ECTS

"Electric Circuit treating system "

Kafr Elsheikh STEM School

SEMESTER ONE   GROUP 18221

GRADE 11(2020/2021)

TEAM Members

1-Rahma Elsayed Fetouh
2-Shaza Hany Mohamed
3- Rana Samir Mohamed
4- Manar El saiedy

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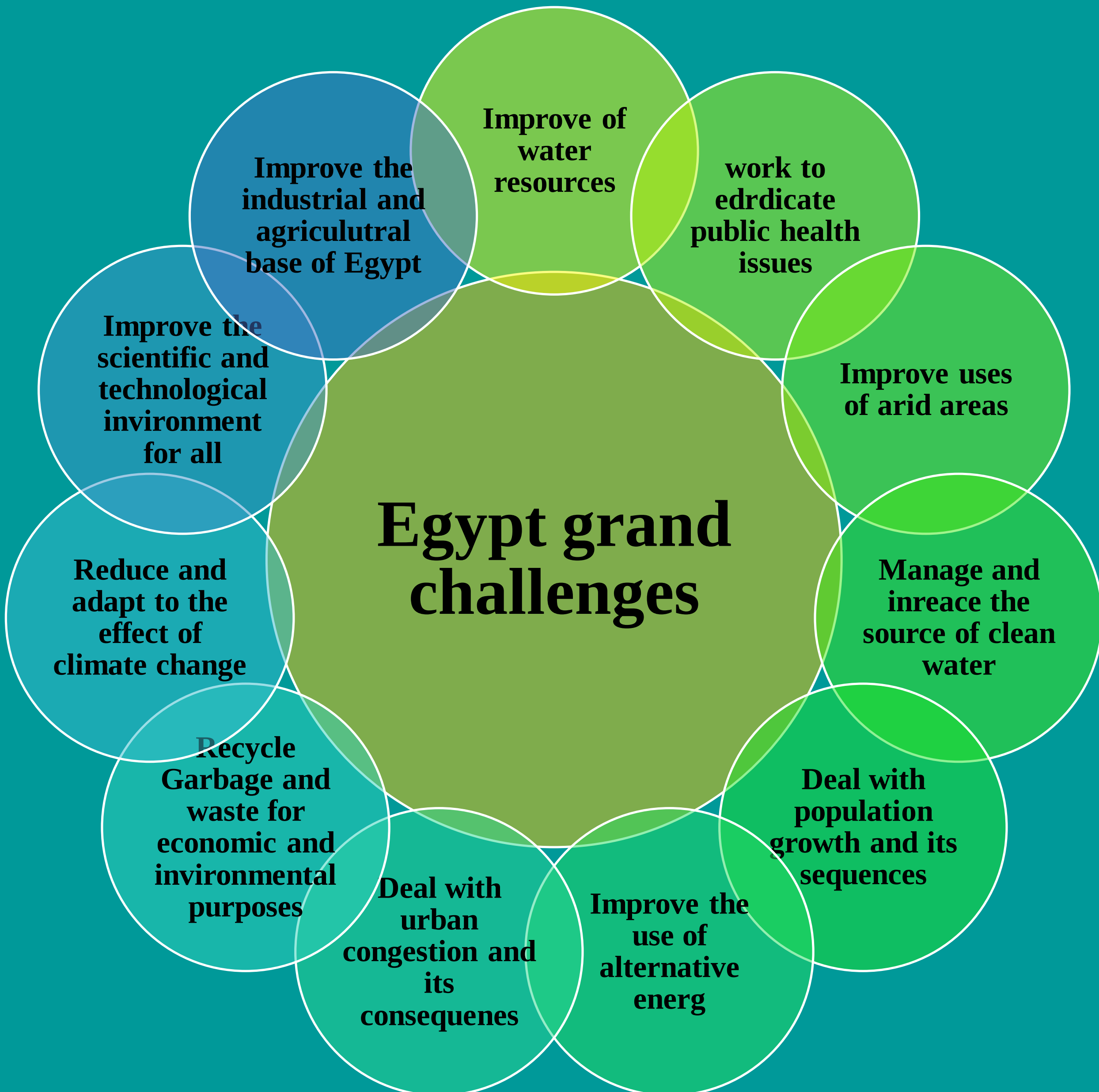
1. Present and Justify a Problem and Solution Requirements.

1.1 Egypt Grand Challenges

“On our earth there is no heaven, but there are pieces of it”

We live in a changing world, constantly surrounded by overwhelming changes and challenges, a world in which we can no longer go on without having clear answers to critical questions. How do we want our future to be? What do we need to realize it?

Egypt is facing many challenges that threaten the life of its people, we can say the water crisis is the biggest one.



1) Water pollution

The base of life, which cannot exist without life, is water. It is the source of human and animal drinking water and the source of agriculture. It is also an important factor for the sector. Our lives on the earth are thus connected to water, and the great Nile River is the lifeblood of Egypt's life. Its revenue is used for domestic use, agriculture and manufacturing, thus confirming our water-related lives. Egypt's share of the Nile is 55, 5 billion cubic meters per annum, under a contract reached in 1959. Egypt's share has not improved, despite the growing number of Egyptians exceeding almost 62 million, which means that the per capita water from the river has declined dramatically (T ahlawi, M. & Farrag, S, 2007). In addition, as a result of chemical and agricultural activities, waste water plants and drainage, the water quality of the River Nile degraded.

Figure (1)

Water pollution

- **Main Sources of pollution**

*Runoffs in agriculture, manufacturing Municipal waste and waste disposal are dumped recklessly into the Nile River, rendering its water unfit gradually for use by humans.

*Sewage Slum water and many other places discharged into the river in Cairo untreated due to lack of care.

*Runoffs in agriculture are containing pesticide pollutants and or herbicides.

*Industrial effluents are often highly toxic, containing heavy metals that can combine with the suspended solids in domestic wastewater to form muck.

- **Consequences of water pollution**

In humans: Drinking or consuming polluted water in any way has disastrous effects on human health. Polluted water causes typhoid, cholera, hepatitis, and various other diseases. Egyptians suffer from long-term diseases and need medical care owing to kidney failure as the air pollution affect bad on the kidney

In Ecosystem:-Water pollution can cause entire ecosystem to collapse if left unchecked. Animals and plants that depend on water for life are the most affected by polluted water pollution may kill the marine animals and the introduction or elimination of certain microorganisms distorts the ecosystem.

Effects the food chain: Disruption in food chains happens when toxins and pollutants in the water are consumed by aquatic animals (fish, shellfish etc.) which are then consumed by humans.

Quantity of water: Pollution and bad water quality have an impact on the quantity and availability of water in several ways as polluted water that cannot be used for drinking, bathing, and industrial purposes, and agriculture effectively reduce the amount of available water in each area.

Figure (2)

Consequences of water pollution

Economics: Managing and restoring polluted water bodies is expensive. Research shows that it will cost at least $660 billion to clean up the effects of the disaster

In Egypt, the food industry uses the largest volumes of water. Several studies revealed that untreated industrial wastes of more than 350 factories were discharged directly into the Nile and the Mediterranean, most of them released explicitly known toxic and hazardous chemicals such as detergents, heavy metals and pesticides (RNPD, 1989). Waterways used to receive about 85% of the industrial water withdrawals back. In addition, the Nile and its waterways currently suffer from the discharge of contaminated agricultural wastewater. The discharge of oil and grease originates from navigation and untreated domestic wastewater.

2) Improve the clean water resources

Improve the clean water resources is a big challenge and it is a position of interest as Egypt has been suffering from severe water scarcity in recent years as many causes.

- **Causes**

*The drought is the most dangerous phenomenon in Egypt and middle east because the researches proved that each year, the precipitation phenomenon will decreased and it means that after ten years, maybe not happen any rains and it causes to decrease the rate of the Nile and it cause other dangerous consequences.

*Rising populations and rapid economic development in the countries of the Nile Basin. Egypt is facing an annual water deficit of around 7 billion cubic meters. Infect, United Nations is already warning that Egypt could run out of water by the year 2025.
*The reality is that water of Nile is being polluted by municipal_waste and industrial waste.
*Agricultural irrigation consumes enormous quantities of water.

In recent years countries along the Nile such as Ethiopia are taking advantage are gaining more control over the rights for the Nile as A big challenge is tackling the issue of Ethiopia building a dam and hydroelectric plant upstream that may cut into Egypt's share of the Nile.

- **Negative consequences**

Figure (3)

The impact of sewage sanitation on

Sanitation is often associated with contaminated water supplies, inadequate access to basic handwashing services and contaminated sanitation. How does sanitation access vary around the world? What are the consequences of unhealthy sanitation on health?

Diarrheal diseases: a significant risk for diarrheal diseases is contaminated drinking water. How many people die each year from diarrhoeal diseases, and how do we avoid them?

Death causes: contaminated water, in particular at low incomes, is a leading risk factor for death. What are people around the world dying from?
Hunger and undernourishment may intensify malnutrition, particularly in children, due to contaminated water. How does undernourishment vary worldwide?

3) Soil pollution

Humans still damage their homes and waste their wealth, we don't stop in only pollute water and air, but we also start to pollute our soil, our factory for food and our land to build to live. Soil Pollution has gradually become a major challenge that we need to overcome for establishing a healthy environment. Soil pollution is the increase of toxic chemicals (pollutants or contaminants) in soil, in high enough concentrations to pose a risk to human health and/or the ecosystem. The pollutants causing the pollution to reduce the quality of the soil and convert the soil inhabitable for microorganisms and macro-organisms living in the soil. Humans can be affected by soil pollution through the inhalation of gases emitted from soils moving upward, or through the inhalation of matter that is disturbed and transported by the wind because of the various human activities on the ground.

- **Causes**

Man-made causes

1. Urban station
2. Industrial wastes
3. Mining
4. Agriculture wastes
5. Domestic wastes and garbage
6. Radioactive wastes

Naturel causes

1. Landslides
2. Hurricanes

Figure (4) Soil pollution

- **Effects**

Soil pollution affects plants, animals and humans alike.

1. **I**nferior Crop Quality. It can decrease the quality of the crop as over time the soil will become less productive due to the accumulation of toxic chemicals in large quantities.

2. **E**ffect on Human Health badly. Increasing of toxic and harmful chemicals will lead to increasing health threats to people living nearby and on the degraded land.

3. **N**egative Impact on the Ecosystem and Biodiversity. It can cause an imbalance in the ecosystem of the soil.

4) Air pollution

Air pollution is a blend of airborne solid particles and gases. Car emissions, factory chemicals, dust, pollen and mold spores may be suspended in the form of particles. In cities, ozone, a gas, is a big part of air pollution. It's also called smog, as ozone causes air pollution. Certain air contaminants are toxic.

- **Causes**

1) The Burning of Fossil Fuels.
2) Industrial Emission.
3) Indoor Air Pollution.
4) Wildfires.
5) Microbial Decaying Process.
6) Transportation
7) Open Burning of Garbage Waste.

- **Air Pollution Effects**

1. Environment: formation of acid rain, atmospheric precipitations in the form of rain, frost, snow or fog, which are released during the combustion of fossil fuels and transformed by contact with water stream in the atmosphere.

Figure (5) Air pollution

2. Global warming: carbon dioxide in the air is one of the causes of the greenhouse effect. That is the cause of the higher temperature of the earth.

3. On human health: air pollution is indeed a significant risk factor for human health conditions, causing allergies, respiratory and cardiovascular diseases as well as lung damage.

- **How to Help Reduce Air Pollution**

✓ You can, walk, ride a bike, or take public transportation
✓ For driving, choose cars that get better miles per gallon of gas or choose an electric car.
✓ You can also investigate your power provider options—you may be able to request that your electricity be supplied by wind or solar.
✓ You can raise awareness of the importance of preserving the atmosphere.

4) Population Growth

The current population of Egypt to date October 26, 2020, is102, 939,046. This phenomenon considered as one of the biggest problems facing Egypt, if it were not the biggest.

- **Causes**

Figure (6)

Population growth

1- Decline in the death rate: the fall in death rate is decline in mortality rate is one fundamental causes of over population.
2- Rise in the birth rate: we have been able to bring in increase in the fertility rates of human beings. Medicines of today can boost the reproductive rate in human beings. There are medicines and treatments, which can help in conception. Thus, science has led to an increase in birth rate. This is certainly a reason to be proud to reach this development of science but advances in medicine have also become a cause to overpopulation.
3- Migration: Immigration is a problem in some parts of the world. If the inhabitants of various countries migrate to a particular part of the world and settle over there, the area is bound to suffer from the ill effects of overpopulation.
4- *Lack of education*: Illiteracy is another important cause of overpopulation. Those lacking education fail to understand the need to prevent excessive growth of population. They are unable to understand the harmful effects that overpopulation has.

- **Relation**

The population growth has a great impact on the total amount of water in Egypt, and the per capita share of water in particular. Because the population is constantly increasing, and the amount of water is constant, with the possibility of decreasing in the next period.

- **Positive consequences** If water crisis is solved, we will allow for this big number of people to use a lot of water from different ways.

- **Negative consequences**

He population increase leads to the consumption of a lot of water in different ways, so if water crises continue with the same consumption, many other problems such as drought and others will be exposed.

5) Work to eradicate public health issues/ diseases

There is no doubt that the current water crisis will negatively affect the public health and cause many life threating diseases

Figure (7)

Generally: If we are talking about a country or a certain region the lack of the amount of water will absolutely lead to bad hygiene and sterilization, which then will lead to many bacteria diseases like cholera and other illnesses like intestinal catarrh

Personally: The lack of the amount of the water deinked may lead to blood clog, dehydration of the body and kidney failure

In order to keep ourselves safe from these consequences we have to find more fresh water resources

1.2 problem to be solved

Water crisis

Water is the one essential requirement of all forms of food production, “No Water, No Food”. It is a source of drinking water for humans and animals and the source of agriculture. Also, it is essential factor for the industry.
Egypt has been suffering from severe water scarcity in recent years. Rising populations and rapid economic development in the countries of the Nile basin pollution and environment degradation are decreasing water availability in the country.

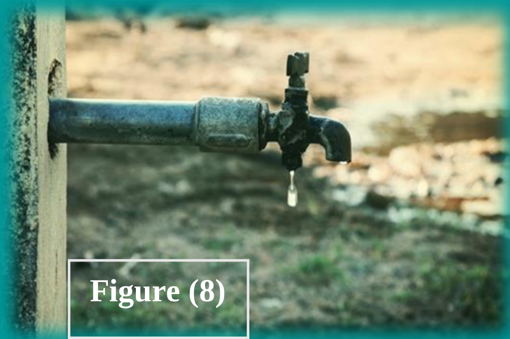


Figure (8)

The United Nations expects Egypt to suffer from water scarcity by 2025. Assuming the continued growth of the population and taking into account land reclamation projects in the desert and the fact that more than 50 %of grains consumed are already imported, Egypt cannot meet its demand for food only by relying on Nile water for irrigation.

Egypt is depending on the Nile flow to provide about 97% of its present water needs with only 660 cubic meters per person, one of the world's lowest annual per capita water shares. But as population is expected to double in the next 50 years, Egypt is projected to have critical countrywide fresh water and food shortages by 2025.

- **Reasons of water scarcity**

1) population growth

Egypt now is suffering from a 31bn cubic meters water shortage annually because of its overpopulation and every citizen's portion should not be less than 1000 cubic meters per year. Egypt suffers from a water deficit of 30 billion cubic meters; it annually needs at least 110 billion cubic meters of water to cover its needs. However, it currently has only 80 billion cubic meters, of which 55.5 billion cubic meters come from the Nile.

2) Pollution of the water

Year	Population	Natural resources
1995	56,766,000	1260m3/y
2000	65,683,000	1200m3/y
2005	74,033,000	
2010	77,000,000	
2015	88,000,000	
2020	100,000,000	

Table (1)

Increase the population of Egypt over the

Water quality of the River Nile decreased because of chemical and industrial processes, wastewater plants, and runoff, the main reason behind the water pollution is chemical and industrial processes. This is Because the factories and manufacturers in Egypt are throwing industrial and animal waste into streams and rivers that lead to environmental and health problems. The second reason is thermal pollution which is caused by heating water that leads to reduce the amount of oxygen in the water which in turn leads to death of the animals, plants and change in water temperature.

3) Climate change

Climate change is expected to increase water demand in many regions, thus shrinking the availability of water. This changing equilibrium will challenge water managers to address the needs of growing populations, fragile environments, fishermen, ranchers, energy users and producers at the same time.
Water scarcity would be less of a concern in certain regions than rises in rainfall, floods, or sea level rise.


Figure (9)

These results can decrease water quality and can affect the facilities we use to do so.
Climate change causes drought, Drought is a big issue as it causes many negative impacts on the water rate also it reduced agriculture yields

Solutions to save the water

There are many solutions and ideas to save the water use in many ways. All ways try to reduce the consumption of the water in industrial, agricultural, and other fields and by distillation, recycling the wastewater or reuse it. But distillation has disadvantages that make us think in other ways. These disadvantages are the energy needs of the unit, the cost, and the slow output. There is also the concern that since distilling water removes all minerals, drinking distilled water may "leach out" minerals such as calcium, magnesium, and fluoride from the body.

- **Recycling**

Any method that increases the consistency of water to make it safe for a particular end-use is water treatment. The final usage could be drinking, agricultural source of water, drainage, conservation of river flow, enjoyment of water or several other applications, including healthy return to the ecosystem. Water treatment eliminates or decreases the accumulation of toxins and unwanted elements such that the water becomes suitable for the intended end-use. This therapy is important for human health and makes humans s to benefit from both drinking and irrigation use.
Depending on the plant's technology and the water it requires to method, the process of water treatment can vary slightly at different places, but the underlying principles are essentially the same.

The standard water treatment process.

Coagulation: The liquid aluminium sulphate (alum) and/or polymer is added to untreated water (raw water) during coagulation. This allows the tiny particles of dirt present to cling together or coagulate when combined with the water. Then these groups of dirt particles combine to form larger, heavier particles called flocs, which through settling or filtration are easier to extract.

Sedimentation: They pass into sedimentation tanks as the water and the floc particles progress through the treatment process. The water is slowly flowing here, allowing the heavy floc particles to settle down to the bottom. The flock that gathers is called sludge at the bottom of the tank and is routed to dry lagoons. The sedimentation stage is not included in direct filtration, and the flock is separated only through filtration.

Filtration: Water passes through a philtre meant to eliminate particles from the inside of it.

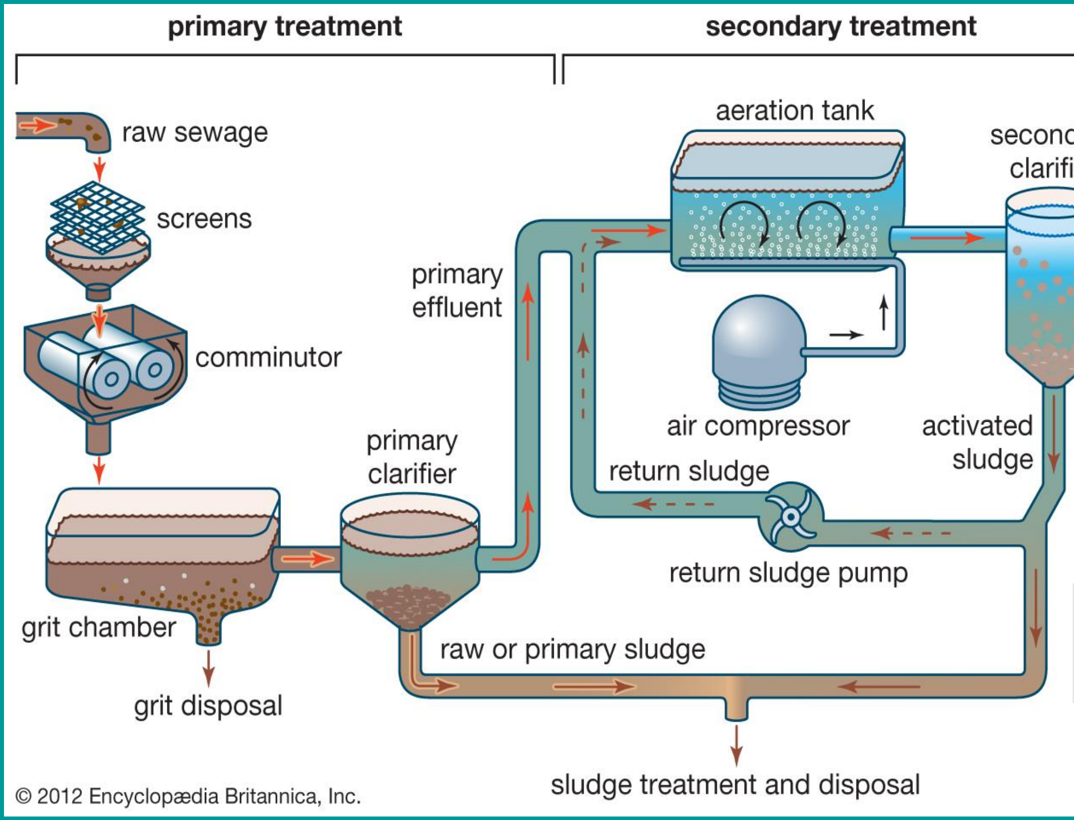


Figure (10)

Water filtration

The filters are made of sand and gravel layers, and crushed anthracite in some cases. The suspended impurities in water are removed through filtration, increasing the efficacy of disinfection. Through backwashing, these philtres are regularly washed.

Disinfection: In order to ensure that all disease-causing microorganisms are killed, water is disinfected until it reaches the delivery system. Chlorine is used because it is a very strong disinfectant and residual quantities can be retained in the water delivery system to protect against possible microbial contamination.

Sludge Drying: In drying lagoons, solids that are accumulated and settled out of the water by sedimentation and filtration are eliminated.

Water fluoridation: is where community water supplies are treated with a concentration of the free fluoride ion., this is adjusted to an optimum level to reduce dental decay

PH correction: To change the pH and stabilize the naturally soft water, lime is applied to the filtered water. In the delivery system, and inside the plumbing of clients, this minimizes corrosion.

- **Reuse**

Reuse is the idea of using the wastewater in the same process again and again to save the water by edit the process itself and find why this process produce wastewater and treat that.
Reuse is the best process as it is not cost and do not need a treatment plant. And the reuse process has many advantages like

There are two main types of water reuse projects: No potable reuse projects treat wastewater for specific purposes other than drinking, such as industrial uses, agriculture, or landscape irrigation. It could also include the use of reclaimed water to create recreational lakes or to build or replenish wetlands that support wildlife. In, addition to that, Potable reuse projects use highly treated reclaimed wastewater to augment a water supply that is used for drinking and all other purposes

Sources of water for potential reuse can include municipal wastewater, industry process and cooling water, storm water, agriculture runoff and return flows, and produced water from natural resource extraction activities. These sources of water are adequately treated to meet “fit-for-purpose specifications” for a particular next use. “Fit-for-purpose specifications” are the treatment requirements to ensure public health, environmental protection, or specific user needs. For example, reclaimed water for crop irrigation would need to be of sufficient quality to prevent harm to plants and soils, maintain food safety, and protect the health of farm workers. Water reuse offers an opportunity to significantly expand supplies of freshwater in communities facing water shortages. Coastal areas of the United States, for example, discharge 12 billion gallons of wastewater into estuaries and oceans every day—an amount equivalent to six percent of the country’s total daily water use. Reusing this water would directly augment the nation’s total water supply.

Investing in a water reuse system is a complex decision with both costs and benefits that extend many years into the future. Generally, water reuse is more expensive than drawing water from a natural freshwater source, but less expensive than seawater desalination. In many cases, lower-cost water sources are already being used, so the cost of water reuse should be compared with the cost of any available new water sources. The costs of water reuse vary greatly from place to place depending on location, water quality requirements, treatment methods, distribution system needs, energy costs, interest rates, subsidies, and many other factors.

1.3 Research

1.3.1 Introduction

In order to find a useful information, we must work hard and do many researches on the addressed problems and the solutions which already applied in order to enhance its performance and make developments on it which will help us in finding the required solution that will save us from many problems facing Egypt

1.3.2 Topics related to the problem

a) Egypt Grand challenges
b) What is water pollution?
c) Forms of pollutions and its definitions
d) Causes of water pollution
e) Main Sources of pollution
f) Organic and inorganic pollution of water
g) Reasons of increase the water consumption
h) Impacts of water pollution on the environment
i) Water related diseases
j) Effect of Acidic rain on the water
k) clean water resources development
l) climate change and its effect on the water scarcity
m) What is population growth?
n) Reduce ,Recycle, Reuse
o) Water crisis causes
p) How to Help Reduce Air Pollution
q) Reasons of water scarcity

1.3.3 Topics related to the solution

1- Solutions to save the water
2- The standard water treatment process
3- Filtration
4- Settling
5- Flocculation
6- Ion exchanger

7- Biological treatment
8- Chemical treatment
9- Mechanical treatment
10- Location of electronics industries which waste the water
11- Reverse osmosis
12- Best layers of filtration
13- Disinfection
14- Activation carbon
15- Effect of zeolite
16- Alkaline chlorination
17- Water softener
18- Deionized water
19- Properties of potassium permanganate
20- Cationic and anionic resins
21- How much the industries have used the water?
22- How much the electronics industry affect the water consumption?
23- How the oxidation process affect the color
24- The Deionization
25- The electrocoagulation
26- Attraction and repulsion between the ions
27- Affect the acidic medium on the alkaline compounds
28- What is the best way to reduce the TDS and neutralize the PH?
29- What are the effects of using resins?
30- What is the best compound for reducing the TDS?
31- How much the lime is effective to neutralize the PH?
32- How much the lime is effective to neutralize the TDS?
33- What is the best material we should use for the container?
34- What are the best measurement tools?

1.3.4 Links

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1.4 Other Solutions already tried

1.4.1 Development of a complete and straightforward hybrid model for gray water treatment

Water reuse is one of the most essential methods for preserving water resources. The aim of the current study was to modify a grey water treatment system with high purification efficiency, low cost, easy maintenance and high availability in all areas.
Ambience. A new simple hybrid model for the treatment of grey water was produced for this objective. In this model, after performing, the processes of settlement and aeration, seven different polypropylene activated carbon and anthracite flutter combinations, In addition to resins, contaminants were removed in three repetitions in single and combined forms and the contaminants were removed.
The results of each step were compared with the standards that were available. The different flow rates are 5, 2, 1, 0.5, 0.25, and 0.1 l / min, respectively.
To evaluate their effects on the reduction efficiencies of the pollutants in the system, the selected system was passed through some different concentrations, at ozone concentrations of 1, 2.5, and 5 g / h, the instantaneous ozonation method was used. The outcomes suggested the weakness for the reduction of pollutants of each filter alone. After the seven combinations have been investigated,
For non-drinking purposes, "polypropylene+resin+activated carbon" was recognized as the best filter. Accounted for the pH, the lowest 10 percent change and chlorine and BOD5 accounted for the highest 90 percent and 80 percent omissions, respectively.

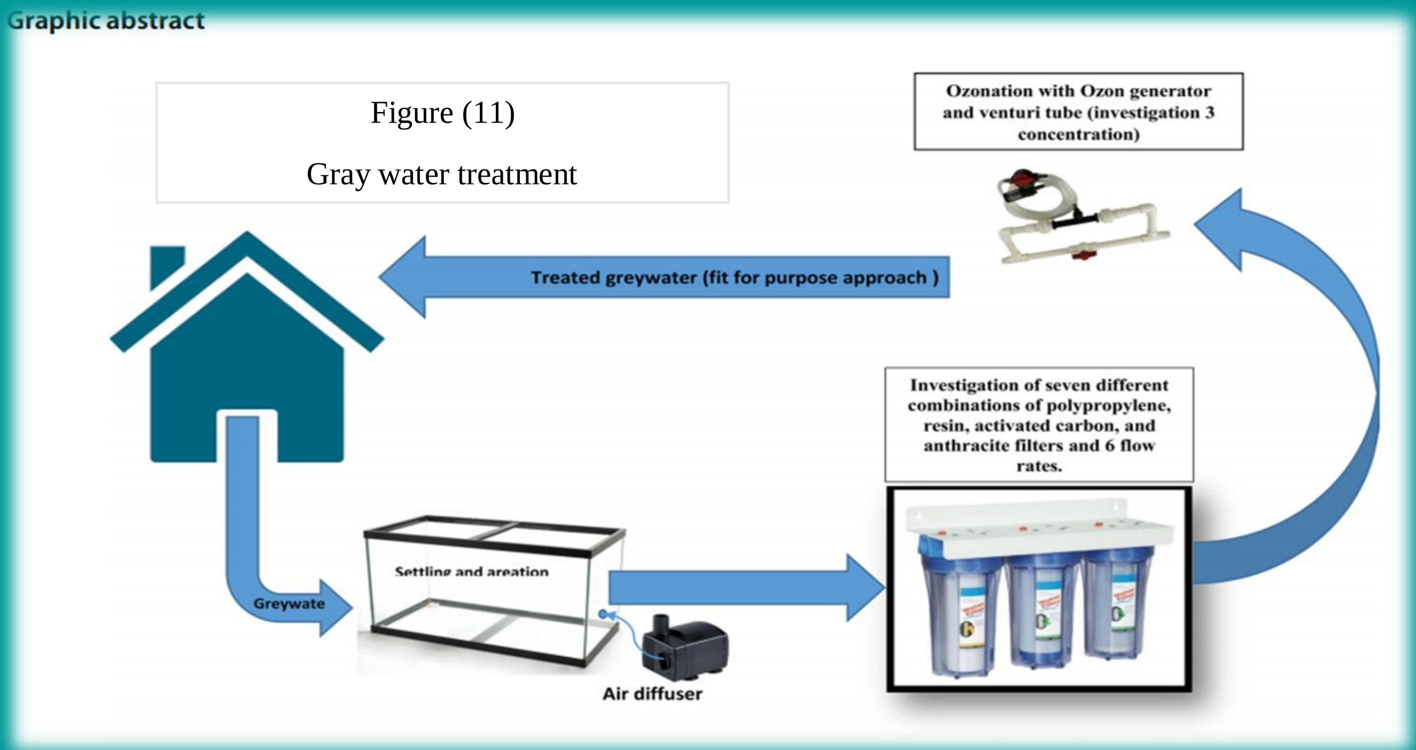


Figure (11)
Gray water treatment

The system showed the best performance at a flow rate of 0.25 l / min or 15 l / h. The minimum production rate of ozone, within any period of time, 1 g / h could remove all the coliform. This treated grey water is appropriate for such non-drinking uses. As places for irrigation and washing.

Urban sewage contains a variety of chemical pollutants, such as toxic substances, heavy metals, organic matter, and living microorganisms (viruses, bacteria, fecal coliform, and fungi). The discharge of raw sewage into the environment and its contact with surface water, groundwater, and soil lead to the contamination of these valuable resources, and if consumed by humans, the risks of the spread of various diseases among people will increase. Until achieving a degree of assurance as one of the objectives of the purification process, wastewater will be still generated via sewage treatment, which can be beneficial for estimating part of the needs of the community to water resources for agricultural use, green space irrigation, aquaculture, recreational purposes, and industrial use

According to the Iranian publication, No. 117-3 (Anonymous 2015), the average household per capita consumption of water without green space has been approximately 150 L per person over 24 h in 2016, of which 30 L has been used for bathroom and toilet. Based on the estimations, the remaining per capita consumption includes 20 L, which has been lost as evaporation and other non-recyclable and aggregate wastes. Therefore, an amount of 100 L per day has turned into sewage with less microbial load, which is called gray water.

Gray water is domestic wastewater collected from washbasins, showers and/or baths, and washing machines that has a much lower degree of pollution in terms of pathogenicity compared to black water (bathroom and toilet sewage); however, depending on its source, it can contain other more or fewer impurities than black water. Removal of common impurities from water or sewage would not seem to be problematic in the current situation about the existing technologies, while gray water treatment systems can now enjoy sufficient stabilities to withstand the shock loads of pollutants

A mechanism of hybrid treatment was applied to the grey

Water produced in rural areas, as shown in the results, the efficiency of this process. After using the cascade, Weir, Aeration, Blending, Filtration, 83, 70, 83, 50, 97,Total dissolved solids (TDS), TSS, 46, and 49 percent of COD, It removed total hardness, oils, anions, and cautions, respectively. In a study on grey water treatment systems, grey water treatment systems were used. With and without a soil land-earthworm layer, a two- and four-floor building

The presence of the mentioned layer significantly increased efficiency and decreased BOD and COD, while the water acidity was regulated in the neutral range as well. The suspended solids were placed above this layer and decomposed by the earthworms using biological methods, a household gray water treatment and its application in a flush toilet were studied.

Gray water treatment was studied by building a 20-L tank containing three layers of gravel and sand. Based on the results, by passing the sewage through the three-layered filter, the dissolved oxygen in the water increased and parameters such as turbidity, COD, acidity, TSS, water hardness, and electrical conductivity (EC) were seen to decrease

The system illustrated in Fig. 2 was used in this research to develop the suggested model. Of course, all the flats were, of course, included.

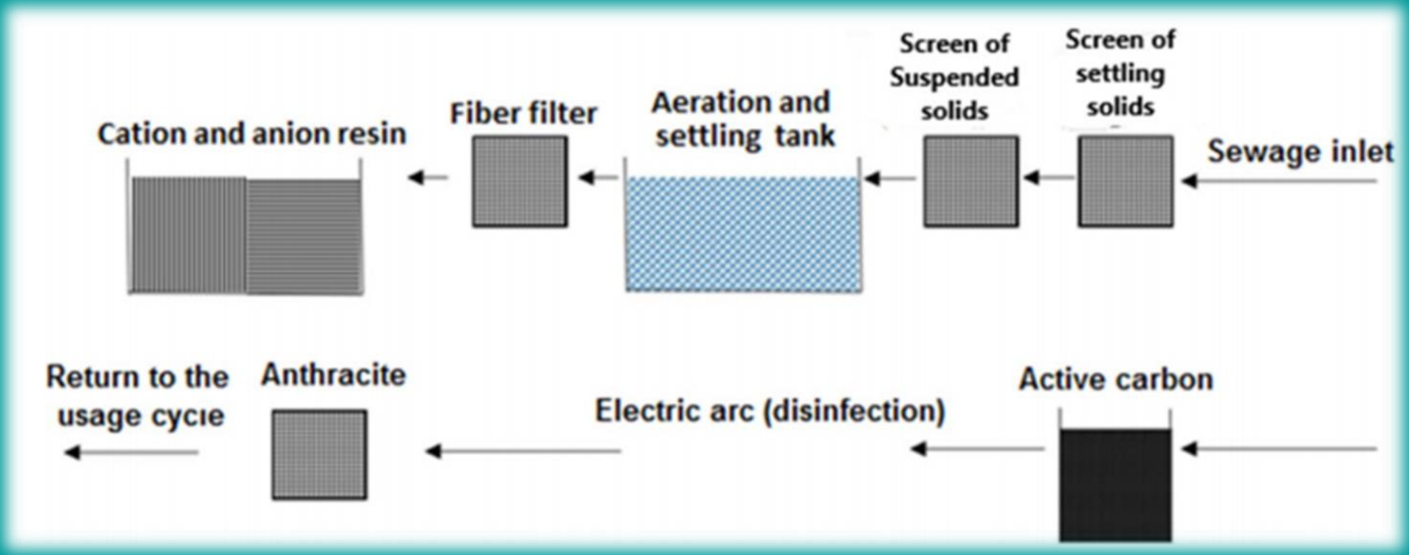


Figure (12) Gray water treatment technique

i. Regarding the purpose of the test, each filter was first investigated separately, and then, the seven combinations of the filters were examined with three repetitions. Figure 1 presents the complete filtration system.
ii. Screens were applied to remove heavy waste materials from the sewage of the washing and dishwashing machines and the bathrooms (e.g., hair).
iii. A glass settlement and aeration tank were selected with the dimensions of 30×40×60 cm and an approximate volume of 70 L.
iv. Foam and oil isolations from the solutions were associated with the aeration and oxidation of some elements due to their compositions with oxygen.
v. The purpose of this unit was to provide their sedimentations.
vi. The next unit included a physical purification with a polypropylene filter to remove the suspended particles like sand, silt, mud, algae, rust, and decayed particles separated from the inside layers of the pipes.
vii. Other filters, such as resins, activated carbon, and anthracite, were added to the system. Caution and anion resins in this study were applied to reduce the amounts of TDS, EC, BOD, TSS, and some other organic and mineral materials, which were granular and branded as Purolite.
viii. Activated carbon in this study was used due to its high potential for mineral absorption and chlorine, color, and odor removal
ix. Disinfection is a crucial stage in the purification process. Ozone was utilized in the disinfection process in this system.

x. The oxygen cylinder used in this system produced a concentration of 99.99% and the output pressure of 5000 kPa as indicated on the measuring gauge at 50 bar (approximately 732 psi), while the Rota meter outflow was 10 l/min.

xi. The last step of the purification system was to use an anthracite column to remove nitrate and further turbidity.

The gray water inside the tank was pumped through the purification system by using two pumps with a power of 30 W providing the maximum flow rate of 1500 l/h, and a single pump of height head 2.3 m could generate the same purification power as well

- Results:-

Twenty gray water samples were collected and prepared based on the intended compositions (Table 1) on different days, and the required measurements were done based on the standard

BOD	TDS	TSS	Ammonia	Nitrate	Phosphate	Bicarbonate	Cl	Na	Turbidity	pH	
114.75	1237.5	72	4	5.5	1.9	49	6.65	136.5	20.15	7.8	Propylene
114.75	1000	167.4	3.6	5.2	2	58.1	2.85	128.7	27.6	7.95	Activated carbon
50	850	153	2.28	3.1	1.6	51.1	6.65	136.5	24.3	7.39	Resin
114.75	1075	108	2.36	3.3	2	52.5	9.5	187.2	10.72	7.95	Anthracite
93.5	1150	45	2.6	4.125	1.9	45.5	6.65	187.2	14.3	7.8	Propylene + anthracite
101.25	1000	99	2.8	4.89	1.96	52.5	2.37	150.15	25.6	7.8	Propylene + anthracite + activated carbon
99.9	1012.5	81	2.84	4.95	1.98	59.5	3.04	150.15	28.27	7.95	Propylene + activated carbon + anthracite
39.15	887.5	55.8	3.52	4.95	1.68	56	2.56	160	21.12	7.95	Propylene + activated carbon + resin
27	875	36	2	3.3	1.6	42	0.95	148.2	18.87	7.15	Propylene + resin + activated carbon
67.5	950	32.4	2.52	3.79	1.6	49	6.65	157.95	25.35	6.4	Propylene + anthracite + resin
66.15	925	46.8	6/2	3.57	1.64	38.5	6.65	156	24.7	5.96	Propylene + resin + anthracite
31	450	40	5	–	50	90	100	70	50	8.4	Maximum permissible standard

Table 2 the effects of single and combined filters on the gray water purification (mg/l)

Methods for each contaminant type. All the measurements taken from the initial gray water samples suggested that the values of some significant elements, such as TSS, and TDS, were higher than the maximum values permitted by the standards. To reduce the concentrations of the contaminants, those types

The current investigation indicated that a combination of the most straightforward common filters in the market, i.e., polypropylene filter, resins, activated carbon, and anthracite, could well purify the studied gray water to the standard level. However, each filter was able to reduce only a certain number of the intended parameters and could not thus affect all the parameters. Filter arrangements and appropriate flow rates significantly changed the results of the present study. After examination, the filter of “polypropylene+resin+activated carbon” was found to have the best performance. This combination was more effective on the reductions in sodium, chlorine, phosphate, nitrate, ammonia, BOD5, TDS, and EC. The mentioned combined filter could determine if the amounts of the pollutants were within the permissible and standard ranges.

Any lower and higher flow rates would slow down the system performance and lower the purification efficiency, respectively. In this system, the disinfection process occurred through instantaneous ozonation, which led to the destruction of all the coliform in the gray water at the concentration of 1 g/h. This treated gray water is suitable for nondrinking

1.4.2 Membrane Bioreactors (MBR)

Membrane Bioreactors (MBR) are treatment processes, which integrate a perm-selective or semi-permeable membrane with a biological process .It is the combination of a membrane process with a suspended growth bioreactor, such as microfiltration or ultrafiltration, and is now commonly used for urban and industrial wastewater treatment with up to 80,000 population equivalents in plant sizes. Since it is a very technical solution, professional design and skilled workers are needed. In addition, it is an expensive but successful incentive for treatment. With the MBR technology, old waste water plants can be upgraded.

By the late 1960s, as soon as commercial scale ultrafiltration (UF) and microfiltration (MF) membranes became available, the MBR method was implemented. Dorr-Oliver Inc. implemented the original procedure and combined the use of an active sludge bioreactor with a filtration loop cross flow membrane.

MBR processes may generate effluent of high quality enough to be discharged to marine, surface or brackish waterways or to be recycled for urban irrigation when used with domestic waste water. Low footprint, fast retrofitting and upgrading of old wastewater treatment plants are other advantages of MBRs over traditional methods.

Compared to traditional settlement separation systems, it is possible to operate MBR processes at higher mixed liquor suspended solids (MLSS) concentrations, thus reducing reactor volume to achieve the same loading rate.

- **Advantages**:
  - High consistency of effluent
  - Elevated loading rate capacity
  - Municipal Wastewater Treatment, Community and Hotel wastewater treatment and reclamation
  - Food, slaughterhouse, brew house wastewater treatment
  - Pharmaceutical, fermentation, chemical, dyestuff and petrochemical wastewater treatment
  - Modification, extension & upgrade of existing biological wastewater plants
  - Ecological- friendly membrane cleaning process

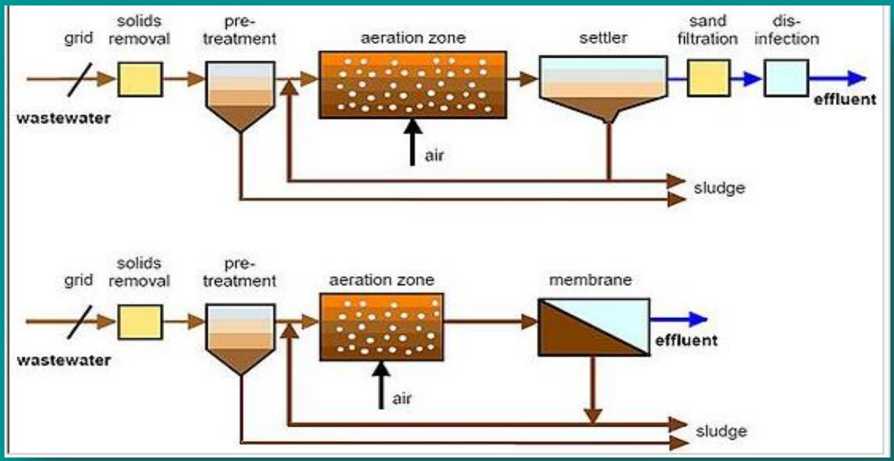
- **Method for treatment and fundamental concepts of design**

In order to provide an advanced degree of organic and suspended solid removal, membrane bioreactors combine traditional biological treatment (e.g. activated sludge) processes with membrane filtration. These systems may also include an advanced degree of nutrient removal when planned accordingly. The membranes are immersed in an aerated biological reactor in an MBR system. Membranes have a porosity varying from 0.035 microns to 0.4 microns (depending on the manufacturer), which is known to be between micro and ultrafiltration.

This filtration level makes it possible to draw high-quality effluent through the membranes and removes the processes of sedimentation and filtration usually used for wastewater treatment. The biological process will work at a much higher mixed liquor concentration, so the need for sedimentation is removed. This significantly decreases the needed process tankage and makes it possible to

Update several existing plants without installing new tanks. To provide optimal aeration and scour around the membranes, the mixed liquor is typically kept in the 1.0-1.2% solids range, which is 4 times that of a conventional plant. The Membrane:
A membrane is simply a two-dimensional substance used, typically on the basis of its relative size or electrical charge, to distinguish fluid components. The capacity of a membrane to allow only specific compounds to be transported is called semi-permeability (sometimes also perm selective). This is a physical process where components that are separated remain chemically unchanged. Components that pass-through membrane pores are called permeate, while rejected one’s form concentrate or retentive.
There are five types of membrane configuration which are currently in operation:

- Hollow fiber (HF)
- Spiral-wound
- Plate-and-frame (i.e. flat sheet (FS))
- Pleated filter cartridge
- Tubular



- **Pre-treatment:**

Fine screening is an essential pre-treatment step in order to avoid unwanted solids in the waste stream which enters the membrane tank. This minimizes solid accumulation and protects the membrane from damaging debris and particles, extends the life of the membrane, reduces operating costs and guarantees a higher quality of sludge as well as trouble-free operation.

- **Operation and Maintenance**

Many MBRs use weekly chemical maintenance washing, which lasts 30-60 minutes, and recovery cleaning, which takes place once or twice a year when filtration is no longer durable. A deposit that cannot be removed is considered "irrecoverable fouling" by available cleaning methods. Over the years of service, this fouling builds up and ultimately influences the life-time of the membrane (RADJENOVIC et al 2008). Both O&M activities have to be completed by trained employees.

- **Health Aspects**

In general, the installation and maintenance of MBR systems is carried out by professional personnel, who should be properly qualified with regard to any health risks. Biological system sludge (e.g. mechanical dewatering or drying bed) should be dewatered and incinerated with the ashes being deposited in a managed landfill.

Despite of all of these advantages MBR is not the best solution because of these Disadvantages:

- High cost of operations and capital (membranes)
- Complexity and fouling of membranes
- Costs of energy

Also, the high coast for the MBR is considered one of the disadvantages as the current MBR market has been estimated to value around US$216 million in 2006 and to rise to US$363 million by 2010.

1.4.3 Water softener

A water softener is a system that is used to soften water, by removing the minerals that cause the water to be hard.
When water contains a significant amount of calcium and magnesium, it is called hard water. Hard water is known to clog pipes and to complicate soap and detergent dissolving in water. Water softening is a technique that serves the removal of the ions that cause the water to be hard, in most cases calcium and magnesium ions. Iron ions may also be removed during softening. The softening devices can remove up to five milligrams per liter (5 mg/L) of

Fig (14) Water softener

dissolved iron.

Water softeners are specific ion exchangers that are designed to remove ions, which are positively charged. Softeners mainly remove calcium (Ca^{2+}) and magnesium (Mg^{2+}) ions. Calcium and magnesium are often referred to as 'hardness minerals'.

Ion exchangers are often used for water softening. When an ion exchanger is applied for water softening, it will replace the calcium and magnesium ions in the water with other ions, for instance sodium or potassium. The exchanger ions are added to the ion exchanger reservoir as sodium and potassium salts (NaCl and KCl).

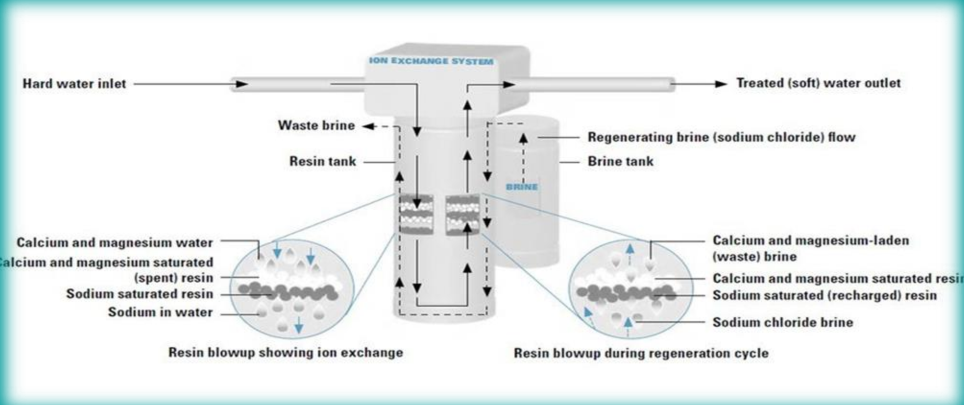


Fig. (15) Water softener technique

Water softener has two main processes

Ion Exchange

A physical and chemical process filters the water through an exchange media known as resin or zeolite. Typically, the resin is a synthetic or natural, sand-like material coated with positively charged sodium ions. As the calcium and magnesium dissolves into positively charged ions, an ion exchange environment is created. The water flows through the unit while the resin releases its sodium ions and readily trades them for the calcium and magnesium ions. The water flowing out of the device is now considered soft.

Regeneration

Clearly the resin is not an inexhaustible exchange site. When all the sodium exchange sites are replaced with hardness minerals, the resin is spent and will no longer soften water. At this point, the water softener will need to be run on an alternate cycle called regeneration. During this cycle, resin is backwashed with a salt solution. The brine is reverse flushed through the system taking with it the calcium and magnesium ions that had been adsorbed on the resin. Once backwashing is complete, the softener can be returned to use. Some water softeners will automatically switch to the operation cycle. Others have a manual switch. Illustrates both cycles of the water softening process--ion exchange and regeneration.

- Advantages

i. Most consumers would agree that hard water leaves scales on pots, soap films on skin, and detergent curds in the washing machine. More importantly, scales can also buildup on hot water heaters and decrease their useful life. Soap film and detergent curds in bathtubs and appliances indicate that you are not getting the maximum cleaning action from these products. Soft water not only eliminates these nuisances but also protects appliances and saves cleaning time.

ii. It is a well-developed technology that has been used in homes for almost 65 years. The equipment is reliable, effective, and widely available, providing consumers with convenient features and a selective market. The simple technology of softening makes it easy to bypass toilets and outdoor faucets. Finally softening systems are adaptable for mixing softened and unsoften water to produce a lower hardness level.

iii. The costs of a water softener can vary between € 0, 20 and € 0, 40 a day. An average range for the hardware only is around $500-$1500.

- Disadvantages

i. The major disadvantage to water softening is the potential health risks for people on low sodium diets. The exchange of hardness minerals for sodium adds 7.5 milligrams per quart for each gpg of hardness removed. In addition, calcium and magnesium are eliminated from the homeowner's diet.

There are many applications like Twin Alternating Water Softener 126 GPM - South Korea
Commercial Twin Water Softener 120,960 GPD - Ecuador
Steel Water Softener for Groundwater Remediation 100,000 GPD - USA which they used this system to treatment the wastewater especially that have many TDS in it and could reuse it again.

1.4.4 OxyMem, the Flexible MABR.

The Membrane Aerated Biofilm Reactor (MABR) has moved from the pilot stage through the demonstration stage and is now a commercial available technology for the biological treatment of wastewater. The MABR is carrying on with the current trend of engineering reactors to provide specific conditions which take advantage of non-sterile environmental bio-technology processes. The counter diffusion of the oxygen and substrate in the membrane attached biofilm provide a unique and controllable environment for processes such as simultaneous nitrification/denitrification as well as high rate systems utilizing pure Oxygen.

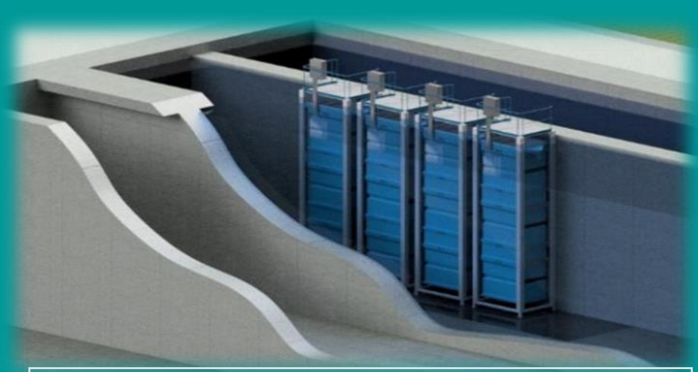


Figure (16) OxyMem MABR Retrofitted into an existing Activated Sludge Lane.

The treatment of wastewater by biofilm systems is older than the activated sludge process, with the first Trickling Filters being installed in the late 1800's. The process characteristics that made biofilm systems attractive initially, such as biomass retention, low solids production and ability to withstand shock loads are still valued today. But thanks to improvements in reactor design it has been possible to improve the processes. Today biofilm systems have very high rate of reaction, can be used to encourage the growth of specific bacterial such as Anammox and by controlling parameters such as DO and pH even achieve multiple processes in one reactor. The MABR is next stage in this reactor development and because of the counter diffusion of Oxygen and the pollutants the MABR allows for another level of control in a Biofilm Reactor.

The OxyMem MABR system utilizes dense hollow fiber silicone membranes to supply oxygen to a biofilm that grows on the membranes and treats the pollution in the wastewater. The membranes thus have a dual function, they provide oxygen to the system and act as a support for the bacteria to grow on. The OxyMem MABR combines biological treatment for carbon and nitrogen removal which brings effluent to required discharge standards, The OxyMem MABR creates an ideal environment to support a biofilm which absorbs and consumes carbon and nitrogen based pollutants. The OxyMem System has been demonstrated at various sites across the world and with the results being discussed.

Fig. (17) Images of the OxyMem hollow fiber

The membranes are placed into a module containing surface area available for biofilm growth and oxygen transfer. Biofilm grows naturally when the membranes are place in municipal wastewater, or a seed can be used

To speed up the biofilm development. The OxyMem system can be operated as a biofilm system, where all the nutrient removal is carried out in the membrane attached biofilm. In this case, the only suspended solids leaving

The system are detached biomass. The OxyMem can also be operated as a combination Fixed Film-Activated Sludge process, where the treatment is carried out by both the attached Growth and the suspended growth at the same time. This allows for differences in microbiological populations between attached and suspended growth.
OxyMem MABR systems are operated will low air pressure inside the hollow fiber membranes typically 200mBar, with air being exhausted constantly from the membranes. This air can be analyze to calculate the Oxygen transfer rate and provide real time feedback on the activity of the micro-organisms attached to the membranes (Respirometery).

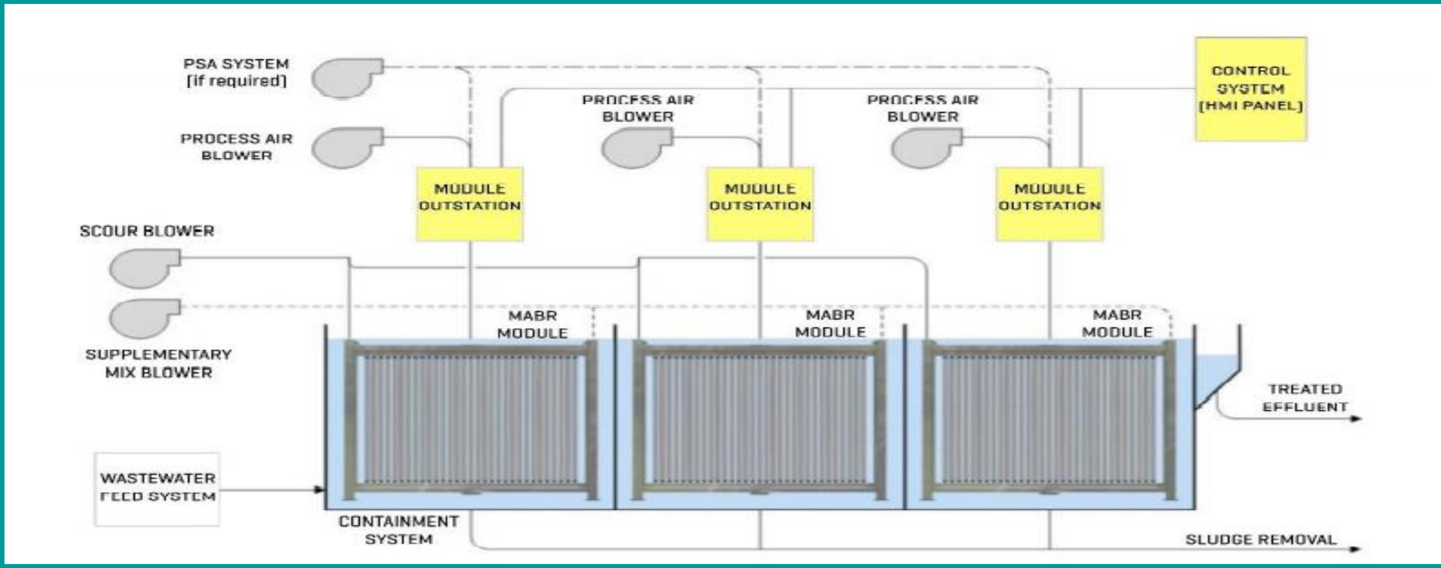


Fig.(18)OxyMem System operating as a pure

- Results

To date OxyMem systems have been installed to treat both Municipal and Industrial wastewaters and has achieved both high loading rates as well as low energy utilization in both types of installation. A summary of the results achieve is shown in Table 1.

Country	Type of Wastewater	Flowrate (m^3/day)	Vol (m^3)	Performance				Modules
				Inlet	Removal	Effluent	Energy/ Sludge	
Algeria	Domestic/ Municipal	100	15m^3					2
Brazil	Municipal (Lagoon)	90 170	27m^3	COD 300-400mg/l BOD 100-170mg/l sCOD 150-200mg/l N-NH4 35-55mg/l TSS 70-130mg/l	COD>80% BOD>90% N-NH4>80% TSS>90% COD>70% BOD>90% N-NH4>50% TSS>90%	COD<80mg/l N-NH4<10mg/l TSS<10mg/l BOD<10mg/l COD<100mg/l N-NH4<20mg/l TSS<15mg/l BOD<20mg/l	0.15 kWh/m3	3 (Air)
Netherland	Industrial (Food Manufactur er)	6	9	COD 10,000-12,000mg/l sCOD 4,000-6,000mg/l N-NH4 50mg/l TSS 6,000-9,000mg/l	COD>50% sCOD>80%	TCOD ≈ 5000 sCOD ≈ 1000		1 (O_2)

Table (3) Summary of result of installed OxyMem system

The MABR significantly reduces the energy requirement for the aerobic treatment of wastewaters because of its unique approach to the supply of Oxygen. Considering both the energy required for aeration and the energy required for mixing,

A major energy saving is also because the system can be operated with very low air pressures. The pressure loss due to air flow in the hollow fiber membranes is

While the OxyMem MABR has been demonstrated from the treatment of several types and strengths of wastewater. One of the most interesting things it the future potential which this approach to biofilm and environmental biotechnology allows. The independent control and direction of supply of the pollutant and the reactant allow for much higher levels of control of rates of reaction and locations of zones of reaction that was possible previously

The MABR is another tool in the environmental engineer's ability to control and manipulate the micro environment in a biological treatment reactor to achieve desired process outcomes. The MABR has been deployed as a Fixed Film treatment system where all of the degradation takes place in the biofilm, along with in a side stream situation where the waste water was recirculated through the OxyMem Reactor, in both case the MABR provided treatment for the wastewater proving its flexible nature.

1.4.5 Textile dyeing industry (dyed without waste)

Dye factories use about 80 liters of water per kilogram of tissue. Every year around 12,000 kilometers of textile materials are dyed. And for that, millions of liters of water are needed, the factory says it consumes an average of some 350 million liters of water every year After use, the water is full of colorants, chemicals, and salts. This water is used first to whiten the cloth, then coloring it and developing colors to stabilize it because it is unstable. Finally, we get water saturated with colorants and citrus fruits. the pollution of water bodies with these compounds causes changes in the biological cycles of the aquatic biota, particularly affecting the photosynthesis and oxygenation processes of the water body, for example by hindering the passage of sunlight through the water. Many textile dying factories neutralize the acidity of the water and then dump it into the wastewater to go to the water treatment plant. Wastewater treatment in textile and dye industry mainly involves treatment of highly colored wastewater containing variety of dyes in different concentrations. The

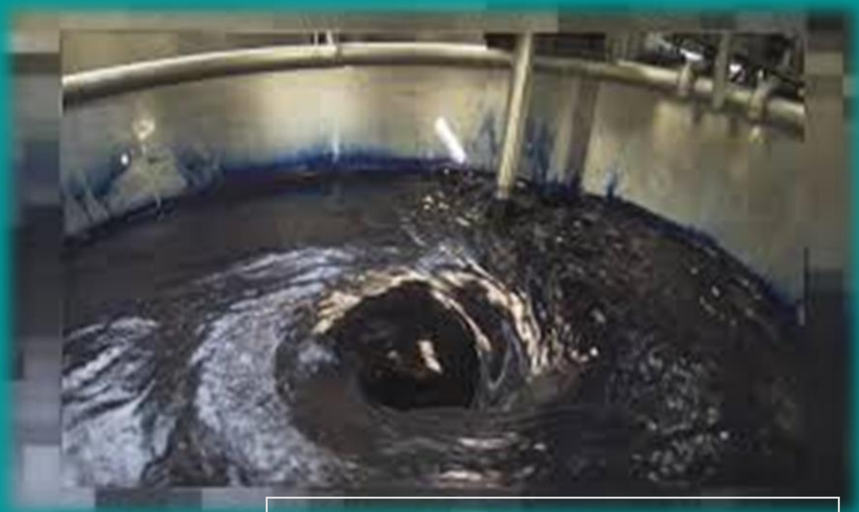


Figure (19) Waste water used in dyeing

wastewater needs to be treated prior to discharge by effectively removing dye color to protect environment and as per the statutory guidelines. The technics to save this water and save the environment are used in factory in Belgium

- **there are two main processes to solve this challenge:**

- **Electrocoagulation (eliminates colorants)**

Electrocoagulation is the most used method in the treatment of textile wastewater. Electrocoagulation is about put iron positive ion in a solution that contain negative charges to interact with each other and form a bigger body which could be removed by Sedimentation and filtration processes.

We use this process as many pollutants in water are composed of inorganic particles, such as mud or oxidized minerals, and biological molecules such as germs or algae. These particles generally carry a negative charge, so they repel each other and form a uniform, stable, almost unfilterable system. The stability of this system is reflected in the stay of these particles apart and scattered in the liquid and due to their lack of precipitation, and it stems from the forces that work in the environment between the liquid and the surface of the solid molecule, so the electrocoagulation helps a lot to sediment the minerals and other polluted solid molecules.

-after this process, they use the filtration process, and it happens easily as the particles become larger after the electrocoagulation process

- **Reverse osmosis (contributes to the elimination of salts)**

A reverse osmosis system is one of the most extensive methods of filtration. It removes 98% of dissolved solids and working on reduce the TDS, too.

(RO) is a water purification process that uses a partially permeable membrane to remove ions, salts, unwanted molecules and larger particles. In reverse osmosis, an applied pressure is used to overcome osmotic pressure, a colligative property that is driven by chemical potential differences of the solvent, a thermodynamic parameter. Reverse osmosis can remove many types of dissolved and suspended chemical species as well as biological ones (principally bacteria) from water, and is used in both industrial processes and the production of potable water. Reverse osmosis (RO) membrane is widely used in industrial wastewater treatment and reclamation processes. It removes dissolved solids like arsenic and fluoride through the RO

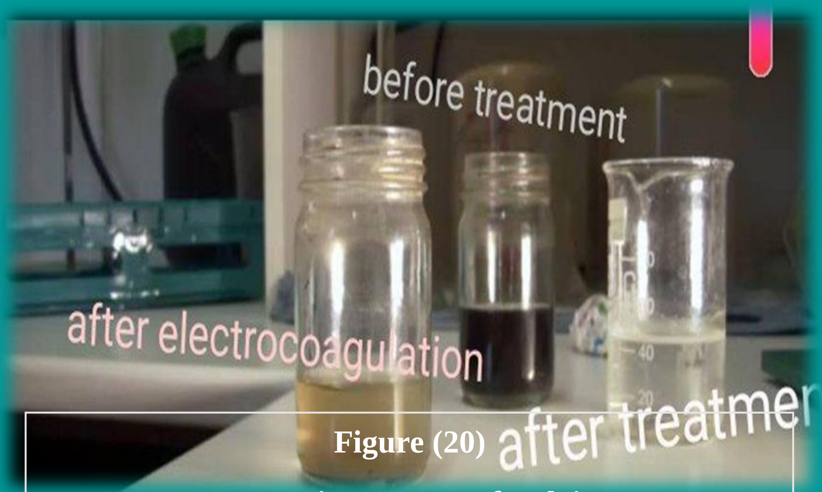


Figure (20)
Reverse osmosis treatment for dying water

membrane. An RO system also includes sediment and carbon filtration for a broad spectrum of reduction. The carbon filters in an RO system remove chlorine and bad taste and odors, and the sediment filter removes dirt and debris

Table 1: Initial Characteristic of Outlet Effluent

parameters	Untreated Outlet Effluent
1. PH	7.9
2. TDS	1700
3. TSS	400
Color	Dark Brown

- ✓ **Advantages**

1. After these main steps, there are 93-96% from the polluted molecules are removed.
2. The water become usable again in the same process after.

- ✓ **Disadvantages**
  1. It is slow process as they could reuse the water after long time as the treatment is talk long time.
  2. it is extremely cost process

Table 4: Final Characteristic of Outlet

1.4.6Aeration

Wastewater aeration is the process of adding air to waste water to allow the pollutant components to be aerobically bio-degraded. In most biological wastewater treatment systems, it is an important component. Biological treatment uses microorganisms that exist naturally in waste water to degrade waste water pollutants, as opposed to chemical treatment that uses chemicals to react and stabilize contaminants in the waste water stream.

To help biological oxidative processes, many water treatment processes use a number of ways of aeration. Enabled sludge that may use fine or coarse bubble aeration or mechanical aeration cones that pull mixed liquor from the base of a treatment tank and expel it from the air in which oxygen is absorbed into the liquor is a common example. Aeration is part of the phase known as the secondary treatment process in urban and industrial waste water treatment. In secondary treatment, the most popular alternative is the activated sludge process. In the activated sludge method, aeration is focused on the pumping of air

Table (5) Final Characteristic of Outlet Effluent after Treatment with Sawdust

parameters	Treated Outlet Effluent
1-PH	7.2
2-TDS	1241
3-TSS	218
4-Color	Light Khaki

into a tank that encourages the microbial growth of waste water. The microbes feed on the organic material, creating flocks that can settle out quickly. "Bacteria that form the "activated sludge" after settling in a separate settling

Tank .The most important aspect of a treatment system utilizing the activated sludge method is considered to be aeration. The amount of wastewater treatment it achieves is directly influenced by a properly built aeration device. The secret to rapid, economically feasible, and reliable waste water treatment is the adequate and uniformly distributed supply of oxygen in an aeration device.

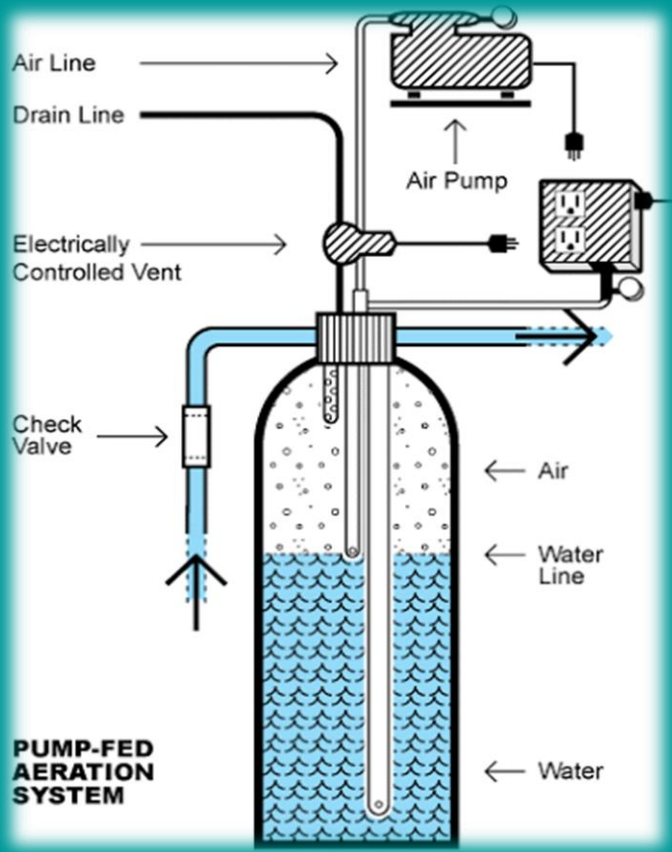


Figure (21) Aeration work mechanism

- **Mechanism of working:**

Aeration provides bacteria with oxygen for waste water treatment and stabilization. The bacteria require oxygen to allow biodegradation to take place. Bacteria in the waste water use the supplied oxygen to break down the organic matter containing carbon to form carbon dioxide and water. Bacteria are unable to biodegrade the incoming organic matter within a reasonable period without the availability of adequate oxygen. Degradation must occur under septic conditions that are sluggish, odorous, and produce incomplete pollutant conversions in the absence of dissolved oxygen. Any of the biological processes convert hydrogen and Sulphur under septic conditions to form hydrogen supplied and convert carbon into methane. Other carbon will be converted into organic acids which in the basin, create low pH conditions and make it more difficult for the water to treat and promote odour formation. Bio-degradation of organic matter in the absence of oxygen is a very slow biological process.

- **Water quality:**

In water bodies that suffer from hypoxic or anoxic conditions, water aeration is often required, often triggered by upstream human activities such as sewage discharges, agricultural run-off, or

over-baiting a fishing lake. Aeration can be accomplished by the injection of air from a fountain or spray-like system into the bottom of the lake, lagoon or pond or by surface agitation to allow the exchange of oxygen on the surface and the release of gases such as carbon dioxide, methane or hydrogen sulphide.
A significant contributor to low water quality is increased levels of dissolved oxygen (DO). Aerobic bacteria help decompose organic matter, and not only do fish and most other marine organisms require oxygen. Anoxic conditions can occur when oxygen concentrations become poor, which can decrease the water body's ability to sustain lives.

1.4.7 ACCEPTED MANUSCRIPT

Removal of Scale Forming Species from Cooling Tower Blow down Water by Electrocoagulation Using Different Electrodes
When water evaporates from the tower, dissolved solids (such as calcium, magnesium, chloride, and silica) remain in the recirculating water. As more water evaporates, the concentration of dissolved solids increases. If the concentration gets too high, the solids can cause scale to from within the system.

This project studies that Electrocoagulation (EC) process using Al-electrode is a promising technology for the removal of scale forming species from CTB water. it removes melted hardness and silica ions from cooling towers (CTB) using Fe, Al, and Zn electrodes. This experiment was based on samples collected from the urea fertilizer plant in Helwan. Cairo. Egypt and measuring the impact of some operational parameters: electrolysis time, current density, inter-electrode distance and stirring rate were studied and evaluated for the maximum efficiency.

In the perfect operating position, Al-electrode removed the scale forming species from CTB water more efficiently than Zn and Fe electrodes. Al, Fe, and Zn electrodes removed 55.36% and 99.54%, as well as 36.99% and 98.93% 38.63% and 95.62% for the total hardness and silica ions, respectively.

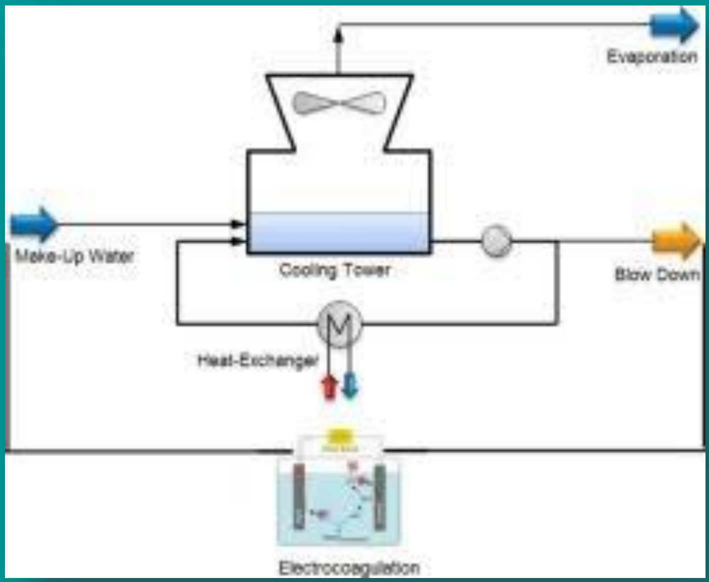


Figure (22) Cooling towers blow down technique

The electrocoagulation generated sludge was characterized by SEM-EDX, XRD, and FTIR. The present investigation inferred that Al-EC generates amorphous nature crystalline and another anode material (Fe and Zn) forms definite crystalline particles. EDX showed Mg^{2+}, Ca^{2+}, and silica ions in the sludge that proved the removal of these scale species from CTB water.

The primary reactors taking place in the EC cell with different anode materials: -- At the cathode:

$$2H_2O + 2e^- \rightarrow H_2 (g) + 2OH^-$$

At the anode: When, aluminum as anode

$Al (s) \rightarrow Al^{3+} (aq) + 3e^-$
$Al^{3+} (aq) + 3 H_2O \rightarrow Al(OH)_3\downarrow + 3H^+$
$4Fe \rightarrow 4Fe^{2+} + 8e^-$ **When, iron as anode**
$4Fe + 10H_2O + O_2 \rightarrow 4Fe(OH)_3\downarrow + 4H_2$
$Zn (s) \rightarrow Zn^{2+} (aq) + 2e^-$ **When, zinc as anode**
$Zn^{2+} (aq) + 2H_2O \rightarrow Zn(OH)_2\downarrow + 2H^+$

ii. Results and discussion of the project:

Parameter	Unit	Value
pH		8.10
Turbidity	NTU	7.93
TDS	mg/l	1670
Total-Alkalinity (as $CaCO_3$)	mg/l	150
Total-Hardness (as $CaCO_3$)	mg/l	765
Ca-Hardness (as $CaCO_3$)	mg/l	485
Mg-Hardness (as $CaCO_3$)	mg/l	280
Silicates (as SiO_2)	mg/l	27
Chloride	mg/l	250
Zn	mg/l	1.2
Total-phosphate (as PO_4)	mg/l	5.80
Fe	mg/l	0.1
Sulphate (as SO_4)	mg/l	733
NH_3	mg/l	0.59
NO_3 (as N)	mg/l	6.00
NO_2	mg/l	0.92

Table 6: Characteristic of cooling tower blow down water were collected from Helwan Fertilizer Company, El-

i. Efficiency of the removal of hardness and silica ions increases by increasing the current density from 1.43 to 14.29 mA/cm2, at the electrolysis time of 60 min, the removal efficiency of the total hardness increased from 19.4 to 55.36%, 11.62 to 36.99 %, and 18.0 to 38.63 % for Al, Fe, and Zn electrodes, respectively. Also, the removal efficiency of silica ions increased from 67.74 to 99.54 %, in addition to Al, Fe, and Zn electrodes 50.22 to 98.93 % and 65.25 to 95.62 % successively.

ii. Between the poles the effects of distance on the efficiency of removal of hardness and silica ions, as between poles increase the distance will reduce the efficiency of removal, and the opposite. In addition to the stirring rate, the stirring speed also increased the removal efficiency of scale forming species increased. But as another increase in stirring speed continued beyond optimal value, there was Decrease in removal efficiency.

EC sludge characteristics SEM-EDX, XRD, and FTIR, scale forming species could be removed by the hydroxide flocs generated in the EC cell.

Advantages:

- ✓ The project used wastewater from urea fertilizer factory (Helwan Fertilizer Company).
- ✓ Removal of scale forming species from cooling tower blow down water was investigated by EC.
- ✓ EC process effective for removing hardness ions (Ca2+, Mg2+) and dissolved silica responsible for scale formation on cooling water systems.

- ✓ The maximum removal efficiency of 55.36 % and 99.54 % was achieved for hardness and silica ions respectively using Al-electrode at a current density of 14.29 mA/cm2.

1.4.8 Salmonid hatchery water reuse systems.

Salmon have existed for millions of years and are a critical part of the Pacific Northwest's economy and culture. As the demand for salmon has grown, so has our dependence on hatcheries. Hatcheries currently contribute between 70-80°/o of the fish in coastal salmon and steelhead fisheries in the Pacific Northwest. Salmon play a major role in aquatic and terrestrial ecosystems. When salmon return to their natal streams to spawn and die, they bring large amounts of nutrients from the marine environment into rivers and streams, salmon support religious ceremonies held by Pacific Northwest Indian Tribes and are a vital part of Tribal economies. Salmon also supports the greater Pacific Northwest economy. In 1996, fish caught by Washington commercial fishers were worth an estimated $148 million. Besides, recreational anglers spent approximately $700 million on fishing-related expenses, which translates into about $1.3 billion and over 15,000 jobs.

Hatcheries are fish breeding and raising centers that have been built primarily to enhance Harvest in commercial, sport, and Tribal fisheries, and reduce the impacts of development that destroys or degrades salmon habitat and blocks migratory routes. Hatcheries improve the survival of young salmon (eggs, fry, and juveniles). More young salmon survive in the hatchery than would survive in the wild because there are no predators in hatcheries, food is abundant, and the environment is relatively constant. But we do not know if hatchery stocks have the same resilience as wild salmon populations. If hatchery stocks cannot survive on their own in the wild, they will need a hatchery to sustain them forever. This can be problematic because:

- Mechanical and technical difficulties occur periodically in hatcheries, such as disruption of power or water supplies or disease outbreaks.

- Hatcheries are expensive to operate, requiring a large and constant source of funds.

Aqua care Environment Inc. completed the successful design and installation of a reuse system at the Lummi Natural Resources Skookum Hatchery in Deming, WA in 2014. The deteriorating concrete corridors have been replaced and the project is completed within three months. This system has reduced the use of the hatchery for water by ~80% and allowed it to fall in line with current and future water usage regulations.

This system has reduced the use of the hatchery for water by ~80% and allowed it to fall in line with current and future water usage regulations. Also, the system is low maintenance, partially automated, and long-lasting. Similar systems have been constructed at other locations on the West Coast and are helping hatchery managers reduce their need for clean source water. And here are some reasons why the water reuse system is beneficial:

-

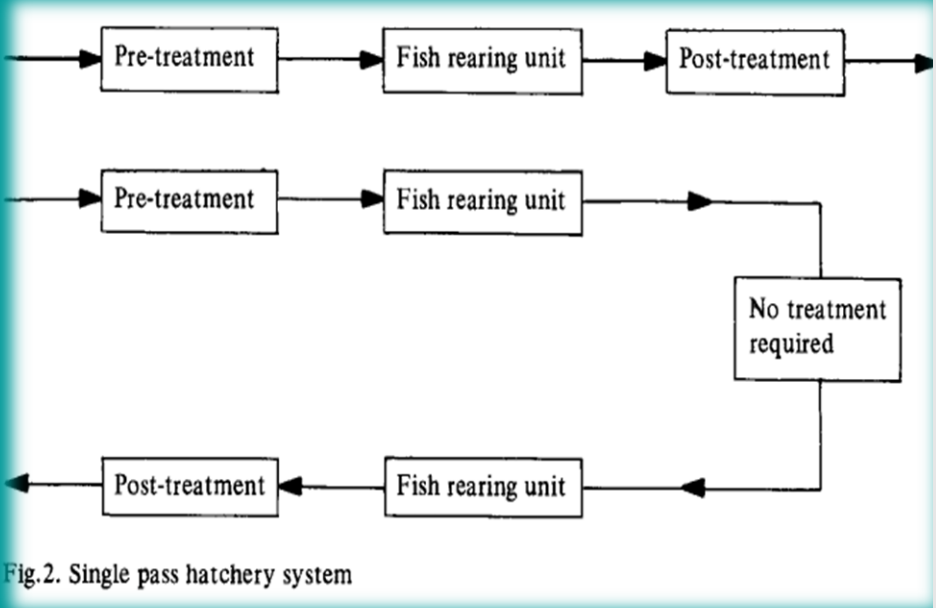


Figure (23) Single pass hatchery system

- Reduce Water Use by 80%: Reuse is an alternative to flow through systems when the source water is limited, contaminated, or costly. Reuse decreases the volume of incoming water that needs to be pumped, treated, heated, or chilled. And it decreases the volume of effluent water that may require treatment. It also provides security against changing climate or regulatory conditions.
- Reduce heating or chilling costs by 80%: If heating the water is necessary for hatchery operation a reuse system has the potential to save a significant amount on energy costs. Sending previously chilled or heated water down the drain is costly and wasteful. Reducing water use reduces temperature control demands, which decreases energy and equipment costs. In low nitrogen producing egg incubation systems, the temperature can be carefully managed by recirculating up to 98% of the water.
- Good Design: A hatchery reuse system captures solids and re-aerates the water to decrease CO_2 and increase O_2 levels. Also, Water can be treated with UV and heated or chilled while being circulated. This circulation can be done economically when designed properly to allow the use of low head, high volume pumps.
- Proven system: Reuse is the conservation of water in hatcheries throughout the United States. Systems have been built to reuse the Salmonid hatchery for the California Department of Fish and Wildlife, and customers near Bellingham and Rochester, WA. These systems have proven cost-effective and manageable. They can be operated seasonally and have added biosecurity to traditional flow systems.

1.4.9 Electronic Industry

The electronics manufacturing industry has been identified as one of the fastest growing industries .It is very important industry as its products are used in many manufactures such as the circuits in electrical devices in homes and all of the materials in robots are products from electronics industry so it is so important to look at industries like that as it is in growing and it is essential to water to be saved from the beginning to construct perfect factories which produce good products and save the water consumes on the same time. Industrial wastewater from electronics industries contains a high load of cyanide, toxic metals and chemical oxygen demand (COD).

The factory is specialized in the production of fans, ovens, mixers, toasters, washing machines, cookers and other electronics house machines. Daily water consumption of the factory is 100 m3, producing the industrial effluents 90 m3 from all producing lines and discharged into the nearby agricultural drain.

The main process responsible for the production of hazardous compounds is electroplating. Electroplating process plays an important role in the development of electronics manufacturing industries in the world; however, this sector is a source of enormous amount inorganic pollutants (CN, Cr, phenols, other heavy metals) in the water bodies. Electroplating is done by dissolving the desired metal at the anode and depositing it at cathode through the passage of electrical current. Electroplating wastewater has low organic matter, but have a high toxicity.

Further chromium is also released in electronics industry from electroplating, anodizing, chromating and metal finishing; other sources of chromium include tannery, dying and fertilizer industries

The characterization of wastewater was performed for various parameters including pH, TDS, TSS, BOD, COD, oil and grease content, phenol, total phosphate (PO4) phosphorous, cyanide and heavy metals.

The main goal in this treatment is…:

- Destruction of cyanide
- Removal of nickel and chromium
- Heavy metals and oil and grease.

The main processes to treatment the water are

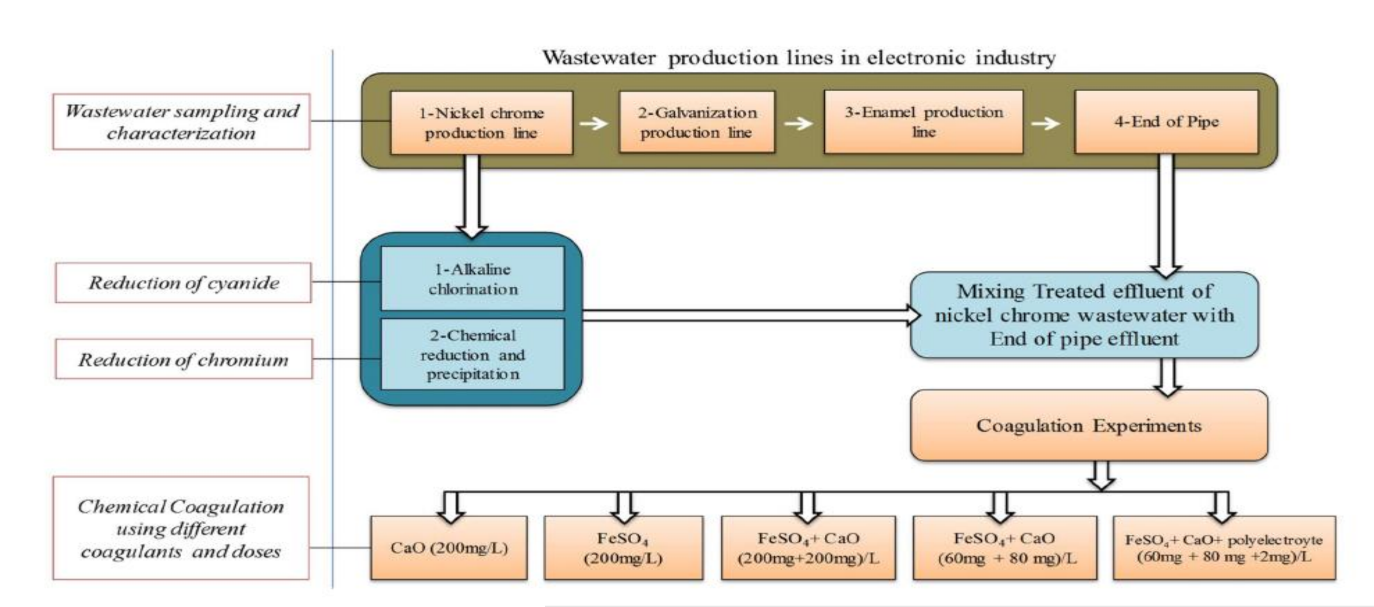
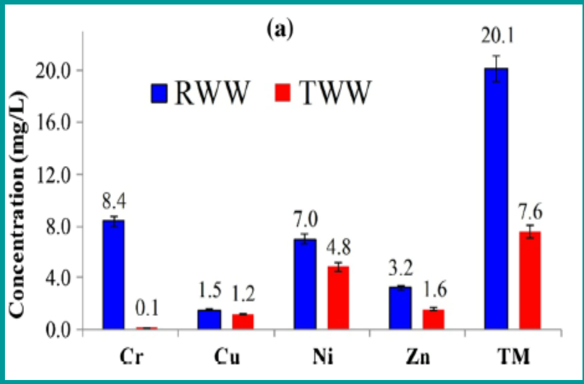


Figure (24) Wastewater production lines in electronic industry

1-Alkaline chlorination

Alkaline chlorination removed 100% of cyanide during the 2-h process. The alkaline chlorination is the most widely method used for destruction of cyanide from wastewater and even removed the free cyanide species. During alkaline chlorination, the complete removal of cyanide is achieved due to oxidation by active chlorine. Moreover, it has to be noted that violent agitation must accompany the chlorination, to prevent the formation of cyanide salts. The probable reaction with excess chlorine and NaOH can be expressed as follows:

$2NaCN + 5Cl_2 + 12NaOH \rightarrow N_2 + 2Na_2CO_3 + 10NaCl + 6H_2O$



Graph (1) Effect of alkaline chlorination and chemical reduction on wastewater of electronic industry

- Reduction of hexavalent chromium (chemical reduction)

Hexavalent chromium (Cr^{+6}) is one of the common heavy metals and highly toxic even at low concentration. The results showed that the chemical reduction with $FeSO_4$ and $6H_2O$ reduced the Cr^{+6} by almost 100%. This significant decrease in chromium was mainly due to the reduction of Cr^{+6} to Cr^{+3}.

Effect of alkaline chlorination and chemical reduction

Heavy metal removal efficiency after pretreatment (alkaline chlorination + chemical reduction) of wastewater of nickel–chrome production line.
Ex: RWW raw wastewater, TWW treated wastewater

2-Electric coagulation

It was found that the use of coagulants in combination provided more promising treatment capability. In case of TDS, maximum degradation was observed in C4 ($FeSO_4$ 60 mg/L + CaO 80 mg/L) where up to 87% removal was achieved.
Effect of various Coagulants removals of various
Pollutants on mixed pretreated and end pipe effluents such as TDS, TSS, BOD, COD, oil and grease.

Parameter	Raw wastewater	Treated wastewater		Permissible limits
		C4	C5	
pH	8.6	8.5	9.0	6–9
TDS (mg/L)	1570	205	243	2000
TSS (mg/L)	60	40	33	60
BOD (mg O_2/L)	213	43	55	60
COD (mg O_2/L)	934	67	97	100
Oil and grease (mg/L)	50	6.5	2.5	10
Phenol (mg/L)	0.003	N.D.	N.D.	0.005
Total phosphate P (mg P/L)	25	N.D.	3.7	10
Cyanide (mg/L)	2.1	N.D.	N.D.	0.1
Cr (mg/L)	6.0	<0.02	0.42	–
Cu (mg/L)	1.85	<0.01	<0.01	–
Ni (mg/L)	2.35	<0.02	<0.02	–
Zn (mg/L)	12.65	0.54	0.35	–
Total metals (mg/L)	22.85	0.54	0.77	1.0
Sludge volume (ml/L)	–	40	130	–
Sludge weight (g/L) at 105 °C	–	0.54	1.6	–

Table (7) Treatment electronic industry wastewater results

Advantages
Cyanide and chromium (Cr^{+6}) were efficiently removed from nickel–chrome production line before entering of wastewater to end pipe effluent.
Alkaline chlorination and chemical reduction) were removed cyanide and Cr^{+6} by 100%
Disadvantages
After all of this cost and complicated processes, the water is not efficient to reuse in the same process

2. Generating and defining a solution

2.1 Design Requirements:

In order to do a successful solution, first of all, we must take in consideration two important design requirement, the first one, which cannot be changed, is the water quality.
If we are talking about water quality so we are talking About: TDS, pH or BOD, we must contribute to two of them and try to keep their percentage in the resulted water after treatment good and suitable to use it again in the same process or another one.
TDS is the total dissolved solids in a solution and is measured by a special device called TDS meter, it affects the conductivity and the amount of dissolved ions refers to the water acidity.
The other solution requirement is either environmental impact, efficiency or cost. we must control one of them and work for it to get the best results, so if we are working for the cost of the prototype, it is a must try to reduce the cost as possible so that solution's cost must be lower than the cost of buying fresh water for using it.

If the cost is considered to be a design requirement, the cost of production and implementation must be included.

- **The total cost of the prototype is 450 L.E (5 pounds (chemicals) +445 other constructing materials)**
- **The total cost of chemicals in real life application is 30L.E**

The last design requirement we can work for is efficiency,
Efficiency is defined as the ratio of effective and useful work done by a specific machine, also it is the ability to do work with the least amount of effort, so the successful solution must have this ability, and this can be accomplished by:

- Build a Sketch for the prototype
- Build a Physical Prototype.

<u>Our team's prototype was built to address the following requirements:</u>

- **TDS and pH** ,and this is because the industry we are working for requires deionized water which means that it must have very low TDS, also it requires a water with a pH from 6 to 8, this is because ions or TDS in the water will affect the effectiveness of the electric circuits.
- Efficiency as TDS is 64% $\frac{\text{Change}}{\text{Before}} \times 100$
- PH value compared to natural water (7) is from (6) to (6.5)

2.2Selection of solution:-

Our solution is editing the process in the electronics factory in Banha. The products of this factory are circuits used in Arduino, ovens, fans, and many things in the electrical field. They are used 1000 liters every day in their process. They use the water to wash the circuits from certain solutions and metals like copper and lead. The water just used to wash the circuits because the circuit is made by putting its raw material in certain solutions (ammonia, permanganate, copper, lead, and platinum) and after each one of these solutions, the raw material is washed by the water and in each stage, they use new and clean water. Our solution is to treat the water used to wash the circuit after the potassium permanganate stage. Potassium permanganate is a compound, KMnO4, is an inorganic compound that combines manganese oxide ore with potassium hydroxide. This wastewater isn't acceptable to use again or to throw into the industrial drainage as it is much polluted. After the Potassium permanganate solution, there is a washing stage, it is about 100 liters, 50% of deionized water and 50% of tap water and it is changed every day .Its *TDS* is **7600 mg/L**, its *PH* is **10** its *color* is **dark purple.** Our mission is to convert it to colorless water and remove the ions (make TDS less than 100 mg/L) and neutralize the PH. This mission accomplished by three steps.

Figure (25) Polluted water in washing stage after potassium permanganate

- **Steps**

It's mainly focusing on reusing the polluted water in electronic industry for making doubled side circuit specifically in the washing step with variety of solutions and each one has a specific mission

We will mainly work on the washing using water after passing the circuit with KMnO4 solution and this is a crucial step in the electroplating

*in order to get rid of this material

1. Adding amount of H_2SO_4 to make the medium of the solution (KMnO4) acidic to be able to react.
2. Because the one of the properties of the permanganate that it is react in acidic medium.
3. -Adding $FeSO_4$ because it oxidized the solution to change the color
4. -Adding calcium carbonate (Ca (OH) 2) to do double union reaction with the solution to reach determine TDS and PH.

5. -attraction between positive and negative charges (deionization

- **Chemicals**

Figure (26) Colorless water after first chemical treatment

We are chosen to use chemicals as it is the easiest way in this case because removing the color of permanganate is difficult so after research, we found that the best way to remove the potassium permanganate's color is using chemicals.
We are used H_2SO_4 to make the medium of the solution acidic because the permanganate never goes through any reactions without making its medium acidic so we put some drops of H_2SO_4 to prepare it for the reaction. After that $FeSO_4$ is used to oxidize the solution ("to change the color of a certain solution, we need to oxidize it"), and the best and easiest way to oxidize the permanganate is using any compound with (Fe2+). A certain amount of FeSO4 is used to change the color.

After this step, we could convert the color of the solution to colorless but the PH becomes 1.3 (more acidic because we used strong acid (H_2SO_4) in the reaction) and the TDS becomes more than $1*10^4$ mg/L.

- **Using lime**

Lime Ca $(OH)_2$: Lime is the generic term used to describe hydrated lime. Calcium hydroxide (hydrated lime) is chemical frequently used to raise the pH of raw water before the water is treated with alum or ferric sulfates for coagulation/flocculation. Lime is predominantly used to adjust pH, but as a softener, it can also be used as a coagulant aid. The lime bonds with the other particles and increases the size / weight of the particles which then increases the speed with which they settle out of the water. One significant application of calcium hydroxide is as a flocculation, in water and sewage treatment. It forms a fluffy charged solid that aids in the removal of smaller particles from water, resulting in a clearer product. This application is enabled by the low cost and low toxicity of calcium hydroxide.

Lime is used because it is effective and cheap. We used it to precipitate dissolved solids (SO_4, Fe, Mn, and CU) and raise the PH.
After putting the limestone, a precipitate is formed so we filtered it by using medical gauze and sand. The sand is used because it has more efficiency than filter paper and it isn't need to change every

time so it is considered a costless. Using sand is more efficient, too because it helps to remove the dissolved solids in the water.
After using limestone, the TDS becomes 5000 mg/L and the PH becomes 6.5. The PH becomes good and the color isn't changed and the remaining point is reducing the TDS to less than 100 mg/L (which was achieved by the last step.

- **The electrical method**

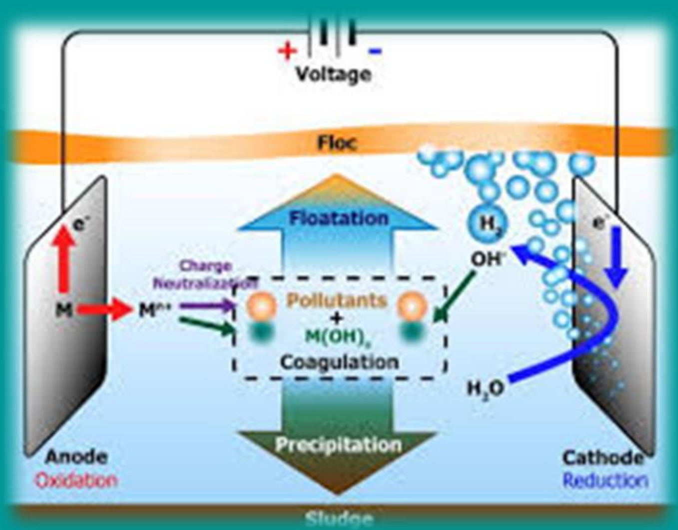
The final step is the deionization process. Deionization process an ion-exchange process in which water flows through resin beds.

Deionization: - is an ion-exchange process in which water flows through resin beds. Synthetic, cation resin exchanges hydrogen ions (H) for positive ions, and anion resin exchanges hydroxide ions (OH-) for negative ions.
This is the efficient and scientific way but unfortunately the anion and cation resins aren't fount in Egypt so we simulate it by copper and aluminum electrodes to do the same action and there are also efficient and achieve our goals.
This process is about two electrodes (copper and aluminum) one of them connected by the positive side of the battery (battery is a source of the charge) and another electrode connected by the negative charge of the battery. This process for happening attractions between the positive and the negative charge. The positive electrode attracts the negative ions which dissolved in the water and the negative electrode attracts the positive ions in water. We use this process because it removes the ions without affected the PH and it is a simple process and low cost.

Figure (29) Aluminum &cupper electrodes

Figure (30)

Deionization process mechanism



- After this process, the PH is 6.5 (not changed) and the TDS is 2370 mg/L (it is not the actually mission, we want the TDS to be about 90 mg/L to let reusing the water again without any disorder in the main process but 2370 mg/L is result from testing the prototype and we use copper and aluminum as a deionization process but the fact is the copper and aluminum are just a simulation to the actual process we want to do, we want to use cationic and ionic resins and they are very efficient and they will achieve our mission but they aren't provided in Egypt so we replace them with copper and aluminum as a simulation. We expected that the cationic and ionic will produce 90 mg/L not less than it because there are dissolved solids which not electrolyte so this process cannot remove them and they cannot affect the water in this process because our mission is to wash the circuit by this water again and the important point is remove the electrolytes to avoid any lose in the products). After that, the water could be used in the same process again and it won't affect the product.

2.3Selection of prototype

- Our prototype is about 3 stages, the default stage (which has the wastewater), and the other two stages are about the treatment. First stage is a box of wastewater which need to treat so it stuck with a tap which opened to let the water to go to the treatment stage. Treatment stage is about two boxes. One box for the treatment by chemicals and adding the limestone to the solutions to precipitate the dissolved solids. And the second one for the filtration and the deionization process.

- The path of the water is moving it from its default stage which happen the washing in it and which causing the water to be wasted to the second box by a tap which opens directly when the washing is done. The second box is the main box because the main treatment happens in it as the chemicals are put in it and the limestone. The third stage is the filtration and the deionization process. This step starts with a cone which a sand is put in it to filter the water. After this filtration, the deionization process starts, its material is (two electrodes copper and aluminum, source of electricity) we connect positive of the battery to the copper and negative the battery to the aluminum and all of that is found in the last container after getting the filtered water. Finally, there is a pump to push the water to the first stage after finishing the treatment.

- Our prototype is low cost, the cost is 245 pounds in the prototype and this cost for the containers, the taps and the pump, the cost of the chemicals is really little because we use little amount of it so it is difficult to calculate the cost of it so we considered it 2 pounds. The cost in the large scale will be 450 Pounds for the containers and the pump as it will be larger so more cost than the prototype, in addition to 30 pounds daily for the chemicals. This cost is really low comparing with using 100 liter of water every day in addition pollute the Nile and harm the industrial drainage.

In what ways can your prototype be tested?

- We get the wastewater sample from the factory in Banha.
- Put it in the first container as a simulation to the place which the water be wasted in it.
- Open the tap to throw the water in the second container to start treating
- Put few drops of H_2SO_4. Then after few seconds certain amount of $FeSO_4$ is added to the container.
- The color will be colorless so after that, certain amount of limestone will be added to the sample to precipitate the dissolved solids.
- The precipitate will be formed. Then the tap will be opened to let the sample to be filtered by the cone and the sand which found in the last container.
- After few minutes, the filtration will be done and the water will be in the last container.
- Deionization process will start after that and it will take 15 minutes.
- After 15 minutes, the water will be pumped to the second container to filter again and then pumped to the first container to return the cycle again after using the water to wash and after waste it.
- We measure the TDS and the PH of the water after pumped it to the first container and we found that the TDS is 2370 mg/L and the PH is 6.5 and it colorless so it is acceptable to use again in the same process again and do this cycle again and again.

Simulation

- The prototype will be two boxes made from Acrylic as it cannot react with the chemicals with different heights to allow the gravity to make pressure on the water to enter the membrane
- The first box will be 10.5*13.5*22.5to as its capacity 2 liters and this box will mainly for the chemical part (adding KMnO4- H2SO4 –FeSO4) and allow them to help in color removal, after that we will add calcium hydroxide (Ca (OH)2) to reduce dissolved solids and increase the PH.
- The second box have level lower than the other one and connected to it with tube its diameter will be less than 5 cm and it will have a filter at the end.
- We will control the water moving from the first to second through tape at the end of the first one attached to the tube. After that we will do deionization process by this, we can sure that the water will be less polluted as the TDS amount decreased.
- Our test plan is first:
- -measure the TDS and PH of the main contaminated water (water with KMnO4)
- -secondly, we will add some chemicals to remove the color (H2SO4 -FeSO4) and them measure the TDS which will cause higher in the dissolved solids and the PH that will be decreased, after that the water will be mixed with (Ca (OH)2), then it will be passed

through the tube passing the filter, the TDS down to 4530 ppm and PH up to 6.43. to disappear the TDS by nearly 90%, we will inter the solution to deionization process.

- The result will be a water which we can use again in the same industry with low number of salts and normal PH ,After preparation and doing the test plan

TDS	PH
Before (7500) ppm	Before (10.11)
After: less than 100 ppm	After (6.87)

Table (8)

TDS & PH treatment results

3. Constructing and testing a prototype

3.1Materials &Methods

▪ 3.1.1safety precautions

……As you Know "Safety always comes first" so we made sure that there is no danger on the users who tested our prototype or anyone who deals with the prototype so we have done and applied the safety precautions.
The materials that we used to insure our safety:

				
Heat resistant gloves	**Apron**	**Gloves**	**safety goggles**	**Lab coat**

▪ 3.1.2 Materials

To conduct our current prototype, we have to deal with different materials, and we had to choose the best as we can to be able to apply our thinking with the best way and show our work with great form, so our materials were:

The total cost is 450 L.E

3.2 Test plan: -

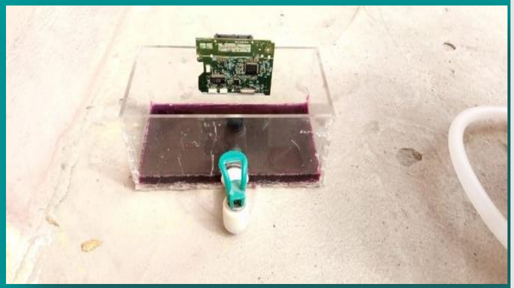
We choice two design requirements to walk on it to conduct our prototype and test plan:

The first one was water quality; we tested this condition by making water colorless after chemical reaction between the polluted water and sulfuric iron and sulfuric acid. And balance PH (6.5) and TDS (appox.1000ppm) by adding calcium hydroxide.

Figure (27) Filtration of calcium hydroxide to balance PH and reduce TDS

The second was prototype efficiency, we tested it by calculate the ratio between the efficiency of water before and after entering our prototype. And we find it has high efficiency according to color, PH and TDS of the final water.

- **Methodology**



Testing prototype occurs by using 1000mL of wasted water, 40ml is added firstly to make the solution acidic (because the waste water contains potassium permanganate and it is dissociate in acidic solution.

Then, 250ml of $FeSO_4$ is added to oxidize the waste water then the color could be changed. After changing the color, 25gram from the Lime ($Ca(OH)_2$) is added to deposit the dissolved solids and balance the PH. Then this solution is poured with its precipitation by opening the tap to the cone that have gauze and sand for the filtration.

Table (8). Materials

Item	quantity	description	usage	cost	Source of purchase	Picture
Acrylic	1800 cm^2	It is a transparent material like Glass, close to plastic.	It is used in making 3transparent containers.	100 L. E	Acrylic factory.	
Wood and plywood	3375 cm^2 plywood, 400 cm wood	Plywood with strength 4 mm. Wood with strength 10 mm.	It is used to make the prototype's body (different stages that carry other material).	150 L. E	Wood factory (wood workshop).	
Iron sulphate ($FeSO_4$)	50 gm.	Salt powder is soluble in water.	It is used in oxidizing the solution to remove the color.	25 L. E	Chemical's store.	
Sulfuric acid (H_2SO_4)	150 ml	The colorless and viscous liquid that is soluble in water	It is used to make the solution's medium acidic.	35 L. E	Chemical's store.	
Pump and hose	1 &1	Pump from medium size, can pumping the water for 85-100 cm. Water Hose with length 75 cm.	It is used for pumped water from last step to reusing it again in the first step.	75 L. E 10 L. E	Sanitary tools shop	

Funnel	1	Tube that is wide at the top and narrow at the bottom.	It is used for guiding solution into a small opening, to filter it.	10 L. E	Sanitary tools shop	
Gauze	1 roller	A thin translucent fabric of cotton.	filtration	10 L. E	pharmacy	
Electrodes	2	2 electrodes from aluminum and copper with strength 4mm &length 10*18 cm	It is used in deionizin g process for the solution.	45 L. E	Metal potter factory	
Taps	2	A device by which a flow of solution from a container can be controlled.	It is used to drop the solution between the container s and different stages.	10 L. E	Sanitary tools shop	
Calcium hydroxide (Ca $(OH)_2$)	4 kg	A soluble white crystalline powder commonly produced in the form of slaked lime.	It is mixed with the solution and precipitat ing with some dissolved solids.	2 L. E	Quarry	

From the cone to the third box in the last stage deionization process has been done. And using the water pump to raise the clean water to the industrial process to reuse it again.

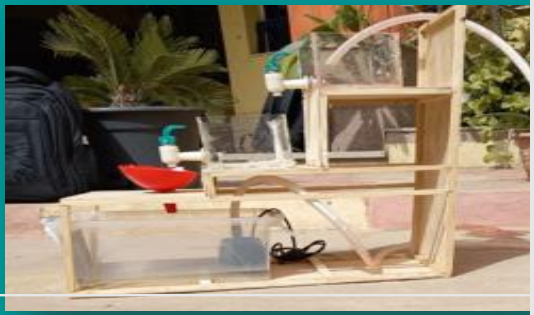


Figure (29) final prototype for treat water of electronic industry in washing potassium permanganate stage

Finally, the cleaner water becomes 6.5 PH and 1000 TDS after the treatment with law cost and creative process.

Failure trials:

Trial 1	The primary idea was making a layers of filter to remove the TDS and neutralize the PH and remove the color. These layers are sand, gravel, morenga plant, and zeolite. It was high efficiency solution as it makes the PH neutral and reduce the TDS but transfer the color from violet to dark yellow so we cancel this solution.
Trial 2	We did a lot of searches and reach another idea to remove the color of water by using different chemicals, we added Iron chloride ($FeCl_2$) to permanganate's water, but it was not affected and formed a black deposit so we replace $FeSO_4$ and it works. We tried to mix colored water with Iron sulfate ($FeSO_4$), and this also did not affect, so we add for them sulfuric acid (H_2SO_4) before ($FeSO_4$) to make the solution's medium acid and allow for ($FeSO_4$) to react with solution and effect on it and remove the color of permanganate. $FeSO_4 + KMnO_4 + H_2SO_4 = Fe_2(SO_4)_3 + MnSO_4 + K_2SO_4 + H_2O$  **Figure (30) Reaction between Iron chloride & polluted water**
Trial 3	The first one was using resins to get rid of dissolved solids, but it was not a good idea because these resins can remove only calcium &magnesium and we have not any of them. 
Trial 4	We tried using sodium hydroxide (NaOH) with molarity=1M to remove Magnesium as a deposit and it was a hope also to treat the acidity of the medium, but it was not successful as we wanted, too. Because it makes PH nature but a reaction with solution is occurred and formed other compositions.

After these trials it was found that, a great solution to that second trouble. As we mentioned selection of solution and it was Calcium hydroxide (Ca $(OH)_2$), it helped to remove the biggest number of solids with precipitate it and change PH as it considered a base. Also we can get water with more quality by using deionization process with two electrodes (Aluminum &Cupper) and power supply, but we made it in our prototype just as a simulation, for non-availability of materials (cationic and ionic) resins.

Figure (32) PH &TDS after finishing the process

Finally, we use pump to raise clean water from the last step to enter the industry and do its natural process.

3.3 Data Collection

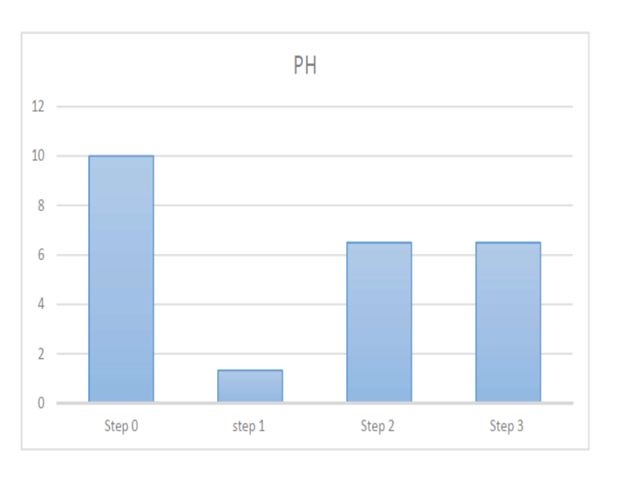
The prototype is about 3 steps and we cared about testing the sample of water after each step. From table (1), graph (1) and graph (2), it shows the proportions of the PH and TDS after each step and shows the effect of water color after each step.

Number of step	Process	PH	TDS	Color
Step Zero	Before the treatment	10±0,2	7600±5 ppm	Violet
step 1	Adding chemicals	1.33±0.2	10.000±5 ppm	Colorless
Step 2	Adding the lime ($Ca(OH)_2$)	6.5±0.2	5000±5ppm	Colorless
Step 3	The Deionization	6.5±0.2	1000±5ppm	colorless

Table (9) PH, TDS, and color through prototype steps

We use beaker to test the sample in it to know the volume and get accurate number and it helps us to test many times without waste the sample.

1) First step we take 10 mL from waste water and its PH was 10±0.2 and its TDS was 7600 ppm and its color was violet. Then we put 0.4 from H2SO4 and 2.5 from FeSO4, the PH become too acidic, 1.33 and the TDS 10,000 ppm and it is too bad number but we could return the color to colorless water. After that we put 0.3 g from the lime (Ca (OH) 2) and stirred the solution. The PH becomes 6.5 and TDS become 5000 and the color isn't changed. Finally we use a simulation of deionization process to increase the efficiency of the project.



Graph (2)

PH at different prototype

Trial Number	PH	TDS
First trail	6.3	900
Second trial	6.7	1200
Third trial	6.4	900
Average	6.5	1000

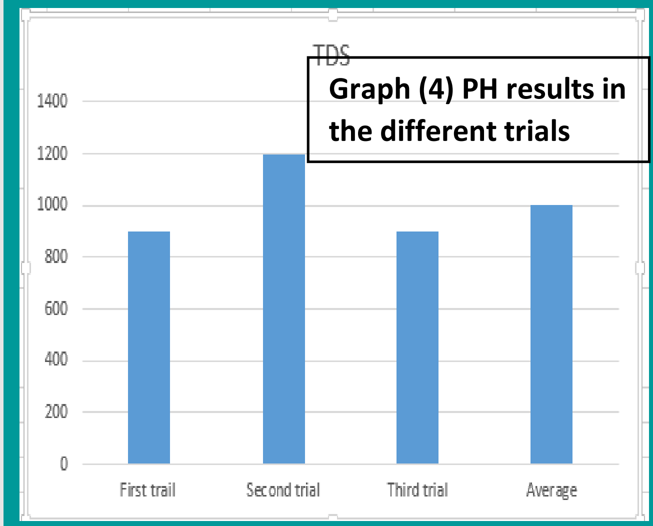
Table (10)

PH &TDS results in different trails with

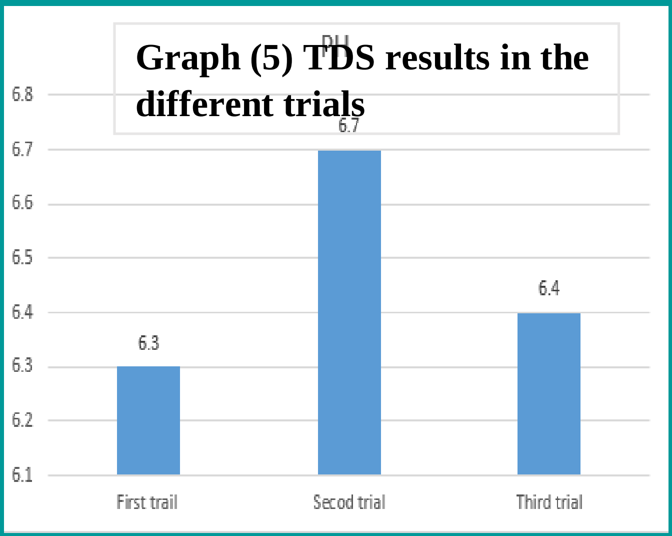
In the final test of the prototype, we care about putting the same amount of chemicals and lime which we tested on it before to get the probability proportions of TDS and PH to know how much it will differ from trial to another. The PH wasn't changed much and it is close to the average PH so it is High precise and high accuracy. The TDS isn't precise enough as shown in the table () but because the value is bigger.

Graph (3)

TDS at different prototype



Graph (4) PH results in the different trials



Graph (5) TDS results in the different trials

3.3.1Measurement tools

1. PH Meter

PH meter is used to measure the PH and we analyze the sample, too in water station to be sure from the result.
After every experiment, the PH meter is used to evaluate the experiment.
The reading error was (+- 0.1)
Our measurement is slightly accurate because we use different devices and always measure many time and get the average to get the right number.

2. TDS Meter

TDS meter is used to measure the TDS (total dissolved solids).
We use it after any trial to evaluate the trial if it helps the solution or not.
The reading error was (+-5).

3. Beaker

It is the main measurement tool as we measure the volume of the sample before and after treatment. But it isn't much accuracy with small amount so we use pipet with the small amount.

OR

4. Evaluation, Reflection, Recommendations

4.1 Discussion

As a result for the previous procedures that we followed the prototype worked efficiently and it was cheap, safe and stable. And due to the modifications that we added to our project, we guarantee that our solution will solve the water & pollution problem in Egypt as it's so efficient and suitable for the limited Egyptian economy.

When we tested our prototype, it proved for us that it's:-

Efficient: because when we tested it, the concentration of the salts in the water decreased from 11200 ppm to 700 ppm.

Low Cost: Because we used the materials that the school provided for us, and we used the cheapest available materials.

Safe: because it has no sharp tips, it doesn't have electricity or heat.

Testable: as we were able to test its ability to work effectively and do its purpose which is clarify water and manipulating the amount of TDS and PH

Measurable: it was not complicated for us measure the amount of TDS and PH and get the ctual results every time with precision and accuracy

4.2 Conclusion

There is a difference between knowing something and hearing about it, just because you "heard" doesn't mean you "knew", so you must know our conclusion by estimating every single result so after collecting data and after trying many different solutions, we found that After we made the test plan and analyzed the results, we conclude that our project is effective and successful because it achieved the design requirements. It has a high permeability, low cost, suitable strength and it is saving a high amount of water. It is easy to apply in reality. Compared to other existing solutions our prototype is capable of save great amount of water for using it again in the electronic industry up to 600 Liter daily and this will help to solve the water shortage and pollution problem in Egypt.

Product of our prototype is a very large amounts of high purification water, and we could exploit there large amounts to in many things in short time. But the perfect usages for it is in the cycle again because it's important as the future depend on the newly updated technology and for reason it's consumption of water is high so we should focus on solving it

4.3 Recommendation

To improve our project and keep it more effective in the future, we recommend people who will complete our work, designers who will design it in the real life and any one will work in this project after us to:-

<u>What we recommend for the future work in the Water pollution field:</u>

- They should think in a creative way and according to the EDP (Engineering Design Process) steps.
- They should learn about the water treatment bases and the different water resources and contaminants.
- They should learn about the whole cycle to produce electric cells
- They should also learn about the tradition way to produce the cells which produce to many toxins
- They should be co-operative with one another to make a good project.

<u>If you need to start from the point that we stopped at:</u>

- You should research for the types of the membranes and the different techniques for water treatment.
- Your solution must be safe and ecofriendly.
- You should study the pumping system and trade off to choose the best of them.
- Try to solve the problem in water not in electroplating but in H Process as it more polluted
- Get another kind of batteries that are the same capacity, but smaller size. For the process of Electro dialysis
- Use alternative of resins that will be cheap for stage of purification of water and resins is any natural or synthetic organic compound consisting of viscous liquid substance that treat water by process of ion exchange.
- Apply the idea of Sensors , to make a seclude and after a period of time it will add the specific chemicals for the process of treatment
- As shown in the results that the produced water is completely free of salts which decreases its nutritious benefits, so in the future we will add a barrier in the pipes that water flows to homes, this barrier contains Pascalite clay which is: a calcium bentonite white clay. As this clay has many benefits one of its most important benefits is that can mineralize water and won’t affect the flavor of your water.

4.4 Learning Outcomes

Subject	Learning outcome	How it was useful in our Capstone
Chemistry	L.O.1 Outline the purification of the water supply. Describe two different processes whereby sea water can be converted into drinkable water.	We have learned how to use simple distillation to separate soluble salt and carbon to remove tastes and colors and we learned how to calculate rates of chlorination to disinfect the water and how to determine the concentration of solutes by different methods and from Chemistry we ascertained that Quantitative and qualitative analysis are tools to study solutions and we studied Total dissolved solid (TDS) that enabled us from measuring the total amount of mobile charged ions.
	CH.2.03 - Describe characteristic properties of acids and bases and preparation of salts.	We have studied that Since acids increase the amount of H+ ions present and bases increase the amount of OH- ions, under the pH scale, the strength of acidity and basicity can be measured by its concentration of H+ ions. This scale is shown by the following formula: $pH = -\log[H^+]$.
	CH.2.04 - Describe the effect of concentration, pressure, surface area, temperature and catalysis (including enzymes) on the rates of reactions and explain these effects in terms of collisions between reacting particles.	We have learned how to determine the rate of chemical reaction and the change of concentration of reactant and product.

Earth Science	ES.2.01 - Students will analyze how the unusual properties of water contribute to its pathways through earth's systems.	We have studied different physical properties of water and water cycle that can help us to overcome our challenge. We studied wind sources also.
	ES.2.02 - Students will model factors which affect water reservoirs and associated costs ES.2.04	We have learned how to determine the amount of water used for different purposes (industry, irrigation, drinking…etc.) We studied abundant ways of treatment like using lime (calcium hydroxide) causes the particle to coagulate and stich together to form large flocs and this flocs settles fast. We studied also the filtration and how the sand and gravel are good filters. We studied also the disinfection (using chlorine) and it helps us to know about its byproduct and its causes.
English		We ascertained new vocabulary and how to write our poster and portfolio and improving our language for presentation.

Math	MA.2.01 - Create, interpret and analyze polynomial and absolute value functions that model real-world situations	We have studied different properties of the algebraic function and how to make its graph that can help us in our portfolio and poster.
Mechanics	ME.2.01 - Students will be able to model the force of friction when analyzing applied problems in Newtonian mechanics.	We have studied friction (kinetic and static friction). In our capstone, we found that there is a kind of friction called fluid friction. Let's say that there is a liquid drop of falling water, we can see that some force is also restricting the fall of drop but it falls after small time. After dropping on the surface, some small droplets are also stay on the surface that is due to kind of friction called fluid friction. It is a resistance offered by a fluid against its flow. It can be explained by knowing more knowledge about viscosity. There is another kind of friction in our capstone which called kinetic friction that prevent the flow of water in the pipe, so we were careful to use smooth materials in our prototype to reduce the friction.
Biology	BI.2.01 - Use evidence to evaluate the risks and benefits of using Genetically Modified Organisms to support economic, social and environmental sustainability. • Explain the intended and unintended consequences of the use of GMO's • Describe the trade-offs of the use of genetically modified food.	We have studied selective breeding and Genetically modified organisms but we thought that Selective breeding was safer and better than GMOs and GMOs may have negative results that can hurt us and It's a new method so Scientists don't know much about this method so I think Selective breeding is so good to use so we used it

Physics	PH.2.01 - Students will be able to use Newton's Universal Law of Gravitation when considering effects of gravity far from the Earth's surface, or near other planets.	We have studied gravitational force that helps us to determine the direction of the flow of water to make it easy to go down not upwards. As we study the attraction between the positive and negative charges and the repulsion between the same charges (positive charge with positive charge) or (negative charge with negative charge). This principle has many applications which was benefit to remove the TDS.

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