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RESEARCH ARTICLE

TREATMENT OF MUNICIPAL WASTE WATER THROUGH ADSORPTION USING DIFFERENT WASTE BIOMASS AS ACTIVATED CARBON

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ABSTRACT

Water purification is very necessary to provide clean and quality water to all livings for their survival. Various techniques for water treatment is in use now a days. The most common and useable method is the adsorption. The activated carbons generated from different ingredients like walnut shell, bagasse and the rice husk. The adsorbent generated from activated carbon can be efficiently utilized for municipal wastewater to be treated to reduce TSS, TDS, COD, turbidity, EC, pH and Temperature. These activated carbons occur naturally and environmentally friendly. Also, no bad effect on humans. Mostly used for the treatment of municipal wastewater. Walnut Shell, Bagasse and Rice Husk conversion to activated carbon minimizing the cost of waste transfer and gives cheap resources for generation of activated carbon.

KEYWORDS

Municipal wastewater, pH, COD, TDS and rice husk

1. INTRODUCTION

Water quality is mostly affected by the continuous increase in Pakistan's population due to which the required demand which are agriculture, industrial and domestic are greatly decreasing. The water in Pakistan is continuously wasting and if this problem is not controlled in a proper way then the country will be in a serious threat of water scarcity. The Quality of water is continuously diminished because of the waste discharge from municipal and industrial wastewater release without not taking proper step to treat this water and drain into pure surface water and the using fertilizers for agriculture purpose [1]. The quality of water is controlled in some parts of the country but due to poor management its quality is difficult to maintained to meet the required demand. Water availability has reduced to 997 m3 from 55600 m3 [2].

In Pakistan, which is a poor country, here the conditions become more contrary because of lack of resources and the water treatment here is of no so much value. Mostly in big cities the available amount of pure water to people living there is very unsatisfactory. The environmental survey estimated the death ratio in Pakistan due to wastewater disease due to drainage of municipal and industrial wastewater into the pure drinking water scheme [3]. The most important impurities present in wastewater are the dissolved organics and inorganics, the total dissolved solids and gases, the total suspended solids, the volatile compounds and the traces of heavy metal including chromium, zinc, lead, copper, arsenic, cadmium and mercury.

Therefore, the water purification is very necessary to provide clean and quality water to all livings for their survival. Various technique for water treatment is in use now a days including the coagulation, membrane filtration, precipitation, ion exchange, adsorption and the chemical method to obtain the desired quality of water. The most common and useable method is the adsorption. In this technique we use the activated carbon as the adsorbent to remove the impurities present in wastewater [4]. The activated carbons can be generated from different ingredients like the saw dust, almond shell, corn cob, wheat husk, coconut shell, kikar charcoal, peanut shell and dry tree leaves. But the main focus in this study will be on the three types of activated carbons generated from walnut shell, bagasse and the rice husk.

2. MATERIALS AND METHODS

2.1 Preparation of Activated Carbon

The sugarcane bagasse and walnut were put first in the pressure cooker and the pressure cooker was then place on fire. These two ingredients were place on fire for about half an hour to convert these ingredients into carbon. This process is taken place in the kitchen at home. The gases which are generated during the burning of these materials are exhausted on the large opening located at the top of the pressure cooker. The three ingredients which include sugarcane bagasse, walnut shell and rice husk were grinded in the shaker to achieve the desired particle size for desired mesh number. The grinded particles were then put in the sieve analyzer. After grinding the particles were put in the sieve analyzer to sieve particle of size 325 microns which is the desired one. The sieve of 48 mesh screen was used for obtaining this desired particle size. The screening process is carried out to achieve appropriate size for activated carbon. The three materials which include sugarcane bagasse, rice husk and walnut shell were chemically activated. The solution of distilled water and sulfuric acid were prepared at normal conditions. The distilled water was taken as 500 ml and sulfuric acid as 15 ml. Then mixing taken place and solution of desired level were prepared. This solution was put into three different beakers and the particles of bagasse, rice husk and walnut shell were drop into it. Completely mixing of these particles in the solution occur by keeping these solutions for about 3-4 hours. Then these particles were separated from the solution and then keep these particles for about 16-19 hours for soaking. After this the particles were washed two to three times with distilled water to remove the free acidity from these particles. The particles were then placed on the hot plate for drying. Then these particles were placed into open atmosphere for further drying. After this the dried particles were put in different polythene bags for further process.

2.2 Different Bed Filters

The filter bed was prepared from the hard-plastic pipe dia of which is about 0.8 inch and which were bought in the local market of Quetta city. The pipes were fitted in the equipment placed in the central lab of Chemical Engineering department. After the complete installment of pipes different filter beds were prepared using the activated carbons produced from bagasse, rice husk and walnut shell. The filter bed length maintained as 24 inch for all the ingredients. Then the next step is pass the municipal wastewater through these filter beds to obtained the desired results. About five experiments were performed in the lab and obtained about five different samples at the bottom as a result of these experiments.

2.3 Wastewater Collection

The wastewater was collected from the main drainage line located somewhere in Shehbaz town in Quetta. This line of wastewater is basically the main junction where all the wastewater of Quetta is collected here, and this water is the most polluted among all the wastewater in Quetta because this is the most populated zone in this city.

2.4 Sample Preparation

The total samples collected after the experimental work were about five (5) in number. The three activated carbons were used in this work which include bagasse, rice husk and walnut shell. One mesh size was maintained and the dose of the three activated carbons were also taken constant.

Table 1: Walnut Shell Based Activated Carbon

No of Sample	Dose of Activated Carbon(g)	Particle Size (Mesh)	Particle Size (µm)	Retention Time (Min)	Flow Rate (L/min)
01	45	48	325	75	0.3

Table 2: Sugarcane Bagasse Based Activated Carbon

No of Sample	Dose of Activated Carbon(g)	Particle Size (Mesh)	Particle Size (µm)	Retention Time (Min)	Flow Rate (L/min)
01	45	48	325	75	0.3

Table 3: Rice Husk Base Activated Carbon

No of Sample	Dose of Activated Carbon (g)	Particle Size (Mesh)	Particle Size (µm)	Retention Time (Min)	Flow Rate (L/min)
01	45	48	325	75	0.3

Table 4: Combined Bed (Walnut Shell, Sugarcane Bagasse, Rice Husk)

No of Sample	Dose of Activated Carbon (g)	Particle Size (Mesh)	Particle Size (µm)	Retention Time (Min)	Flow Rate (L/min)
01	45	48	325	75	0.3

Table 5: Mixed Bed (Walnut Shell, Sugarcane Bagasse, Rice Husk)

No of Sample	Dose of Activated Carbon (g)	Particle Size (Mesh)	Particle Size (µm)	Retention Time (Min)	Flow Rate (L/min)
01	45	48	325	75	0.3

2.5 Experimental Procedure

First wash and clean the equipment properly to prepare it for experimental work. Then prepare the filter bed column from the hard-plastic pipes and fitted it in the equipment used for wastewater treatment. The activated carbon produced from walnut shell, sugarcane bagasse and rice husk will drop into the bed column and maintain the length of filter bed of about 24 Inch. Weigh each activated carbon of 45 grams for each 5-sample using the digital weight balance. The weighted activated carbon was drop in the bed filter. Power on the start button and maintain the flow rate as 0.3 L/min. Give a retention time to each sample was about 75 minutes. The filtration was done twice in order to remove the impurities completely and obtain a clear filtrate at the end. The column was washed after each run. The clear filtrate was collected in a neat and clean bottle. All the sample were placed in the lab for some time and then they were sent into the research center to conduct different tests for each sample.

The conditions used for all the experiments performed in this research work are same i.e

Particle size used----------325 micron (48 mesh)

Dose of Activated Carbon----------45 grams

Bed Length----------24 inch

Flow Rate----------0.3 L/min

But the efficiency for every bed will be different

3. RESULTS AND DISCUSSION

The principle objective of this research work is to remove Total Dissolved Solids (TDS), Color, Total Suspended Solids (TSS), Temperature, Turbidity, pH and Chemical Oxygen Demand (COD). This work is performed by using three different ingredients as activated carbon and the same dose was used for these materials.

3.1 Total Suspended Solids (TSS)

By using 45 grams dose of activated carbon made from walnut shell and a particle size of about 325 microns for the expulsion of Total Suspended Solids from the municipal wastewater. The pretreatment water has Total Suspended Solids of 100 ppm. The removing efficiency on these conditions is 100%. This removal percentage is same for all the pollutants like COD, TDS, Turbidity, Temperature, pH and Electrical Conductivity present in municipal wastewater.

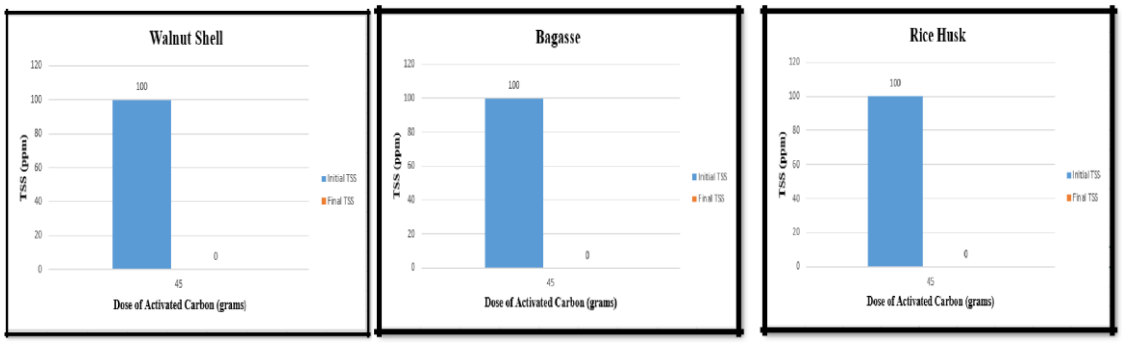

Figure 1: TSS Reduction with Walnut Shell, Bagasse and Rice Husk using 325 µm particle size

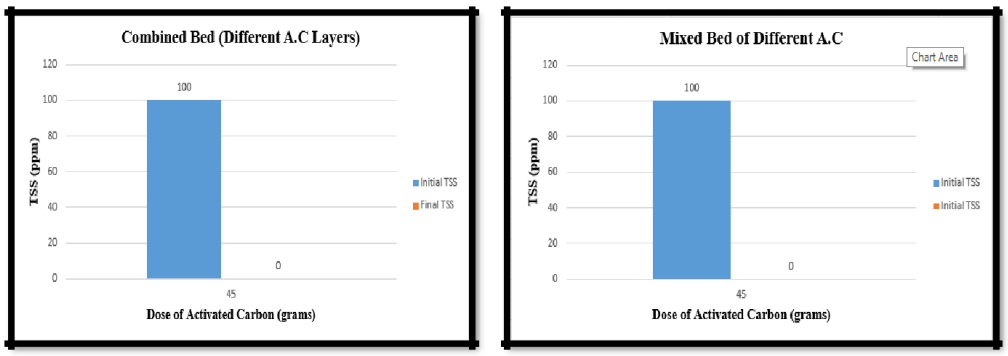

Figure 2: TSS Reduction with Combined & Mixed Bed of A.C using 325 µm particle size

3.2 Total Dissolved Solids (TDS)

The total amount of TDS in pretreatment water is 3870 ppm. By using walnut activated carbon of particle size 325 µm and dose of 45 grams, to reduce the amount of the Total Dissolved solids from 3870 ppm to 1667 ppm this removing efficiency of TDS for walnut shell activated carbon is 57%. The total quantity of TDS in wastewater is 3870 ppm and it reduce to 3280 ppm by utilizing bagasse activated carbon the removal percentage of TDS for bagasse activated carbon is about 16%. With the help of using rice husk activated carbon the pretreatment amount of TDS in water is 3870 ppm and it reduce to 2320 ppm with removing efficiency of 40%. Using the combined bed of different activated carbon maintaining the same conditions for activated carbon using in this bed, the total quantity before of TDS before the treatment is 3870 ppm and it falls into 768 ppm with 81% removal efficiency. Different activated carbon i.e walnut shell, bagasse and rice husk is mixed up and passing wastewater containing through it. The removal percentage of TDS for this bed is 79%.

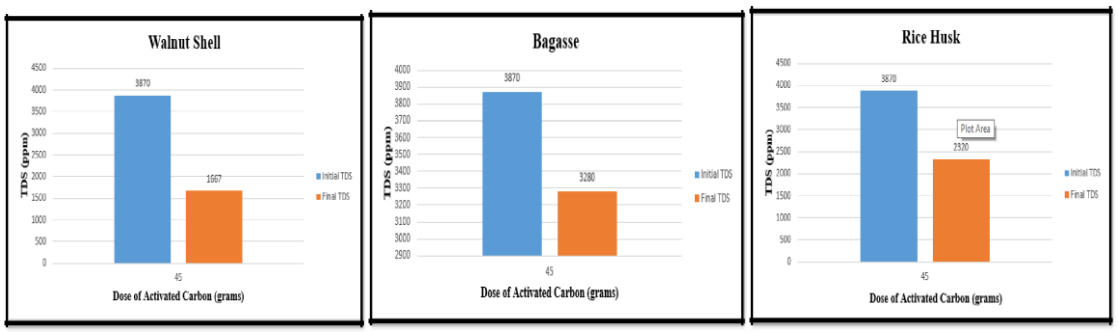

Figure 3: TDS Reduction with Walnut Shell, Bagasse and Rice Husk using 325 µm particle size

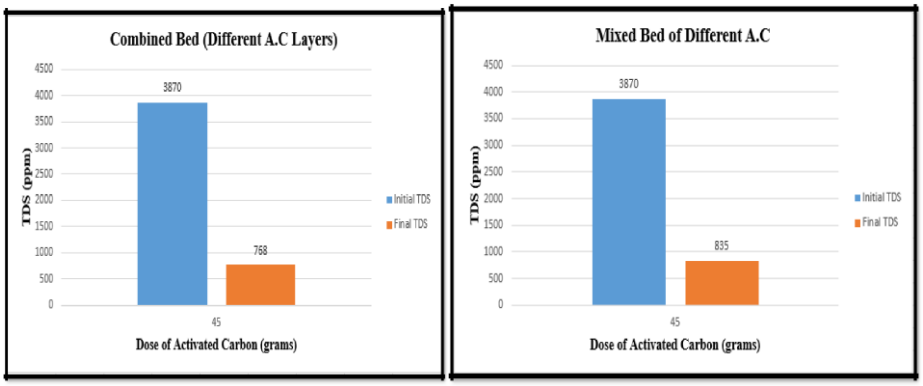

Figure 4: TDS Reduction using Combined and mixed Bed of size 325 µm

3.3 Chemical Oxygen Demand (COD)

The amount of COD present in wastewater before the treatment is 240 ppm and by utilizing this type of activated carbon it cut off to 88 ppm with removing efficiency is 64%. The bagasse based activated carbon has capacity to reduce the original amount of COD which is 240 ppm present in wastewater to 72 ppm and the efficiency for this COD removal is 70%. Rice Husk used as activated carbon in this research has the capacity to decrease the amount COD to 116 ppm with 52% calculated removing efficiency. Using the combined bed of activated carbon containing rice husk, walnut and bagasse having removing efficiency of COD is 80%. The mixed bed of activated carbon lower down the original amount of COD from 240 ppm to 24 ppm and the removal efficiency calculated for this type is 90 %.

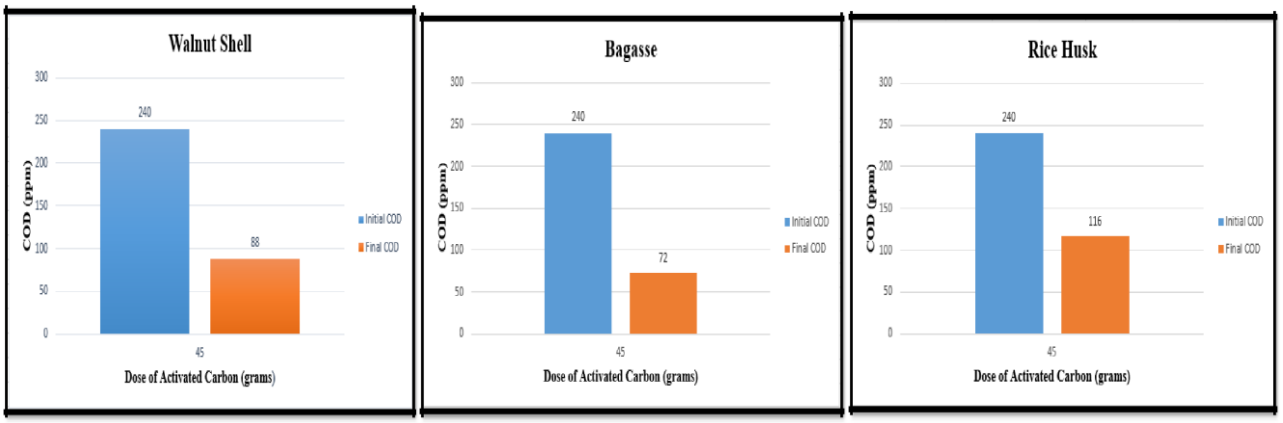

Figure 5: COD Reduction using Walnut Shell, Bagasse and Rice Husk of particle size 325 µm

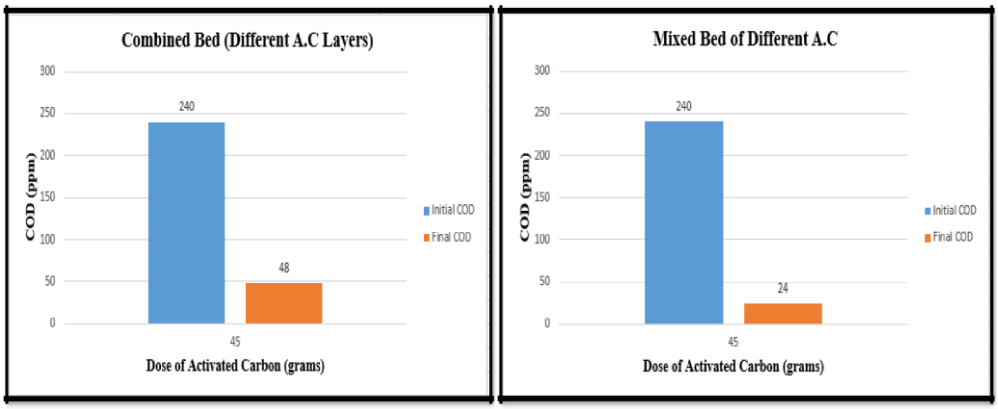

Figure 6: Reduction of COD using Combined and mixed Bed having particle size of 325 µm

3.4 Turbidity

Walnut Shell used as activated carbon in this work has the capacity to expel out the pollutant known as turbidity and the efficiency of this type of activated carbon used in this research is about 97%. Using the bagasse activated carbon for the removal of turbidity of the same size as walnut shell and has an efficiency of 97.50%. The total amount of turbidity present in municipal wastewater is 250 NTU and it lower down to 4.14 NTU by using rice husk activated carbon. The efficiency of removing turbidity is 98%. By passing the wastewater through this bed the amount decreases to 2.45 NTU from 250 NTU. The efficiency of removing is 99%. The removal efficiency is same as calculated for combined bed (99%).

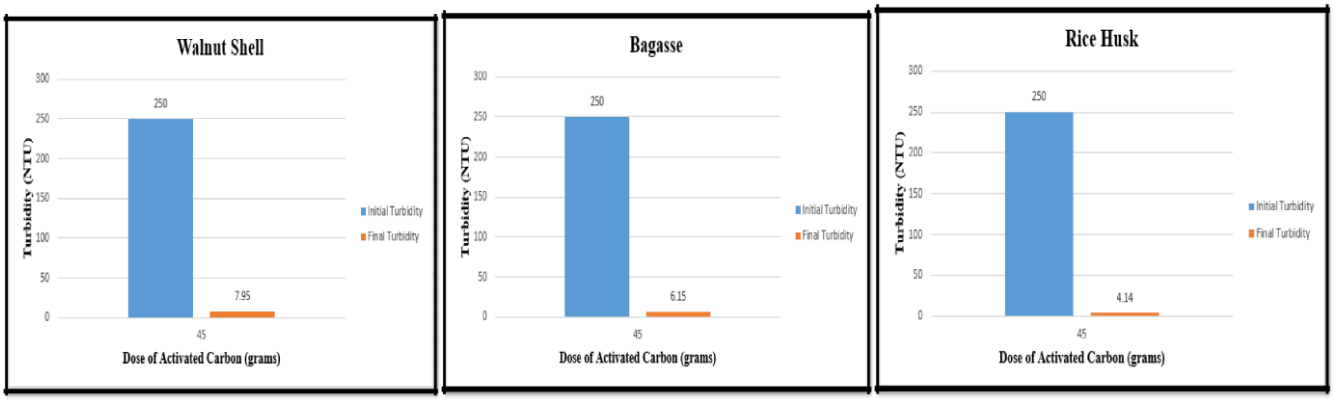

Figure 7: Reduction of Turbidity based on Walnut, Bagasse and Rice Husk Activated Carbon using 325 µm of particle size

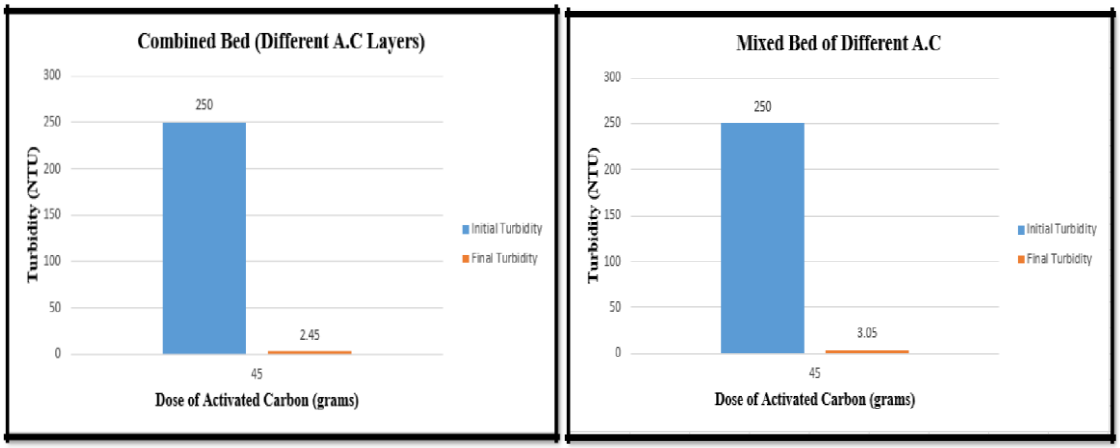

Figure 8: Reduction of Turbidity utilizing Combined and Mixed Bed of Activated Carbon of particle size 325 µm

3.5 Electrical Conductivity (EC)

The walnut shell based activated carbon has the capacity to minimize the amount of EC present in wastewater and it decreases to 2600 µS from the original amount which is 6060 µS. The removing efficiency is about 57%. The bagasse activated carbon has removal efficiency for EC is about 16%. The wastewater is treated using the rice husk activated carbon which has the capacity to adsorb large quantity of pollutants. Using in this research the quantity reduce to 3630 µS from 6060 µS. The calculated removal efficiency is 40%. This bed of activated carbon has the efficiency to remove 79% of the EC from the municipal wastewater. The mixed bed efficiency for EC removal is 81%.

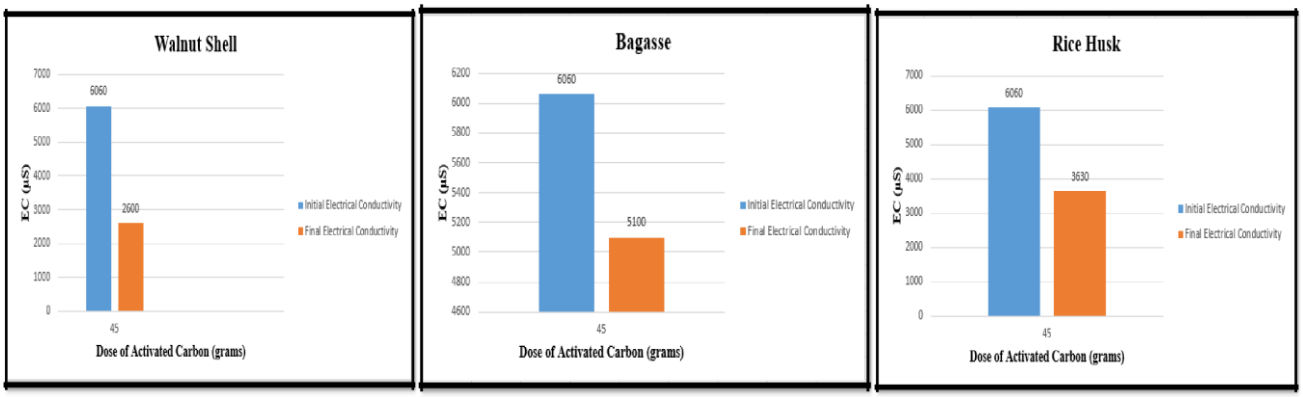

Figure 9: EC Reduction by using Walnut Shell, Bagasse and Rice Husk Activated Carbon of particle size 325 µm

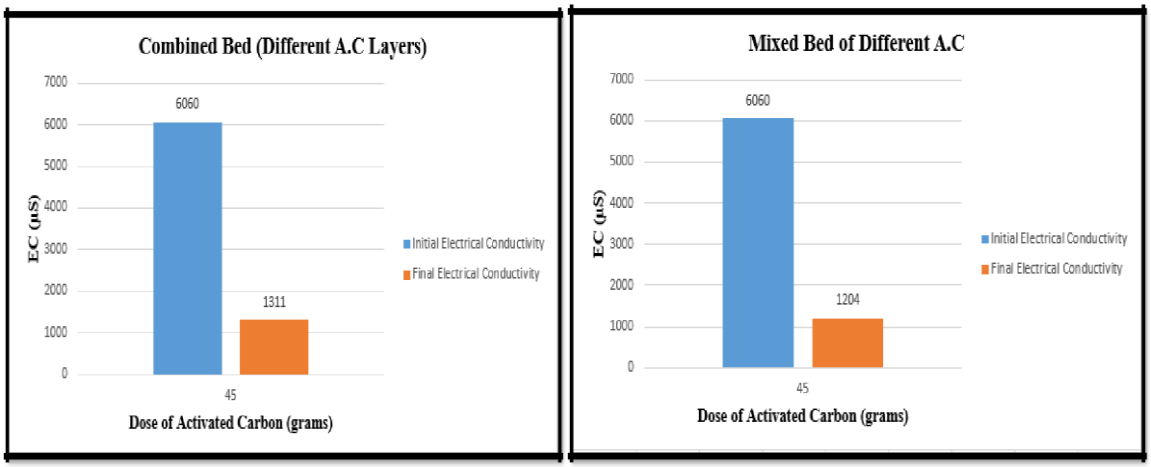

Figure 10: Reduction of EC using Combined and mixed Bed of Different A.C of 325 µm particle size

3.6 pH

The walnut shell based activated carbon used in this experimental work is used to treat water and to obtain best results as much as possible. The walnut shell changing the pH of water and tends to lower down its acidic nature from 2.0 to 3.0. This result is same for bagasse activated carbon and rice husk activated carbon. The combined bed has the efficiency to lower down the acidic strength of wastewater from 2.0 to 5.0 when passed through it. The pH value changes from 2.0 to 6.8, from strong acidic towards low acidic when the wastewater is passed through the mixed bed of different activated carbon.

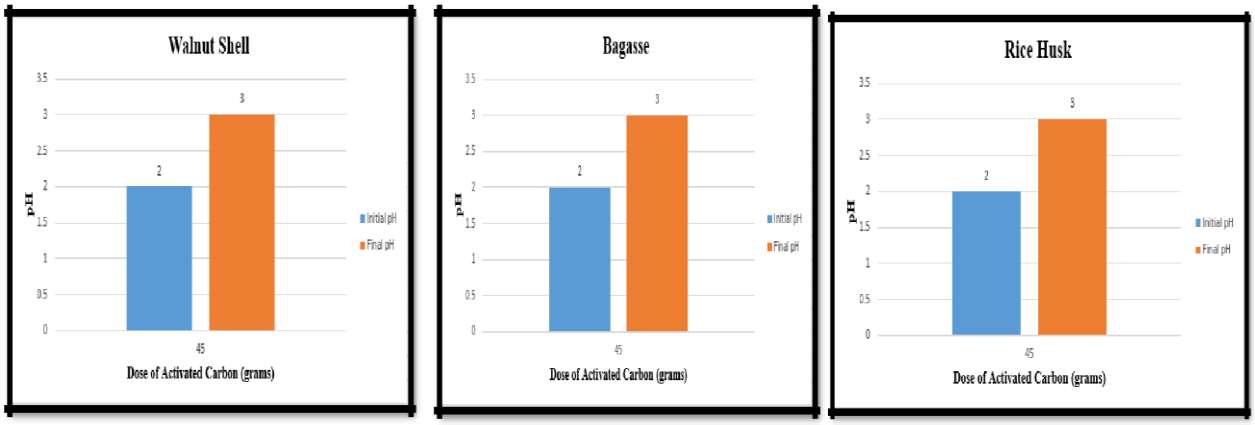

Figure 11: Lowering Acidic Strength of wastewater using Walnut Shell, Bagasse and Rice Husk Activated Carbon of particle size 325 µm

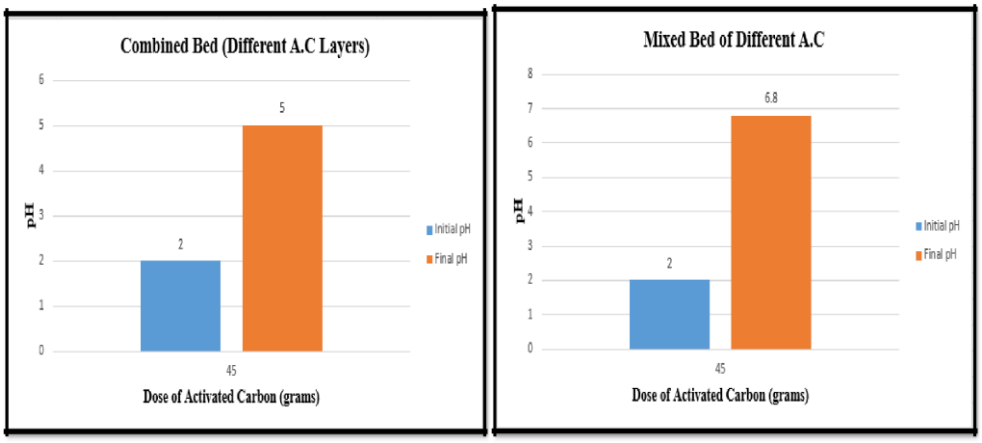

Figure 12: Changing the acidity towards neutral condition using Combined and mixed Bed of Activated Carbon of 325 µm particle size

3.7 Comparison of Different Activated Carbon and Their Mutual Bed

The comparison of % removal efficiency of different activated carbon and their mutual activated carbon bed used in this research work for different pollutants present in municipal wastewater i.e. TSS, TDS, COD, Turbidity and Electrical Conductivity (EC).

Figure 13: Comparison of Different Activated Carbon and their Mutual Bed (% Removal)

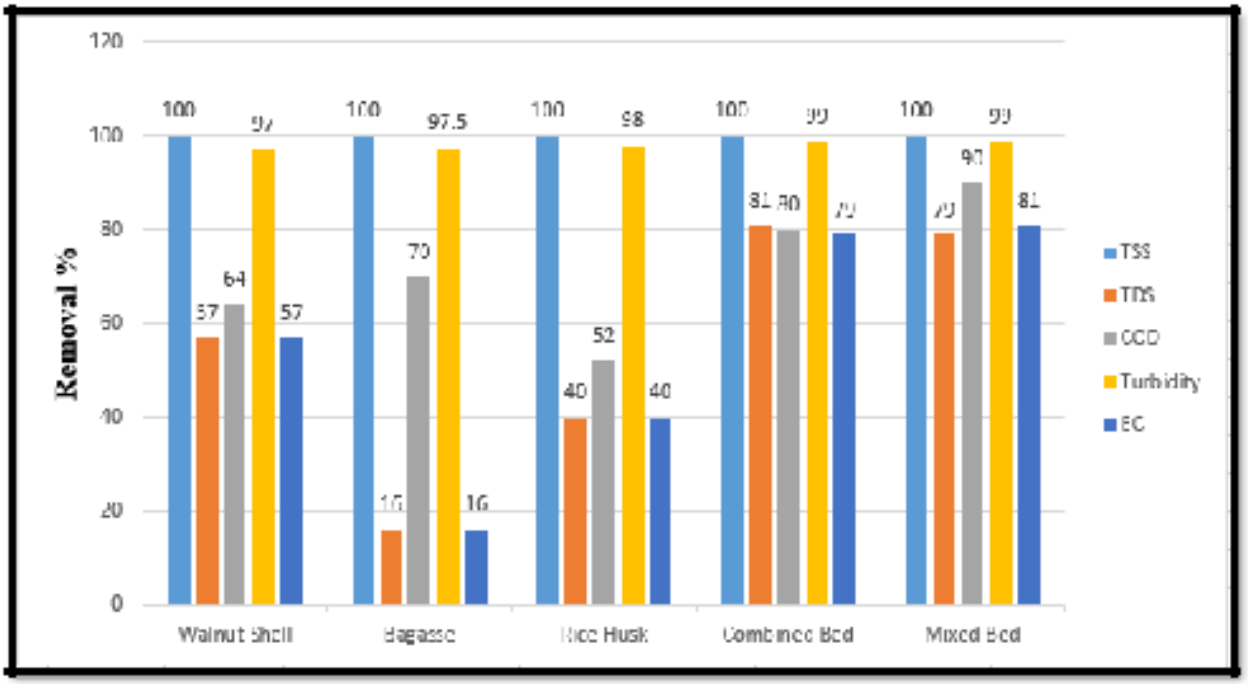

Table 6: Comparison of Different Activated Carbon and their Mutual Bed

Untreated Sample	TSS (ppm)	TDS (ppm)	COD (ppm)	Turbidity (NTU)	pH
	100	3870	240	250	2.00
Walnut Shell	0.00	1667	88.00	7.95	3.00
Bagasse	0.00	3280	72.00	6.15	3.00
Rice Husk	0.00	2320	116	4.14	3.00
Combined Bed Activated Carbon	0.00	768	48	2.45	5.00
Mixed Bed	0.00	835	24	3.05	6.8
of Activated Carbon					

4. CONCLUSION

The adsorbent generated from activated carbon can be efficiently utilized for municipal wastewater to be treated to reduce TSS, TDS, COD, turbidity, EC, pH and Temperature. These activated carbons occur naturally and environmentally friendly. Also, no bad effect on humans. Mostly used for the treatment of municipal wastewater. Walnut Shell, Bagasse and Rice Husk conversion to activated carbon minimizing the cost of waste transfer and gives cheap resources for generation of activated carbon. The COD adsorption study reveal that the mixed bed of different activated carbon has better removal efficiency as compared to other beds of activated carbon. The TDS removal efficiency is higher for combined and mixed bed of activated carbon. It is concluded from the overall study of all the activated carbon the walnut shell based activated carbon has better and most effective result as compared bagasse and rice husk based activated carbon. Also, the mixed bed of walnut shell, bagasse and rice husk activated carbon show best results as compared individual results of used activated carbon in this research. The treated water by with bagasse, rice husk and walnut shell activated carbon is openly release into rivers, streams and lakes and can also be used agricultural purpose. This water is now suitable for the plants and aquatic animals.

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