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The Use of Sawdust at different thickness as low cost adsorbent in wastewater treatment

Engy A. Elsakka*[1], Hanan A. Fouad[2], Ahmed M. Hassanain[2]

[1] Department of Civil Engineering, Modern University of Technology and Information, Cairo, Egypt
[2]Department of Civil Engineering, Faculty of Engineering at Shoubra Benha University, Egypt.
* Corresponding Author
E-mail: Engyelsakka24@gmail.com,hanan.kamel@feng.bu.edu.eg,eng ahmed.hassain@yahoo.com.

Abstract: This study aimed to evaluate the effectiveness of low-cost adsorbent materials in filters for wastewater treatment at the Zenin Wastewater Treatment Plant in Giza, Egypt. Various thicknesses of sawdust were used as the adsorbent material. The concentrations of water parameters obtained were compared with the Egyptian specifications for the use of treated wastewater in irrigation, and the suitability of the wastewater parameters was confirmed. The Multimedia filter process effectively removes contaminants such as Biochemical Oxygen Demand (BOD), Chemical Oxygen Demand (COD), Total Suspended Solids (TSS), pH, ammonia, nitrite, nitrate, and nickel from the effluent. After the primary sedimentation tank using 40 cm sawdust as low cost adsorbent, the BOD, COD, TSS, ammonia ,NO3, oil and greases and NI reduce from 226.8 mg/l, 353.81mg/l, 376 mg/l, 18 mg/l, 0.5 mg/l, 30 mg/l, 0 mg/l , to 59 mg/l ,98 mg/l , 41 mg/l,8.1 mg/l, 0 mg/l, 7 mg/l, 0 mg/l with removal efficiency 73.98%,72.3% , 89.1% , 55% , 100 %,76.67 % which is matching the Egyptian specifications for water intended for irrigation purposes grade C . We increase the depth from 40 cm to 80 cm to improve the proprieties of treated wastewater for irrigation from grade c to grade B. the BOD, COD, TSS reduce from 132 mg/l, 220 mg/l, 380 mg/l to 28 mg/l ,41 mg/l , 23 mg/l, with removal efficiency 78.78%,94% , 93.94% . The Low cost adsorbents have good act in the treatment system. Hence this technology is Eco-friendly and cost effective.

Keywords: filtration, low cost adsorbent, natural adsorbent, sawdust, Sugarcane bagasse.

1. INTRODUCTION

The study aimed to investigate the effectiveness of using low-cost adsorbents, specifically sawdust, as a filter media for treating wastewater at the Zenin wastewater treatment plant in Giza, Egypt. The purpose was to reuse the treated water for irrigation after it goes through the primary sedimentation tank. Filtration is a mechanical process that separates solid particles from a fluid phase. The properties of the filter material, such as its thickness, pore size, and resistance, play a significant role in its performance.

Furthermore, the characteristics of the particles being filtered, including their shape, distribution, and size, can have a significant impact on the effectiveness of the filtration process [1].

In the study, sawdust was tested at various thicknesses, along with other factors that influence the removal rates of wastewater parameters. The primary goal of the research was to obtain water suitable for irrigation, specifically grade B water, which is used for cultivating dry grain crops, cooking, processing vegetables, fruit crops, and medicinal plants. The concentrations of various water parameters resulting from the treatment process were compared to Egyptian specifications for using treated water for irrigation purpose, 2015 [2]. The study aimed to verify the compliance of treated water parameters with these specifications.

Nowadays, sawdust has an important role as adsorbent of wastewater pollutants [3].It was demonstrated the efficacy of sawdust in the removal of undesirable substances from water. [4]

Sawdust, as a lignocellulose material, can serve as a viable precursor for the production of activated carbon. [5]Specifically, sawdust is composed primarily of hemicellulose, cellulose, and lignin [6][7].

2. Materials and Methodology

2.1 Filtration Tank:

The filtration tank has the following dimensions: length - 0.3 m, width - 0.3 m, and height - 1 m. To make it easier to observe the media layer, a 10 cm wide and 80 cm long acrylic part was installed in the middle of one side of the filter (refer to Figure 1). At the bottom of the filter, there is a tap with a 1-inch diameter.

Fig 1. Filter model

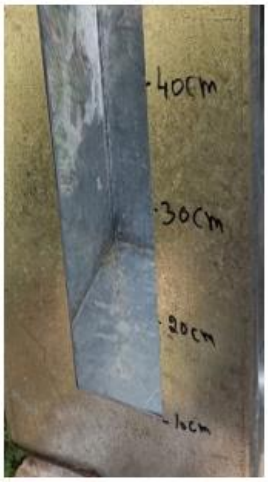

Fig 2. Acrylic part

2.2 – Media Materials Used

2.2.1 Preparation of Sawdust as an Adsorbent:

To prepare sawdust as an adsorbent: The sawdust is then washed using hot boiled water.

After washing, the sawdust is dried in the sun at a temperature of 40-43°C for 3 days until it reaches a constant weight.

Fig 3. Prepared Sawdust

Filtration Process:

The domestic wastewater was collected from the primary sedimentation tank at Zenin wastewater treatment plant. The wastewater underflow a filtration process, flowing downwards from the top to the bottom of the filtration tank. After the filtration process was completed, the water was collected.

2.4. Sample Collection

Samples were taken from the filter. A layer of gravel, 10 centimeters thick, was added to the filter base to raise the medium and prevent any blockage of the outlet. Various tests were performed on the sawdust at different depths of 40 cm: BOD, COD, TSS, pH, temperature, ammonia, nitrate, oil and gas, and nickel. Additionally, BOD, COD, TSS, and pH were measured at a depth of 80 cm to improve the efficiency of removal. (Figure 4)

Fig 4. Sawdust at (80 cm) and (40 cm)

3. RESULT AND DISCUSSION:

3.1 AT 40 CM OF SAWDUST

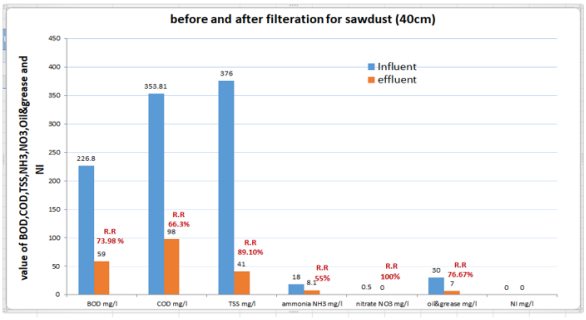

Fig 5, The value of influent and the effluent BOD, COD, TSS, Ammonia, Nitrate, oil and grease and Nickel on y- axis and noting its removal % (R.R) using 40 cm of sawdust as media filter

FIGURE 5 shows the value of influent BOD, COD, TSS, Ammonia, Nitrate, oil and grease and Nickel for wastewater out from the primary sedimentation tank before filtration as a secondary treatment from zeinen wastewater treatment plant and the effluent BOD, COD, TSS, Ammonia, Nitrate, oil and grease and Nickel after filtration on y – axis, and its values, noting its removal ratio (R.R).

However, the BOD before filtration out from the primary sedimentation tank is 226.8 mg/l. After filtration using sawdust as an adsorbent media, the BOD decreases to 59 mg/L, with great removal efficiency 73.98% which reach the permissible concentration for BOD according to the Egyptian specification for water intended for irrigation purpose grade C which does not exceed 80 mg/ l

On the other hand, the COD rate after filtration increased from 353.81 mg/l to 98 mg/l with removal efficiency 72.3%.Mohamed S. Azab et al. [8] found by using sawdust in wastewater treatment that the parameters of treated wastewater in terms of BOD and COD are greatly improved respectively by 85.0%and 79%.

The TSS rate reduced from 376 mg/l to 41gm/l which does not exceed 50mg / l, and matching the Egyptian specifications for water intended for irrigation purposes grade C with removal percentage 89.1 %.Mohamed S. Azab et al. [8]found by using sawdust in wastewater treatment that TSS were greatly improved by 87.7%.

Moreover, the amount off ammonia, nitrate and nickel (NI) are reduced from 18 mg/l, 0.5 mg/l and 0 mg/l respectively to 8.1 mg/l, 0 mg/l, and 0 mg /l with removal efficiency 55 %, 100%, the same value, which is according to the Egyptian specification for water intended for irrigation.

For oil and grease the value before filtration 30 mg/l and reduce after treatment to 7 mg/l which exceed 3 mg / l, and doesn't match with the Egyptian specifications for water intended for irrigation purposes. Mohamed S. Azab et al. [8] found by using sawdust in wastewater treatment that O&G

3.2 AT 80 CM OF SAWDUST

are greatly improved by 82.7%.

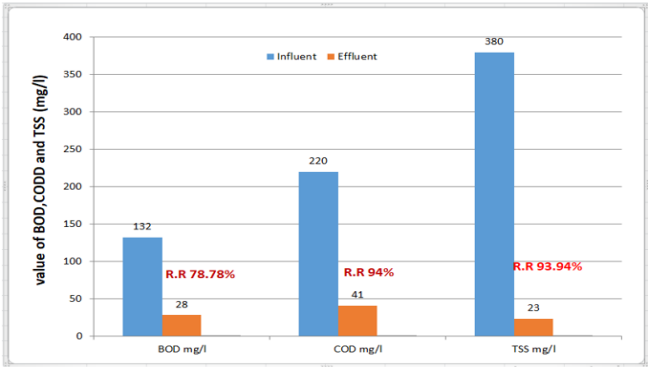

Fig 6. The value of influent and effluent BOD, COD, TSS on Y-axis using 80 cm of sawdust noting its removal %

FIGURE 6 shows the value of influent as a secondary treatment from zeinen wastewater treatment plant and the effluent BOD, COD, TSS on Y – axis ,noting its removal efficiency.

However, the BOD before filtration out from the primary sedimentation tank is 132 mg/l and after filtration using sawdust as adsorbent media the BOD is 28 mg/l .with great removal efficiency 78.78% which reach the permissible concentration for BOD according to the Egyptian specification for water intended for irrigation purpose grade B which does not exceed 30 mg/ l. Mohamed S. Azab et al. [8] discovered that the use of sawdust in wastewater treatment significantly improved the BOD parameter of the treated wastewater, reducing it from 3600 mg/l to 1800 mg/l.

On the other hand, the COD rate increased from 220 mg/l to 41 mg/l after filtration with removal efficiency 94% which not match with the permissible concentration for COD according to the Egyptian specification for water intended for irrigation purpose which does not exceed 50 mg/ l. Mohamed S. Azab et al. [8] found by using sawdust in wastewater treatment that the COD parameter was greatly enhanced, decreasing from 5700 mg/l to 2100 mg/l.

The TSS rate reduced from 380mg/l to 23gm/l which does not exceed 30 mg / l, and matching the Egyptian specifications for water intended for irrigation purposes grade B with removal percentage 93.94 %.Mohamed S. Azab [7] found that the use of sawdust resulted in a significant reduction in TSS, decreasing it from 5225 mg/l to 2200 mg/l.

3.3 COMPARISON BETWEEN 40 CM AND 80 CM OF SAWDUST

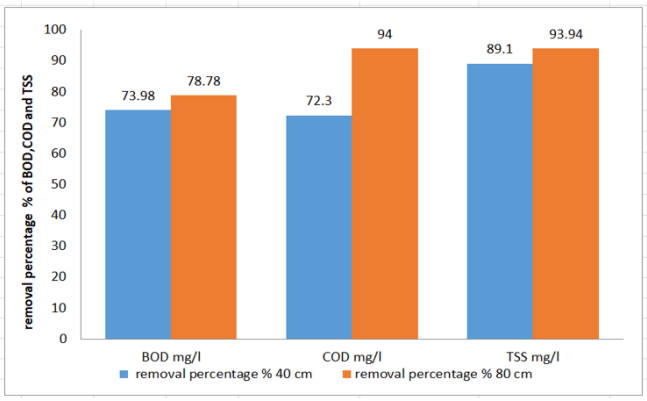

FIG 7. The relation between the removal percentage after filtration using sawdust with thickness 40 cm and 80 cm of BOD, COD and TSS after filtration using sawdust

FIGURE 7 shows the relation between the removal percentage after filtration of wastewater out from the primary sedimentation tank using sawdust with thickness 40 cm of BOD, COD, and removal percentage of BOD, COD, TSS after filtration using sawdust with thickness 80 cm as low cost

adsorbent on X – axis , and its values , on Y- axis noting its removal efficiency.

However, the removal percentages of BOD after filtration using sawdust as an adsorbent media with thicknesses of 40 cm and 80 cm, respectively, are 73.98% and 78.78%. These results indicate that the removal efficiency improves with an increase in the thickness of the media layer.

On the other hand, the removal percentages of BOD after filtration using sawdust as an adsorbent media with thicknesses of 40 cm and 80 cm, respectively, are 66.3% and 94%.

The removal percentage of TSS rates at 40 cm and 80 cm increased from 89.1% to 93.94%. These values indicate that increasing the thickness of the adsorbent has a significant effect on filtration. This suggests that using sawdust as a low-cost adsorbent for filtration is more effective when the thickness is increased. Overall, this method is successful, cost-effective, and environmentally friendly.

Elanda Fikr et al. [9] discovered that using zeolite as a low-cost adsorbent resulted in average phenol levels after treatment at thicknesses of 40 cm, 60 cm, and 80 cm, with percentage reductions of 63%, 77%, and 89%, respectively.

4. CONCLUSION AND RECOMMENDATIONS

4.1 CONCLUSION

1. After passing through the primary sedimentation tank, where sawdust is used as a low-cost adsorbent with a depth of 40 cm, the levels of BOD, COD, TSS, ammonia, NO3, oil and greases, and NI are reduced. The initial levels of these pollutants were 226.8 mg/l, 353.81 mg/l, 376 mg/l, 18 mg/l, 0.5 mg/l, 30 mg/l, and 0 mg/l, respectively. After treatment, these levels decreased to 59 mg/l, 98 mg/l, 41 mg/l, 8.1 mg/l, 0 mg/l, 7 mg/l, and 0 mg/l, respectively. The removal efficiencies achieved were 73.98%, 72.3%, 89.1%, 55%, 100%, and 76.67%, respectively. These results meet the Egyptian specifications for water intended for irrigation purposes, specifically grade C.
2. We increased the depth from 40 cm to 80 cm in order to improve the quality of treated wastewater for irrigation, upgrading it from grade C to grade B. As a result, the levels of BOD, COD, and TSS decreased from 132 mg/l, 220 mg/l, and 380 mg/l to 28 mg/l, 41 mg/l, and 23 mg/l, respectively. The removal efficiencies were 78.78%, 94%, and 93.94%.
3. This study concludes that low-cost adsorbents are highly effective in removing unwanted pollutants from sewage.
4. The multimedia filtration process plays a crucial role in eliminating impurities, such as BOD, COD, TSS and PH.
5. It also concluded that multimedia filters have an effective wastewater pretreatment process. Therefore, the technology is environmentally friendly and cheap.

4.2 RECOMMENDATIONS

1. Promote sustainable advanced treatment technologies.
2. High-efficiency, energy-saving and environmentally-friendly treatment technologies will be the most sustainable technologies recommended for the removal of toxic pollutants in wastewater.

REFERENCE

[1] Adebakin, I.H., Adeyemi, A.A., Adu, J.T., Ajayi, F.A., Lawal, A.A., Ogunrinola, O.B., 2012. Uses of sawdust as an admixture in the production of low-cost and lightweight hollow sandcrete blocks. Am. J. Sci. Ind. Res. 3 (6), 458–463.

[2] The Egyptian Code for the Use of Treated Sewage in Agriculture, 2015, ECP 501 – 2015.

[3] M. Sćiban, B. Radetić, Z. Kevresan, and M. Klašnja, “Adsorption of heavy metals from electroplating wastewater by wood sawdust,” Bioresource Technology, vol. 98, no. 2, pp. 402–409, 2007.

[4] Shukla, A., Zhang, Y.H., Dubey, P., Margrave, J.L., Shukla, S.S., 2002. The role of sawdust in the removal of unwanted materials from water. J. Hazard Mater. 95 (1-2), 137–152

[5] Smith, N., Ha, N.M., Cuong, V.K., Dong, H.T.T., Son, N.T., Baulch, B., Thuy, N.T.L., 2009. Coconuts in the Mekong Delta: an Assessment of Competitiveness and Industry Potential. Prosperity Initiative Report.

[6] M. Z. H. Kazmi, A. Karmakar, V. K. Michaelis, and F. J. Williams, “Separation of cellulose/hemicellulose from lignin in white pine sawdust using boron trihalide reagents,” Tetrahedron, vol. 75, no. 11, pp. 1465–1470, 2019

[7] M. Danish and T. Ahmad, “A review on utilization of wood biomass as a sustainable precursor for activated carbon production and application,” Renewable and Sustainable Energy Reviews, vol. 87, pp. 1–21, 2018.

[8] Mohamed S. Azab (2008) Waste-waste treatment technology and environmental management using sawdust bio-mixture, Journal of Taibah University for Science, 1:1, 12-22,

[9] Elanda Fikri1,2*, Reta Athaya Mutiara Farid3 , Yosephina Ardiani Septiati3 , Nanny Djuhriah3 , Neneng Yetty Hanurawaty3 , Amar Sharaf Eldin Khair4, Effect of Zeolite and Activated Carbon Thickness Variation as Adsorbent Media in Reducing Phenol and Manganese Levels in Wastewater of Non-Destructive Testing Unit, J. Ecol. Eng. 2022; 23(8):40–48