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Research paper

Performane of Activated Carbon Adsorption in Removing of Organic Pollutants from River Water

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Abstract

This study presents a water treatment process by using a down-flow fixed bed activated carbon contractor model. Two types of activated carbon (AC) used, powder and granular activated carbon from date pits as a raw material, the parameters tested are biochemical oxygen demand (BOD), chemical oxygen demand (COD), total suspended solid (TSS), total dissolved solid (TDS) and pH. The column diameter and bed depths are made constant, whereas the size of activated carbon is varies. The obtained removal efficiencies for sample of river water are 39.8% of BOD, 41.8% of COD, 81.8% of TSS and 67.7% of TDS for granular AC. For powdered AC the removal efficiencies of parameters are 34.7% of BOD, 17.6% of COD, 72.7% of TSS and 50% of TDS. The granular AC made from date pits is the best activated carbon because of low cost of raw material and it is widely applied for usage in the water or wastewater treatment, as it is very effective in terms of cost and performance to cater the increasing demand of clean water.

Keywords: *Activated carbon; Adsorption; Date pits; water treatment*

1. Introduction

Water is a chemical compound with the chemical formula H_2O (2 molecules of hydrogen bonded with a molecule of oxygen by covalent bonds). It can exist in solid, liquid and vapor from depending n its surrounding temperatures. Water covers about 70% of the earth surface and it is very essential for every living organism in the whole world. Although it covers most of the earth surface, fresh water occupied only a small fraction from all the water body, taking 2.5% from earth water; whilst the other 97.5% is in ice from and groundwater. Safe drinking water is vital to humans and other life form. However, some observers have estimated that by 2025 more than half of the world population will be facing water based vulnerability [1].
Wastewater is any water that has been adversely affected in by the influence of anthropogenic in the quality, including of that discharged by domestic, industrial commercial and agricultural activates. The wastewater may be contaminated by a wide variety of pollutants and need to be treated through a series of process physically and chemically before released to local water system or disposed from the source [2].
Activated carbon is a form of carbon that is processed to produce very small, low volume carbon that are very porous and high surface area, for the adsorption or chemical reactions. due to its high degree of micro porosity, just one gram of activated carbon has a surface area in access of 500 m^2, with 1500 m^2 being readily achievable as determined by adsorption of nitrogen gas [3].
Many previous studies investigated the using of different agricultural waste as a raw material to produce activated carbon, such as rice husk [4], jute and coconut fibre [5], coconut husk [6], sago palm bark [7], and modified activated carbon [8, 9, 10].
The activated carbon contractors generally consist of the activated carbon that will act as the filter bed inserted in the contractor, commonly fabricated from concrete or steel columns in rectangular or cylindrical shape. The commonly used system for fixed bed down –flow activated carbon contractor is by discharging the wastewater sample on top of the column to the filter bed, as it will allow the flow of the wastewater downward by gravitational force instead of applying pumps and the products will be withdrawn at the bottom of the column. The activated carbon will be hed in place by creating an under drain system at the bottom of the contractor. In order to avoid too much head loss due to accumulation of substances and clogging of bed surface, backwash and surface wash is required [11].
The main objectives of this study are to evaluate the performance of the down flow fixed bed activated carbon contractor for the removal of dissolved, colloidal and suspended constituents from river water, and to compare the quality of water after being treated by different types of activated carbon.

2. Experimental Work of Study

2.1 Sample Collection

The sample of water was collected from Euphrates river in Al-Nasiriya city in Iraq and stored in a cool place in lab until use. The experimental work involved measuring the following parameters: pH, biochemical oxygen demand (BOD), chemical oxygen demand (COD), total suspended solids (TSS), and total dissolved solids (TDS). These parameters were analyzed according to the Standard Method Examination of Water and Wastewater [12].

2.2 Activated Carbon Columns

The activated carbon will be obtained from the suppliers that comprises of activated carbon originated from palm oil shell. Table 1 shows the properties of the activated carbon.

Table 1 Properties of activated carbon [7]

Commodity	Activated carbon
Grade	USS4 *8 Mesh
Apparent density	0.47-0.49 gm/cc
Moisture content	5% max
Iodine Number	1100 mg/gm min
Ash content	9-10% max
pH value	9.0-11
Surface area	1050 m^2/g min

The existing column size will be used, by taking the only most effective size of diameter and bed depth, as to fulfill the requirement of this study which is to observe and compare the efficiency of two different origins of activated carbons. The existing column diameters are 4 cm, with 10 cm height and 5 cm bed depths.
The observation of the efficiency of the activated carbon was done by using four columns with two types of AC, granular activated carbon (GAC) and powdered activated carbon (PAC). It has been designed to consist of a storage tank to hold influent on top of the filter bed that is connected to four activated carbon beds with constant dimensions.

3 Results and Discussion

The parameters taken into consideration for assessing the quality of absorption of the carbon contractors used are BOD, COD, TSS, TDS and pH. Table 2 shows the value of the obtained BOD, COD, TSS, TDS and pH for raw and treated sample of river water.

Table 2 Raw sample analysis

Parameter	Influent concentration (mg/L)
BOD	225
COD	486.4
TSS	220
TDS	160
pH	8.18

Figure 1 and 2 show the removal efficiency of BOD for two types of AC granular and powdered. It can be observed that for the analysis of BOD, the powdered AC have greater efficiency compared to the granular AC originated from palm oil shells. Slight difference of influent BOD values at 352 mg/L higher than the other values of post filtration with activated carbons.

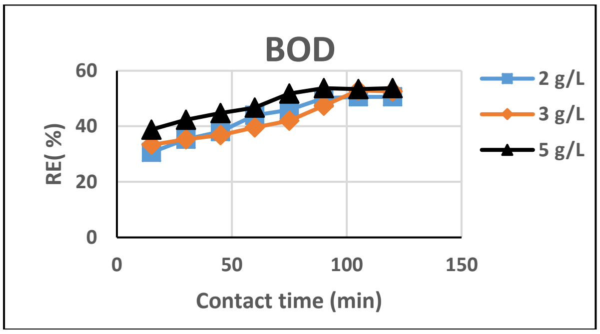

Figure 1 Removal Efficiency of BOD using GAC

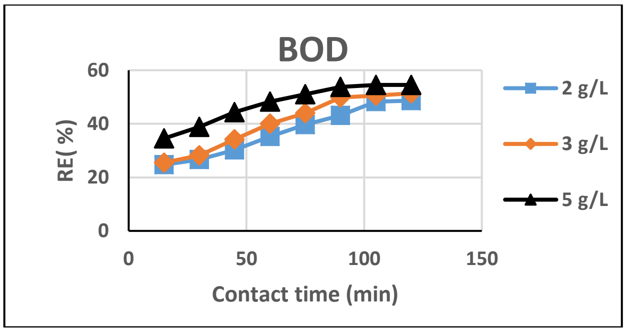

Figure 2 Removal Efficiency of BOD using PAC

Figure 3 and 4 show the removal efficiency of COD using granular and powder AC made from palm oil shells. The value of COD is comparably higher for water sample before undergoing any filtration of filter media involved which is 101.6 mg/L of COD value. After filtration with AC, these value is still considered as insignificant compared to filtered effluent with AC which results 87.8 mg/L of COD value. According to the particle size of AC involved, there are only a slight difference in values of COD after filtered with filtration media of different sizes. For COD removal. The powder is observed to be more efficient compared to the granular type of AC.

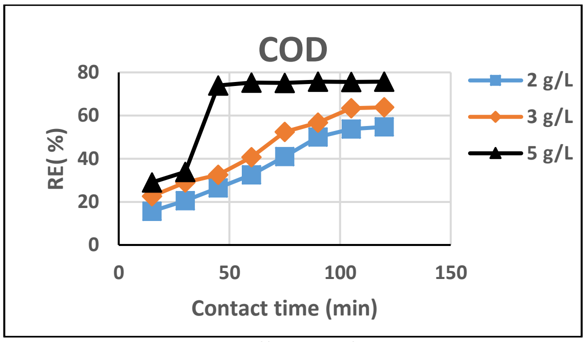

Figure 3 Removal Efficiency of COD using GAC

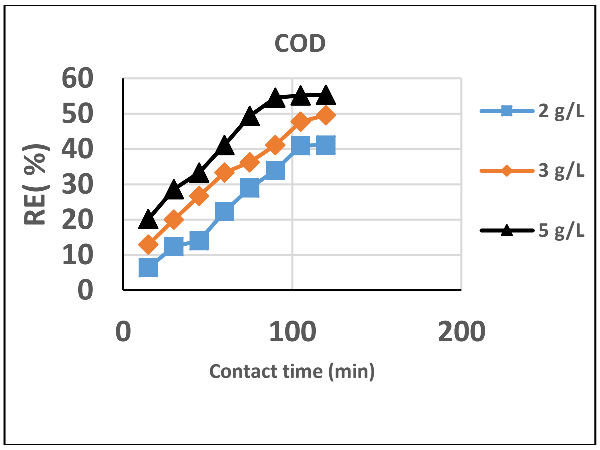

Figure 4 Removal Efficiency of COD using PAC

Figure 5 and 6 show the results of TSS parameter being conducted for sample of river water treated using AC contractor. The value of TSS before treatment was 240 mg/L which was reduced to 60 mg/L after treatment. From these results, it can be seen that the adsorption process using palm shell activated carbon is effective in removing total suspended solid from water.

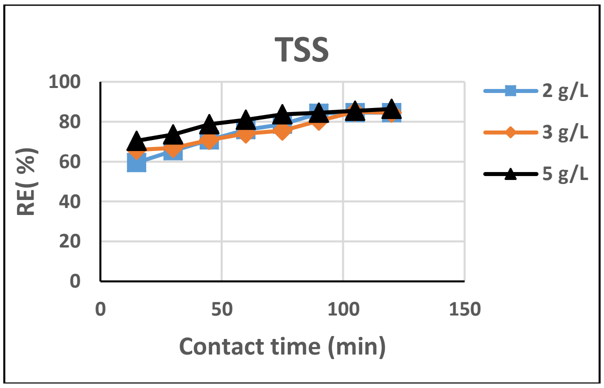

Figure 5 shows removal efficiency of TSS of sample of water using GAC.

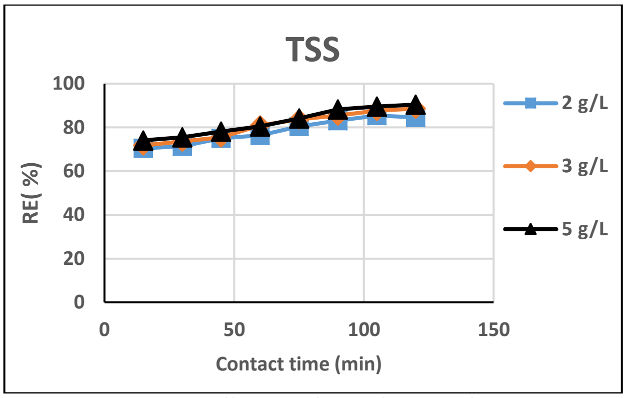

Figure 6 shows removal efficiency of TSS of sample of water using PAC.

Figure 7 and 8 show the removal efficiency of TDS from sample of water using palm oil shell AC. The initial value of TDS was 60 mg/L. the value of TDS contents has been increased after filtration with two types of AC. With the reading of 190 mg/L for treatment with powdered AC and 180 mg/L for treatment with granular AC. This is mainly due to AC properties, as an organic based materials, may have reacted with the water sample ; thus giving effluent with higher TDS content.

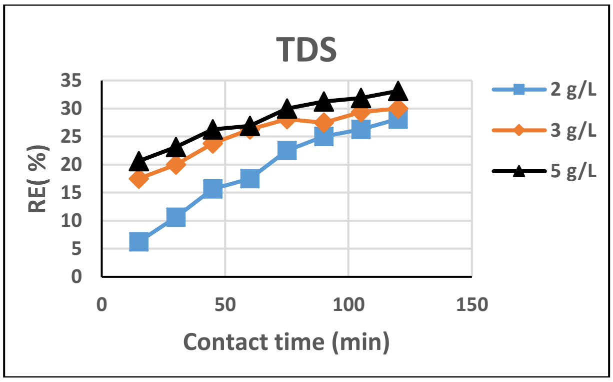

Figure 7 shows removal efficiency of TDS of sample of water using GAC

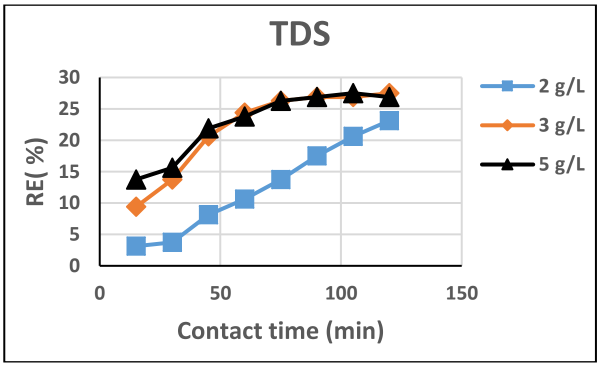

Figure 8 shows removal efficiency of TDS of sample of water using PAC

The pH results 7.72 for influent, which can be considered as slightly basic. However, after treatment with two types of AC granular and powdered, the effluent become more basic than the influent pH reading, as the filtration with granular AC gives 8.18 and 8.21 with powdered AC.

Table 3 shows a comparison of removal efficiencies of parameters COD, BOD, TDS and TSS of granular and powdered activated carbon.

Table 3: Comparison of RE (%) of parameters using granular and powdered AC

Parameter	RE (%)	
	Granular AC	Powdered AC
BOD	39.80	34.70
COD	14.81	17.60
TSS	81.82	72.73
TDS	150	166.67

4 Conclusion

The objective aimed in this study have been achieved. A few down-flow fixed bed AC contractor have been developed. Some water quality parameters involved in this study (e.g. BOD, COD, TSS, TDS and pH) have been assessed accordingly and simultaneously to get the best efficiency results of AC types and origin according to the quality of effluent sample. From the obtained results, it can be concluded the following :

1. The best activated carbon in terms of removal efficiency is the granular AC, which has highest values after testes with both water samples compared to powdered AC.
2. The removal efficiency of parameters BOD, COD, TSS, TDS and pH are 39.80%, 14.81%, 81.82%, 150% and 6.61 using granular AC, While are 34.70%, 17.60%, 72.73%, 166.67% and 7.52 using powdered AC.

Acknowledgement

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