

Reusing system of the ballast water

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ملخص:

تعد زيادة استهلاك المياه مشكلة تواجهها مصر، ويكمن أحد حلولها في إعادة استخدام المياه، وتتعلق إعادة الاستخدام بتغيير العمليات التي تؤدي إلى إنتاج المياه الملوثة بحيث يصبح الماء الناتج صالحاً للاستخدام مرة أخرى. مشكلتنا الرئيسية في هذا الفصل الدراسي هي إعادة استخدام المياه غير الصالحة للاستعمال أو الملوثة. نحن لا نعالج المياه، لكننا نغير العمليات لجعل المنتجات الثانوية للمياه قابلة للاستخدام مرة أخرى في العملية نفسها أو حتى في عملية مختلفة. حلنا هو إعادة استخدام مياه الصابورة في نقل النفط. السفن النفطية تتجه من دولة إلى أخرى وهي محملة بالنفط، وتعود هذه السفن محملة بمياه الصابورة بدلاً من الزيت لمنع مخاطر انقلاب هذه السفينة، ولجعل السفينة مستقرة، وهو الغرض من عودة مياه الصابورة إلى بلدانها الأصلية بسلام. هدفنا هو تنقية مياه الصابورة الممزوجة ببقايا الزيت من خلال الاعتماد على فرق الكثافة بينهما. الخطوة الأولى هي وضع مصدر هواء قوي في الخزانات لتوفير بعض الفقاعات داخل الخزان. ثانياً. وضع بعض قشور الحديد داخل الخزانات لإصاق هذه القشور بالفقاعات، ثم بواسطة مجال مغناطيسي جذب فقاعات الملوثات المرتبطة بالمقاييس الحديدية، ويبقى ماء الصابورة في الخزان لاستخدامه مرة أخرى. قبل كتابة خطة الاختبار، أظهرنا متطلبين للتصميم: الأول هو جودة مياه الصابورة التي تتكون من جزأين، هما: التعكر والزيت والشحوم وجميع المواد القابلة للاستخراج بواسطة الكلوروفورم في الماء. ومتطلبات التصميم الثانية هي التأثير البيئي. من خلال إجراء الاختبار، كانت النتائج مذهلة للغاية؛ لأنها حققت متطلبات التصميم التي وضعناها لجعل هذا المشروع قابلاً للتطبيق لإعادة استخدام هذه المياه الملوثة بعد تنقيتها.

وقد حصل المشروع على شهادة من جامعة بنسلفانيا على فكرته وإمكانية تنفيذه.

■ Abstract

Increasing water consumption is a problem faced by Egypt one of its solutions is reusing water. Reuse is about changing processes that result in polluted water byproducts so that the resulting water is usable again. Our major problem in this semester is to reuse unusable or polluted water. we are not treating the water, but we are changing processes to make water byproducts usable again in the same process or even a different process. Our solution is to reuse ballast water in transporting oil. Oil ships are heading from one country to another, and they are loaded with oil. These ships return to be loaded with ballast water instead of oil to prevent the risk of overturning this ship and to make the ship stable which is the purpose of the ballast water to return to their original countries in peace. Our goal is to purify this ballast water mixed with oil residues, by relying on the density difference between them. The first step is to place a source of strong air in the tanks to provide some bubbles inside the tank. Secondly, put some of the iron peels inside the tanks to stick these peels with the bubbles, then by a magnetic field attract the pollutant bubbles that are attached to the iron scales, and the ballast water remains in the tank to be used again. Before writing a test plan, we demonstrated two design requirements. The first one is ballast water quality which has two parts the turbidity and oil, grease and all extractable matter by chloroform in water while the second design requirement is the environmental impact. By making a test, the results were so amazing, because it achieved the design requirements that we put to make this project applicable for reusing this polluted water after purifying it.

■ Introduction

Egypt faces many challenges that delay its successful. From over population, pollution and etc. the two major challenges that will be solved is reducing pollution and manage and increase the source of water.

There are many types of pollution, but the most influential types of pollution in general and on humans in particular: Air pollution, Soil Pollution, and our capstone problem Water Pollution as shown in figure 1, the contamination of water bodies, usually because of human activities. One of this human activity is casting the water mixed with petrol and oil in oceans which the problem that will be solved.



(Figure 1)

Egypt will need to improve other sources of clean water for agriculture and citizens' usage or Egypt will be hit by a severe drought that will lead to catastrophic economic consequences. As a result, the solution of purifying the water mixed with oil will allow to reuse this water again in this process or in another process whichs considered as a new source of water.

We searched for many prior solutions but we choose the most successful one which is Hampton Roads Sanitation District (HRSD). It is wastewater reuse and treatment utility that protect public health and waters. In some parts of eastern Virginia, in conjunction with sea level rise, is a problem that leads to flooded neighborhoods and vulnerable communities. Land subsidence is, in part, attributed to overdrawing groundwater aquifers. HRSD is addressing this by using highly treated and reusing wastewater to replenish the aquifers with up to 120 million gallons of water a day. This will

ultimately keep about ٩٠ percent of HRSD's wastewater discharge out of the Elizabeth, James and York rivers.



(Figure 2)

This project improves water quality and reuse it, helps communities adapt to sea level. It also has many weaknesses that we tried to avoid like, the estimated price is very high so it cannot be used in developing poor countries

For choosing our solution, we used the collected data and the prior solutions to form our new project by mixing its strengths solution and avoiding its weakness. The ballast water is the fresh or salted water used in ships tanks to make the ship stable and prevent the overturning of the ships. In the oil ships ballast water is mixed with oil that is in the tanks and return to the oceans or rivers as wasted and polluted water. Our solution comes from this problem by purifying and treating the ballast water which is mixed with oil. The amount of wasted ballast water is huge amount that can be reused and not wasted also it pollute the oceans and rivers as it contains the oil residue

This problem will be solved and the ballast water can be reused again. This solution addresses the design requirements by a scientific proved method. By purifying the ballast water and exerting the oil from it, we obtain good ballast water quality which is a design requirement and also, we make positive environmental impact as we prevent pouring mixed ballast water with oil in rivers and oceans.

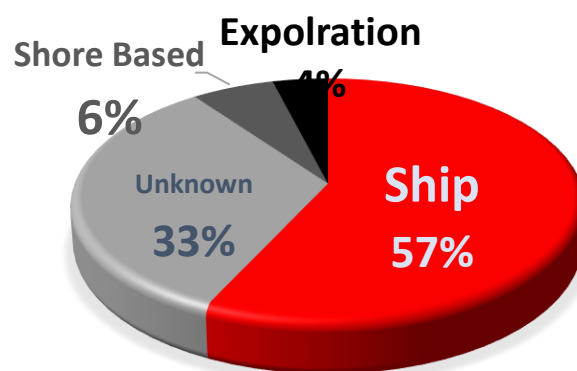


Figure 3

Materials

Name	Quantity	Description	Image	Price
Clear acrylic	6 sheets to make a box with a handle	A transparent thermoplastic homopolymer used as an impact resistant alternative to glass		300 L.E
Air blower	1	equipment or a device which increases the velocity of air or gas when it is passed through equipped impellers.		From (fab lab)
Iron filings	250 grams	very small pieces of iron that look like a light powder. They are very often used to show the direction of a magnetic field.		From (chemistry lab)
Magnets	4 pieces of magnets in the form of cuboid	A magnet is a material or object that produces a (magnetic field). a force that pulls on other ferromagnetic materials.		From (physics lab)
Pipes	3 pipes	A pipe is a tubular section or hollow cylinder, used to convey substances which can flow — liquids and gases (fluids).		Recycled pipes 0 L. E
Oil	Oil for the experiment	Oil is a slippery liquid that comes from minerals as well as animal and vegetable fat. and do not mix with water		From (chemistry lab)
Silicone glue	2 can	a type of adhesive that contains silicon and oxygen atoms, making it a good water-resistant solution		12.5 l. e For one can
Total cost				
325 l. e				

■Methods

The following are the main points and logic considered in the methodology of the reusing system for the ballast water of transporting oil:

- (A) The project is based on a box made of six acrylic sheets in addition to a hand handle on the top sheet of the box
- (B) The dimensions of the prototype have been chosen with following justification: (1) Total length= 30 cm, (2) Width=25 cm, (3) Thickness= 4 mm. All these lengths are also selected in order to withstand the air pressure generated by the different Speeds of the air blower.
- (C) The use of pipes of different shapes so that they are used: (1) Two open pipes are used with an opening with a diameter of 5 cm and a height 6 cm in one of the acrylic sheets in order to receive the air coming from the air impeller, (2) the use of two other pipes with an opening slightly larger from, (3) its amount 5.5 cm and at a higher height of 17.5 cm for the iron filings loaded with oils to be removed through these connected pipes
- D) Make a water tap so that the water is removed after cleaning it from the oil.

This box, in all its parameters, is a simulation of the ballast water reuse system for transporting oil in the ship's tanks.

■Test Plan

Our test plan aims to get success in collecting oil from water by big amount so we could reduce the turbidity and make water density closer to the pure water so we could make reusing for the water used in balancing and cleaning containers in the ships that transfers petroleum oil.

Our design requirements were:

- 1- Reduce turbidity and make water density closer to pure water.
- 2- Make an eco-friendly environment we made a test on three samples with different three quantities of oil and iron fillings.

Our test plan steps for each trial:

- 1-We measure the amount of oil and the amount of iron filings.
- 2-Start adding oil to the water container.
- 3-Use an air pump to stir oil in water.
- 4-Stop the air pump and start adding the iron fillings.
- 5-Start using the air pump again for seconds.
- 6-Start moving magnetic bars on the outer surface of the container.

7-After the magnetic bars collect iron fillings in the corners start to rise them up and put them in the output tube.

8-Wait for the output iron filings that carries amount of oil.

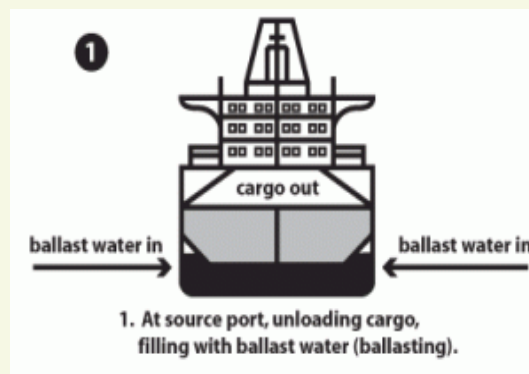
9-Measure the output then compare it with the first amount of iron fillings then calculate the difference between them to know the amount of output oil.

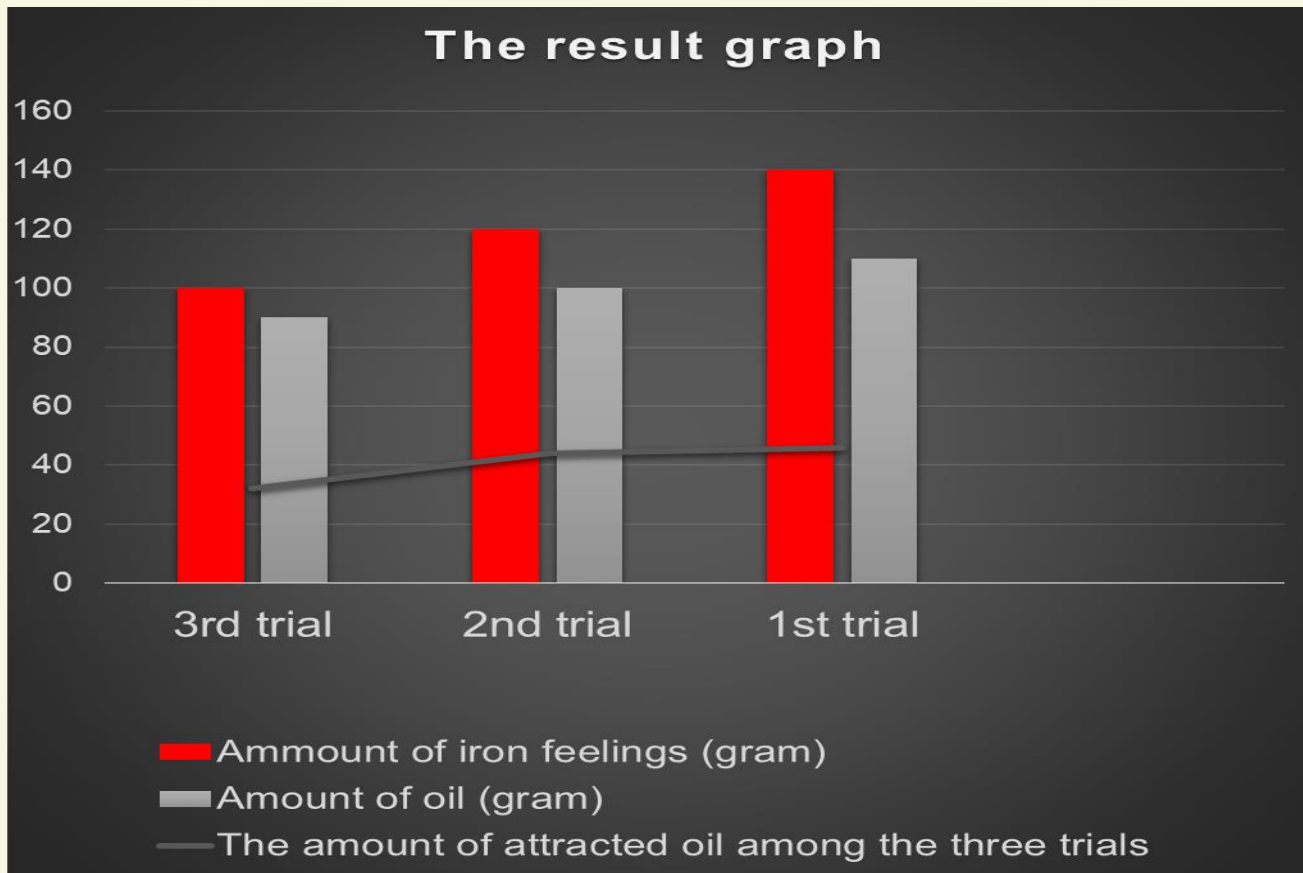
10-Try for another two trials to get an average.

Results

According to the results of the testing when I put 100 gm of oil and 120gm of the iron filings, the amount of iron filings and the oil pollutants weights 164 gm. So, the amount of attracted oil is 44 gm from the original amount that weighs 100 gm. By changing the amounts of the input of the oil and the iron filings, I found that the project has the ability of attracting 43% of the oily pollutants in water.

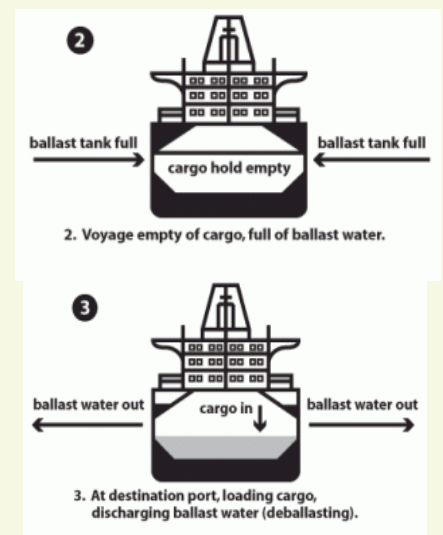
	Amount of iron filings (X)	Input of the oil	Amount of iron filings with the oil that has been caried (Y)	Amount of the oil has been caried Y-X
(1)	140 gm	110 gm	183	46
(2)	120 gm	100 gm	164	44
(3)	100 gm	90 gm	139	39





Analysis

Our project is a treating system of the ballast water that resulting from the process of transportation of oil. The ballast water any solid or liquid that is brought on board a vessel to increase the draft, change the trim, regulate the stability or to maintain stress loads within acceptable limits. The ballast water is a global problem that affects all oil-exporting and importing countries, explaining that the problem lies in the design of the ship itself, and if it is empty, it floats and is driven by waves, adding, "The ship must be heavy to submerge in the water and stabilize, so they are forced to replace the oil with water that is taken in the port of discharge. In the case of transportation of oil, the ballast water is loaded with the pollutants of oil. The problem is that the ballast water that is placed in the ships' containers instead of the oil mixes with the petroleum sediments on the walls of the containers.



After the ships are returned, the workers in this field throw the water dirty with oil into the sea, which in turn pollutes the seawater because oil has a toxic effect on marine organisms when they absorb it. The hydrocarbons

that make up the oil accumulate in the fatty tissues, liver, and pancreas of fish, which in turn kill humans after suffering cancer. It also negatively affects invertebrates, plankton, shellfish, mammals, marine birds, and coral reefs. That polluted water is thrown in the oceans or rivers. So, that water is considered as a wasted water. If we treated that water and reduce

The percentage of oil in it, we would be able to reuse that water in the same field again

And reduce the consumption of water in the usage of ballast water. Our project provides treating system of the oily ballast water to reuse it again in the same field. The project is depending on some physical properties as the differences of the density between the oily pollutants and the water. The oily pollutants will float on the surface of water, so, we will be able to take out the oil from water easily. In our project we will take the oil out of water according many steps:

- Start to mix the mixture with an air source like an air pump to stir that
- Heterogeneous mixture with each other and make some air bubbles in the mixture.
- Pour and add some of iron filings to the tank.
- That iron filings will stick on the bubbles of air making a layer of iron on That bubbles.
- Use a magnetic field to attract the attract the pollutants and the iron filings.
- After repeating that process several times, the percentage of oil will decrease, and the water will be able to be reused again in the same field. According to the prototype, the prototype had been made of the acrylic glass. And the tallest pipe for entering the air source throw the air pump, the small pipe for the output of the pollutants and iron filings.



After testing that prototype, our project proved its success, 44% of the oil pollutants have been took out from the tank. So, that water can be used again in the same field again.

According to our results of the testing when we put 100 gm of oil and 120gm of the iron filings, the amount of iron filings and the oil pollutants

weights 164 gm. So, the amount of attracted oil is 44 gm from the original amount that weighs 100 gm. By changing the amounts of the input of the oil and the iron filings, we found that the project has the ability of attracting 43% of the oily pollutants in water.

The project achieved all the selected design requirements. First, the turbidity of the oily water after and before using our treating system. The turbidity of the polluted sample before treating was 589 NTU, while the purified sample has turbidity equal 360 NTU. The other design requirements are measuring the oil and the grease and all extractable matter by chloroform. The polluted sample has a measure of 4.5 g/l, while the purified sample has a measure of 3.7 g/l. All our analysis and measurables is certified by Integrated

Management of Domestic & Industrial Wastewater and Sludge and Dokki Research Center.

$$\text{Efficiency of the turbidity } (\tau) = \left(\frac{\tau_0 - \tau_f}{\tau_0} \right) \times 100\%$$

$$\text{Efficiency of the turbidity } (\tau) = \left(\frac{589 - 360}{589} \right) \times 100\%$$

$$\text{Efficiency of the turbidity } (\tau) = 39\%$$

Integrated Management of Domestic & Industrial Wastewater and Sludge

قسم بحوث تلوث المياه
مجال الإدارة المتكاملة للمخلفات
الأنسية والصناعية السائلة والصلبة

نتيجة تحليل العينة الواردة من أ.ر. معز محمد صبرى

Date: 10/1/2021

Parameters	Units	Influent	Effluent
Turbidity	NTU	589	360
Oil and grease and all extractable matter by chloroform	g/l	4.5	3.7

• This sample has been received by Mootaz Mohamed Sabry

Head of Domain
Prof. Dr. Fatma El-Gohary

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□ L.O connections with the project:

L.O subject	L.O connection
Lo.6 physics	According to the sixth learning method in physics, we studied the magnetic field and how we used it to pull the magnetized materials, which is the scientific basis upon which the idea of the project is based by drawing iron filings using magnets from outside the acrylic box. Another point is Magnetic flux is a measurement of the total magnetic field which passes through a given area. It is a useful tool for helping describe the effects of the magnetic force on occupying a given area (the iron filings in the acrylic box).
Lo.1 Chemistry	In the first learning outcome in chemistry, we learned several water quality parameters such as: total dissolved solids, water turbidity, pH and dissolved oxygen. Turbidity is the measure of relative clarity of a liquid. It is an optical characteristic of water and is a measurement of the amount of light that is scattered by material in the water when a light is shined through the water sample. In addition to turbidity, we chose oils, grease and all materials that can be extracted with chloroform as quality parameters for water because it is the most suitable for what our project achieves in the Design requirements. We also found a noticeable difference between the water before treating it and cleaning it from oil and after removing oil from the water.
Lo.3 mechanics	In the third learning output we studied work in mechanics. Since work = force multiplied by displacement, and since we are in our project, we use magnetic force, so work has an effect on our project in terms of: As the iron filings are withdrawn by the magnetic force greater than the friction force on any surface of the acrylic box. Therefore, the value of the magnetic pulling force of iron filings is greater than the coefficient of friction of acrylic, so the work done by the friction force is negative. Although the iron filings move in the direction of the magnetic force, the work done on the filings is considered positive.
Lo.1 geology	According to the first learning outcome in geology, we studied the physical and chemical properties of water and the water cycle. In our project we have used the most important property of water which is density. Density is a measurement that compares the amount of matter an object has to its volume. An object with much matter in a certain volume has high density. We used this property because oil is less dense than water, it will always float on top of water, creating a surface layer of oil. This made it easier for us to get the idea of drawing oil out with iron filings.
Lo.4 geology	In the fourth learning outcome we learned a lot about pollutants and water treatment. And the effects resulting from pollution of water with petroleum products. Petroleum and oils are generally considered to be organic industrial wastes. Therefore, water must be purified from these residues in order to preserve water sources. So, in our project, we used the idea of drawing petroleum residues from the water using a magnetic field, where iron filings were placed in the water, and when withdrawn, they stick to petroleum particles and pull them with

□ Conclusion:

The state of increasing the usage of water will make us face a dilemma we will suffer from it which is the rarity of water sources and water quantities which considered as an enormous challenge but one of the best solutions for this challenge is to make processes that enable the reusing of water after using it in a process and use it in the same one or in new process, one of the process that make a huge consumption of water is the process of transportation of petroleum oil as after transporting it the containers in ships is filled by ballast water, our solution makes water available to reuse it after this process by using iron fillings, air pump and magnetic field , we have made test for our solution and it gave successful results as we had a container filled with water mixed with oil then we had air pump to stir them then we added iron fillings then made air pump into container then by magnets we have collect iron fillings then put the output out of the container, three trials had been made after each one we have calculated the quantity of output oil and how the water become more clear at the end the average percentage of the output oil is 43% of the oil in the container was filtered and became an output, so we concluded that our idea has been succussed to

make water available to reuse so it will leads to decrease the consumption of water.

Reccomendation:

- The project can be modified by using safety insulated electromagnet instead of a normal magnet as it more power that can pull the iron filings with more oil and that will increase the efficiency of the project and will reduce the cost.
- Another recommendation is to use metal instead of iron fillings as it has high cost and will not save money so we can use another metal which will be attracted by the magnet with more oil.
- by oil removing process from the metal fillings it can be reused instead of using new metal fillings to be attracted to the magnet with the oil
- by increasing the number of magnets, the power of it will increase so that it will attract the metal fillings more and more with larger amount of oil
- The third modification in the project will be the method of drawing oil from the water using a powerful magnet and wrapping it with a piece of plastic so that the iron filings do not stick to it and the magnet is placed inside a hose, so the oil is drawn from the surface of the water by pulling the iron filings in the water which will carry the oil with it. Anyone who will work on this project should start from our endpoint and use our recommendations that will be benefited for him instead of finding some researches.

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