Low-Cost Filter Media for Removal of Hazardous Pollutants from Industry Wastewater Effluents

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1 Introduction

Water is the most important human need to survive in this world [1, 2]. Water is necessary for all human activities and living organisms [3–5]. The problem of scarcity of potable water has become an important issue because most of the water on the planet is salt water [6], which represents more than 2/3 of the planet's surface. What increases the problem of water scarcity is the pollution of the little water available for drinking by some factors resulting from man-made factors [7, 8]. Urbanization [9–12], industrialization [10, 11, 13, 14], agricultural [13–15], surface runoff, and sediment transport [2]. It is one of the most important factors causing the deterioration of water quality standards that reach people. It is estimated that 4 billion people around the world do not have access to clean drinking water [16]. Pollution that reaches water leads to poor quality and makes it transmit to humans many diseases that affect human health, especially in developing countries that suffer from poor quality of drinking water [17–19].

To ensure the supply of water in appropriate quantities and high quality, waste water treatment techniques have been applied, which are divided into three main types: biological, chemical and physical treatment [20].

Physical treatment depends on separating the pollutants physically from the water only without a significant change in its chemical and biological properties. As for the chemical treatment, it depends on adding a specific chemical that targets a specific pollutant in order to remove it. Biological treatment uses microorganisms to biodegrade pollutants in wastewater that reduce organic and nutrient content in wastewater [21].

To choose the appropriate type, several factors must be taken into account, the most important of which is the effectiveness of the technology to remove the targeted

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pollutants in wastewater, ease of operation, low cost, and the labor required to operate this technology.

Industrial effluent is water generated from the use of water in the entire industrial process. One of the things that worries the world is the disposal of huge quantities of liquid waste in random and improper ways, which leads to high pollution of water and the environment and causes great health risks. Therefore, this waste must be disposed of in healthy and sound ways and by following sound economic techniques that adhere to certain standards [22].

wastewater are produced from domestic or industrial activities and constitute the main sources of pollution. This liquid waste is a great challenge because it has a serious impact on the environment and pollutes water sources and must be treated. The large expansion of industry has led to the deterioration of the environment in developing countries in the recent period, as this waste is disposed of in water bodies without proper treatment [23].

Environmental pollution with untreated industrial wastewater is a major problem facing developing countries in particular. It has become necessary to develop low-cost technologies and systems to treat industrial wastewater that is loaded with many harmful organic and inorganic pollutants, especially heavy metals. Period and adsorption are one of the most important technologies that are characterized by their ease of operation and low cost, in exchange for high efficiency in removing pollutants.

During the flotation process, wastewater containing suspended matter is added to the surface of the porous medium, where the suspended matter is removed as the wastewater filters through via several of different processes. These include straining, sedimentation, impaction, interception, adhesion, adsorption, focculation, and biological degradation, particularly for organic removals on the top of the filter material. The intrinsic characteristics of the filter media play a critical role in the efficacy of pollutant removal. Among these are effective size, size distribution, slope, density, and porosity [24].

Adsorption is one of the most used technologies in the treatment of industrial wastewater. In short, it depends on the transfer of a substance from one surface to the surface of another substance. Adsorption is divided into two types: chemical adsorption and physical adsorption [25]. The type of adsorption depends on the strength of attraction between the pollutant and the adsorbent. There are many factors that affect the adsorption process, including pH, temperature, and surface area [26].

Although the adsorption process has become an important and available process, the materials used as adsorbents are expensive. Therefore, many researchers tended to study low-cost and high-efficiency materials to achieve sustainability in nature [27].

Studying the ability of some low-cost adsorbents to remove pollutants from wastewater, and we reached excellent results that help in environmental sustainability and provide great advantages and opportunities for using these adsorbents commercially in the future. Therefore, it is crucial for tanning enterprises to properly practise environmental management that filter media that is possibly effective, affordable, and locally accessible be identified as an adsorbent. However, due to the country's rapid growth in construction and expansion, ordinary sand for filter media is expensive, difficult to get, and ineffective at removing dangerous pollutants through adsorption; as a result, pottery filtration must be used in place of sand filtration [28].

Pottery clay was examined as a unique type of clay, with particular attention paid to the composition and characteristics of porcelain, rubber reinforcement, flame retardant additives, toxin adsorption in medicine, ornamental materials, geologic features, and mechanical qualities. Additionally, studies on the adsorption of Ni(II) and Cu(II) on pottery clay and glaze [29–31]. shown that the material has remarkable adsorption capabilities. However, because of the usual regional peculiarities of soil distribution, it is both economical and environmentally friendly to use local resources in engineering applications. In Egypt, ceramic clay is generally separated into white, red, and grey varieties, and the adsorption capacities for different heavy metals are different. The adsorption properties of pottery have only been the subject of a few number of research to date. In the current work, pottery was employed as a low-cost adsorbent and filter medium, and experiments were conducted to examine the effectiveness of the material for a variety of contaminants and the effect of fine pottery thickness on adsorption.

2 Material and Methods

2.1 Study Design

This research aims to study the efficiency of using different types of pottery in a filter to remove hazardous pollutants from industrial wastewater. The effect of the thickness of the pottery layer in the filter on the efficiency of removing pollutants was studied. Pottery was tested as a low-cost filter media for removal conductivity, TDS, TSS, COD, pH and Cr.

2.2 Filter Media

Pottery samples were collected from pottery workshops. The collection of samples of different types of pottery (red, white, gray) was considered. The different samples were crushed, classified, and the effictive size was determined by means of standard sieves suitable for the filter. Before placing these samples in the filter, they were washed with distilled water and dried by exposing them to the sun for four days.

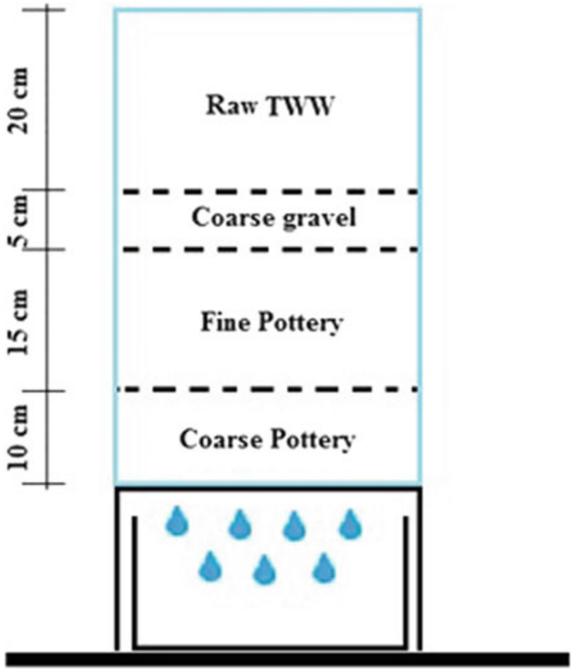

Fig. 1 Section elevation of the filter tank

2.3 Design and Set Up of the Filter

A tank was made of glass as a filter. Its dimensions were as follows: 60 cm in height and 35 cm in length. Its square base was perforated from the bottom with 9 holes of 0.5 cm in diameter, to drain the treated water and collect it in a tank below the filter [32]. After the completion of making the filter, the filter layers were placed as follows: 10 cm of pottery with a size ranging from 10 to 25 mm, (4:15) cm of pottery with a size ranging from 1.5 to 4.5 mm, and the filter layers were topped with a layer of fat coarse gravel with a thickness of 5 cm [33] in order to protect The upper filter layer from corrosion as shown in Fig. 1.

2.4 Wastewater Sample Collection and Filtration

A composite sample of industrial wastewater was collected from textile factories and transported in plastic containers. An analysis of the physical and chemical properties of the composite sample was carried out before passing through the filter. The mean concentrations of selected physicochemical parameters were presented in Table 1. The combined wastewater sample was added to the filter, and the treated samples

Table 1 Charactristic of textile wastewater composte sample

S. No.	Parameter	Concentration (mg/l) Expect pH and T°
1	pH	10.4
2	T°	24
3	COD	865
4	Cr	1.7
5	TDS	2381
6	TSS	668
7	Conductivity	3721

coming out of the filter were subjected to laboratory measurements to determine their physical and chemical properties.

2.5 Wastewater Collection and Analysis

An analysis of the samples of the composite industrial wastewater and samples of the treated water coming out of the filter was carried out in order to study its physical and chemical properties and to determine the effectiveness of this filter for removing pollutants from the industrial wastwater. The effect of the depth of the fine layer of pottery with a size ranging from 1.5 to 4.5 mm was studied at heights of 40, 80, 120, 150 mm. The following parameters were measured for water samples conductivity, TDS, TSS, COD, pH and Cr. In this study, the characteristics of the liquid waste generated from the textile industry were determined before and after treatment and passing through the filter. To measure the characteristics of the treated water from the filter, a sample was collected within 24 h, three times throughout the day, and then mixed well before measurement.

3 Result and Disscussion

3.1 Effect of Pottery Type

As shown in Fig. 2, the efficiency of removing pollutants from wastewater with red pottery is often better than white and gray pottery. Red pottery, its efficiency in removing COD is much greater than white pottery, with a difference of up to twice. But The removal of Cr, the best type to remove was white pottery, followed by red pottery, then gray pottery.

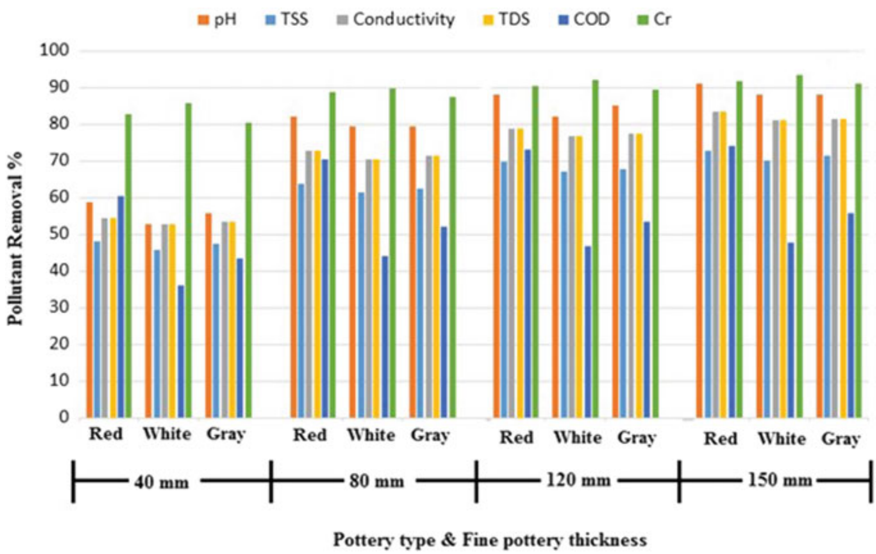

Fig. 2 Comparison of different type of pottery on the removal efficiency pH, TSS, conductivity, TDS, COD and Cr

3.2 Effect of Pottery Thickness

As shown in Fig. 2, the increasing in fine pottery layer thickness, the greater the percentage of pollutants will be removed, due to the increase in the surface area of the adsorbent to which pollutants are attracted. The maximum removal of pH, pH, TSS, conductivity, TDS, COD and Cr is reached 91.2, 72.9, 83.7, 83.7, 74.3 and 93.5% respectively at a thickness of 150 mm.

To measure the organic material and inorganic nutrients present in water samples such as nitrate or ammonia, we measure the amount of oxygen required to chemically oxidize these substances by estimating the chemical oxygen demand. The value decreased from 865 mg/L to the lowest value of 221 using red pottery with a thickness of 150 mm. Red pottery, its efficiency in removing COD is much greater than white pottery, with a difference of up to twice. Figure 2 shows a comparison between the removal of COD for different types of pottery and the thickness of the fine pottery layer 40, 80, 120 and 150 mm.

The element chromium (Cr) was found in wastewater samples. In the textile industry, heavy metals are widely employed to enhance and increase colour efficiency. Cr mean level in wastewater was 1.7 mg/L. Cr treatment value ranged from 0.33 to 0, 0.11. white pottery with thickness 150 mm was shown to be the best removal for Cr. The Cr was shown to be significant in the white pottery results. The best type to remove was white pottery, followed by red pottery, then gray pottery. Figure 2 shows a comparison between the removal of Cr for different types of pottery and the thickness of the fine pottery layer 40, 80, 120 and 150 mm.

Solids that pass through a filter with pores < 2 μm are called total dissolved solids. To measure the amount of TDS, the conductivity electrode is used and measured in ppm. The average TDS value for compost wastewater was found to be 2381, whereas treated values ranged from 1121 to 388. TDS removal was shown to be most effective with 150 mm thickness of red pottery. The results proved the effectiveness of using pottery as a filter media to remove TDS from the liquid waste of the textile industry. The results proved the effectiveness of using pottery as a filter media to remove total solids from the liquid waste of the textile industry. Figure 2 shows a comparison between the removal of TDS for different types of pottery and the thickness of the fine pottery layer 40, 80, 120 and 150 mm.

Traditional pollutants in water bodies are known as (TSS). TSS values for the untreated compost wastewater sample were found to be 668, whereas treated values ranged from 361 to 181. Disease-causing bacteria and toxicity may be present in the suspended solids. TSS may also cause an obnoxious odour to be released during anaerobic degradation. It's also used to assess the effluent and influent quality. It also has the ability to reduce oxygen consumption in plants [34]. Figure 2 shows a comparison between the removal of TSS for different types of pottery and the thickness of the fine pottery layer 40, 80, 120 and 150 mm.

When a sample of untreated wastewater was studied for pH measurement, the mean value of untreated effluents was shown to be 10.4. The values that were treated ranged from 8.6 to 7.3. Figure 2 shows a comparison between the removal of pH for different types of pottery and the thickness of the fine pottery layer 40, 80, 120 and 150 mm.

The untreated industrial wastwater sample had a mean electrical conductivity value (EC) of 3720, while the treated effluents had EC values ranging from 1752 to 606. Despite the fact that the results were within acceptable limits, red pottery was found to be the most effective treatment for EC removal. The higher EC value indicated that effluents contain a lot of salt [35], which causes salinity in soils and degrades natural water resources. Figure 2 shows a comparison between the removal of Conductivityfor different types of pottery and the thickness of the fine pottery layer 40, 80, 120 and 150 mm.

4 Conclusion

The investigation's findings have led to the following important conclusions: The characteristics of polluted textile effluent were very high strength wastewater and a variety of hazardous substances. The used approach gives a useful and efficient method for reducing pollutants. Red pottery had a strong chance of reducing TDS, pH, and conductivity pollutants from textile wastewater, but it had less of a chance of doing so for COD pollutants. The decrease of chromium from textile effluent also had encouraging results for white pottery. By employing various processes, such as filtration, all varieties of pottery have the ability to control high strength industrial wastewater, such as textile effluent, and can serve as an alternative to sand filtration. White pottery has a greater ability to decrease chromium than red pottery, however when we examine the average efficiency to reduce those chosen wastewater characteristics, red pottery performed better than white pottery and grey pottery.

5 Recommendations

As a result, using low-cost adsorbents that are readily available locally might help develop a low-tech approach to sustainable wastewater management. Any company with an interest is allowed to employ these substrates as the filter medium in the filtration bed or alternatively change out the sand in the currently installed filtration bed for the treatment of wastewater.

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