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Prosopis Juliflora Carbon and Commercial Activated Carbon in the removal of COD from aqueous solution

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ABSTRACT

The local domestic wastewater is analyzed for determining its major pollutants. The efficiency of Prosopis Juliflora Carbon (PJC) and commercial grade activated carbon (CAC) is determined to remove Chemical Oxygen Demand (COD) from the wastewater. For this purpose a system of standardized batch absorbers under steady state conditions is used to study the effect of these media. The influence of treatment contact time, adsorbent dose, initial COD concentration and agitation speed on the rate of percent removal COD is evaluated. As alternative to commercial Activated Carbon Prosopis Juliflora Carbon (PJC) blend has shown quite effective adsorbent capacity for COD removal from the domestic wastewater. Though its capacity is lower than that of commercial grade activated carbon, the low cost material makes it an attractive option for the treatment of domestic wastewater.

Keywords: COD, Activated Carbon, wastewater analysis, water treatment, physicochemical analysis of water.

INTRODUCTION

Pollution of water by organic and inorganic chemicals is of serious environmental concern. Domestic wastewater differs in characteristics from the industrial wastewater. In domestic wastewater the organic load mainly due to the processes like food processing, washing of floor, cloths, utensils, animals, bathing and sewage. The main components of domestic wastewater are proteins, carbohydrates, detergents, tannins, lignin, humic acid, fulvic acid, melanic acid and many other dissolved organic compounds [1]. The organic content of wastewater is traditionally measured using lumped parameters such as BOD, COD and TOC [11,12]. These parameters as such do not show any chemical identity of organic matter.

A number of conventional treatment technologies have been considered for treatment of wastewater contaminated with organic substances. Among them, adsorption process is found to be the most effective and cheap method. Adsorption as a wastewater treatment process has aroused considerable interest during recent years [13,14]. Commercial activated carbon is regarded as the most effective material for controlling the organic load. However due to its high cost and about 10-15 % loss during regeneration, unconventional adsorbents like Prosopis Juliflora Carbon (PJC), peat, lignite, bagasse pith, wood, saw dust, raw tea powder and raw agricultural wastes etc. have attracted the attention of several investigations on the removal studies. Adsorption characteristics have been widely investigated for the removal of refractory materials for varying degree of success [2].

Thus the removal of organic material by adsorption onto low cost waste material has recently become the subject of considerable interest. This approach offers a potentially simple and economic "End of Pipe" solution to the challenges set by new legislation covering effluent discharges. Several investigations explored the use of Prosopis Juliflora Carbon (PJC) as an adsorbent for the treatment of wastewater to remove a variety of organic compounds and color [3,4,5,6]. It is concluded that Prosopis Juliflora Carbon (PJC) has a significant capacity for adsorption of organic compounds from aqueous solutions. It was reported that the carbon content of Prosopis Juliflora Carbon (PJC) plays a significant role during the adsorption of organic compounds by Prosopis Juliflora Carbon (PJC) [7]. The adsorption capacity increases with the increasing carbon content of Prosopis Juliflora Carbon (PJC). However, a review of the literature showed that very little investigation has been conducted to find out the suitability of Prosopis Juliflora Carbon (PJC) blend for the removal of COD from the domestic wastewater. Objective of the research was to demonstrate the use of Prosopis Juliflora Carbon (PJC) as an alternative media over activated carbon, to gain an understanding of the adsorption process.

Prosopis Juliflora Carbon (PJC) is a carbon that results from the carbonisation of local seemai karuveli is available in the barren land. One of the main advantages of COD removal by using Prosopis Juliflora Carbon (PJC) over the other chemical treatment methods is that it is in abundance and easy availability makes it a strong choice in the investigation of an economic way of COD removal. Other advantage is that it could easily be removed after the pollutants are adsorbed because it contains porous [15,16].

In the present study various parameters affecting adsorption like contact time between the waste water and the adsorbent, adsorbent dose, initial COD concentration and agitation speed have been investigated and data on adsorption isotherms have been presented [17,18].

EXPERIMENTAL SECTION

Wastewater samples were collected from the urbanized village of virudhunagar, Tamil Nadu, India. The pH and EC of the samples were measured on the site and the other parameters were analysed in the lab according to the standard procedure [8]. Samples were stored at temperature below 3^{o}C to avoid any change in the physico-chemical characteristics. The COD of the samples were estimated before and after adsorption giving different treatment.

Prosopis Juliflora Carbon (PJC) was obtained from local vendor, popularly is called as seemai karuveli, Sattur-626 203, Tamil Nadu, India. The sample received was washed with distilled water to remove surface dust and was dried in sun. Then it is carbonized in muffle furnace at 250°C, powderised and then the sample is stored in the laboratory in airtight plastic container

Table 1: Physico-chemical analysis of domestic wastewater

Sl. No	Parameters	Observed Values	Maximum Permissible Limit
1.	pH	7.2	6.8-8.5
2.	Electrical Conductance-EC (m mhos/cm)	0.31	0.1
3.	Temperature (0C)	20.5	16-32
4.	Turbidity (NTU)	320	5-10
5.	Total Solids (mg/l)	990	500
6.	Total Suspended solids (mg/l)	341	10-50
7.	Total dissolved solids (mg/l)	690	450
8.	Chemical Oxygen Demand (mg/l)	1080	30-45
9.	Biochemical Oxygen Demand mg/l	783	3-4

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Adsorption studies

In this study all the experiments were carried out at ambient temperature in batch mode. Batch mode was selected because of its relative simplicity. The batch experiments were run in different glass flask of 250 ml capacity using average speed shaker. Prior to each experiment, a predetermined amount of adsorbent was added to each flask. The stirring was kept constant for each run throughout the experiment ensuring equal mixing. The desired pH was maintained using dilute NaOH/ HCl solutions. Each flask was filled with a known volume of sample having desired pH commenced the stirring. The flask containing the sample was withdrawn from the shaker at the predetermined time interval, filtered through whatmann No. 44 filter paper. The experiments were carried out under different experimental conditions.

Experimental conditions

The following studies were conducted for activated carbon and Prosopis Juliflora Carbon (PJC) blend (1:1).

Study for initial COD concentration: These studies were performed by keeping all the conditions constant (Contact time of 30 min., adsorbent dose of 20 g/L and agitation speed of 500 rpm) except changing the initial COD conc. by using simulated COD bearing solutions prepared by dissolving known amount of glucose in distilled water.

Study for contact time: These studies were conducted by agitating 100ml sample with optimum COD concentration 1080 ppm and known amount of activated carbon and 1:1 Prosopis Juliflora Carbon (PJC) as an adsorbent agitated it for different time period, 5 - 300 minutes. After the predetermined time intervals, the sample were withdrawn, filtered and determined the residual COD concentration.

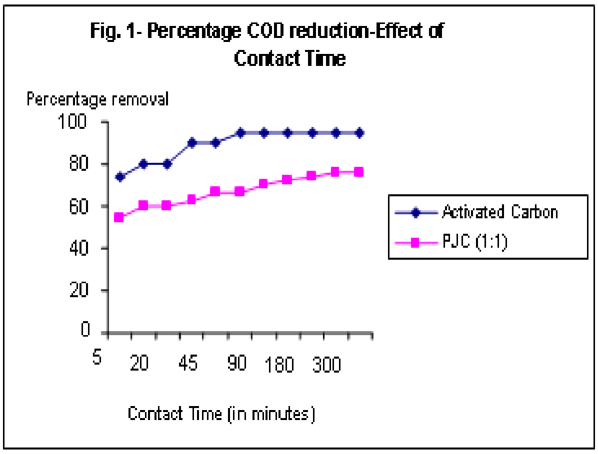
Study for adsorbent dose: These studies were conducted by varying the amount of adsorbent. A known volume of sample was treated with different doses of Activated carbon 5.0-50 g/L and

Prosopis Juliflora Carbon (PJC) blend (1:1) of 5.0–50 g/L. The samples were agitated for specific time, filtered and then analyzed for the residual COD.

Study for agitation time: These studies were performed by varying agitation speed from 100 rpm to 1000 rpm and keeping all conditions constant. Finally analyzed the sample for residual COD concentration.

RESULTS AND DISCUSSION

The results observed after the physico-chemical analysis of the wastewater as depicted in table: 1 showed that the domestic waste water is highly polluted with the organic load and suspended matter. Organic load is depicted in terms of COD and BOD values. The COD concentration is much higher than the permissible limits.



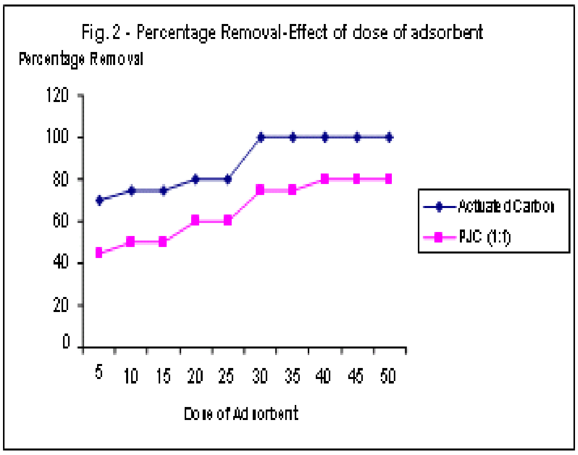


Fig. 1 represents the percent removal of COD for different contact time both by the Prosopis Juliflora Carbon (PJC) blend and commercial activated carbon. It seems that COD removal has been achieved to the extent of more than 70% by Prosopis Juliflora Carbon (PJC) (1:1) blend at a maximum time period of 300 minute and the trend of percent COD reduction with Prosopis Juliflora Carbon (PJC) blend was comparable to that of commercial activated carbon. From the removal curve (fig. 1), it has been seen that equilibrium attained in 240 minutes. The smooth and independent nature of curve indicates formation of monolayer cover of the adsorbate on the outer surface of the adsorbent. The adsorption process for the studied adsorbent follows first order kinetics and Freundlich adsorption isotherm.

Fig. 2 indicates the effect of adsorbent dose on the percent COD reduction by Prosopis Juliflora Carbon (PJC) blend and also compared its trend with that of commercial activated carbon. It was observed that maximum removal occur at the dose of 40 g/l for Prosopis Juliflora Carbon (PJC) blend and 30 g/l for commercial activated carbon and that is 80 % and 100 % respectively. After that the equilibrium was set up by further addition of adsorbent dose. Prosopis Juliflora Carbon (PJC) blend shows fairly the same trend to that of commercial activated carbon. The trend of dose effect on percent COD reduction both by Prosopis Juliflora Carbon (PJC) (1:1) blend and activated carbon are also represented. The results showed the tremendous increase in percent

COD removal with the increment of adsorbent dose, owing to the increase in the number of adsorption sites [9]. At lower doses, the significant small adsorption is possibly due to the saturation of surface active sites with the adsorbate molecules.

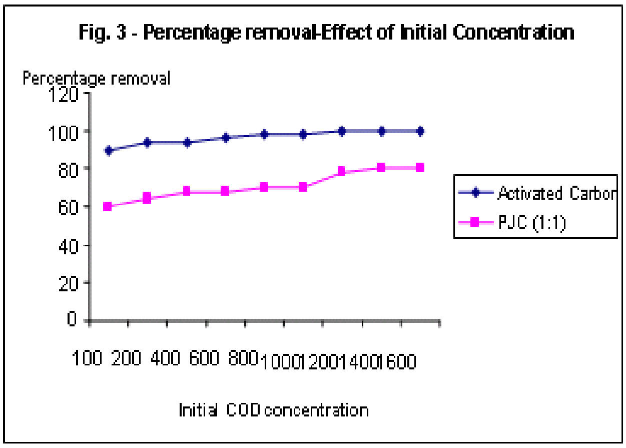


Fig. 3 - Percentage removal-Effect of Initial Concentration

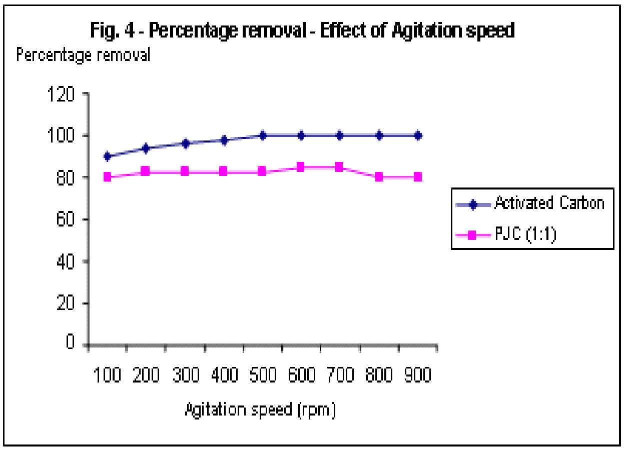


Fig. 4 - Percentage removal - Effect of Agitation speed

Fig. 3 represents the effect of initial COD conc. on % COD reduction by Prosopis Juliflora Carbon (PJC) blend and commercial activated carbon at the optimum adsorbent dose and the contact time as predicted from table 3 and 4 respectively. The Prosopis Juliflora Carbon (PJC) blend seems to be fairly active adsorbent even at higher initial concentrations. At lower initial concentrations, the ratio of the initial number of moles available to the adsorbent surface area is low and subsequently the fractional adsorption becomes independent of initial concentration. At higher concentrations, the available sites of adsorption become fewer and hence the % removal of COD depends upon the initial concentration [10]. The COD removal of over 60% -80% obtained with Prosopis Juliflora Carbon (PJC) blend within the concentration range investigated. The comparison in trend of % COD reduction by Prosopis Juliflora Carbon (PJC) blend with respect to commercial activated carbon under this condition is depicted in the figure 3.

Fig. 4 indicates the effect of agitation speed on % COD removal by Prosopis Juliflora Carbon (PJC) and commercial activated carbon. The agitation speed varied from 100 rpm to 800 rpm, keeping the initial conc., contact time and adsorbent dose constant. The results indicate that there is a definite improvement in the extent of adsorption with increase in the speed of agitation and then equilibrium was set up after 500 rpm. And after that, decreased which the film covering the adsorbent surface due to the rate of adsorption owing to the mass transfer resistance contributes.

CONCLUSION

It is revealed from the studies that the treatment of domestic wastewater can be done by Prosopis Juliflora Carbon (PJC) obtained from local place to reduce the organic load. The relative adsorptive capacity (in % with respect to AC) of Prosopis Juliflora Carbon (PJC) blend adsorbent for the adsorption of COD under optimum and identical experimental conditions are listed above. AC has higher adsorptive capacity than Prosopis Juliflora Carbon (PJC) blend (1:1). Eventhough it is observed that the COD can be reduced up to the extent of 90 % by use of Prosopis Juliflora Carbon (PJC) blend. The trend of % COD removal by Prosopis Juliflora Carbon (PJC) blend is fairly comparable to that of commercial activated carbon. Therefore it is the cost-effective alternative to commercial AC for the economic and efficient removal of Chemical Oxygen Demand from domestic wastewater. It is physically viable and economically viable approach.

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