batteries but, the battery has low performance as the work produced is low. The solution chosen is using cement kiln dust instead of cement in the battery producing electric energy. Cement kiln dust is one of the by-products that harm the environment. It pollutes the air as it is produced from the Cement factories while making the cement. Taking utilization of the cement kiln dust will have a huge positive impact on the environment. The cement kiln dust has high potential energy and has the same metallic elements that are in the regular cement but with different ratios which makes it unusable in building constructions, but it still can conduct electricity. Making a battery from cement kiln dust will save the environment from its harm and the potential energy in it will be used in storing and producing electric energy. The prototype will be made by using the cement kiln dust and mixing it with some metal powders, forming a cathode block and an anode block with a nickel plate between them which will help in electron transfer and forming electric energy. The design requirement that our prototype has to accomplish is to produce **0.003W after 30 days** and the prototype will be tested using the Avometer by measuring the potential difference and current intensity to calculate the amount of power produced.

Materials & Method

Table (1)

Material	Cement kiln dust	Graphite powder	Copper powder	Aluminum powder	Iron fillings	Zinc powder	Copper oxide rod	Aluminum rod	Nickel plate	Container	water
cost	— (By-product)	155 L.E. per Kg (By-product)	188 L.E. per Kg (By-product)	60 L.E. per Kg (By-product)	5 L.E per Kg (By-product)	40 L.E per Kg	4705.9 L.E. per m^2	1294.12 L.E. per m^2	470.6 L.E. per m^2	2.5 L.E.	–
Amount used	2.2kg	120g	60g	120g	60g	60g by 2.4 L.E.	42.5 cm^2 by 20 pounds	42.5 cm^2 by 5.5 pounds	212.5 cm^2 By 10 pounds	1	908ml
Source	Cement factory	Graphite factory	Lathe workshop	Lathe workshop	Blacksmith shop	Chemical workshop	Chemical workshop	Chemical workshop	Mechanic workshop	Market	Water Tap
Usage	Used as a medium between the cathode and the anode	Increasing the conductivity	Increasing the conductivity	Increasing the conductivity	Increasing the conductivity	Increasing the conductivity	Used as the cathode	Used as the anode	Used as a splitting and conducting surface between anode and cathode	Used to put the materials in it	Mixed with (Cement kiln dust) to make it work
Illustration											

Total cost	40.4 L.E.

The materials listed in **table (1)** were utilized to construct the prototype, which is a renewable, long-lasting, electricity-producing battery depending mainly on cement kiln dust in its body composition. This battery's manufacturing process was composed of five phases.

The first phase involved arranging all of the safety procedures, such as donning lab coats and gloves to prevent injury or textile damage, as well as wearing face masks to prevent the inhalation of any dangerous dust.

The second phase involved arranging the materials into anodes and cathodes like what is shown in **table (2)** and preparing two plastic containers where anode and cathode materials would be mixed with cement kiln dust as shown in **Fig. (1).** In addition to cutting the upper part of the main container of the battery like what is shown in **Fig. (2)** with a cutter to make it with dimensions of - the height of 15cm, - diameter of 13cm.

In the third phase, (**0.06 Kg**) of zinc powder, (**0.06 Kg**) of aluminum powder, (**0.06 Kg**) of iron filing, and (**0.06 kg**) of graphite powder were combined with (**1.1 Kg**) of cement kiln dust, and with the addition of (**0.454 L**) of water, all these materials were mixed in the anode container. On the other hand, (**0.06 Kg**) of copper powder, (**0.06 Kg**) of aluminum powder, and (**0.06 Kg**) of graphite powder were mixed with (**1.1 Kg**) of cement kiln dust and (**0.454 L**) of water in the cathode container. Both containers are vigorously stirred with a stick and shaken to achieve thorough mixing.

The fourth phase involved placing nickel plates in the main container. They were cut using aviation with dimensions of - height of **17cm**, - length of **12.5cm**, it split the container into two blocks. Each block has dimensions of: - height **15cm**, - radius **6.5cm**. Then the components of anode and cathode containers were dumped in the main container, each one in its block. After that, a copper oxide rod had been cut with a hoop cutter with dimensions of - a height of **17cm**, - a length of **2.5cm**. was placed in the cathode half and an aluminum rod had been cut with a hoop cutter with dimensions of - height **17cm**, - length **2.5cm**. was placed in the anode half. Also, some pores were made on the upper surface of the prototype as indicated in **Fig. (3)**.

In the fifth phase, the power produced by the battery had been measured by using an Avometer and crocodiles. Avometer is a multiple measuring device that could measure the electric current intensity in Ampere, the electric potential difference in Volt, and resistance in Ohm. One crocodile was attached to the anode and the other to the cathode. The prototype achieved the design requirement as it produced **more than 0.003 W**. Then, the amount of power was measured again after some time. Different graphs and tables were established to show and compare the efficiency of the prototype after each period, as the idea of the cement kiln dust battery depends on how long will it last.

Fig. (1) the container that was used to mix the anode and cathode materials.

Fig. (2) the container where the anode and cathode materials will presence.

Table (2)

Anode	cathode
Zinc powder (60g)	Copper powder (60g) and copper oxide rod
Aluminum powder (60g) and aluminum rod	Aluminum powder (60g)
Graphite powder (60g)	Graphite powder (60g)
Iron filings (60g)	–

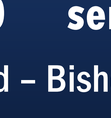

Fig. (3) the final prototype

Results

First Trial

The positive result is that the potential difference **(Volt)** didn't change too much as it was **constant** for long periods. The negative result is that the prototype couldn't achieve the design requirements, as it produced about **0.002 W in 30 days** and our design requirements are to achieve **0.003 W in 30 days**.

Table (3) Graph for the first trial

Time (Days)	Watt ($Volt \times Ampere$)
0	0.024
2	0.023
4	0.022
6	0.020
8	0.014
10	0.011
12	0.009
14	0.009
16	0.008
18	0.007
20	0.005
22	0.003
24	0.002
26	0.002
28	0.002
30	0.002

Second Trial

The positive result is that the prototype could achieve the design requirements as it produced **0.004 W in 30 days** and our design requirement is **0.003 W in 30 days**. The negative result is that the **cross-section area** of the iron piece that was used to connect the two containers was **small** so the prototype didn't achieve the best results.

Table (4) Graph for the second trial

Time (Days)	Watt ($Volt \times Ampere$)
0	0.026
2	0.021
4	0.018
6	0.018
8	0.014
10	0.013
12	0.011
14	0.009
16	0.009
18	0.009
20	0.008
22	0.004
24	0.004
26	0.004
28	0.004
30	0.004

Third Trial

The positive results is that the prototype could achieve the design requirements as it produced **0.011 W in 30 days** and our design requirement is to produce **0.003 W in 30 days**. The negative result is that the volume of the battery is **large** if compared with the volume of the first **($384.84 cm^3$)** and the second **($1815.84 cm^3$)** to the third prototype **($1990.98 cm^3$)**.

Table (5) Graph for the third trial

Time (Days)	Watt ($Volt \times Ampere$)
0	0.078
2	0.071
4	0.071
6	0.068
8	0.062
10	0.060
12	0.060
14	0.052
16	0.047
18	0.041
20	0.032
22	0.021
24	0.011
26	0.011
28	0.011
30	0.011

Analysis

Recycling garbage and waste for economic and environmental purposes is the grand challenge of this semester. Since by-products are a type of waste that pollutes the environment and throwing them will waste the potential energy in it, a solution was chosen to recycle the by-products by taking advantage of the stored potential energy in it to produce alternative energy. Therefore, an idea was inspired by the project of Chalmers University of Technology in Sweden which is making a cement battery that store and produce electric energy. Although cement batteries have high efficiency in storing energy, it costs money. Using the cement kiln dust which is a by-product of cement that has the same metals that help in conducting electricity as an alternative for the cement in the battery will have an advantage on the environment, and will save money. To see if the solution solves the mentioned problems a prototype has been built.

The first prototype was made using the information that was learned about galvanic cells and redox reactions (R. Thomas Myers, Keith B. Oldham, & Salvatore Tocci , 2006, pp. 604-623), in **(CH.1.14)** as in **Fig. (4)**. It consists of 4 main parts: The anode rod, the cathode rod, the medium, and the container. The cathode was aluminum and the anode was steel as the difference between their electronegativity is high, and the redox reaction was easily created between them. The body consisted of the mixture between the water and the cement kiln dust, as the metals in the cement kiln dust acted as the medium for the electrons to transport from the anode to the cathode. The container was a steel can that can act as a second anode to gain more electrons from the cathode. Some pores were made in the cement to recharge it with water so it can live longer. The information that had been learned about the law of conservation of energy in **(PH.1.9)** helped us to identify the potential energy that is stored in the Cement Kiln Dust and helped us to know how to change it from one form to another.

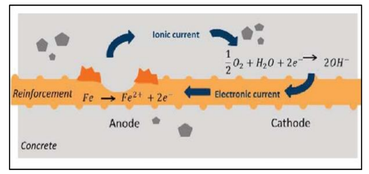

Fig. (4) the redox reaction process

After the prototype was tested, it gave a negative result as it produced **0.002 W after 30 days** and didn't achieve the design requirements. The first trial resulted in some observations which can lead to the success of the battery, which are: The two anodes decreased the efficiency of the battery as the electrons distributed between them, and the metals in the cement kiln dust didn't produce the needed energy to transport the electrons for a long time, the amount of cement kiln dust was a little quantity as the potential energy in it consumed quickly, So it can be deduced that potential energy in the cement kiln dust is directly proportional to its mass.

After noticing these observations, the second prototype was made by putting some **metal powders** that act as a cathode like **copper and aluminum**, and some other **metal powders** that act as an anode like **iron and aluminum** (the aluminum has the anode and the cathode property) to help the movement of the electrons and to give more potential energy. The cathode mixture was in a container and the anode was in another container to be isolated from each other and an iron rod was placed between them to transport the electrons. The same anode and cathode were used but the container was made of plastic for safety and to not react with the mixture.

After the second prototype was tested, it gave a positive result as it achieved the design requirements by producing **0.004W after 30 days**. Some observations were noticed about the prototype that can help in increasing its efficiency, which are: The metals that were added helped in the movement of the electrons, It was deduced from the heat flow rate law ($\frac{\Delta Q}{\Delta t} = \frac{kA\Delta T}{l}$)) (Raymond A. Serway & Chris Vuille , 2010, pp. 375-376), which had been learned in **(PH.1.10)** that the small surface area of the connector between the anode and the cathode block decreased its efficiency as the surface area is directly proportional to the energy produced. Also, the cathode rod can be replaced with a metal oxide to increase its efficiency (Yemeserach Mekonnen , Aditya Sundararajan, & Arif I. Sarwat , 2016, p. 1).

Even after achieving the design requirement, a third prototype was made to get the best results. The cathode rod was replaced with copper oxide to increase its efficiency. The prototype was made in one container, but a nickel plate that has a large surface area was placed between the two blocks of cathode and anode to divide them and to transport the electrons between them easily. The nickel-metal was chosen depending on the information that we learned about metal properties and their usage in **(CH.1.09)**. The quantity of the metal powders was doubled and new metal powders were added like zinc to the anode block to increase the potential energy of the battery, and graphite powder to both sides to increase its conductivity. Finally, a design was made on sketch up to predict the shape of the prototype as in **Fig. (5)**.

After testing the third prototype, the design requirements were achieved as it gave **0.011W after 30 days**. After finishing the 3 trials and analyzing each of them. So now, a comparison between them must be made. Since three test plans were made, data were collected during both tests and represented in graphs as in **Fig. (6)**.

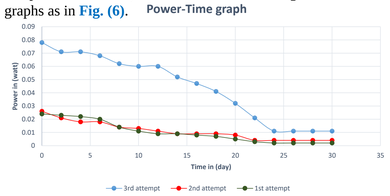

Fig. (6) A diagram that compare the results of the three attempts

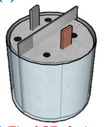

Fig. (5) Final 3D design for the third prototype on sketch up.

Fig. (7) Testing the prototype

Conclusion

At the end of this journey and after several tests and modifications, many conclusions were proved to be essential. The first one is that the electric current increases as the surface area increases. As a result, when it is manufactured on a large scale, it will produce more electric current. The second conclusion is that It is preferable to make the container out of nonmetal rather than metal because it is better at storing energy. Also, aluminum fillings are one of the best metal fillings that aid in the flow of electrons in the battery by acting as an anode and a cathode. Finally, Aluminum and copper are the most effective anode and cathode that were available in Egypt and consumable within our budget.

Recommendation

- A nonmetal container is better to be used than a metal one to achieve safety precautions.
- Silver is the most conductive metal due to its unique crystal structure and its single valence electron. As a result, it will perform admirably in our battery but it has a high cost.
- Titanium is the best anode to use, and lithium oxide is the best cathode to use because they have a useful working potential difference as well, but using them in the project will exceed the budget. (Yinzhong Wang, Errui Wang, Xu Zhang, & Haijun Yu, 2021, p. 1918)
- Nickel oxide hydroxide is rather be used as cathode soluble solution in the mixture of the cathode materials. However, using it in the project will exceed the budget.
- Sulfur tetroxide should've been used to increase the prototype's efficiency. However, it wasn't available in Egypt.
- Cathode and anode rods are rather pure, but it was hard to get the pure ones.
- Project is better to be constructed on large scale in coastal cities to keep it humid to make sure of the constancy of the efficiency for a longer time.

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Acknowledgment

In the end, we would like to thank Allah for guiding and helping us in our journey and gifted us with wisdom and patience to be able to make the right choices. We'd like to thank Mr. Ahmed Emara, our school manager, Mrs. Eman Abdelmonim, the Deputy, Mrs. Nardine, Mr. Tarik, Mr. Mena, Mr. Ismail Shawky, and Mrs. Shaimaa our capstone teachers for guiding us and helping us with the problems that have faced us. Thanks to Mr. Ahmed Khairy the fabrication laboratory teacher for helping us with the lab tools and with building our prototype.

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Galvanized Oven

Obour STEM school

Grade 10 , semester 2 , 2021-2022 , group ID : 21112

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Keywords: Potassium Chloride, by-product, Copper, Aluminum, white sand.

Abstract

The radical development of Egypt has become evident in all fields, but despite this development, there are still many challenges facing Egypt, four of these the challenges that are considered the real stumbling block to the Egyptian renaissance are increasing the industrial and the agricultural bases, reducing pollution, adapting with climatic changes, and recycling, this semesters challenges to be solved. since the main aim is to generate electricity using waste heat which contributes to the climatic change and one of the by-products that cause pollution whereas using KCl (potassium chloride) as a by-product from the nitric acid industry and waste heat as a catalyst for the chemical reaction happened as a consequent of an electrochemical cell of aluminum, copper, and KCl dissolved in water to make electrons flow speeded up with wasted heat that trapped using sand in the salted water. This majority of electrons along with the prototype design have been able to verify the opted design requirements of safety, abundancy of the materials, ecofriendly, recycling, being applicable and testable, because of achieving all the design requirements the prototype has been able to produce 703 millivolts considering the used prototype material and its applicable design of cylinder, since the used iron of oven that has high conductivity of heat and aluminum and copper with their high conductivity of electric currents along with sand and its low specific heat capacity which entirely concluded that the prototype could produces 703 millivolts at 60 degrees Celsius.

Introduction

Egypt is faced with numerous obstacles that limit its progress these limits are Egypt's grand challenges: health issues, improving sources of clean water, improving the use of arid areas, overpopulation, reduce urban congestion, while the challenges that are the real stumbling block to Egyptian renaissance are increasing the industrial and the agricultural bases, reducing pollution, adapting with climatic changes, and recycling are this semesters challenges to be solved.

The real challenge is to create a solution that drips out all challenges, the solution is committed with some demands as it is required to make use of one of the greenhouse gases, waste heat, or by-products. numerous prior solutions were fabricated such as generating energy in the form of heat using slag (a by-product from the iron industry **as shown in figure (1),** which generates a wasted heat)the strength is that there is a chemical reaction happens to increase the slag heat using CO2 (a greenhouse gas) and the gained heat could run any form of turbine while the weakness is that the mentioned chemical reaction gives carbon monoxide (a very dangerous gas), the second prior solution is the Energy of scavengers (waste-heat). Its strengths: not flammable, require little maintenance, less complex, and easier to replace than compressor-based cooling systems.

Figure (1)

Its weaknesses: Cooling is generally slower than in compressor-cooling systems, multistage systems are required for larger temperature differentials, not energy-efficient compared to compressor-based systems, searching on prior solution led to the contribution of the opted solution of making an integration between the by-products and the wasted heat whereas making and electrochemical cell with a homogenous solution of KCl (a by-product from nitric acid industry) added to two strong anode and cathode (copper and aluminum) which creates a flow of electrons increasing the speed of these electrons using wasted heat that rise the electricity to one and half the original since without heat the net gained electricity is 500 millivolts and with heat it is 703 millivolts .this majority of electrons has resulted that the project fits all the design requirements of safety precautions since the used materials in the prototype are iron and aluminum a high resistance heat materials and the test plan was done in the chemistry lab under supervision of the teachers, has high abundancy, it easy to be tested thus we had made various test plans, the material are ecofriendly as they does not harm the environment or emits radiation, all the material used are recyclable since they are all from nature. This success of achieving design requirements is due to the designing prototype and the materials used where the raw material for the oven is iron as an accord to its high conductivity of heat and aluminum and copper a high cathode and anode electrical conductors along with the copper tube that increases the surface area of the reaction, the prototype design is cylinder which is easy to be applied in the industrial field.

Materials and methods

Materials:

Material	Aluminum container	White sand	Pure water	KCl	Copper tube	Recycled iron
Picture						
Cost	100 L.E	5 L.E	50 L.E	12 L.E	20 L.E	500 L.E

Methods:

Firstly, we went to the store of the scraps to get the iron to make the steel oven and to buy the copper tube, then we went to the blacksmith for constructing the oven to be our applicable source of heat with dimensions of 50 cm for the length and 25 cm for the width and 30 cm for the high. **As shown in figure (2)** after that we went to the home appliances store to buy an aluminum pot then we asked the blacksmith to hold the pot on the surface of the oven so that it does not move. As **shown in figure (2),** then we used the sensitive balance to measure the amount of raw materials used in the test plan and we found that the aluminum pot was 324 grams, and the copper tube was 49.5 grams.

Figure (2)

Test plan:

We used the sensitive balance to measure the required amount of the used material thus, we used 360 grams of pure water, and then we mixed it with 40 grams of neutral salt KCL (an ionic compound that will dissolve in water making the electrons flow through the metal), **as shown in figure (3)** and secondly, we measured 1000 grams of white sand, after that, we put the salted solution on the sand all in the aluminum pot, **as shown in figure (4)** thirdly we put a copper tube at the center of the aluminum container in the mix of sand and salted water making sure that the copper tube does not touch the aluminum pot to maintain the area of floating electrons, **as shown in figure (5),** before subjecting the chemical reaction to the fire we measure the volts using a multimeter in DC, and we put the pot on the oven's hot surface and of course, we put the thermometer in the water to measure the change in temperature while the current is increasing to collect the data for the graph.

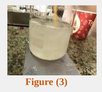


Figure (3)

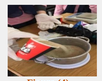
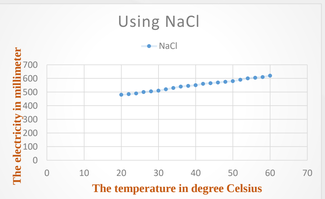


Figure (4)

Figure (5)

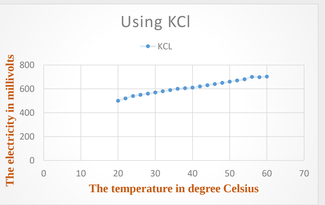
Results

These are the results that were obtained during the various attempts of the test plan, as shown:



Figure(6)

The first was using NaCl as the salted by-product and the maximum net gained electricity was 620 millivolts and the net gained electricity increased with a semi-constant degree of 6.6 millivolts every two degrees Celsius (by getting the average between every ten Celsius) until it reaches the maximum temperature at 60 degree Celsius as the salted water starts to boil thus the flow of electrons through the electrochemical cell was not changed as it remains 620 millivolts **as shown in figure (6), table (1)**

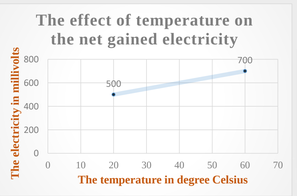


Figure(7)

Secondly, we used KCl as the salted by-product and the maximum net gained electricity was 703 millivolts **as shown in figure(7)** and the net gained electricity increases with a semi-constant degree of 9.5 millivolts every two degrees Celsius until it reaches the maximum temperature at 60 degrees Celsius when the salted water started to boil thus the flow of electrons through the electrochemical cell was not changed as it remains 703 millivolts **as shown in figure(7), table (1)**

Celsius	20	22	24	26	28	30	32	34	36	38	40	42	44	46	48	50	52	54	56	58	60
KCL	500	520	540	550	560	570	580	590	600	605	610	620	630	640	650	660	670	680	700	698	703
NACL	480	485	490	500	505	510	520	530	540	545	550	560	565	570	575	580	590	600	605	610	620

Table (1)



Figure(8)

The condition	Without heat (20 degree Celsius)	With heat (60 degree Celsius)
The electricity in millivolts	500	703

Table (2)

The first trial was without heat and the net gained electricity was 500 millivolts while adding heat, it becomes twice times the original as it becomes 703 millivolts because, the heat plays the role of catalyst **as shown in figure (8), table (2)**

Analysis

Egypt faces eleven major challenges including increasing the industrial and the agricultural bases, reducing pollution, adapting to climatic changes, and recycling which stand in the way of its renaissance, our solution will address all these four challenges especially pollution by using the hazardous neutral salt KCl a dangerous by-product of nitric acid manufacturing and climate changes because of using wasted heat.

During the test plan, results had acquired and dissected into positive and negative results, these results are obtained as followed:

First the positive results:

- According to the quantity of the material used the amount of the net gained electricity is satisfactory as the net gained electricity was approximately one volt.
- there is a direct relation between the size of the container and the net gained electricity **as shown in figure (9), table (3)**

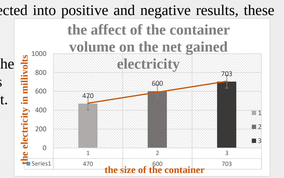


Figure (9)

Without heat the electricity accords acceptable amounts but with heat, the net gained electricity increases to one and a half the original one to be 703 millivolts **as shown in figure (8).**

The volume of the container	Container 1 (the smallest)	Container 2 (the middle)	Container three (the greatest container)
The electricity in millivolts	470	600	703

Table (3)

Secondly the negative results:

- The direct and the indirect heat plays role in the amount of the net gained electricity as when the heat is direct to the aluminum surface the electricity was 980 millivolts, while being indirect **contributed** the electricity to be 703 millivolts.
- Since the chemical reaction breaks in a defined temperature to give the requisite net gained electricity thus, the temperature of the sand must be constant.

Our team had opted for some design requirements as followed:

Ecofriendly: the materials are ecofriendly materials; they do not emit radiation and are not harmful.

Safety: such as wearing coats, gloves and masks to avoid any danger due to the chemicals, making the stand from metal like iron that does not ignite, and the test plan had done in the chemistry lab under the supervision of the teacher.

Recyclable: since the materials are natural materials thus, they could be recycled easily, and KCl could be returned using the reversible chemical reaction after the water evaporates.

Abundance: Used materials are recognized, and easy to test, numerous test plans had been done.

Applicable and testable: the prototype is an oven as a source of heat along with that the cylinder design that is applicable to any industrial field.

we were committed to definite learning outcomes, which were related to the challenges, and this relation opened new dimensions of the scientific foundations on which the idea was built such as:

- Iron has a specific heat capacity of $449\,J/kg\,℃$, sand has a low specific heat capacity of $830\,J/kg\,℃$ compared with water which has $4200\,J/kg\,℃$, Specific heat is how much heat energy is needed to raise the temperature of a substance, whereas $Q = cm\Delta T$ where Q is heat energy in Joules, m is mass in grams, c is specific heat capacity, and ΔT is the change in temperature, accordingly, it needs low heat as well as low time to upraise the temperature.
- potassium is more active than sodium according to the chemical activity series because the K has lower ionization energy than Na due to its bigger atomic size thus the energy required to lose electrons is smaller, therefore the electricity gained from KCL is more than from NaCl.
- copper and aluminum are good conductors of electricity consequently when electricity flow through them there is relatively no resistance additionally due to the theory of thermocouple when subjected a metal from one of its ends to a source of heat there is an electric current travel along the metal to its other end, on that account, there is an extra current exists.
- KCl is a byproduct of the nitric acid industry in Egypt correspondingly with the equation

$$(2KNO3 + 2\,HCl + H2O \rightarrow 2\,KCl + HNO3 + NO2 + H2O)$$

- All these materials are employed to establish the hyposis of galvanic cell, the reaction that mainly happened in a galvanic cell is oxidation, and reduction as copper will be an anode and aluminum will be a cathode, thus, copper will oxidize (Cu2++ 2e-⟶ Cu (s)) and aluminum will reduce(Al⟶ Al+3 + 3e-), and KCl will dissociate in water to be positive potassium and negative chlorine ions, these majority of redox reaction create electrons that flow across the cell which carry electric current, therefore without wasted heat(by using electrochemical cell) the net gained electricity is 500 millivolts **as shown in figure (8).**

With the help of some learning outcomes, we had developed a solution as followed:

Chemistry	CH.1.08: We studied about solutions and created a homogeneous solution out of water and potassium chloride. CH.1.11: We learned about several sorts of chemical processes. Our chemical process involving KCl and H2O is a neutralizing reaction. CH.1.14: We investigated the galvanic cell, which gave us an idea (KCl reacts with H2O).
Physics	PH.1.10: We studied temperature, which led us to employ waste heat sources to produce various types of energy.
Biology	BI.1.10: We obtain oxygen as a byproduct of the photosynthesis process. To generate energy, we use oxygen, a byproduct of photosynthesis, in cellular respiration.
Math	MA.1.07: using the graphs of a quadratic function equations to represent the relation between the alternative source and the amount of the energy. We can represent it on a graph so that we can predict the amount of energy that we will get according to some given
Geology	GEO.1.09: we learned from geology the kinds of energy, we learned about the sources of the kinds of energy after that we started to select which kind of energy, we will work on then during making the prototype we learned about metal and the color that absorb much energy to help us in our project and get high heat to use it in the project.

Conclusion

Egypt suffers from challenges like pollution and climate change. Depending on our prototype test result and analysis, we concluded that the project had achieved all the design requirements as it has produced 703 millivolts as a maximum quantity While using 40 grams of KCL, an aluminum container with 324 grams, A 50 gm copper tube and 360 grams of water and 1000grams of sand . we worked on increasing the efficiency in many ways such as making a change in the type of the salt as we used NaCl in the first try instead of KCL and raising the amount of it, and also changing the temperature of the source of heat because the raising up in the temperature is directly proportional with the volts produced (at a certain limit), the external design of the prototype was changed as we a used a steel model for an oven to represent the life application 50cm length, 25cm width, and 30cm height. We found that the temperature 60 Celsius is giving us the best result which is 703 volts. Finally, our project is the suitable one for solving these grand challenges as it is totally eco-friendly, low cost, testable and recyclable.

Recommendation

The whole world is striving for a radical awakening or being close to perfection in one way or another, but this perfection will not be achieved except by struggle, trying, and adhering to the teachings and recommendations of the predecessors on their projects and research, since our prototype achieved all the design requirements and attained all the demands there is no objection to be better in the presence of some modifications and recommendations such as increasing the aggregate of materials used so, It will lead to escalating the amount of output electricity, trading the white sand with an elective fabric that can hold the warm vitality into it, making the model as a portion of any life application that produces squander warm as this model was built to change over the squandered warm into power, so it's prescribed to utilize it in more life applications such as all mechanical and warm forms and the squandered warm from the sun, and finally changing the current type from DC to AC.

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Acknowledgment

We would want to convey our heartfelt gratitude to our school principal Dr. Ahmed Abd El-Maqsood as well as our capstone teachers as Ms. Noha the general capstone teacher, Dr. Ahmed Morsi the Capstone leader, especially our class capstone teacher Ahmed Sayed and Ms. Ebithal for providing us with the excellent opportunity to achieve our capstone project, we are quite grateful to them. Second, I'd like to express my gratitude to the stuff of stem subjects: Mr. Gad the Fab Lab, Dr. Amin, Ms. Ola and Ms. shimaa the chemistry teacher, and we would not forget Mr. Mahmoud the security guard.

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Beam with No Steel

Obour STEM school

Grade 10 , semester 1, 2021-2022, group ID:21115

Fatma Alzhraa, Hagar Mustafa, Menas Sayed , Nadeen Ahmed, Shahd Hany

Key words : Architecture - Fiberglass- Pinewood-CNC machine – High Population

Abstract

The population in Egypt increases day by day resulting in high urban congestion by the concentration of people in one specific area. Leading to many problems whether environmentally like pollution or economically like unemployment. All of these factors have caused obstruction in Egypt evolution. Arid areas represent a high percent of Egypt's total area. These are lands which have less than ten inches of precipitation per year which makes these areas environment harsh to live in. For this semester multiple solutions have been prepared and the best has been chosen to solve urban congestion and arid areas problem. Considering constructing residential buildings in arid areas by using nonmetallic beams which will reduce the urban congestion. Furthermore, implementing land reclamation to reduce the spread of aridity. Buildings constructed by "H" shaped beam made from pine wood for compression and fiberglass for tension will be characterized by their high efficiency, low cost, and ecofriendly. In addition, the beam that will be used in the construction withstands at least fifty newton of weight without deflecting more than ten millimeter the results will be shown in graph. After attempting the test plan where three points flexural test has been used with two support points at the end of the beam and load attached from the middle. Data has been collected and analyzed; observations assured that these characteristics have been applied to our beam. Which aligns with the design requirements which guarantees the solution is successful. The evaluation of the beam showed that it withstand up to 108 kilograms and deflects only 2 millimeter when 5 kilograms of loads are attached to it from the middle.

introduction

Egypt suffers from massive problems which threaten its evolution and affect it through many aspects for example, economically and environmentally. These problems are also known as (The eleven Egypt grand challenges). Most people wonder if there is a possible solution for these problems, how these problems might be solved. We worked on two critical challenges to solve them using the engineering design process which are multiple steps followed to create a solution for a problem. The challenges that we will focus on for this semester are urban congestion solved by constructing arid areas using non-metallic beam. Solving this problem will not only reduce people concentration in one area but will reduce pollution as well.

There are various prior solutions that have been implemented to solve the urban congestion and arid areas problem for example to previous prior solutions is constructing a nonmetallic beam which is basalt fiber reinforced bars and concrete as in figure(1). It has multiple

Figure (1)

Strength points including that it is four times Lighter than steel bars, it has thermal insulation, moisture absorption, it is also three times Higher in strength than steel bars ,it is very abundant. It is a great solution but it has

Weak points which is it cannot deflect before collapsing which means it will not warn the Resident before it breaks down as a result people lives can be in danger.

Our choice had Fallen on the pinewood to build the nonmetallic beam for Constructing arid areas which contribute low price and high efficiency at the same time. Hence, allowing more people to move easily to new buildings in arid areas due to its convenient price. The beam should not deflect more than 10 mm. when under 50N load. It also should not be heavy to maximize load to weight ratio. And we have succeeded in executing these conditions which align with design requirements. Fiberglass has been put among to the wood pieces to give it much high strength. Our prototype design is H beam as it distributes weight equally among beam parts to allow the beam to carry more load easily and be hard to break. In brief, this solution was chosen because it is cheap, eco-friendly and resist high compression and tension.

Materials

Material	Cost	Amount	Picture
Pine wood	60L.E.	50*12*8 Cm	
Fiber glass	18L.E.	1Meter	
Polyester	50L.E.	350gram	
White glue	15L.E.	100gram	
Polyester hardener (Noroxkp-9)	25L.E.	200gram	
Total Cost	**168L.E.**		

Methods

These series of steps were followed to build our prototype:

During the test plan we attempted to follow all safety precautions to protect ourselves and make sure that everything is being implemented correctly according to the design criteria. For example, gloves and coats have been worn as shown in figure (2), devices used in calculations were used safely in the lab.

To construct our prototype. Firstly, we cut the wood using CNC machine and glass fiber using scissors into pieces.

Figure (2)

Each piece does not exceed Three centimeters in any dimensions to align with design constraints as shown in figure (2). Secondly, the glue has been used as a binding material between the wood and fiberglass .

Hardening material has been put on glass fiber to make it hard after completing the building of the beam as H shaped beam with dimensions of : L=50cm, W=8.5cm, H=8cm .

The glue volume does not exceed twenty percent of the entire volume of the beam.

Methods used for test plan to measure deflection:

First the weight of the beam was measured. Then we put our beam on rocks on two chairs as shown in figure(3).

Figure(3)

Later be able to get the load to weight ratio

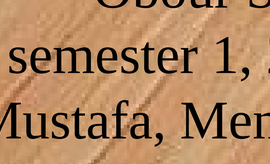
- A 3-point flexural test has been used with contact points
- 2 support points at both ends of the beam to attach the load in the middle of the beam.
- 0.5 kilogram of weight has been applied to the center of the beam as a load. We measured the corresponding deflection by add 0.5-kilogram each time we measure the deflection by using Vernier caliper tool to show results later in graph.

Results

After our prototype has dried and is ready to be tested, a three-point flexural test with two support points was used and an attached bucket from the middle of the beam to add loads in it to get deflection until beam breaks, then by using the Vernier caliper on the surface of the beam, observations have been regarded and the results of the corresponding deflection has been recorded from the Vernier caliper and measures in mm. We considered the positive and negative results that have been revealed during testing and the negative points needed to be improved.

The positive results that have been obtained after test plan: Based on our test plan, our prototype achieved the design requirements.

The beam deflects 2 millimeter as table (1) when we put a load Of 5 kilogram as in graph (1) , Maximum Load of beam which it broke in it is 108kg.wt. as shown in figure(4) and the maximum deflection=14.3mm as in graph (2) And table(2) then the beam breaks as shown in figure(4).



graph(1)

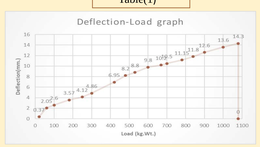
,weight of beam=1kg we minimized the weight of the beam to maximize the load-to-weight ratio which equals to 108,Which increased its efficiency and strength.

Then we calculated the volume of the beam=$1600cm^3$,Volume of glue should be used is 20% of volume of beam= $84cm^3$on the other hand the mass of the glue we already used=100gm, density=1.19 gram/cm^3so the volume of already used glue= $84cm^3$ which aligns with the design constraints which states that the volume of glue should not exceed 20 % of volume of entire beam, surface area of the beam=$0.0425m^2$, as a result the Maximum stress of our beam=24904N/m^2 (Pascal) the maximum deflection of the beam=0.0143m and the actual length of our beam=0.22m so as a result the Maximum strain=0.065 shear modulus=2271280.3922 N/m^2 (Pascal)

Load (kg.wt) × 10	0.5	1	1.5	2	2.5	3	3.5	4	4.5	5
Deflection (mm.)	0	0	0.18	0.37	0.61	0.94	1.2	1.56	1.76	2

Table(1)

when measuring the deflection we used the vernier caliper which is accurate up to



Graph (2)

$(\frac{0.05}{2})$ 0.025mm and in measuring the mass we used the balance which is accurate up to 0.02gram.

The negative results that have been obtained during test plan:

Since we are determined to accomplish best results, we noticed one disadvantage which is wood being affected by external factors for example, weather like humidity, temperature, and erosion by bacterial activity.

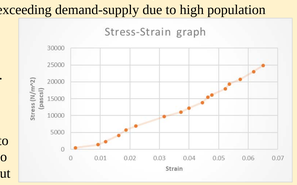
Figure (4)

Load (Kg.wt.) × 10	10	25	30	48	53	60	70	90	100	108
Deflection (mm.)	2.6	4.12	4.86	8.2	8.8	9.8	1.2	10.5	14.2	14.3

Table (2)

Analysis

As there are global issues even when technology is at its highest rate and modern solutions have been proposed there are still many obstacles and challenges that face many countries and Egypt all the time. For example, Arid areas, and as known that lands get influenced by the surrounding environment arid areas have been named like this because they receive little precipitation per year and lack vegetation which makes it hard to live in the hyper-arid, semi-arid areas are in continuous spread due to Egypt limited water resources. On the other hand, there is urban congestion problem which is a simple case of exceeding demand-supply due to high population that has been increasing over time and limited services provided for people. These problems represent an example of challenges that are being worked on in Egypt in the last few years. Many prior solutions have been proposed, for instance, arid area can be solved by land reclamation like Kenya who made seed balls project by throwing seeds coated by charcoal to prevent seeds to get eaten by insects or birds so we can throw the seed balls in arid areas without waiting for rain season. As a positive result it leads to forest growing hence reducing, desertification for negative results only limited amount of seed thrown actually grows. for this semester a solution is provided by constructing arid areas with nonmetallic beam, the high density of population in urban congestion areas will decrease but the problem is constructing more cities and buildings costs a lot of money because of using the metallic beams which are the foundation of architecture. This problem is solved by constructing a nonmetallic beams for constructing using alternative building materials. Which is made from pine wood that has high compression and glass fiber that has a high tension. These are the properties of the real beam, it is also better than the metallic beam because of its low cost as there are many available wood professionals. The beam is constructed as an H shape which enables the load to be distributed equally on the beam surface to carry more weight. After the test plan and observations that have been made we obtained results which have been analyzed and collected to figure out weak points that have been revealed during testing and improve them.



Graph (3)

The positive results include that the beam can hold up to 108 kg. As a maximum load and deflects only 2 millimeters after attaching 5 kilograms of load from the middle of the beam. Besides, Our solution has achieved all design requirements as it stands 5 kilogram and deflects less than 10 millimeter. The Beam dimensions has not exceeded 50x10x10 as its length is (50±1.5), its widths are (9±0.5), its height is (9±0.5) further more , its weight appeared to be 1 kilogram. And every individual piece used in constructing the beam its dimensions did not exceed 3 centimeters according to design constraints. To make our calculations we made sure that we followed the scientific laws correctly such as when calculation volume of used glue we followed these steps: first in order to get the volume of beam . It has been classified into two parts. big Cuboid and two cuboid faces in the sides of H shaped beam.

Volume of the beam = volume of cuboid-volume of empty space in 2 sides $volume\ of\ cuoboid = length \times width \times hight$ = 50×8.5×8=$3400cm^3$

$volume\ of\ 2\ cuboid\ faces\ in\ the\ sides = 2 \times Length \times Width \times Hight$= 2×50×3×6=$1800cm^3$ then we subtracted them to get final volume of beam

Volume of the beam=3400-1800=$1600cm^3$

The volume of glue should be used=20% of 1600=$320cm^3$

$volume = \frac{mass}{density}$

Density of white glue=1.19gm/cm^3, mass of used glue=100gm

$volume\ of\ glue = \frac{100gm}{1.19gm/cm^3} \approx 84cm^3$

Binding material was less than 20 percent of volume of entire beam, the beam weight was minimized in order to maximize the load to weight ratio .

Maximum load of our beam= 108×9.8=1058.4N and Weight of our beam= 1kg×9.8=9.8N, So the maximum load to weight ratio = 1058.4:9.8which is 108 .

The stress and the strain of our beam were calculated according to these following laws to later get the ratio between the shear modulus of our beam and the shear modulus of the real standard steel beam :

Maximum stress = $\frac{force}{surface\ area} = \frac{108 \times 9.8}{0.5 \times 0.085} = \frac{1058.2}{0.0425} \approx 24904 N/m^2$ $(pascal)$.

Maximum strain= $\frac{\Delta L}{L} = \frac{maximum\ deflection}{actual\ length} = \frac{14.3 \times 10^{-3}}{0.22} \approx 0.065$

shear modulus=$\frac{stress}{strain}$ as shown In graph(3) and table (3) "slope of the graph" $\frac{11068.24 - 6917.65}{0.0373 - 0.022}$ ≈271280.4 N/m^2 (Pascal) .

The shear modulus of real standard steel beam=$8.4x10^{10}$

The ratio between shear modulus of our beam to the shear modulus of real standard steel beam=$\frac{271280}{8.4 \times 10^{10}} = \approx 3.23 \times 10^{-5}$

when building the working model we followed all safety precautions to make sure no one is harmed in addition, every tool that has been used to measure the corresponding deflection of beam was returned safely to the lab. For every project, there is negative sides that slightly affect it.The negative results obtained after test plan include that the beam is affected by the temperature and can be burnt. It is not such a big obstruction as it will be solved by isolating the beam with an insulation material (epoxy) .The learning outcomes in every single subject have proposed useful information to be used during capstone.

Subject	Ios	The connection
Physics	PH.1.01 PH.1.02 PH.1.06	SI Units helped us to share our results worldwide the measurement error for the beam enabled us to calculate dimensions error. Concept of forces help us get the net force acting on the beam which equals to zero as it is in static equilibrium which means that the magnitudes of all forces acting on beam are equal. We also learn in physics how to use a verneil caliper tool which help us to measure the length of deflection .physics enable us to get the strain and stress of beam
Chemistry	CH.1.01 CH.102	we learn the scientific method which help us in research by following steps to get a successful solution also chemistry inform us the reaction between different building materials for example, the reaction between binding material of beam and the material of beam itself
Math	MA.1.01	Math teaches us how to calculate the angle of deflection. Also teaches us how to calculate the surface area and the total area of the beam
geology	GE.1.03	In geology we were taught the variety of building materials used in constructing buildings, rural roads, highways and others which lead us to choose best building material according to its characteristics for example, its reaction with acids, its abundance.
mechanics	ME.1.01	we are able to make a graph between two variables like the graph between the deflection and the load
Biology	BI..1.01	Teaches us the relation between the spread of infectious diseases and the urban congestion

Strain	stress
0.00168	4611.8
0.0092	13835.3
0.0118	23058.8
0.0162	41505.9
0.0221	69176.5
0.0316	96847.1
0.0373	110682.4
0.0445	138352.9
0.0507	179858.8
0.0572	207529.4

Table(3)

conclusion

Egypt suffers from urban congestion in many cities. to solve this grand challenge multiple steps have to be made. After working on research and making the first model, we began to choose the appropriate method to test the first model . After analyzing our results we found that we achieved the goal at the end of the road. We concluded that our project is effective and successful because it achieved our design requirements. It has low cost, high efficiency, big stamina, it is ecofriendly and it can be implemented at the reality easily. Pine wood and fiberglass have been used in constructing our beam .our beam had a deflection of 2 millimeter at the weight of 5 kg and could carry 108 kilogram and it will save a lot of money as its cost is only 168 LE.

recommendation

Our project has a lot of advantages but we believe that Everything around us is being developed day by day, So, the solution that has been chosen can be improved through many factors and we recommend everyone who will complete working on our project to:

- Use epoxy as an isolating material to prevent wood erosion by bacterial activity, any temperature changes, or flame.
- Buy materials that will be used from its origin sources as it is cheaper and more abundant with a variety.
- Be careful not to waste materials when building the beam.
- Use modern machines to cut the wood because they are more accurate.
- Prevent constructing pine wood and fiberglass beam in humid areas because wood expands according to external temperatures.
- Use DI-5C tool to measure the deflection accurately.

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Acknowledgment

By the end of the semester, after managing to propose a successful solution for two of the most significant challenges Egypt face (urban congestion and arid areas) ,we would like to thank Allah then thank STEM family and all those who helped us completing our project in every beneficial way and made such a noticeable effort, a big appreciation goes to: DR.Ahmed Abdelmaqsoud MRS: Noha , MR:Ahmed Morsi ,and MR: Mahmoud sawah .

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Brine module

Obour Stem School

Grade 10, Semester 2, 2021/2022, Group 21119

KEYWORDS:
Brine water - Peltier module-circuit -Byproduct

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KEYWORDS:
Electric energy - cathode, anode-waste heat

Abstract:

Facing Egypt's challenges is essential, especially if four of those challenges are recycling, increasing Egypt's industrial and agricultural base, reducing pollution fouling the air, and climate change. In the capstone, the four of them are dealt with focusing on waste heat and byproducts. To clarify, waste heat is the heat not used as it comes from hot combustion gases, heated water, convection, and radiation, it also severely affects the environment as it increases global warming. Likewise, byproducts are not the primary substance produced in industry, using them will reduce pollution and is also beneficial to recycling.

Based on the aforementioned problems the pursued project was decided to be the Brine module which consists of two parts, the first part is saline water electric circuit, two rods, and connection wires, while the other part is the Peltier module. Inasmuch as the idea revolves around getting voltage out of the brine while using the heat differences by the Peltier module increase the overall voltage output of electricity. Furthermore, the brine module has met the design and solution requirements as it is highly efficient in producing a maximum voltage of 1 volt despite limitations in the material. Likewise, it was concluded that the brine module was used correctly making it safe for usage, it is also efficient in producing voltage, also the voltage could be increased if the concentration of salt increases which worldwide has already been happening due to global warming.

Introduction:

Egypt suffers from various challenges, and addressing them is crucial to solving them, this semester focuses on four main challenges: recycling, increasing the industrial and agricultural base of Egypt, reducing pollution fouling the environment, and climate change. Preserving the environment is essential too and solving the problems is the way to achieve it, thus our capstone is about using waste heat and byproducts that may be a potential source of pollution as rather efficient alternative energy resources. Accordingly, Lots of prior solutions focused on utilizing waste heat and by-products, for example:

The Organic Rankine cycle (ORC) architectures for waste heat converts low-temperature heat into electricity recovery it was applied in many countries. Advantages are working with low-temperature gases, and low cost, disadvantages include the lack of experimental data and potential leakage of hazardous fluids. The pursued solution is the saline circuit that consists of two parts: the saline water electric circuit part and the Peltier module part.

Likewise, achieving the design requirements, the saline water circuit part was chosen based on electrolysis, such that water, magnesium, and copper rods are good conductors of electricity while the Peltier module was chosen to utilize wasted heat produced from high temperature emitted by Brine that is estimated to be of 40 degrees Celsius and through the thermal difference between brine and cold sea water which the Peltier will be exposed to electricity is generated .the solution meets the design requirements in which the brine module is highly efficient as it can produce up to one voltage that was measured using a voltmeter

In addition to that, the module has also high conductivity for electricity, in which saline water is known of good conductivity while the rods alone could light a lamp and the wasted heat is contained within the system and efficiently utilized in increasing output voltage. Also, the solution is entirely eco-friendly and safe to use as it aims to reduce the thermal and chemical pollution through easy and safe techniques.

Methods & Materials:

Item	Quantity	Usage	Cost	Source of purchase	Picture	Description
Copper rods	2	anion	40 L.E	El-qasr El-eainy	 Fig.1	It helps in conductivity and flow of electrons
Magnesium rods	2	cation	36 L.E	El-qasr El-eainy	 Fig.2	It helps in conductivity and flow of electrons
250 ml Beaker	3	Collect brine water	45 L.E	El-qasr El-eainy	 Fig.3	to collect water
Connecting wires	1	Connects the system	5 L.E	Hypermarket	 Fig.4	Connects the system to the voltmeter/ the light lamp
NaCl	200 grams	Conducting solute	34 L.E	El-qasr El-eainy	 Fig.5	Contain the ions which will separate
Distilled water	500 ml	Conducting solvent	5 pounds/ liter	Hypermarket	 Fig.6	It helps electrons to move freely
Peltier module	1	Generates volts	62 L.E	Hypermarket	 Fig.7	Generate electric energy depending on the thermal difference
Total cost	212 L.E					

The prototype aims to combine two systems into a single, efficient system that generates electrical energy, with the electrical energy coming from the saltwater circuit and extra voltages coming from the Peltier module.

Methods:

- In the saline water circuit part, saline water is placed in two beakers, each having 210 mL of distilled boiled water and approximately 60.47 grams of NaCl.
- Copper and magnesium ribbon wrapped on a zinc rod are placed in both the containers and connected to a circuit while the copper in the first container was connected with the magnesium wrapped zinc in the second container so that the anode connects with the other anode and so goes for the cathode, resulting in a flow of electrons in the circuit, generating a current flow, and cold water is placed in another beaker.
- To ensure a smooth operation, the Peltier module is placed between the hot and cold beakers. During the process, all necessary safety precautions were taken, including the use of gloves, coats, and protective eyewear.

Test plan:

The water was boiled to a temperature of 40 degrees Celsius and placed in two beakers while the third was filled with chilly water to create the suitable heat difference to operate the Peltier ; from 20 to 30 grams of NaCl were added gradually in water while continuously stirring the solution.

then , the magnesium ribbon wrapped around the zinc was efficient noticeably despite the shortage, and the entire circuit, including the Peltier module, was connected to a direct voltmeter to give correct results. The Design requirements have been achieved as a net voltage of 1 volt Was produced the test plan procedure is represented in figure.8

Fig.8 Test Plan

Results:

After achievement of the test plan, positive and negative results were recorded as follows:

The positive results were that the brine module was made safe to use as it was used correctly as well as it has achieved all of the design requirements of being cost-effective and efficient. In addition, it was a successful trial to stop thermal pollution from further spreading. Another good point is that the brine module has produced a maximum voltage of approximately 1 volt despite the limitations of the material and was measured using the voltmeter as was represented in Figures 9,10.

Figure.9 (399.9 mv)

Figure.10 (0.997 v)

Additionally, The combination of two systems: the brine circuit and Peltier module allowed the production of a higher voltage than it would have been on its own, and the brine circuit was fully benefited. Furthermore, the conductivity of the brine module was affected by the solubility of salt in water and that is represented in the graph represented in figure 11.

Temperature (degree Celsius)	Solubility (g/200)
20	35.89
30	36.09
40	36.37
50	36.69
60	37.04
70	37.46
80	37.93

Table.2 shows the pattern between Temp. and solubility

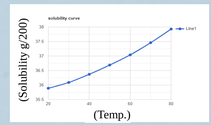

Figure.11 solubility curve

Negative results of the test plan:

The Peltier module produced about 300 ml volt, but it became inefficient once the two sides reached thermal equilibrium preventing it from having heat difference thus no further voltage was produced.

Analysis:

Recycling, pollution, climate change, and increasing Egypt's industrial base were the grand challenges on which we pursued our solution based on. We could successfully conduct a solution that is simple, efficient, and effective. But before conducting that solution, there has been multiple trials of another solution that has failed: the Stirling engine as represented in figure 12. Stirling engines were made using alternative materials, but have failed due to a malfunction that leaked heat, therefore the Peltier module has been added as an alternative solution.

Figure.12 Stirling engine

The pursued solution had some cons and pros which can be summarized in the following context: :

Firstly, Pros:

Combining of two systems in the prototype allowed it to produce a higher voltage compared to utilizing only waste heat or saline water conductivity each on it's own. Although the prototype was built on basic simple bases, its efficiency was proven in conducting electricity as it produced a net voltage of approximately 1 volt. Additionally, the components chosen for the construction allowed a wide room for continuous improvement without any constraints.

Furthermore, utilizing waste heat by using the Peltier module was an excellent choice considering that both hot water and cold water are available for the project since most of the desalination stations that provide the hot brine water are constructed near oceans thus cold water of oceans will provide the low temperature to one side of the Peltier module while the hot side is heated by the brine water.

The brine's high salinity contributed largely to the effectiveness of the project as the brine is considered to have a salinity rate ranging from 3.5% up to 26% of salt content which increases its ability to both generate electricity and a great conducting medium in addition to being characterized by low freezing point and high boiling point which aids in generating the heat difference required for the Peltier module also the solution will keep its temperature for longer periods than pure water, therefore, lessening the need for a continuous supply of heat or cool to either side of the Peltier. In addition to that, the solution will solve thermal and chemical pollution issues that resulted from disposal of brine in oceans therefore aiding in reducing climate change and preserving environment

Secondly, Cons:

With every successful project comes a few disadvantages and our project was no exception as during the testing stage we faced some issues like the low voltage that resulted from the circuit. Another disadvantage is the potential of breaking down the Peltier module if the heat difference was not handled effectively for example if the hot side exceeded the temperature estimated the Peltier will be damaged. In addition to that when the equilibrium between the two sides of the device is reached no more heat will be conducted the problem was overcome by using brine water and seawater as heat and cool sources due to the aforementioned reasons regarding their low freezing point and high boiling point that better allows them to lose heat in a slower rate than pure solutions. Likewise, our project successfully met the design requirements as it did not involve any kind of high pressure or damaging high temperature instead, we utilized by-products' high-temperature emission and electric conductivity that usually were wasted causing both thermal and environmental pollution. Additionally, the output energy was produced in safe amounts which allowed us to experiment in a safe environment.

Furthermore, some measures were taken and includes the solubility of salt in water as The warmer the solution, the higher the solubility of the material being dissolved and therefore the higher the conductivity as well, therefore,

Mass of NaCl added= mass of beaker after adding NaCl – mass of the empty beaker = 104.97 g – 44.5 g = 60.47 g

No. of moles of NaCl added to the aqueous solution $= \frac{mass\ added}{molar\ mass\ of\ NaCl} = \frac{60.47\ g}{58.44\ g/mol} =$ 1.035 moles

Solubility percentage = $\frac{solute\ mass}{solvent\ mass}$ X 100 = $\frac{60.47}{210}$ X 100 = 28.79 %

In addition, the salt concentration in water determines its conductivity. The greater the salt concentration, the higher the conductivity. Brine, having the largest concentration of salts, consequently, has the highest conductivity, therefore, in our module, the concentration was determined by C = number of moles of solute/ volume of solvent

Which equals = 1.035/210 = 0.49%

The concentration- conductivity graph of brine was represented in the graph presented in figure 13.

Concentration	Voltages
0.34 m	260mv
0.68 m	380mv
1.02 m	530mv
1.37 m	690mv

Table.3 shows the pattern between concentration and voltages

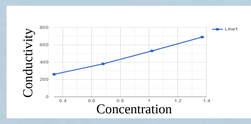

Figure.13 graph of conductivity and concentration

During the process, 3 reactions took place including the reaction of sodium chloride with water , redox reaction between copper and magnesium and redox reaction of water molecules.

- **NaCl + H2O → NaOH + HCl**
- **Cu2+ + Mg → Cu + Mg2+**
- **2H2O + 2e → H2 + 2OH-**

No.	LO.s	
1	CH.l.o13	We learned bout oxidation and reduction (redox reaction), Electrolysis is an example of it.
2	PH.l.o10	We learned about heat and temperature.
3	CH.l.o8	We studied the solubility curve which represents saturation. Above the curve, the solution is supersaturated.
4	CH.l.o10	We learned how to balance a chemical equation, how to calculate moles.
5	English	Helped us in writing (Academic writing).

Conclusion:

Consequently, to the test plan's success, we have come to various conclusions.

• The first conclusion, was that the project had successfully achieved all the design requirements. First, the project used by-products as an input, the project generated clean energy which is electricity and was efficient as it produced one voltage
in addition, the brine module was eco-friendly, use and its materials were practical and available.

• Secondly, the more the concentration of salt was, the more voltage is produced, and when the temperature of the water increased, the solubility of the salt increased until it became supersaturated which increased ionization as much as possible.

• Thirdly, the Peltier module was not as efficient as it should have been due to the small heat difference.

• Lastly, when the prior solutions had been compared with the brine module, it was found that our solution was more efficient and with available by-products, and cost-effective.

Recommendation:

Having more opportunities would have made us do better in our project, therefore, In further future, we hope there will be better opportunities that will improve the project, therefore we recommend

• using the low heat Stirling engine and improving it for it to work efficiently

• adding a better heat isolator in the Peltier module like a varnisher or fiberglass along with ceramic to magnify the heat difference in the Peltier module

• using an ion exchanger membrane to separate ions in the electrolysis of brine such that in electrodialysis of water to increase the efficiency of the brine, we couldn't manufacture it due to time constraints and it was too expensive to buy.

Lastly, we hope that the idea of the project will be improved given that there will be enough time and adequate material.

Acknowledgment:

First of all, I would thank Allah for being able to apply our idea and successfully complete our project. We would like to thank all the people who helped and guided us in our capstone project. Starting with our Schoolmaster, Dr. Ahmed Abd El-Maksoud. our capstone leaders, Mr. Ahmed Morsy and Mrs. Noha Anbar. We would not forget our teachers, Mrs. Wessam Gamal and Eman Abdul Raziq, their suggestions and directions have helped us. Finally, we want to give special thanks to Mrs. Shimaa Sophy for helping us a lot.

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Keywords:
Floods
Recycling
Arched dam
Water storage
Climate change

AQUA DAM

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Qena STEM school Grade 1 Semester 1
2023 / 2024

ABSTRACT

To be a developed country, Egypt needs to solve a numerous problem: Climate change and flash floods, providing water and energy resources, urban congestion and improving arid areas. Solving the previous issues is crucial to Egypt's progress. The main challenge will be overcome is flash floods. Through the recent decades, climate change increased the humidity, making the crust drier and less absorbable to water which increase the amount of flash floods. Flash floods cause harmful dangers to people and urban areas. Adoption of a structure that can stop the flash flood, absorb the shock of it and help exploit the flooding water is a great way to adapt with this problem. This selected solution is the dam. The dam will be an arch dam, to distribute the pressure of water by its inclined surface. The dam can store up to 60 liters, with a pathway which can drain from %25 to %75 of storage water. There is a spillway to spill the extra water of the total capacity automatically. The dam will depend on the pressure of water and the gravitational force exerts on it while draining, to move a gear put opposite on the drainage way. The gear is connected to a generator which will change the kinetic energy to electric energy to be stored in a battery (as a sustainable energy). This project relies on exploiting the shape of the surface to distribute the pressure and the flowing water to generate energy.

INTRODUCTION

Nowadays, Egypt is facing several problems that obstruct its renaissance in many aspects: economic, social, in population organization and adapting to nature change. These challenges represent in: Providing new sources for water and alternative resources of energy, developing the industrial and agriculture bases, adapting to global warming and climate change and their effects, lastly dealing with arid areas, population rise and urban congestion because of it. Utilities (water and electricity) are essential services for industry, economic and social development. Egypt, like any country, inherently needs water, not just as the basic needed for agriculture but also it goes in many industries. Also, water security has been a dangerous issue throughout the subsequent decades. Now, the whole world is rapidly moving to use sustainable energy which is foreseen to create the next energy revolution. Providing an unlimited source of electricity can change industry thoroughly. Having a new water and energy resource is a great step to improve the agriculture and industry in Egypt. From 1897 until now, Egypt population has increased with high rates to be the most population country in the region, as it can be seen in **(fig.1)**

(fig.1)
Egypt population growth rate (%) 1950-2050

High rates of population cause several problems to Egypt including low in family income average, increasing unemployment and the inability of the country to provide basic needs for citizens such as education and other public facilities like care health. Also, it leads to another big problem which is "urban congestion." However, the increase in overpopulation size with the lack of livable places, and the lack of housing availability and affordability of providing necessary needs of life is what causes the urban crowding.

From the later part of 19th (the estimated history of the begging of climate change) until now, and the world has gotten great changes, making high rise of temperature, global warming, a considerable negatively effect on agriculture and a great losing of work forces, climate change is considerable to be the largest threat to the humans in this century. Besides its all effects, climate change has increased the rate of flash floods in the world by. Egypt is also affected by climate; the rate of flash floods increased lately especially in five of the six main urban centers on the coast of Red Sea, as **(fig.2)** shows.

(fig.2)
Urban places exposed to flash floods on the red seacoast.

Choosing the prototype design depended on inspection of other prior solutions. The three Gorges dam in China is a hydropower dam, generating electricity from water, which is a merit for it. As a result, it decreases the usage of coal nearly 50 million tons, contributing adapt with climate change. The dam doesn't adapt to its surrounding environment, causing earthquakes and threatening fish life by holding and preventing it from movement. As contrivance to develop agriculture and electricity generating, the Manantali dam is built. But there were some of biological dangers unexpected.
The dam caused harmful diseases such as Bilharzia and destroyed the forests downstream because of the suppression of the seasonal flood cycle. We benefited from these strengths as the following: we decided to generate hydropower from the dam to make a new electricity resource. From the weaknesses: we recommend studying the environment the dam will be in before building, from: population, animal, and plant life. Also, to study the biological changes the dam can cause like, diseases or killing creatures around. After extensive research, a dam was chosen as the solution to address Egypt's challenges.
The dam aims to absorb flash floods, store water, and provide various benefits, including purification through treatment plants making new resources of water for drinking and agriculture.
In addition, the is expected to produce hydropower by using gravitational force and the pressure of water with a gear connected to a generator, contributing to sustainable energy. By providing water and energy resources, the project aims to enhance agriculture and industry including arid areas, encourage population distribution to arid areas, and reduce
urban congestion.

MATERIALS

Items	Cement	Aluminum bars	Wooden mold	Sand	Small stones	Gate
Usage	Mixed with other materials to construct the dam	Mixed with other materials to construct the dam	The mold that will contain building materials until they dry	Mixed with other materials to construct the dam	Mixed with other materials to construct the dam	Used to control amount of water inside the dam
Source	El Nahda Cement factory	Old bike	Carpentry shop	Street		FAB LAP
Picture						

(table.1) The materials that we used

METHODS

For Constructing our prototype, we followed multiple steps:

1. We stuck these wooden sides together with small nails to make a wooden mold.
2. We mixed our materials (Cement, Sand, and small rocks) together to make equivalent mixture.
3. Then we poured this mixture into the wooden mold we created to take the shape as we designed.
4. We gave them enough time to hold together well and to have more hardness.

(fig.3)

(fig.4)


(fig.5)

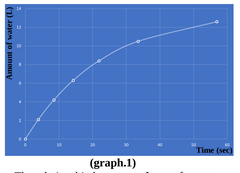
Wooden mold Mixture of materials After contrasting

TEST PLAN

There are a lot of things that we should test to outfit What is required from in the design requirements in the challenge

a. The water must be kept at least 25 cm.
b. The dam structure has a minimum height of 30 cm.
c. The dam's components should be able to withstand a load of at least 10 kg at its midpoint without bending.
d. Gates should be able to discharge water to both 25% and 50 % of the stored water target amount .
e. The minimum storage time of the maximum designed capacity was ensured to exceed 2 hours without any leak during prototype testing.
f. The flow rate of water lost was determined by dividing the total amount of water lost into the values of time

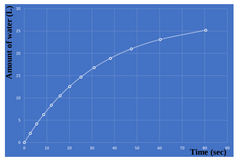
RESULTS



(graph.1)
The relationship between **volume** of water (L) and **time** (sec) of discharging **25%**

(table.2) 25% of the water discharge

Volume (L)	Time (sec)
2.1 L	3.8 sec
4.2 L	8.4 sec
6.3 L	14.2 sec
8.4 L	21.8 sec
10.5 L	33.5 sec
12.6 L	56.8 sec



(graph.2)
The relationship between **amount** of water (L) and **time** (sec) of discharging **50%**

(table.3) 50% of the water discharge

Volume (L)	Time (sec)
2.1 L	2.6 sec
4.2 L	5.4 sec
6.3 L	8.5 sec
8.4 L	11.9 sec
10.5 L	15.8 sec
12.6 L	20.1 sec
14.7 L	25.8 sec
16.8 L	30.9 sec
18.9 L	38.1 sec
21 L	47.4 sec
23.1 L	60.2 sec
25.2 L	80.4 sec

ANALYSIS

Over the period of the three years in STEM Schools, Egypt faces eleven major challenges that require STEM solutions. This semester's project aims to solve four major issues facing Egypt (**Manage and increase the sources of clean water, deal with urban congestion, recycled garbage, and wastes for economic and environmental purposes, and reduce the effect of climate change**) These problems will increase in the future for the world, especially Egypt. Therefore, a solution is required to be found to prevent us from having more effects of these problems in the future.

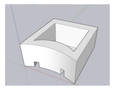
To solve these problems and come up with a scientific solution, we used the **(EDP)** process.

- Start with, the problem was identified by discussing related topics such as (causes of climate change, urban congestion, fewer sources of water and Prior solutions that aim to solve like these problems)
- Second, in terms of solutions, multiple topics were examined to determine the best way to solve these problems.
- After careful study, constructing a dam was the best way to solve the matter.

(fig.6)

The design of our prototype: -

The dam's structure is represented by the prototype, which is a square tank with an arched side. Within the prototype is a gate that may be opened and closed by a hydraulic way using Serigne as in **(fig.8)**


(fig.7)


(fig.8)

Our prototype has some **advantages** like:

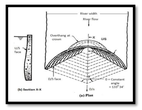
- Its ability to perform its function of protecting the surrounding areas from floods.
- It is constructed out of inexpensive, strong, and common (not rare) material as cement.
- We can use it in irrigation.

In addition, it has some **restrictions** as:

- Its mass is very big and troubles of carrying it.
- Due to its distinctive design, it requires high skill in its construction, which is difficult to find it.
- There is a little difficult to design the gates and control their opening and closing due to its shape that is closer to a semicircle.

Angle of Arc:

Everyone knows that the best solutions, especially for experts, are obtained after many tests and trials. After researching the best angle of the arch that we would employ, We found that **133 degrees** is the most suitable angle for the arch.



(fig.9)

The results of the Test plan: -

- For two hours, the dam was able to hold its maximum load without leaking.
- The dam was able to discharge about 25% and 50% of the total volume of water.
- The dam did not bend when applied to a load of 10 kg at its middle.

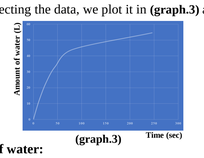
Our testing has enabled us to observe the **following** things:

- **Flowrate of water:**

As we determined the water flow rate for our test. We calculated it using the following law.

Flowrate = Amount of water / specific time

After collecting the data, we plot it in **(graph.3)** and **(table.4) below.**



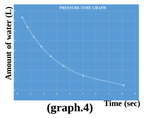
(graph.3)

Amount of water (L)	Time (sec)
2.1 L	1.8 sec
12.6 L	12.4 sec
23.1 L	26.7 sec
33.6 L	45.8 sec
44.1 L	81.2 sec
54.6 L	246.5 sec

(table.4)

- **Pressure of water:**

We calculated the pressure of water that hits our prototype. The formula that we can use to determine the water pressure on the dam is **p=gh**ρ, where g is the water's acceleration equal to 9.8 (the gravity), h is the water's height, and ρ is the water's density, which is equal to one (it may vary if the water isn't clear) as it represented in **(graph.4).**



(graph.4)

LEARNING TRANSFER

Subject /Learning out come	Connections
ES.1.01	It helps us in our choices about the location of the dam.
ME.1.01	We studied how to create a relationship between water volume and time to calculate flow rate and display it graphically.
CH.1.01	We organized our project using scientific methods, which made it easier for us to arrange our ideas, solutions, and techniques..
MA.1.02	We studied the function of charts in presenting data.
ES.1.03	We learned that the best way to identify a strong material is by searching for one with stronger atomic bonds.
CS (Sketch up)	Using this app, we created a 3D model for the Dam.

(table.5)
Subject that helped us

CONCLUSION

The prototype must meet the design requirements to work successfully. For example, our prototype can deal with over water it receives, it can save water in it for as long as possible without any leak. Its durability is more than 10kg. It is made of only one manufacturing material, which is cement. Our prototype can get rid of 50% or 75% of its total capacity, too. Also, It should be mentioned that on our journey to industry to make the prototype, we have found many previous solutions that may be compatible with the manufacture of our prototype, and we were inspired by many ideas from them. All these driving factors and the experiences we have gained made us capable of teamwork, solving problems and acting wisely. After we conducted our experiments on the prototype and took the results, We can determine that the prototype satisfies the design requirements and is suitable for applied in real life based on the results of this test plan. But, If we want to see this idea in real life, we will have to decide where in Egypt gets the most rainfall and construct the project there.

RECOMMENDATIONS

Although our project has multiple advantages, we hope that it will become more efficient in the future, so we recommended somethings:

- **Apply sensor technologies to control the gates:** You can automate the process of releasing extra water from the dam using sensor technologies.
- **Optimize the container's dimensions and structure:** Instead of designing a small container, think about going with a medium-sized design that achieves a balance between price and usability.
- **North Sinai is the most suitable location for the dam:** The best location, considering the dam is constructed in the real life, is North Sinai, especially in Rafah.
- **Do not build the dam in places with sandy soil:** Finding an area with better soil conditions may help reduce waste and increase water storage.
- **Provide the dam with a property of self-cleaning** for water to be available for irrigation.
- **Use an LCD screen** to determine the volume of water.
- **Generate electricity using a linked generator:** Take into consideration designing a generator that can use the power of flowing water to produce energy. The sensors, gates, and other parts of the dam system can then be powered by this electricity, allowing for independent operation.

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ACKNOWLEDGMENT

We are grateful of Allah for helping us on our travel. We would like to thank all the teachers at QENA STEM School, especially professors Shahat Jamea (Capstone teacher), Mahmoud Abdallah (G-10 Leader Capstone) and Ahmed Elmoez (G-10 General Capstone). We are grateful to our friends in G-11 and G-12 for their help and for providing us with the information we need. We appreciate Engineer/Bassam and Engineer/Ashraf Abd ElGhany who supplied us with more information during our field trip to Nag Hammadi.

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Grade 11, Semester 1
2021/2022
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The Migrating Ions

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KEY WORDS: Microbial desalination cell (MDC) / Microbial fuel cell (MFC) / Anion exchange membrane / Cation exchange membrane / Membrane fouling / Salt transfer

ABSTRACT

Egypt, like other countries, suffers from many problems that it is trying to solve, such as (water shortage, overpopulation). Among these problems is the problem of water shortage accompanying population growth, where this growth leads to water consumption and the need to find other sources of water in proportion to the population growth that Egypt is going through. The EDP process was followed in order to find a scientific solution to this problem. First, the topics related to the problem were searched in order to identify the problem, including (population increase / available water sources in Egypt), then the previous solutions were searched in order to obtain ideas for finding solutions to the problem of water shortage. After that, the microbial desalination cell was selected, which is one of the previous solutions that work on developing and addressing its negative points such as the high membrane price and low desalination rate. Several design requirements have been set to test the efficiency of the prototype to be manufactured, including a high energy production rate and a high ions removal rate. The project was tested for compliance with predefined design requirements and it was noted that maximum removal rate found in pure NaCl solution (71.1% of Cl^- and 82.6% of Na^+ were removed). It was also noted that manufacturing ion exchange membranes at a low cost has a 10% lower efficiency than the original high-priced exchange membrane.

INTRODUCTION

Water shortage is a problem facing the whole world and Egypt is one of the countries that suffer from water shortage. Although the Nile River is available as a major source of fresh water, it is not sufficient with the massive population growth that Egypt is experiencing. Therefore, the focus was on unused water sources to benefit from them, in addition to the main water sources for Egypt, such as the Nile River, groundwater and others. Examples of unused water sources are seawater and atmospheric water. The EDP process was followed in order to find a scientific solution to this problem. Several steps have been taken to come up with a solution that will help reduce this problem even by a small part. The problem was searched in the beginning and previous solutions to the problem were found, among these solutions (thermal desalination and desalination using reverse osmosis), which have many advantages in desalinating very saline water but have some problems that make them difficult to implement, which is their high energy consumption, this makes the process more expensive. Therefore, it was attempted to find desalination processes that consume a small amount of energy to solve this problem, so a *microbial desalination cell* was chosen that desalinates water through the energy produced by the oxidation of bacteria, but this desalination process faces many problems, including the high price of membranes and low rate of desalination. Therefore, it was searched for how to solve these two problems by finding ways to make membranes using cheap materials or alternatives to these membranes. A way has already been found to make ion exchange membranes using cheap materials. An experiment was also conducted that helped to know the condition of the saline sample that leads to an increase in the rate of removing ions from the salt water, and it was found that the pure NaCl solution has a large removal rate.

MATERIALS & METHODS

The selection of the materials from which the project will be completed and its components is considered one of the most important stages of the project. Materials must be selected in accordance with the specific design requirements.

1. ***Materials from which the cation exchange membrane is made:***

Item	Cleaning Cloth	Polyvinyl acetate (PVA Glue)	Boric Acid
Picture			
Cost	5 EGP / 1 piece	10 EGP / 0.25 kg	10 EGP / 100 g
Usage	Used as a base of the cation exchange membrane.	It is used to close the small pores between the parts of the base of cleaning cloth to create a membrane base that is impermeable to water.	It is used as a functional group to make a concentrated membrane in an acidic solution to prepare it for ion exchange.

Table 1 *(The materials from which the cation exchange membrane is made)*

2. ***Materials from which the anion exchange membrane is made:***

Item	(PVP)	Polyvinyl alcohol (PVA)	Acetone	Glutaraldehyde	Hydrochloric Acid (HCL)	Potassium Hydroxide (KOH)
Picture						
Cost	12 EGP / 20 gram	26 EGP / 40 gram	15 EGP / 240 ml	24 EGP / 120 ml	1 EGP / 3 ml	44 EGP / 51.6 gram
Usage	Make the polymer base of the membrane by mixing them together at a specific concentration to each other		Make cross linking solution that bond short polymers chains together.			Make functional group that make anion exchange membrane

Table 2 *(The material from which the anion exchange membrane is made)*

3. ***Materials for the entire prototype:***

Item	Acrylic sheets	Copper Rod	Zinc Rod	Anion Exchange membrane	Cation Exchange membrane	Resistor (10 Ω)	crocodile wire
Picture							
Cost	250 EGP / (70 * 70) cm	20 EGP / 1 rod	35 EGP / 1 rod	122 EGP / 1 membrane (25cm * 15cm)	25 EGP / 1 membrane (13 * 13) cm	2 EGP / resistor	5 EGP / 2 wires

Table 3 *(The materials that make up the entire prototype)*

The total cost of the entire prototype = 250 + 20 + 35 + 122 + 25 + 2 + 5 = ***459 EGP***

❑ *Methods*:

After the materials used in the construction of the prototype have been included, in this section the steps of building the project will be explained using the materials previously mentioned.

○ ***The steps used in the construction of the prototype:***

➢ The container was built from acrylic with dimensions *45cm * 15cm * 15cm*.

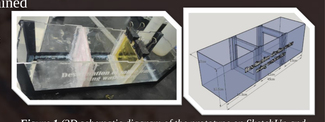


Figure 1 *(3D schematic diagram of the prototype on SketchUp and real prototype design)*

○ ***Manufacturing an anion exchange membrane*** *(30cm*20cm)*

- Mix 20g of (PVA) with 10g of (PVP) to make the base of the membrane, and then leave it to harden in a period of *24 hours to 48 hours*.
- Make cross linking solution by mixing (*100ml glutaraldehyde 2% with 50 drops of HCl with 200 ml acetone*), and then put the PVA and PVP base into it and leave it 40 minutes.
- After that, take the membrane and put it into the solution of (*300ml H_2O with 51.6ml of KOH*) and put all of the solution with the membrane in the oven in temperature *60 degree Celsius for 3 hours*.

○ ***Manufacturing a cation exchange membrane*** *(30cm*30cm)*

Get a cleaning cloth and start covering it with polyvinyl acetate (PVA glue) until all the pores are covered, after that the cleaning cloth and glue sprayed with boric acid.

❑ *Test Plan:*

○ ***Measurable design requirements that must be fulfilled in the prototype:***

1. The quality of water suitable for irrigating agricultural crops that can grow with a high degree of soluble solids such as cotton.
2. Low energy consumption and high energy production of microbial fuel cell.
3. Low cost of the prototype.

○ ***Test plan steps:***

The prototype was prepared by processing the anodic chamber and cathodic chamber and desalination chamber. In order to prepare the desalination chamber, three different types of saltwater samples, (***pure NaCl solution, synthetic seawater, and real seawater***) were used in the desalination chamber. and the ion exchange membranes were put between chambers and desalination chamber. Then the test plan was worked on for two consecutive weeks where ion transport measurements are taken every two days to obtain the result of the total dissolved solids (TDS) of the water during the process.

➢ A **voltmeter** was used to monitor and measure the voltage produced by the microbial fuel cell.

➢ **ion chromatography (IC) system** was used to calculate Anions and cations in saltwater samples.

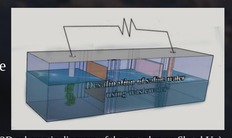


Figure 2 *(3D schematic diagram of the test plan on SketchUp)*

RESULTS

In the test plan, data is collected to check whether the predetermined design requirements have been reached or not. In the test plan, *two design requirements were verified*:

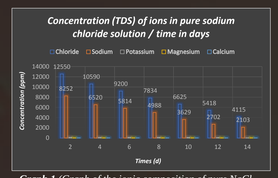
- The rate of ion transport across membranes and the total dissolved solids in salt water Over time.
- The energy production rate of the microbial fuel cell.

✓ *The rate of ion transport across membranes* was calculated by the **TDS meter.**

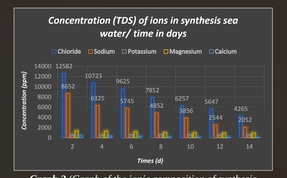
✓ The energy production rate of the microbial fuel cell was calculated by **voltmeter**.

days	Electric potential (V)	Resistance (Ω)	Current intensity (Amp)
Starting point of experiment	0	0 Ω	0
2	283 mV	10 Ω	0.0283 Amp
4	365 mV	10 Ω	0.0365 Amp
6	456 mV	10 Ω	0.0456 Amp
8	312 mV	10 Ω	0.0312 Amp
10	209 mV	10 Ω	0.0209 Amp
12	101 mV	10 Ω	0.0101 Amp
14	65 mV	10 Ω	0.0065 Amp

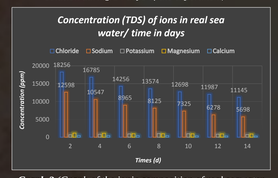
Table 10 *(Voltage results that generated from the anodic chamber during 14 days)*



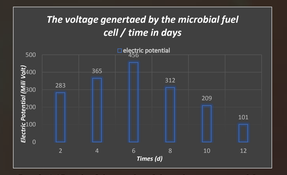
Graph 1 *(Graph of the ionic composition of pure NaCl solution during 14 days of the experiment)*



Graph 2 *(Graph of the ionic composition of synthesis seawater during 14 days of the experiment)*



Graph 3 *(Graph of the ionic composition of real seawater during 14 days of the experiment)*



Graph 4 *(Graph of the results of the voltage generated from the anodic chamber during 14 days) days)*

Ions	Saltwater in desalination chamber			Catholyte	Anolyte
	Pure (NaCl) solution	Synthetic seawater	Real seawater	Phosphate buffer	domestic wastewater
Cl^-	14250	14650	20325	16	320
Na^+	12110	10690	14232	530	-
K^+	112	532	498	5233	-
Mg^{+2}	0.658	1452	1256	0.325	-
Ca^{+2}	0.981	511	528	9	-

Table 4 *(ionic compositions of the saltwater solutions used in the desalination chamber)*

days	Cl^-	Na^+	K^+	Mg^{+2}	Ca^{+2}
starting point of experiment	14650	10690	532	1452	511
2	12582	8652	562	1347	403
4	10723	6325	587	1298	341
6	9625	5745	592	1180	269
8	7852	4852	601	1025	158
10	6257	3856	612	978	106
12	5647	2544	589	947	95
14	4265	2052	578	911	78

Table 6 *(Results of the ionic composition of synthesis seawater during 14 days of the experiment)*

Ions concentration (ppm)	Fast removal zone		
	Pure (NaCl) solution	Synthetic seawater	Real seawater
Chloride	841 ppm / day	837.5 ppm / day	1011.5 ppm / day
Sodium	1049 ppm / day	824 ppm / day	877.8 ppm / day

Table 8 *(Average ions removal in the fast removal zone)*

Zone	Voltage
From starting point of experiment to day 6	An increase of 76 mV / day
From day 6 to day 14	A decrease of 50 mV / day

Table 11 *(Average voltage change in the whole process)*

days	Cl^-	Na^+	K^+	Mg^{+2}	Ca^{+2}
starting point of experiment	14250	12110	112	0.658	0.981
2	12550	8252	125	0.852	0.975
4	10590	6520	130	0.985	0.973
6	9200	5814	131	1.01	0.962
8	7834	4988	122	1.07	0.941
10	6625	3629	115	0.362	0.975
12	5418	2702	98	0.268	0.952
14	4115	2103	32	0.167	0.963

Table 5 *(Results of the ionic composition of pure NaCl solution during 14 days of the experiment)*

days	Cl^-	Na^+	K^+	Mg^{+2}	Ca^{+2}
starting point of experiment	20325	14232	498	1256	528
2	18256	12598	698	1163	496
4	16785	10547	821	1102	475
6	14256	8965	936	984	456
8	13574	8125	1024	965	433
10	12698	7325	964	942	401
12	11987	6278	852	933	369
14	11145	5698	739	912	346

Table 7 *(Results of the ionic composition of real seawater during 14 days of the experiment)*

Ions concentration (ppm)	Slow removal zone		
	Pure (NaCl) solution	Synthetic seawater	Real seawater
Chloride	635.6 ppm / day	649.5 ppm / day	388.8 ppm / day
Sodium	463.8 ppm / day	461.6 ppm / day	408.3 ppm / day

Table 9 *(Average ions removal in the slow removal zone)*

ANALYSIS

There are 11 major challenges to Egypt that will be solved over the three years in STEM. Challenge this semester is about water shortages and how to take advantage of non-used water such as saline water in oceans and atmospheric water. The (EDP) process was followed in this problem in order to find a scientific solution to this problem.

1. Topics related to the problem were discussed in order to identify this problem such as (available water sources in Egypt / causes of water shortage in Egypt / population growth and its relationship to water shortage / water uses in Egypt).
2. After identifying the relevant problem and topics, the previous solutions for the problem were discussed, such as (electrolysis/ Microbial Desalination Cell), these solutions helped choose the solution that will be worked that is (***microbial desalination cell***).

Microbial desalination cell is a tri-functional project that (desalinate water / produce electricity from bacteria / wastewater treatment).

❑ **Advantages of Microbial Desalination Cell**:

1. Do not depend on an external source of electricity because they produce energy by oxidation bacteria.
1. It has no great cost due to its little energy consumption.

❑ **Disadvantages of Microbial Desalination Cell**:

1. Low desalination rate , Degradation of organic matter, Poor electrochemical performance, Membrane fouling, Low microbial activity.

Work was chosen on the membranes and trying to develop *Ionic exchange membranes* at a low price and has the same quality or quality of less than manufactured membranes.

Ion exchange membranes have already been developed and manufactured by inexpensive chemicals, where the membrane was manufactured *at a lower 10 times* of the original membrane price but manufacturing ion exchange membranes at low cost has **10%** lower efficiency than the original high-priced exchange membrane.

❑ **Design requirements of the prototype**:

After the project will be determined, the project design requirements are identified which is must be measurable to be able to know if the prototype success or not. These requirements are as follows:

1. High rate of *ion transfer to ion exchange membranes*, which leads to a decrease in the percentage of (**TDS**) in the water.
2. High power production by *microbial fuel cell* in the *anodic chamber*.

❑ **Prototype Test Plan:**

After the prototype has been built, a test must be carried out to ascertain whether the prototype meets *the design requirements* or not.

❑ ***Analysis***

Anions and cations were calculated for all three samples of saltwater solutions using an ion chromatography (IC) system. The analyses were carried out on salt water samples taken every two days to examine the ions transportation and removal rates. The voltage also was recorded every two days using voltmeter that connected with 10 Ω external resistor. The current intensity was calculated using the Ohm's law equation (V=IR).

❑ ***Discussion***

Ions transport across the membranes in MDC:

This rate was calculated using 3 different samples of saline water (pure NaCl solution/synthetic seawater/real seawater), Transportation via membranes in MDC depend on decreasing ions mass in the desalination chamber.

Graphs 1, 2, 3 (in *Results* section) shows that the concentration of *Cl^-, Na^+, K^+ Ca^{+2}, Mg^{+2}* in pure NaCl solution, synthetic sea water, real sea water respectively, decreases in the desalination chambers by the transportation of ions from desalinating liquid to the other chambers.

It was noted that K+ concentration in desalination chamber increase with passes of time that occur because the K^+ diffused from the catholyte to the desalination chamber and accumulated gradually in the liquid being desalinated, which ultimately increased the ions concentration in the desalination chamber. this situation can be prevented by using a proper approach for *pH control* rather than using buffering agents.

✓ ***Table 12*** **s**ummarize the removal percentage of ions from the three different samples of salt water being desalinated during 14 day of operation.

The results indicated that the *highest removal percentage* is in **pure NaCl solution**, while *moderate removal percentage* and *low removal percentage* were observed when using **the synthetic** and **real seawater** samples, respectively. The reason of the slightly lower removal percentage of ions with the synthetic and real seawater was due to *the competition in ions migration from the complex mixture of seawater*.

Type of desalinated liquid	Removal percentage (%)			
	Cl^-	Na^+	Mg^{+2}	Ca^{+2}
Pure NaCl solution	71.1	82.6	-	-
Synthetic seawater	70.8	80.8	37.2	84.7
Real seawater	45.1	59.9	27.3	34.4

Table 12 *(removal percentage in salt water samples)*

- During the 14-day batch operation, there are two different zones in the removal of ions:
  Fast removal zone (*From starting point of experiment to day 6*).
  Slow removal zone (*From day 6 to day 14*).

Linear equation that represent rate of removal in each zone: ***(Y = - AX + B)***

A = average change in concentration of ion in the zone

B = start concentration of ion in the zone

Table 13 *(Learning outcome used in this project)*

Chemistry	Geology	Biology	Physics	Math
L.O.2.01	L.O.2.01	L.O.2.01	L.O.2.03	L.O.2.01
L.O.2.02	L.O.2.02	L.O.2.02	L.O.2.04	L.O.2.05
L.O.2.05	L.O.2.04			

CONCLUSION

Microbial Desalination Cell is a desalination system based on *self-generated bioelectricity and concentration gradients* to transport salt ions across membranes. In this study, the focus was on the transport properties of salt ions in three different samples of saline water (pure NaCl solution/ synthesis seawater/real seawater) and it was found that the ion transfer efficiency depended on several factors, ***including***:

✓ The composition and concentration of salt in the liquids to be desalinated.

✓ Ion exchange membrane.

Several things were noted during this study, **including**:

➢ The rate of ion transfer in (*pure NaCl solution*) is more than that of ion transfer rate in synthesis seawater and real seawater.

➢ K^+ ions is back diffused into the desalinate chamber from catholyte solution.

➢ Manufacturing ion exchange membranes at low cost has 10% lower efficiency than the original high-priced exchange membrane.

RECOMMENDATIONS

After all this discussion about the project, we have come to the end of the project and in this section, we will introduce some recommendations for future work in this project and recommendations to help other teams to works and develop this project.

❑ ***Recommendations for real-world applications of the project:***

1. Making a desalination plant with a full section to make the membranes needed for the project
2. using the same materials that were used in our low-price project.

Establishing a desalination plant next to a sewage treatment plant or treating industrial water.

❑ ***Recommendations to other teams wishing to continue work on this project:***

Working on developing the project and finding ways to increase the efficiency of the project, such as making modifications to the ion exchange membranes used or modifications to the bacteria used to produce the energy operating the reaction.

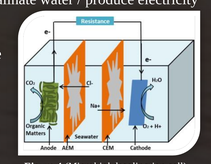


Figure 4 *(Microbial desalination cell)*

LITERATURE CITED

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