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Removal of Emulsified Oils in Contaminated Water by Air Flotation and Filtration Techniques

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ABSTRACT

The study was conducted for the purpose of removing the emulsion oils that polluted water, as a processing unit was designed and manufactured by the researcher, the two phases included a basin for the air flotation to separate the emulsion oil in the water. For the purpose of removing the remaining water polluted oil, and samples were taken after (10,20,40) minutes to test the effect of time in the treatment method with air, as well as samples after nominating the candidates to test their efficiency.

The results demonstrated the efficiency of both the flotation basin with air and two filters high efficiency in removing the emulsion polluted water, as it was the highest efficiency of the flotation basin at 40 minutes and the removal rate was 98. 33 %, as well as the candidates have proven efficiency in removing the remaining oil from the bundle of cavity, and that the highest removal rate is (96, 100) %, respectively, for both sponge filter and Eucalyptus powder filter, and this is confirmed by the results of the concentration of Turbidity.

Keywords- Flotation, Oil, wastewater, Filteration.

I. INTRODUCTION

Water is necessary for life and essential for living organisms. However, industrial and economic growth has led to the production of industries that produce a large amount of pollutants continuously and at high rates of wastewater, which requires treatment before disposal (Varjani *et al.* 2019; Zafra *et al.* 2015; Chen,2018).

Waste water is water that contains excess substances that negatively affect its quality, making it unusable. The pollutants excreted in industrial waste water affect the environment, and some of the pollutants are organic and some are inorganic. When these components are not treated, it may pose a danger. On the environment and living organisms, and the removal of these pollutants from industrial wastewater in an effective manner has become necessary (Abdelbasir and Shalan, 2019; Sulekha and Chem, 2016).

The oil/water emulsion is produced in the waste water from various sources, such as oil refineries, workshops, gas stations, as well as edible oil factories and soap factories. The oil recovery process will depend on how the oil is present in the water stream in different forms in free and emulsified form. It is possible to remove Free oils in water by density difference as they float on the surface of the water, but the emulsions may be soluble in water and therefore require complex methods, including mechanically and chemically (Hanafy and Nabih, 2007). When left untreated before being discharged into sewers, it causes environmental degradation, health risks and threatens the ecosystem (Welz *etal*. 2007).

Many treatment processes are used for pollutants, including biological, physical, and chemical treatments. Flotation is used to remove emulsified oils from water (Welz *etal*.2007), as well as activated carbon membranes, oxidation, reverse osmosis (RO), activated

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sludge, activated alumina, and activated (Nagwekar ,2014; Nagwekar, 2014; Tetteth and Rathial, 2018).

In view of the environmental problem posed by water pollution by oily compounds resulting from industry, oil refineries and daily household activities, especially oil in its emulsified form, it is necessary to remove it with technologies and methods that are easy to use, low cost and safe for health and the environment, especially since the processes for removing emulsified oil are usually done by adding chemical compounds. To find a simple, sustainable and environmentally friendly way.

II. MATERIALS AND METHODS

1- Processing unit design and manufacture:

The treatment unit was designed and manufactured to remove contaminated oils from the wastewater by the researcher. The treatment unit included **two stages**:

The first treatment stage: It included the manufacture of a basin used to separate the emulsified oils from the water, and the principle of the device's work is flotation by pumping air from the bottom of the basin. The basin was made of high-density polyethylene plastic with dimensions (24*16*16) inch, it has an upper side opening for the entry of polluted water, and on the opposite side there are two exit holes Water, a lower one for the exit of treated water and an upper one for the exit of separated oils. The ventilation system was placed at the bottom of the basin, which is a network of fine tubes with a diameter of (0.25) inch, perforated with very small holes and distributed over an area at the bottom of the basin. It was connected at one end to a rubber tube that connects to an air pump outside the basin used to pump air, Figure (1a&b).

The second treatment stage: It included the manufacture of two filters used to filter the treated water in the first trip to remove the remaining oils in the water. The filter was designed in a cylindrical shape of high-density polyethylene with dimensions (16*2.5) inch. It has two openings, an upper one for the entry of polluted water, and the other lower for the exit of treated water. The filtration material, which is the powder of the bark of the eucalyptus plant, was placed in one of the filters. The bark of the eucalyptus plant was collected and dried at a temperature of (40) C○, then crushed by an electric mill to make a powder. In the second filter, the synthetic sponge material with a height of (16) inch, is included from the total height of the filter, figure (1 C&D).

2- Preparation of the contaminated material and operation of the treatment unit:

The contaminated substance was prepared by taking the oils excreted during the oil change of motor vehicles in the industrial area and mixed with distilled water at a concentration of (1.5) mg/l, and was continuously shaken for the purpose of emulsifying the oils in the water. Through the entry hole, after that the air motor was started and the air was pumped into the air tubes in the ventilation network at the bottom of the treatment basin and thus the air bubbles will rise to the top of the basin and the emulsified oil droplets will be raised with them to the top of the water surface and samples were taken for different periods of time (10,20,40) minutes to estimate the importance of time In the treatment and selection of the optimal time, the oils floating on the surface as a result of flotation were collected from the upper effluent, while the treated water was drained from the lower effluent and passed to the two filters of sponge filtration and the pant powder filter separately from the entry slot at the top of the filter. After filtration, the treated water was collected from The Effluent, and each filter was filtered separately to compare the efficiency between them. Samples were taken from the treated water to estimate the amount of remaining oils.

As for the floating oils as a result of the air flotation processes, they are withdrawn through the upper outlet opening and collected outside the unit.

3- Appreciation of studied traits:

Determination of the oil concentration: The oil concentrations in the treated water were estimated by taking 100 ml of the treated water and placing a separation funnel and adding 20 ml of carbon tetrachloride solvent CCl4 to it and mixing quietly and leaving for 5 minutes to separate the aqueous part at the top and the lower part that contains the solvent with the oil in the bottom part The solvent was taken with the oil and placed in a separation device for the purpose of separating the oil from the solvent, which consists of a thermal heater and a thermal condenser. The volume of the remaining oils was estimated and the processing efficiency was extracted according to the equation:

Processing efficiency% = ((A-B)/ A) *100

Where:

A: oil concentration before treated.

B: oil concentration after treated.

Turbidity Estimation: The turbidity in the treated water was estimated using a device of type (HANA-LP2000 Turbidity meter) and the NTU unit was used.

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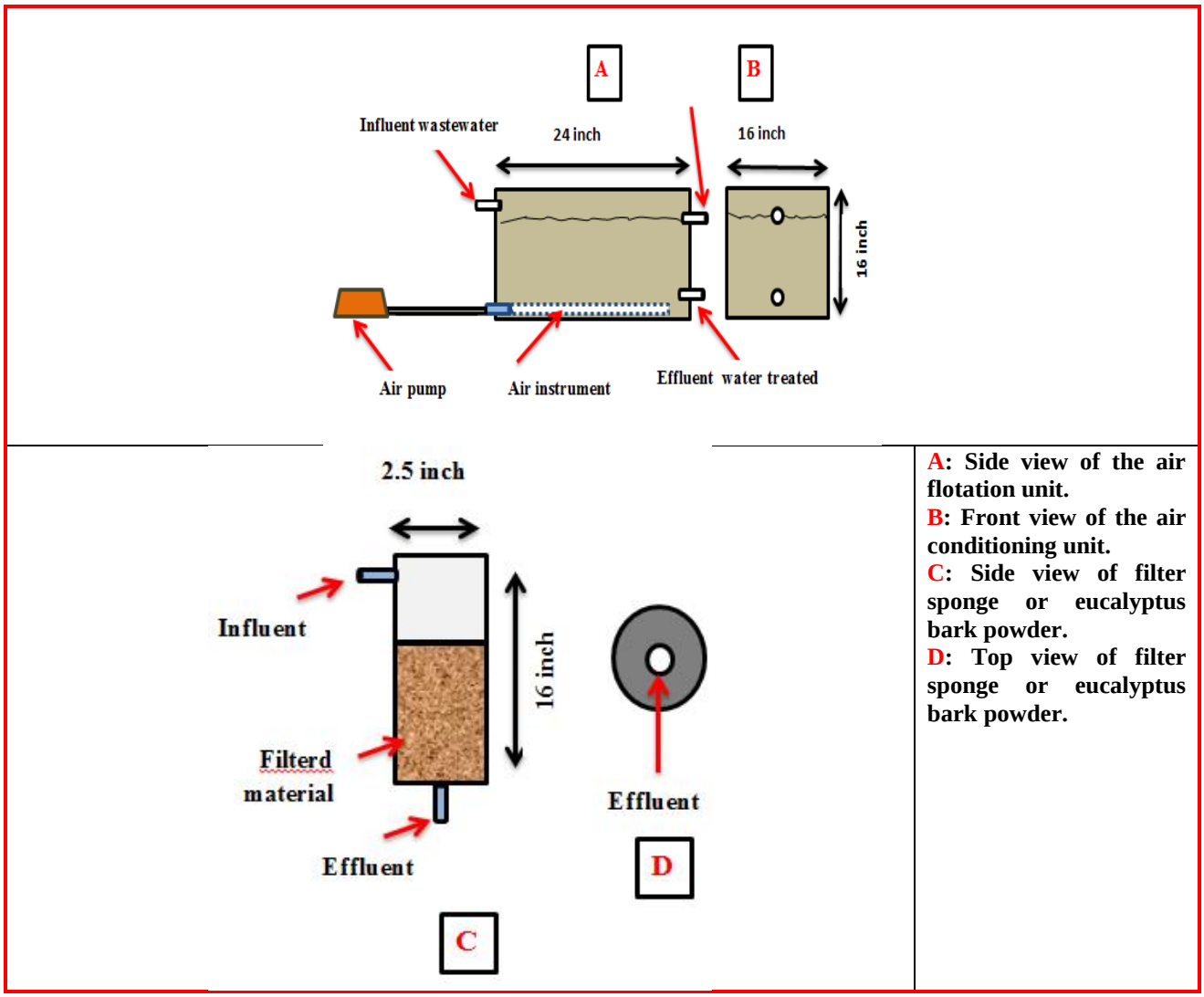

Figure 1: Planning to Treatment Unit of emulsion Oil wastewater.

III. RESULTS AND DISCUSSION

In this research, a treatment unit was designed and manufactured in two stages. The first includes separating oil from water in the oil-in-water emulsion by means of a flotation basin by pumping air from the bottom of the basin. The second stage involves removing the remaining emulsified and treated oil in the first stage through two filters, a sponge filter. And filtering the eucalyptus bark powder separately, Table (1) shows that the flotation process by pumping air proved efficient in separating the emulsified oil from the water, and the time period factor is important in the removal percentage, as it was found that the remaining oil concentrations are (0.5, 0.04, 0.025) ppm, i.e., with a removal rate of (66.67, 97.33, 98.33)%, respectively, for times (10, 20, 40) minutes, compared to the concentration of the comparison treatment of 1.5 ppm, which proves that the flotation process is important and efficient in breaking the emulsification between oil and water, especially since these The method is low cost, easy to use and sustainable, and it is more important than if chemical compounds were added to separate the emulsified oil from the water and the resulting negative effects on the environment.

Table 1: Efficiency of air flotation in removing oils polluting water.

Time Floatation (min.)	10	20	40
Conce. Of Oil (ppm)	0.50	0.04	0.025
Removal Ratio (%)	66.67	97.33	98.33

Table (2) also shows that the second stage of the treatment unit is efficient in removing oil polluted from the filtered water through sponge filters and eucalyptus bark powder, as the table shows that both filters were efficient, but the eucalyptus powder filter was more efficient than the sponge filter, as The

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remaining oil concentrations in the sponge filter were (0.070, 0.003, 0.001) ppm for both times (10, 20, 40) minutes, with a removal rate of (86.0, 92.5, 96.0)%, respectively, while the remaining oil concentrations were (0.031). , 0.0015, 0.00) ppm for both flotation times (10, 20, 40) minutes, respectively, and removal efficiency rates (93.8, 96.25, 100)%, respectively, and although both filters are efficient, the filter of eucalyptus bark powder is more efficient Although the treated water for 40 minutes was the best ratio for separating oil from polluted water, flotation at 10 minutes and filtering for eucalyptus plants were suitable.

Table 2: Efficiency of filtration using sponge filters and eucalyptus plant powder in removing polluting oils from water(%).

Time of Air Floatation (min.)	10	20	40
Sponge Filter (ppm)	0.070	0.003	0.001
Removal Ratio (%)	86.0	92.5	96.0
Eucalyptus Powder Filter (ppm0	0.031	0.0015	0.00
Removal Ratio (%)	93.8	96.25	100

Table (3) shows the concentrations of turbidity in the treated water at the stage of flotation and filtration decreased in all treatment stages and the removal rate increased with the increase of the flotation period compared to the concentration of turbidity in the untreated water which is 171.0 NTU. As the filtration through eucalyptus bark powder is better (10.35, 6.94, 0.90) NTU compared to filtration through a sponge filter (10.88, 7.51, 1.03) NTU for flotation times (10, 20, 40) minutes.

Table 3: Efficiency of air Flotation and filtration with Sponge filters and Eucalyptus plant powder in removing Turbidity resulting from oils polluting water (N.T.U.).

Time of Air Floatation (min.)	10	20	40
Treatment Air Floatation	18.10	15.32	10.88
Sponge Filter	10.88	7.51	1.03
Eucalyptus Powder Filter	10.35	6.94	0.90

The treatment unit has proven its high efficiency in removing the contaminated emulsified oil in the water in the two phases of air flotation and filtration through sponge filters and eucalyptus bark powder. The water surface, and both filters work according to the principle of adsorption, and this technology is low cost, sustainable and easy to use. These results agree with (Hanafy and Nabih, 2007; Welz et al, 2007).

IV. CONCLUSION

The efficiency of the treatment unit in its phases is high in air flotation and filtering in removing the polluted emulsion oil.

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