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Effect of *Eucalyptus wood saw dust* Powder on Reduction of COD and TDS in a Dairy Industry Wastewater

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ABSTRACT: The effectiveness of Eucalyptus wood saw dust powder, a cheap agro-based product, as an adsorbent was evaluated to remove COD and TDS present in a dairy industry wastewater. Experiments were carried out by adding Eucalyptus wood saw dust powder to the dairy industry wastewater at different dosages, different rapid mixing contact time and slow mixing contact time. Maximum removal for COD and TDS in a dairy industry effluent was obtained at an optimum dosage of 100 g/l, an optimum rapid mixing contact time of 15 min. and an optimum slow mixing contact time of 30 min. The results showed that the percentage reduction in concentration of COD and TDS in a dairy industry wastewater by Eucalyptus wood saw dust powder as an adsorbent is about 87.8 % and 84.6 % respectively. The model also developed to check the reproducing ability of the experimental investigations. The results of the experimental investigations and model studies indicated that the Eucalyptus wood saw dust was effectively used as an adsorbent to remove COD and TDS present in a dairy industry wastewater.

INTRODUCTION

The dairy industry is a major source of food processing wastewater. Dairy industry wastewater generally contains a high organic load, due to the presence of diluted milk/milk products, and contains significant quantities of cleaning and sanitizing compounds. The dairy industry in India is generated 6-10 litres of wastewater per litre of the milk processed. Wastewater management in the dairy industry is well documented, but wastewater production and disposal remain a problematic issue. In recent years, increasing awareness of water pollution and its far reaching effects has prompted concerted efforts towards pollution abatement. Earlier works revealed the suitability of variety of agro-based materials like moringa oleifera seed, corncob, groundnut husk, rice husk, tea leaves carbon, saw dust to treat the industrial wastewater. The bioremediation studies also done by several researchers to mitigate the industrial contaminants. The present study focused to determine an effect of Eucalyptus wood saw dust powder, a cheap agro-based product, as an adsorbent for removing chemical oxygen demand (COD) and total dissolved solids (TDS) present in a dairy industry wastewater at different dosages, different rapid mixing contact time and different slow mixing contact time. Also, the experimental values of dairy industry wastewater were simulated with the model and the same were compared for reproducibility.

MATERIALS AND METHODS

Adsorbent Preparation

Eucalyptus wood saw dust was washed with tap water and then deionized water to remove particulate material from their surface. After that, they were dried in sun. The dried materials were ground using pulverizer. The ground Eucalyptus wood saw dust was then sieved through 200 microns sieve to get uniform geometrical size for use. Then, they were dried in an oven at 100 °C for 3 h. The dried Eucalyptus wood saw dust powder was kept in air tight box at 4 °C for the experimental use in later stage.

Collection and Analysis of Sample

For the present study, the wastewater samples were collected from dairy industry, Chennai, Tamil Nadu with the help of air tight sterilized bottles, took to the laboratory and then they were stored for analyzing COD and TDS concentrations in a dairy industry wastewater. The initial COD and TDS values for a dairy industry wastewater were determined as per standard procedure given by APHA (2005) and found to be 8320 mg/l and 3085 mg/l respectively. The Phipps and Bird jar test apparatus was used for evaluating and optimizing the coagulation process. This method consists of batch experiments involving rapid mixing at the rotational speed of 100 rpm and slow mixing at the rotational speed of 20 rpm for enhancing flocculation process. The sedimentation is allowed for a period of 60 min. Dairy industry wastewater was filled in four glass beakers of 1 litre capacity and was kept in the Phipps and Bird jar test apparatus for agitation.

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The experiments were performed at different dosages (for Eucalyptus wood saw dust powders varying from 20 to 140 g/l at an interval of 20 g/l), different rapid mixing contact time (varying from 5 to 30 min. at an interval of 5 min.) and different slow mixing contact time (varying from 10 to 50 min. at an interval of 10min.). The top clear wastewater from each beaker after settlement of 60 min. was collected and further, filtered with Whatman filter paper for removing impurities and then the cleared wastewater was taken for analyzing COD and TDS as per standard procedure given by APHA (2005). The adsorption removal percentage of COD and TDS in a dairy industry wastewater by Eucalyptus wood saw dust powder was calculated by using the following formula:

$$\text{Percentage Removal} = \frac{(C_1 - C_2)}{C_1} \times 100 \quad (1)$$

in which C_1 is the concentration of COD in mg/l and TDS in mg/l before treatment with Eucalyptus wood saw dust powder and C_2 is the concentration of COD in mg/l and TDS in mg/l after treatment with Eucalyptus wood saw dust powder.

RESULTS AND DISCUSSION

Effect of Rapid Mixing Contact Time

Fig.1 shows the effect of rapid mixing contact time on removal of COD and TDS in a dairy industry wastewater with Eucalyptus wood saw dust powder as an adsorbent of 20 g/l and a slow mixing contact time of 10 min. against the rapid mixing contact time of 5, 10, 15, 20, 25, and 30 min.

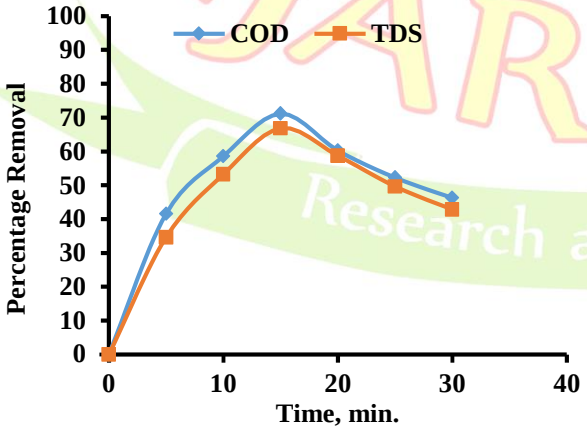
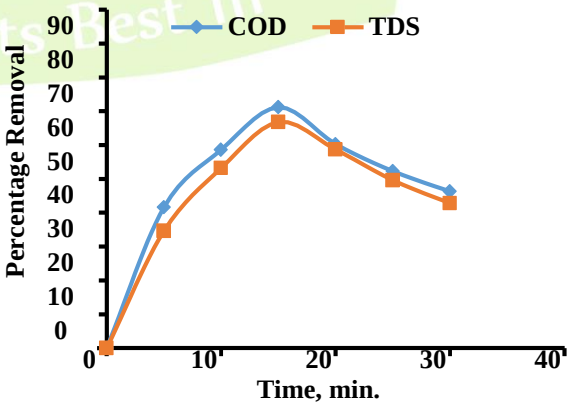


Fig.1 Effect of Rapid Mixing Contact Time by Eucalyptus wood saw dust

From Fig.1, it may be observed that up to 15 min. rapid mixing contact time, the reduction in concentration of COD and TDS increase, beyond which they decrease. The percentage reduction in concentration of COD for a rapid mixing contact time of 5, 10, 15, 20, 25, and 30 min. were found to be 41.6, 58.6, 71.2, 60.3, 52.3 and 46.3 % respectively. Similarly, the percentage reduction in concentration of TDS for a rapid mixing Dairy industry wastewater generally contains a high organic load, due to the presence of diluted milk/milk products, and contains significant quantities of cleaning and sanitizing compounds. The dairy industry in India is generated 6-10 litres of wastewater per litre of the milk processed. Wastewater management in the dairy industry is well documented, but wastewater production and disposal remain a problematic issue. In recent years, increasing awareness of water pollution and its far reaching effects has prompted concerted efforts towards pollution abatement. Earlier works revealed the suitability of variety of agro-based materials like moringa oleifera seed, corncob, groundnut husk, rice husk, tea leaves carbon, saw dust to treat the industrial wastewater. The bioremediation studies also done by several researchers to mitigate the industrial contaminants. The present study focused to determine an effect of Eucalyptus wood saw dust powder, a cheap agro-based product, as an adsorbent for removing chemical oxygen demand (COD) and total dissolved solids (TDS) present in a dairy industry wastewater at different dosages, different rapid mixing.

TDS in mg/l before treatment with Eucalyptus wood saw dust powder and C_2 is the concentration of COD in mg/l and TDS in mg/l after treatment with Eucalyptus wood saw dust powder.

Thus, an optimum rapid mixing contact time leading to maximum COD and TDS removal is 15 min. (Fig.1). Further, an optimum rapid mixing contact time (15 min.), at which maximum removal of COD and TDS in a dairy industry wastewater was 5923.84mg/l and 2060.78 mg/l respectively and an optimum rapid mixing contact time (15 min.), which is corresponding to the lowest residual COD and TDS obtained for a dairy industry wastewater was 2396.16mg/l and 1024.22mg/l respectively.



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contact time of 5, 10, 15, 20, 25, and 30 min. were found to be 34.6, 53.2, 66.8, 58.7, 49.6 and 42.8 % respectively. Thus, an optimum rapid mixing contact time leading to maximum COD and TDS removal is 15 min. (Fig.1). Further, an optimum rapid mixing contact time (15 min.), at which maximum removal of COD and TDS in a dairy industry wastewater was 5923.84mg/l and 2060.78 mg/l respectively and an optimum rapid mixing contact time (15 min.), which is corresponding to the lowest residual COD and TDS obtained for a dairy industry wastewater was 2396.16mg/l and 1024.22mg/l respectively.

Effect of Slow Mixing Contact Time

Fig.2 shows effect of slow mixing contact time on removal of COD and TDS in a dairy industry wastewater with a Eucalyptus wood saw dust powder as an adsorbent of 20 g/l and an optimum rapid mixing contact time of 15 min. against the slow mixing contact time of 10, 20, 30, 40 and 50 min.

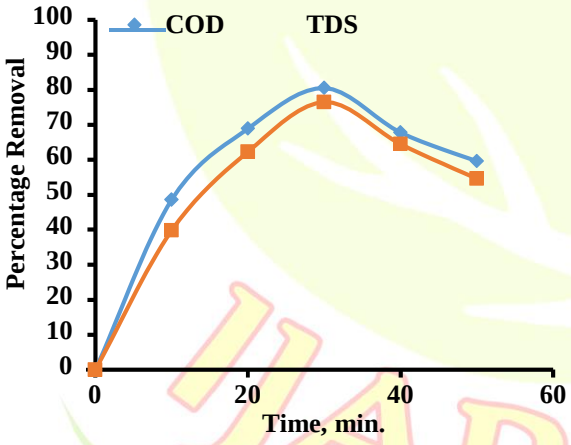

Fig.2 Effect of Slow Mixing Contact Time by Eucalyptus wood saw dust

It can be observed from Fig.2 that up to 30 min. slow mixing contact time, the reduction in concentration of COD and TDS increase and beyond which they decrease. The percentage reduction in concentration of COD for a slow mixing contact time of 10, 20, 30, 40 and 50 min. were found to be 48.6, 68.9, 80.5, 67.8 and 59.6 % respectively. Similarly, the percentage reduction in concentration of TDS for a slow mixing contact time of 10, 20, 30, 40 and 50 min. were found to 39.8, 62.3, 78.6, 64.5 and 54.6 % respectively. Thus an optimum slow mixing contact time for which the maximum COD and TDS removal occurs is 30 min. (Fig.2). Further, an optimum slow mixing contact time (30 min.) at which maximum removal of COD and TDS in a dairy industry wastewater was 6697.6 mg/l and 2424.81mg/l respectively and an optimum slow mixing contact time (30 min.), which is corresponding to the lowest residual COD and TDS obtained for a dairy industry wastewater was 1622.4mg/l and 660.19mg/l respectively.

contact time of 5, 10, 15, 20, 25, and 30 min. were found to be 34.6, 53.2, 66.8, 58.7, 49.6 and 42.8 % respectively. Thus, an optimum rapid mixing contact time leading to maximum COD and TDS removal is 15 min. (Fig.1). Further, an optimum rapid mixing contact time (15 min.), at which maximum removal of COD and TDS in a dairy industry wastewater was 5923.84mg/l and 2060.78 mg/l respectively and an optimum rapid mixing contact time (15 min.), which is corresponding to the lowest residual COD and TDS obtained for a dairy industry wastewater was 2396.16mg/l and 1024.22mg/l respectively.
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The first order rate constant was calculated from the slope of the straight line by least square fit (Fig.4). The rate constant k_1 and R^2 values for the parameters COD and TDS in a diary indsutry wastewater (Fig.4) at an optimum rapid mixing contact time of 15 min., an optimum slow mixing contact time of 30 min. and an optimum adsorbent dosage of 100 g/l are presented

TDS with different dosages, different rapid mixing contact time and different slow mixing contact time. The results showed that maximum percentage removal was obtained at an optimum dosage of 100 g/l (*Eucalyptus wood saw dust* powder), an optimum rapid mixing contact time of 15 min. and an optimum slow mixing contact time of 30 min. The results indicated that the *Eucalyptus wood saw dust* is more beneficial in treating a dairy industry wastewater as adsorbent. Also, the experimental values of dairy industry wastewater were validated with the first order kinetic model and the model study concluded that the developed model is having reproducing capacity of the experimental data obtained from the dairy industry wastewater.

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Effect of Eucalyptus wood saw dustDosage

Fig.3 shows the effect of *Eucalyptus wood saw dust* powder as an adsorbent on removal of COD and TDS in a dairy industry wastewater with an optimum rapid mixing contact time of 15 min. and an optimum slow mixing contact time of 30 min. against the different adsorbent dosage of 20, 40, 60, 80, 100, 120 and 140 g/l.

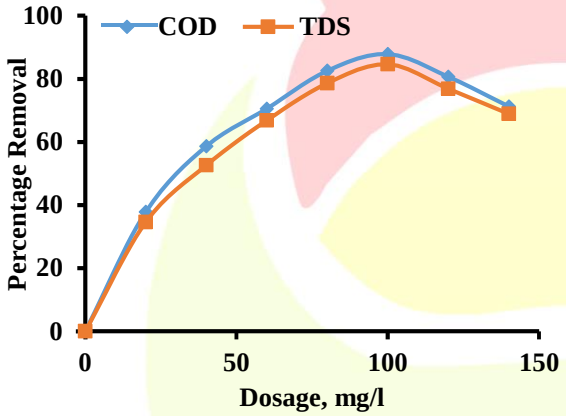

Fig.3 Effect of Adsorbent Dosage by *Eucalyptus wood saw dust*

From Fig.3, it may be observed that up to 100 g/l of *Eucalyptus wood saw dust* powder dosage, reduction in concentration of COD and TDS in a dairy industry wastewater increase, beyond which they decrease. The percentage reduction in concentration of COD for a *Eucalyptus wood saw dust* powder dosage of 20, 40, 60, 80, 100, 120, 140 g/l, respectively were found to 37.8, 58.6, 70.5, 82.5, 87.8, 80.6 and 71.2 % respectively. Similarly, the percentage reduction in concentration of TDS for the dosage of 20, 40, 60, 80, 100, 120, 140 g/l, respectively was found to be 34.6, 52.6, 66.8, 78.6, 84.6, 76.8 and 68.9 % respectively. Thus, an optimum dosage for which the maximum removal of COD and TDS occurred at 100 g/l (Fig.3). Further, an optimum dosage (100 g/l) at which maximum removal of COD and TDS in a diary industry wastewater was 7304.96mg/l and 2609.91mg/l respectively and an optimum dosage (100 g/l), which is corresponding to the lowest residual COD and TDS obtained for a dairy industry wastewater was 1015.04mg/l and 475.09mg/l respectively.

Model Development

In this study, the experimental data are fitted with first order kinetic model. The first order model is given by

$$-\frac{dC}{dt} = k\,C \qquad (2)$$

$$\frac{1}{}$$ on integration the Eqn.2 becomes

where C_0 is the initial concentration of COD and TDS in mg/l, C is the concentration of COD and TDS in mg/l at time 't', 't' is degradation time, days and 'k_1' is the first order rate constant, $days^{-1}$. The negative sign indicates as time increases the rate constant decreases.

The first order rate constant was calculated from the slope of the straight line by least square fit (Fig.4). The rate constant k_1 and R^2 values for the parameters COD and TDS in a diary indsutry wastewater (Fig.4) at an optimum rapid mixing contact time of 15 min., an optimum slow mixing contact time of 30 min. and an optimum adsorbent dosage of 100 g/l are presented in Table 1.

Table 1: The kinetic parameter and the regression equation for the parameters COD and TDS in a dairy industry effluent at an optimum rapid mixing contact time of 15 min., an optimum slow mixing contact time of 30 min. and an optimum adsorbent dosage of 100 g/l

Sl. No.	Parameters	k_1	R^2
1	COD, mg/l	0.0399	0.9881
2	TDS, mg/l	0.0467	0.9929

From the Table 1, it may be observed that the R^2 value for COD and TDS respectively was 0.9881 and 0.9929. This R^2 value indicates that the ability of the first order kinetic model in describing the kinetics of the present work. In other words, the model is fitted well with the experimental data for both COD and TDS parameters. Thus, from the kinetic studies, it was found that the reduction of COD and TDS in a dairy industrywastewater follows the first order kinetic model.

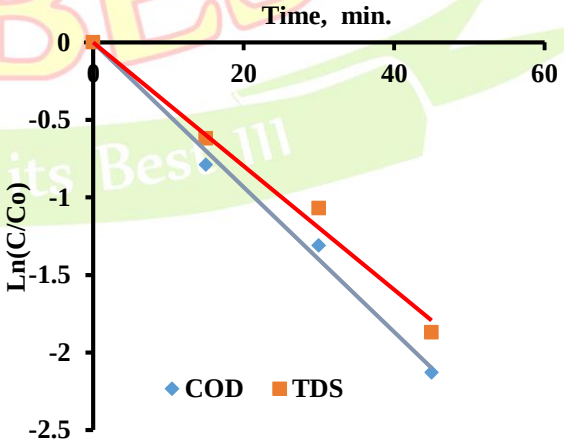

Fig.4 First order Kinetic Model for the parameters COD and TDS in a dairy industry effluent at an optimum rapid mixing contact time of 15 min., an optimum slow mixing contact time of 30 min. and an optimum adsorbent dosage of 100 g/l

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CONCLUSION

In the present study, experiments were conducted to find out the suitability of *Eucalyptus wood saw dust* powder as an adsorbent for removing COD and TDS present in a dairy industry wastewater. The experiments were conducted for removing COD and TDS with different dosages, different rapid mixing contact time and different slow mixing contact time. The results showed that maximum percentage removal was obtained at an optimum dosage of 100 g/l (*Eucalyptus wood saw dust* powder), an optimum rapid mixing contact time of 15 min. and an optimum slow mixing contact time of 30 min. The results indicated that the *Eucalyptus wood saw dust* is more beneficial in treating a dairy industry wastewater as adsorbent. Also, the experimental values of dairy industry wastewater were validated with the first order kinetic model and the model study concluded that the developed model is having reproducing capacity of the experimental data obtained from the dairy industry wastewater.

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