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COD Removal from Industrial Wastewater Using Spent Tea Leaves

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ABSTRACT: Several chemical and physical processes are used to remove COD from wastewater but adsorption onto activated carbon has been found to be one of the most efficient physicochemical treatment techniques. Spent tea leaves is a potential low cost adsorbent for the removal of COD from wastewater. Freundlich and Langmuir adsorption isotherm models were used to know the adsorption capacity of spent tea leaves and to describe the interaction of adsorbate molecules with adsorbent surface from the obtained data. The data of COD removal from industrial wastewater fitted well with both Freundlich and Langmuir isotherm model. But Langmuir isotherm model fitted better as the correlation coefficient of Langmuir isotherm model (0.9493 for COD) was higher than Freundlich isotherm's correlation coefficient value (0.8843 for COD).

KEYWORDS: Adsorption, Adsorbent Surface, Freundlich and Langmuir adsorption isotherm model.

I. INTRODUCTION

Composite industrial effluent is characterized by significantly high Chemical Oxygen Demand (COD) and Total Organic Carbon (TOC) content along with a large number of non-biodegradable organic dyes and other chemicals used in manufacturing (Quader, 2010). The overall economy of Bangladesh has registered a steady improvement with more than 6% average growth during the last few years. At the end of every process in the industry the chemicals are washed by water which causes liquid waste which are released to natural water bodies. Such uncontrolled release of industrial effluents to natural water bodies causes environmental degradation and increases health risks to human beings. This study, was aimed to carry out experiments using spent tea leaves (STL) for the removal of organic contaminants specially COD from the industrial effluent. Different treatment methods are available. Activated carbon produced by carbonizing organic materials has shown good adsorption capacities. But commercially available activated carbon is expensive for use (B. M. W. P. K. Amarasinghe et al. 2007). In this study, an approach is undertaken to find out the efficiency of a low cost adsorbent "Spent tea leaves" for the removal of COD from industrial wastewater.

II. RELATED WORK

S.S Ahluwalia and D. Goyal (2005) used waste tea leaves to remove Lead, Iron, Zinc and Nickel from 20mg/L metal solution by different percentage of dried biomass of waste tea leaves. Mohammad Abdul Hossain et al (2005) analyzed the kinetics of Cr(VI) adsorption on used black tea leaves. The tea leaves were boiled with distilled water for 8h. The sample was dried at 378K for 24h and sieved out in a diameter of 0.25×10^{-3} to 0.5×10^{-7} m. A stock solution of synthetic wastewater containing 1.0 kg.m^{-3} of Cr (VI) was prepared by dissolving potassium dichromate ($\text{K}_2\text{Cr}_2\text{O}_7$). The experimental data fits pseudo second order kinetic model. The adsorption capacity increases with temperature. Yoshita, A., Lu, J.L., Ye, J.H. and Liang, Y.R. (2009) prepared an adsorbent using spent tea leaves and used it to remove lead (Pb) from solution. In this research work, spent tea leaves were used as adsorbent for the removal of absorbance of, COD from tannery wastewater collected from a industry located in Savar. The adsorption behavior was analyzed using Langmuir and Freundlich adsorption isotherm. Again the adsorption kinetics were investigated using pseudo first order and pseudo second order kinetics models.

III. METHODOLOGY

The research work began with the collection of spent tea leaves from our households followed by 1. Oven drying and grinding of spent tea leaves, 2. Batch adsorption process 3. Feasibility studies of spent tea leaves as an adsorbent 4. Batch adsorption process and 5. Adsorption isotherms.



The sample of spent tea leaves were collected from the households and a tea stall. The collected spent tea leaves were then repeatedly boiled and filtered manually in order to remove soluble and colored compound. After filtration, the filtered sample was then oven dried at 105°C for 24 hours. The dry sample was then grinded manually. This grinded sample was used as adsorbent. The grinded spent tea leaves were used for the batch adsorption process. The adsorbent dose was kept same for all the concentration of wastewater. Adsorbent dose was selected 3.5 g/L (B.H. Hameed, 2008). So, 0.875gm of spent tea leaves were used for 250mL solution. The test is performed for two different initial concentrations of wastewater and four different adsorbent dose. The samples were normally filtered. There are two digestion methods used in the COD test. Here the latest micro method was used as the Micro Digestion Method minimizes reagent consumption and reduces the required space and equipment to one reactor block. Each test set-up is a self-contained disposable vial, which is inserted into a block heater. Here the solution was diluted upto 2 times and a 2 ml of solution were disposed in the COD vial at two-hour digestion time in the reactor block. After 2 hour the oxidation was completed and the samples were cooled to determine the amount of dichromate consumed by titrimetrically or colorimetrically. The whole procedure was repeated for 10 min, 20 min, 30 min, 45 min & 60 minutes.

Experimental results

The studies of COD removal were conducted with varying amount of adsorbent starting from 0.5-20gm/l (IRJET, MdNur et al). Here the test was performed for adsorbent dose of 5, 10, 14 and 20g/L. Tannery sample of 250 ml was treated with different amount of doses of tea waste adsorbent. The COD removal was examined at different time of 10, 20, 30, 45 and 60 min. The reduction of COD concentration in solution with contact time is shown in Table 1. The gradual change of COD of samples with different adsorbent dose are shown in Figure 1. Table-2 and figure -2 it is shown that the removal is higher for first 30 mins. The COD concentration is reducing with the increase of adsorbent dose but reducing rate is not so significant. The efficiency of COD removal is more for first 30 min as well as upto 60 min of contact time. The efficiency is highest for 5g/L and 10g/L of adsorbent dose. There are some scattered data also found for increasing adsorbent dose but it is effective. From Figure-3 Freundlich isotherm for COD removal for 60 min contact time, the adsorption capacity is found to be 44.15 L/mg. The Regression coefficient is found 0.8843 which indicates almost a good linearity. Figure-4 shows Langmuir isotherm model of COD removal and the correlation coefficient (R^2) is found from the plot is 0.9493 which indicates a good linearity that means the applicability of the test. The adsorption capacity, $q_m = 1/n = 4.87$ Pt-Co (per gram of adsorbent per liter).

TABLE-1: COD REMOVAL AT DIFFERENT CONTACT TIME FOR DIFFERENT ADSORBENT

Time (min)	COD(mg/l) for 5mg/l	COD(mg/l) for 10mg/l	COD(mg/l) for 14mg/l	COD(mg/l) for 20mg/l
0	1504	1504	1485	1485
10	1006	987	921	903
20	912	902	880	867
30	850	805	798	778
45	782	750	710	688
60	710	702	677	643

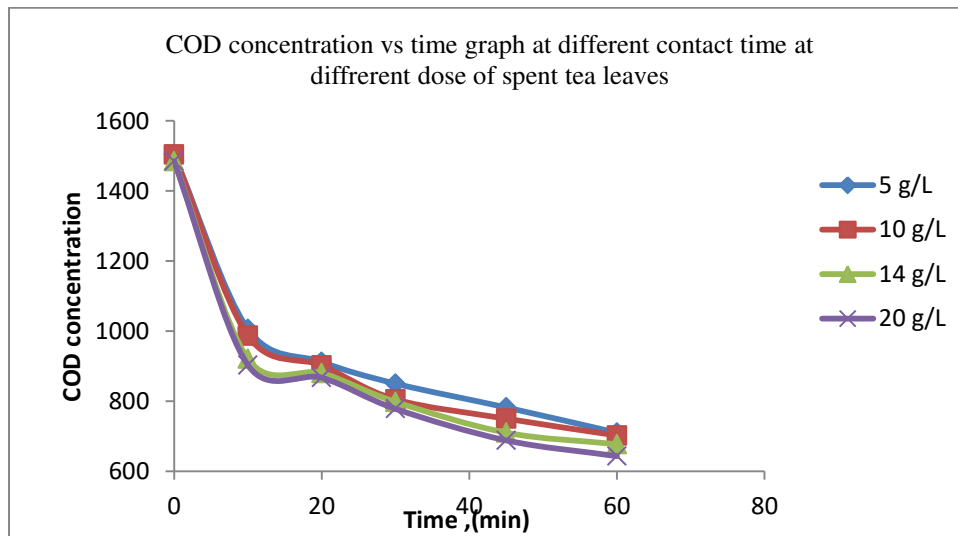


Figure 1: Typical COD concentration at different contact time for different adsorbent dose of spent tea leaves.

Table 2: COD removal efficiency(%) at different contact time for different adsorbent dose

Time (min)	5 g/L	10 g/L	14 g/L	20 g/L
0	0	0	0	0
10	33.11	34.38	37.98	39.19
20	39.36	40.03	40.74	41.62
30	43.48	46.48	46.26	47.61
45	48.01	50.13	52.19	53.67
60	52.79	53.32	54.41	56.70

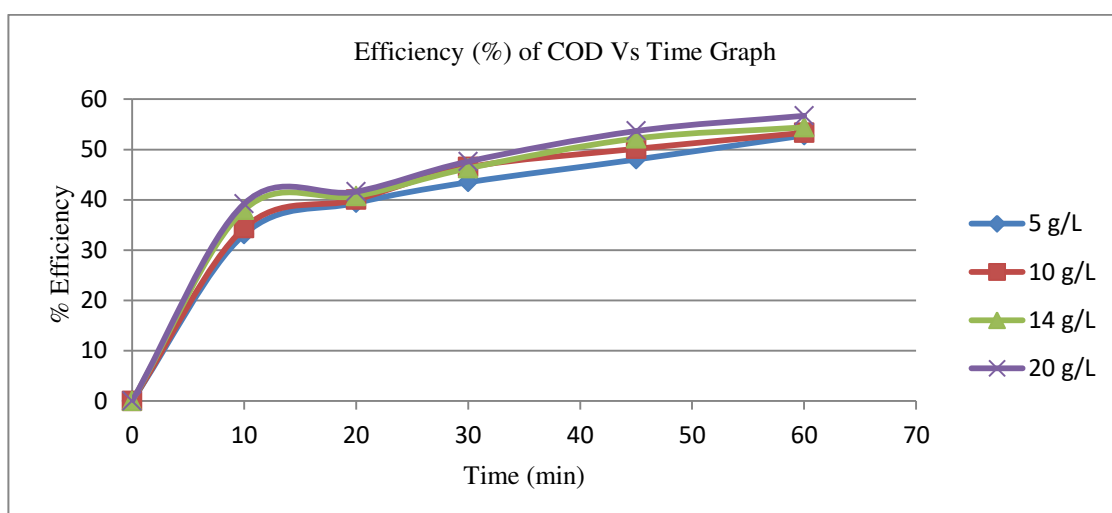


Figure 2: COD removal efficiency of industrial wastewater using spent tea leaves of different dose.

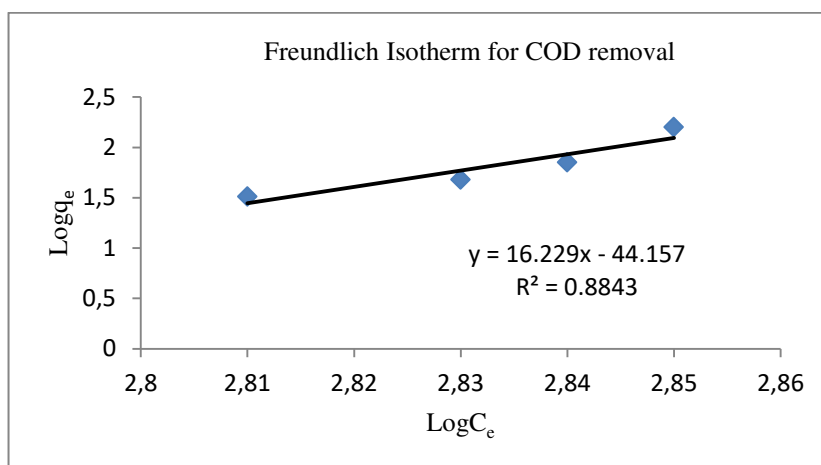


Figure 3: Freundlich Isotherm for COD removal for Industrial Wastewater using STL

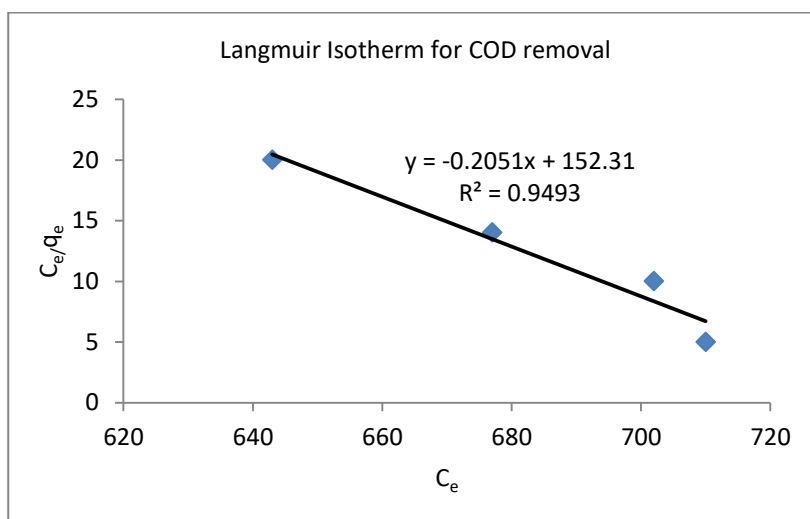


Figure 4: Langmuir Isotherm for COD removal from industrial wastewater using STL

IV. CONCLUSION

The main objective of this thesis was to evaluate the efficiency of Spent Tea Leaves as adsorbent for COD removal from industrial effluent. To perform the study initial and important task was to choose STL as activated carbon. The pH, temperature, adsorbent dose, contact time all are considered in this study. The adsorbent isotherms were analyzed here. The following conclusion can be drawn from here:

- Equilibrium contact time for COD removal from wastewater was found 60 minutes. Maximum removal efficiency was found 56.70 % for initial concentration of 1503 mg/L.
- The data of COD removal from industrial wastewater fitted well with both Freundlich and Langmuir isotherm model. But Langmuir isotherm model fitted better as the correlation coefficient of Langmuir isotherm model ($R^2=0.9493$ for COD) was higher than Freundlich isotherm's correlation coefficient value ($R^2= 0.8843$ for COD). The possible reason is the formation of monolayer of the adsorbate onto the surface of the spent tea leaves adsorbent.

- From the experiment it is found that the COD removal efficiency increases with the increase in adsorbent dose added. The maximum value of efficiency was found at the dose concentration 20g/L. It is found that rapid increase of efficiency occurs between the concentrations of 5 to 10 g/L. After that the change in efficiency became slightly increasing.

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