Mesopotamia Environmental Journal
ISSN 2410-2598
Journal homepage http//:www.bumej.com

DOI: http://dx.doi.org/10.31759/mej.2018.4.4.0016

Removal of organic matters from domestic wastewater by using adsorption technique

Layla Abdulkareem Mokif[1] , NoorAlaa Abdulhusain[1], Hind Mufeed Jalil[1], Jasim M.Salman[2]

[1]Environmental Research and Studies Center , University of Babylon, Iraq.

[2] Department of Biology ,College of Science , University of Babylon,Iraq.

Corresponding author: **laylaabdulkareem86@yahoo.com**

To cite this article:

Mokif L. A., Abdulhusain N. A., Jalil H. M., Salman J. M.Removal of organic matter from domestic wastewater by using adsorptiontechnique. *Mesop. environ. j*., 2018, Vol. 4, No.4, pp. 16-24.

Received date: 26/8/2018 accepted date: 18/10/2018 published date:1/12/2018

Abstract:

In this research a low cost material (*Citrus aurantifolia)* was used as adsorbent for removing of organic matter expressed as biological oxygen demand (BOD) from domestic wastewater. Batch experiments were used in this study under certain experimental conditions. The results showed that the maximum value of adsorption capacity of *Citrus aurantifolia* with BOD (13.5) mg/g. The maximum removal efficiency of BOD was (69.75%) at higher mass of adsorbent (5gm). The coefficient of determination values were higher for Freundlich than for Langmuir. Freundlich isotherm is better fitting isotherm for the experimental data with a correlation coefficient of 0.8806. The results demonstrated that the best contact time was (105 min.) and removal efficiency increases as contact time increase. The results revealed that the removal efficiency of BOD from wastewater increases when the amount of adsorbent increase.

Keywords: Adsorption, wastewater, BOD, Freundlich Isotherm, Langmuir Isotherm

ISSN 2410-2598

Introduction

Organic contamination occurs due to the release of organic compounds in water bodies. The main sources of organic pollution are domestic wastewater, urban wastewater, industrial and agricultural waste. Organic contamination in the receiving water is expressed by the biological oxygen demand (BOD), chemical oxygen demand (COD) and total organic carbon (TOC) [4]. The treatment of domestic wastewater and subsequent use of treated wastewater can prevent water pollution and reduce demand for water fresh water in the irrigation sector [11]. Treatment may be primary, secondary and tertiary. Many traditional treatment methods, such as ion exchange, reverse osmosis, membrane filtration, etc., have been used, but the cost involved in all these methods has been reported to be very high. Absorption has been proved as an effective method due to less land requirements and flexibility in the use of raw materials.For removal of the organic contaminants from waste water adsorption has become one of the best effective and economical method, thus this process has aroused considerable interest during recent years [2, 7, 8, and 12]. Agricultural substance such as neem leaves, rice husk, fruit peels etc. are being extensively used for research in wastewater treatment, which prevents several types of pollution due to dumping or open burning [4]. Several materials have been studied for the adsorption of BOD and COD, such as animal horns avocado peel carbon, and a natural form of Zeolite, was used as the adsorbent against BOD and COD [1]. Fly ash can be used as a promising adsorbent for removal of various types of pollutants from wastewater. Low-cost adsorbents of different origin like industrial waste material, bagasse fly ash and jute-processing waste can also be used for removal of organic matter from wastewater [7]. Limestone was observed to be the most effective in removing of BOD and TDS when used as adsorbent [3]. The coconut coir activated carbon has been showed good results in removal of organic matter and COD from the effluent and can be considered as effective adsorbent. Although higher doses of coconut coir activated carbon are required for the BOD and COD removal [11]. Coconut shell activated carbon which, have been investigated as the possible adsorbents for the reduction of BOD and COD from sugar industry effluents [10]. Granular activated carbon of less than 1.18mm particle size produced from waste Nigerian bamboo can effectively remove organic pollutants from industrial waste water effluents before the discharge into the river [13].

The aim of this study is removal of organic matter expressed as biological oxygen demand (BOD) from domestic wastewater by using *Citrus aurantifolia* as adsorbent.

Materials and methods

A-Samples collection

The samples of wastewater were collected from wastewater treatment plant at Hilla city. Table (1) show the characteristics of wastewater in this study.

Table (1) the characteristics of wastewater

Parameters	Units	Value
pH	-	7.86
Initial BOD	mg/l	350
TDS	mg/l	999
EC	µs	1999

B-Preparation of Adsorbent

In this study the adsorbent material was *Citrus aurantifolia* powder which prepared by sinking of the *Citrus aurantifolia* waste in H_3PO_4 (10%) for one hour and then dried by using the oven at (100 C°), then the waste were grinded by electrical grinder to be as powder fig (1)

Fig.1: *Citrus Aurantifolia* after Préparation steps

C-Experimental Procedure

Batch experiments were used in this study under certain experimental conditions. The experiments were achieved in conical flask of 250 ml capacity. The volume of wastewater samples of the reaction mixture was 100 ml. Different amounts of adsorbent material (1, 2, 3, 4, and 5) gram were added to 100ml of wastewater samples which agitated at 400 rpm for (105 min.) [5]. All experiments were done at temperature of (25±5C°) and PH of 7.86. BOD concentrations were measured according to the standard methods for the examination of water and wastewater by American Public Health Association (APHA) [6]. To study the effect of contact time on removal of BOD different periods of time (30, 45, 60, 75, 90 and 105) min were examined with 100 ml of wastewater samples and (5 gram) amount of adsorbent. The reaction mixtures were filtered to remove any suspended adsorbent.

The percentage removal of BOD was estimated by using the following equation:

$$\%removal = \frac{Co - Ce}{Co} * 100 \qquad (1)$$

The adsorbed amount (qe) is calculated by the following equation:

ISSN 2410-2598

$$q_e = \frac{V(C_o - C_e)}{W} \qquad (2)$$

Where:

*C*o, Ce = is defined as initial and equilibrium concentrations of BOD (mg/l) respectively in the solution

V= solution volume (*L*) and

W= adsorbent mass (gm).

Results and discussion

1-Effect of contact time

Fig. (2) Shows the effect of contact time on removal of BOD. The results demonstrated that the best contact time was (105 min.). The removal efficiency increases as contact time increase because of more active surfaces are available for absorption in the initial phase and toward the end of the longest contact time experiment [12].

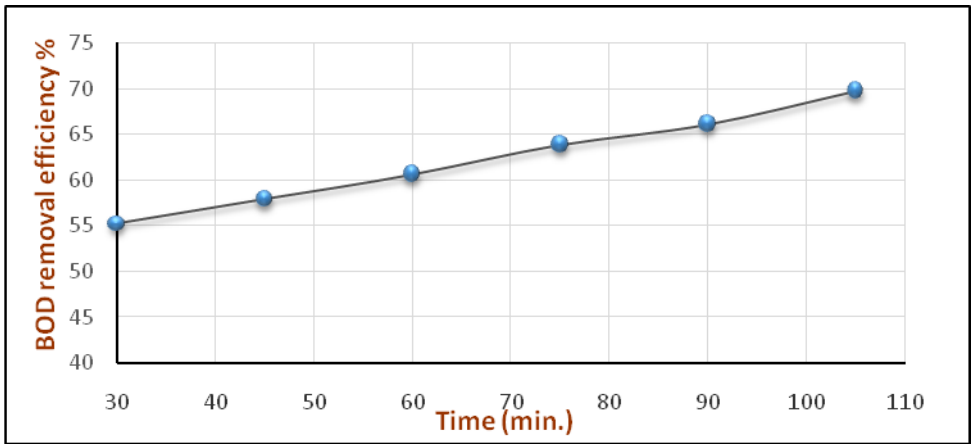

Fig. 2: the effect of contact time on removal efficiency of BOD, pH=7.86, amount ofadsorbent =5.0 gm.

2-Effect of amount of adsorbent

Fig. (3) Shows the effect of amount of adsorbent on removal efficiency of BOD. The result pointed that the optimum amount of adsorbents for BOD removal was (5gm).The results revealed that the removal efficiency of BOD from wastewater increases when the amount of adsorbent increase because of the increasing in the amount of adsorbents increase the surface area of absorption[11].

ISSN 2410-2598

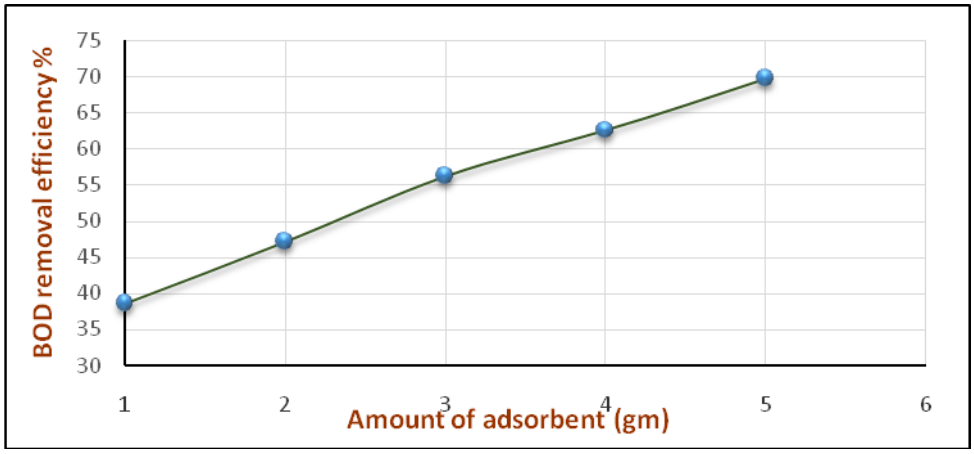

Fig. 3: the effect of amount of adsorbent on removal efficiency of BOD, pH=7.86, contact time=105 min.

Isotherm studied

A-Equilibrium Isotherm *Citrus aurantifolia*

Table (2): equilibrium isotherm for *Citrus aurantifolia* at (C_o=350 mg/l, time =105 min., pH=7.86, Vol. =0.1L)

W(gm.)	Ce(mg/L)	qe(mg/g)	Removal%
1	215	13.5	38.57
2	185	8.25	47.14
3	153.3	6.56	56.2
4	131.1	5.47	62.54
5	105.87	4.88	69.75

B. Estimation of Adsorption Isotherm Constants for *Citrus aurantifolia*System

The Langmuir, Freundlich, and the equilibrium adsorption isotherms of BOD adsorption onto the *Citrus aurantifolia*at 25±5C° are shown in Fig. 4, Fig. 5 and Fig.6

ISSN 2410-2598

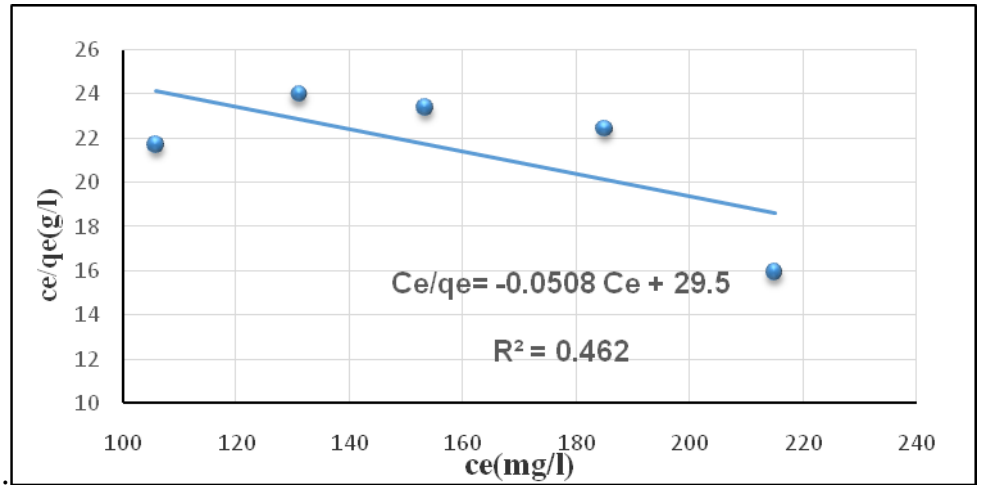

Fig. 4. Langmuir adsorption isotherm of BOD onto *Citrus aurantifolia* at pH=7.86

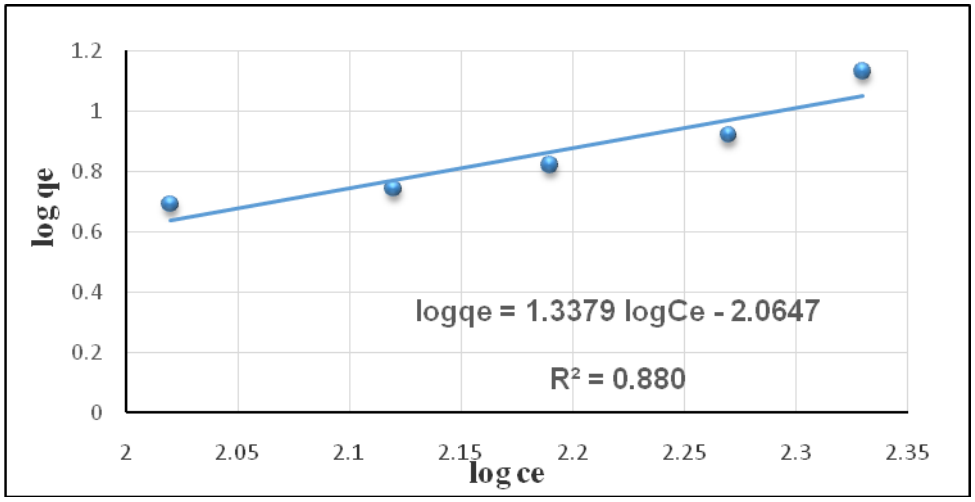

Fig. 5. Freundlich adsorption isotherm of BOD onto *Citrus aurantifolia* at pH=7.86

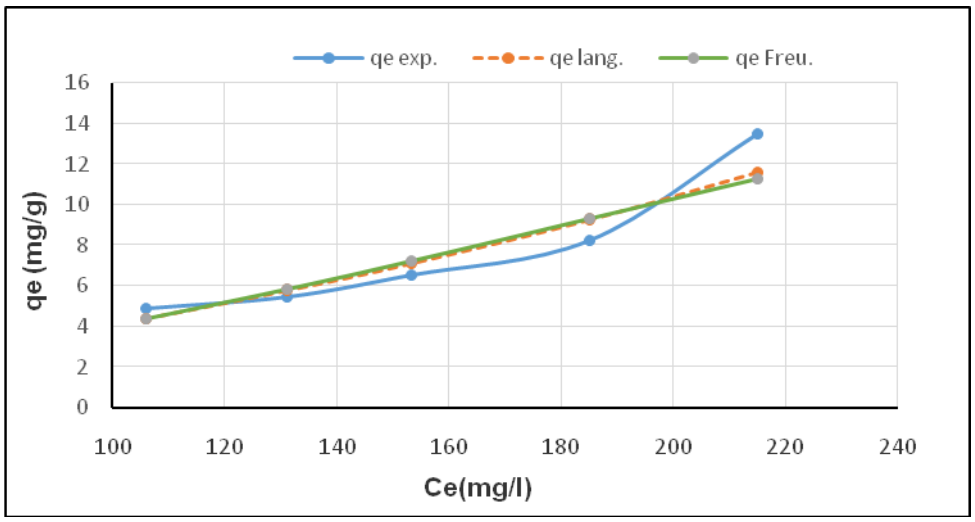

Fig. 6. Equilibrium adsorption isotherm of BOD onto *Citrus aurantifolia* at pH=7.86

ISSN 2410-2598

C. Adsorption Isotherms

The Langmuir and Freundlich adsorption isotherms models are expressed by the following equations (3) and (4) respectively

$$qe = \frac{qmax\ K\ \ Ce}{1 + KCe} \quad \ldots\ldots\ldots\ldots\ldots\ldots (3)$$

$$q_e = K_F\ C_e^{1/n} \ldots\ldots\ldots\ldots\ldots\ldots\ (4)$$

Where:

qe: The amount of adsorbate adsorbed per unit mass of adsorbent at equilibrium (mg/g).
Ce: is defined as the equilibrium concentration in the solution (mg/l).
*q*max: The maximum capacity of adsorption
K: is constant of the adsorption equilibrium (rate of adsorption),
KF the adsorption or distribution coefficient (mg/g (l/mg) $^{1/n}$) is roughly an indicator of the adsorption capacity of the adsorbent .and
1/n: is the adsorption intensity.

The experimental data were correlated with the Langmuir and Freundlich equations (Eq.3and Eq.4). For BOD the constant of Langmuir and Freundlich isotherms are summarized in Table (3) for *Citrus aurantifolia*

Table (3) Langmuir and Freundlich isotherm parameters for BOD Adsorptions onto *Citrus aurantifolia*

Model	Parameters	Value
Langmuir (Eq.(3))	q_{max} (mg/g)	-19.685
	K (l/mg)	-0.00172
	R_L	2.513
	R^2	0.4621
Freundlich (Eq.(4))	K_F (mg/g (1/mg) 1/n)	0.00862
	1/n	1.3379
	R^2	0.8806

According to figures. (4 to 6) and table (3) the results reveal that the maximum value of the adsorption capacity of *Citrus aurantifolia* with BOD was (13.5) mg/g.The maximum removal efficiency of BOD was (69.75%) at higher mass of adsorbent (5gm). In order for assessing of the various isotherms and their capability to correlate with experimental results the coefficient of determination (R^2) was used to ascertain the fit of each isotherm with experimental data. From Table (3), the

coefficient of determination values were higher for Freundlich than for Langmuir. Freundlich isotherm is clearly better fitting isotherm for the experimental data with a correlation coefficient of 0.8806.

Conclusion

1-The *Citrus aurantifolia*show acceptable removal of BOD from domestic wastewater.
2- The results showed that Freundlich isotherm is clearly better fitting isotherm for the experimental data.

3- The results demonstrated that the best contact time was (105 min) ant the removal efficiency increase as contact time increase

4- The results revealed that the removal efficiency of BOD from wastewater increase when the amount of adsorbent increase.

References

[1] Omer, M. F.; Renuga V.; Sripriya, N. and Udaya, P. N.K. Adsorption Isothermal Studies on the Removal of BOD and COD of a Leather Tannery Effluent using Clinoptilolite, Vol.10, No.1, pp. 496-500.2017.

[2] Emmanuel, O. A. and Olalekan, A. M. B. COD removal from industrial wastewater using activated carbon prepared from animal horns, Vol. 7, No.21, pp. 3887-3891. 2008.

[3]Mortula, M. and Shabani, S. Removal of TDS and BOD from Synthetic Industrial Wastewater via Adsorption,Vol.41 , pp.166-170.2012.

[4] Mukundan, U. and Ratnoji S. S. Cod Removal from Sewage by Activated Carbon from Rice Husk- An Agricultural By Product, Vol. 4, No. 6, pp.5003-5007.2015.

[5] Patel, H. and Vashi R.T. Treatment of Textile Wastewater by Adsorption and Coagulation, Vol.7, No.4,pp**.** 1468-1476. 2010.

[6] APHA (American Public Health Association). Standard methods for the examination of water and wastewater. 19th ed. Washington, D. C. 1995.

[7]Lakdawala, M. M. and Lakdawala, J. M. Adsorption study of BOD content from Sugar Industry waste water by low cost material Fly ash, Vol.3, No. 2,pp.497-502**.** 2012.

[8] Lakdawala, M. M. Biological oxygen demand (BOD) removal of sugar industry waste water-A comparative study of adsorption capacity of PAC and GAC,Vol. 8, No.2, pp.765-772.2016.

[9]**Rajwar, B. S. and Pandey, I. K.** Removal of COD & BOD from contaminated water By using fly ash as an adsorbent: A Review**,**Vol. 4, No. 1, pp.1537-1543. 2015.

[10] **Ghodale, M. D.; Kankal S. B**. Investigation of optimum operation parameters for BOD and COD removal using activated carbon,Vol. 2, No. 4, pp.38-43. 2014.

[11] **Kulkarni, S. J.** Removal of organic matter from domestic wastewater by adsorption.
Vol. 2, No. 10, pp.1836-1839. 2013.

[12]**Wirnkor, V. A.** ;**Amonia, B. O. and Ngozi, V. E.** Batch and Column Adsorption of BOD and COD in vegetable oil industry effluents Using Activated Carbon from Fluted Pumpkin
(Telfairia, Occidentalis. Hook. F) Seed Shell, Vol. 39, pp. 64-77.2014.

[13]**Ademiluyi, F. T.; Amadi, S. A.; Jacob A., N.** Adsorption and Treatment of Organic Contaminants using Activated Carbon from Waste Nigerian Bamboo,Vol. 13,No.3,pp. 39 – 47.2009.