



Comparative Studies on Application of Various Adsorbents in Fire Industry Waste Water

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ABSTRACT: In present study deals with an attempt is made to study the feasibility of natural adsorbent like Cashew Nut Shell, Date Seeds, Orange Peel and Coir pith on the reduction of COD of textile waste water. The sample textile waste water was collected from the textile industry located at Salem. The collected waste water was kept as stock solution and the sample used for the studies was prepared by diluting the stock solution for avoiding fault results. Four different natural adsorbents are selected based on the literature reviewed in the previous chapter. Cashew nut Shell, Date seeds, Orange peel and the Coir Pith are selected as natural adsorbent for this present study. Batch studies were carried out with the selected adsorbents of cashew nut shell, date seed, coir pith and orange peel to analyze the COD reduction of each adsorbent, to determine the effective adsorbent out of the selected four adsorbents and to optimize the parameter affects the adsorption process. The performance of the four selected adsorbent of Cashew nut shell, date Seed, Coir Pith and the Orange Peel was evaluated in terms of the COD reduction after specified contact time in this studies. Then batch studies to determine effective adsorbent was carried by the initial concentration of the COD of the textile waste water is kept same as initial concentration of the dye. 10 g of each adsorbent was added to the conical flask. After 20 minutes contact time the supernatant liquid from each conical flask was collected through syringes in the time interval of 10 minutes. The collected sample was analysed for the COD concentration using standard procedure. The highest Percentage removal shown by Date seed was 67%, the highest Percentage removal shown by Cashew nut Shell was 45%, the highest Percentage removal shown by Coir Pith was 33%, and the highest Percentage removal shown by Orange Peel was 23%. From the graph plotted above it is clear the date seed shows highest percentage of COD removal followed Cashew nut shell. Lowest COD reduction was shown by the Orange Peel adsorbent. So Date seed can be used as an effective adsorbent for the reduction of COD in the treatment of textile waste water.

KEYWORDS: Adsorption, adsorbent, COD reduction.

I. INTRODUCTION

Water is an indispensable natural resource essential for all living matter. Without water no living matter such as human beings, animals, plants can survive. Water occupies about 71% of the earth's surface and the amount of water is about 1400 million cubic meter. But 97% of this water is in the oceans and saline lakes which is useless for any purpose.¹ Only 3% of the total water, is fresh water, of this fresh water nearly 80% exists as snow in the polar region and only 20% of this is available for human consumption either for the domestic use or for agricultural purposes. The fresh water is available in rivers lakes, ponds and other sources.^{2,3} It exists as a liquid between 0°C and 100°C. It has very high specific heat and so warms up and cools down slowly. It is a solvent for many nutrients, which are essential for life. Because of high surface tension water is easily absorbed by plants and reaches the top of the trees from the roots. Water freezes into ice, which is lighter than liquid water and so it floats on the surface. The water under the ice remains a liquid enabling millions of aquatic organisms to survive.⁴ These are some of the qualities of water which helps all living organisms to survive and grow. Animals and plants have about 60% of water in their bodies. So water is rightly called the "elixir of life".

Water pollution has become a serious problem around the world. Many industries such as textile, paper, paint, pharmaceuticals, food, leather, cosmetics, tannery, printing and plastics used wide varieties of dye in order to color their product.⁵ Among those industries, textiles industry ranked first in the usage of dyes for coloration of fiber. Considering both volumes discharged and effluent composition, wastewater from the textile industry was declared as one of the major sources of wastewater.^{7,8}



At present, several methods have been developed to treat textile wastewater but they cannot be used individually because this wastewater has high salinity, color and non-biodegradable organics.⁶In coagulation process, large amount of sludge is created which may become a pollutant itself and increase the treatment cost. Oxidation process such as ozonation effectively decolorizes almost all dyes except disperse dyes but does not remove COD effectively. Electrochemical oxidation produce pollutants which increases the treatment cost.^{8,9} There is no single process capable of adequate treatment mainly due to the complex nature of these effluents. The use of combined processes has been suggested recently to overcome the disadvantage of individual unit processes. Most of the existing processes include an initial step of activated sludge treatment to remove the organic matter followed by oxidation, UV radiation, membrane separation, or adsorption. Adsorption is an effective method of lowering the concentration of dissolved dyes in the effluent resulting in color removal. Other means of dye removal such as chemical oxidation, coagulation and reverse osmosis are generally not feasible due to economic considerations.^{10,11}

The adsorption process is one of the most efficient methods to remove dyes from effluent. The process of adsorption has an edge over the other methods due to its sludge free clean operation and complete removal of dyes even from dilute solution. Natural adsorbents are the most widely used adsorbent because of its extended surface area, micro porous structure, high adsorption capacity and high degree of reactivity.^{12,13,15} There is a growing interest in using low cost commercially available materials for the adsorption of COD. A wide variety of low cost materials such as agricultural by product, waste coir pith, Indian rosewood sawdust, pine sawdust, banana pith, rice husk, orange peel, industrial solid waste such as Fe(III)/Cr(III) hydroxide and silica are used as low cost alternatives to activated carbon.¹⁴

The case study is on wastewater from one of a textile mill in Salem. The mill is manufacturing cotton and polyester/cotton blend woven fabric. The production consists of desizing, scouring, bleaching, mercerization, dyeing and finishing.¹⁶The wastewater is then neutralized and treated in anaerobic pond with retention of 10-15 days. The wastewater is then treated in activated sludge treatment plant. The wastewater sample for this study was taken after the activated sludge treatment plant. The range of COD concentration of wastewater is 48,000mg/L. It has been reported that usage of natural adsorbents can effectively remove COD of domestic waste landfill leachate. Hence this research was undertaken to investigate the suitability of natural adsorbents as alternative and cheaper filtering medium capable of removing COD from textile plant waste water.¹⁷

II. MATERIALS AND METHODOLOGY

2.1 Preparation of Adsorbents:

Four different natural adsorbents are selected based on the literature reviewed in the previous chapter. Cashew nut Shell, Date seeds, Orange peel and the Coir Pith are selected as natural adsorbent for this present study. The preparation of these natural adsorbent is explained below

2.1.1 Cashew Nut Shell

Cashew nut shells collected from Pudukkottai District, Tamilnadu, India, is used as an adsorbent. This natural waste was thoroughly rinsed with water to remove dust and the soluble material and was allowed to dry at room temperature. Then it is dried in hot air oven at a temperature of 105°C for one hour. After drying the cashew nut shell is crushed into powder and sieved through the 100 μ size sieves.

2.1.2 Date Seed

Date Seed powder is used for adsorption study. Date seeds were dried and grounded into small particles. Then they were boiled with distilled water to remove water-soluble impurities. The supernatant solution was filtered off. This process was repeated several times until a clear supernatant solution was obtained. The completely dried powder free from water-soluble impurities was then used for preparation of Date Seed powder. Date Seed powder was prepared by drying the date seeds at 105°C for one hour in hot air oven. Then Date Seed are grinded into very fine powder. After sieving through a 100 μ size the date seed powder is used as an adsorbent.

2.1.3 Orange Peel

Orange peels are collected from the local areas. The peels are dried at temperature of 105°C for 48 hrs to remove moisture content. After drying process, peels were grinded to fine powder and sieved through 600 μ size.



2.1.4 Coir Pith

Coconut fibers were collected from nearby shop and were washed thoroughly with distilled water and dried at 55°C for four hours in oven. Some portion of the fibre were grounded and sieved to the particle size of 150 μ m and the rest of the fibre were cut into the filament form with uniform length at 2.0 cm.

III. PERFORMANCE EVALUATION STUDIES

a. Performance Evaluation of Cashew Nut Shell

Cashew nut shells collected from Pudukkottai District, Tamilnadu, India, is used as an adsorbent. This natural waste was thoroughly rinsed with water to remove dust and the soluble material and was allowed to dry at room temperature. Then it is dried in hot air oven at a temperature of 105°C for one hour. After drying the cashew nut shell is crushed into powder and sieved through the 100 μ m size sieves. The sample textile wastewater of known COD concentration were taken in ten 250 ml conical flask. The prepared adsorbent were added to each conical flask the dosage of 1,2,3,4,5,6,7,8,9,10 grams. The solution was stirred in a shaker for 20 minutes and allowed to react. After 20 minutes contact time the supernatant liquid from each conical flask was collected through syringes in the time interval of 10 minutes. The collected sample was analysed for the COD concentration using standard procedure.

b. Performance Evaluation of Date Seed

Date Seed powder is used for adsorption study. Date seeds were dried and grounded into small particles. Then they were boiled with distilled water to remove water-soluble impurities. The supernatant solution was filtered off. This process was repeated several times until a clear supernatant solution was obtained. The completely dried powder free from water-soluble impurities was then used for preparation of Date Seed powder. Date Seed powder was prepared by drying the date seeds at 105°C for one hour in hot air oven. Then Date Seed are grinded into very fine powder. After sieving through a 100 μ m size the date seed powder is used as an adsorbent. The sample textile wastewater of known COD concentration were taken in ten 250 ml conical flask. The prepared adsorbent were added to each conical flask the dosage of 1,2,3,4,5,6,7,8,9,10 grams. The solution was stirred in a shaker for 20 minutes and allowed to react. after 20 minutes contact time the supernatant liquid from each conical flask was collected through syringes in the time interval of 10 minutes. the collected sample was analysed for the COD concentration using standard procedure.

c. Performance Evaluation of Coir Pith

Coconut fibers were collected from nearby shop and were washed thoroughly with distilled water and dried at 55°C for four hours in oven. Some portion of the fibre were grounded and sieved to the particle size of 150 μ m and the rest of the fibre were cut into the filament form with uniform length at 2.0 cm. The sample textile wastewater of known COD concentration were taken in ten 250 ml conical flask. The prepared adsorbent were added to each conical flask the dosage of 1,2,3,4,5,6,7,8,9,10 grams. The solution was stirred in a shaker for 20 minutes and allowed to react. after 20 minutes contact time the supernatant liquid from each conical flask was collected through syringes in the time interval of 10 minutes. the collected sample was analysed for the COD concentration using standard procedure.

d. Performance Evaluation of Orange Peel

Orange peels are collected from the local areas. The peels are dried at temperature of 105°C for 48 hrs to remove moisture content. After drying process, peels were grinded to fine powder and sieved through 600 μ m size. The sample textile wastewater of known COD concentration were taken in ten 250 ml conical flask. The prepared adsorbent were added to each conical flask the dosage of 1,2,3,4,5,6,7,8,9,10 grams. The solution was stirred in a shaker for 20 minutes and allowed to react. After 20 minutes contact time the supernatant liquid from each conical flask was collected through syringes in the time interval of 10 minutes. The collected sample was analysed for the COD concentration using standard procedure.

IV. RESULT AND DISCUSSION

Batch studies were carried out with the selected adsorbents of cashew net shell, date seed, coir pith and orange peel to analyse the COD reduction of each adsorbent, to determine the effective adsorbent out of the selected four adsorbents and to optimize the parameter affects the adsorption process.

4.1 Performance evaluation studies

The performance of the four selected adsorbent of Cashew nut shell, date Seed, Coir Pith and the Orange Peel was evaluated in terms of the COD reduction after specified contact time in this studies.



4.1a. Performance Evaluation of Cashew Nut Shell

Cashew nut shells collected from Pudukkottai District, Tamilnadu, India, is used as an adsorbent. This natural waste was thoroughly rinsed with water to remove dust and the soluble material and was allowed to dry at room temperature. Then it is dried in hot air oven at a temperature of 105°C for one hour. After drying the cashew nut shell is crushed into powder and sieved through the 100µ size sieves. The sample textile wastewater of known COD concentration were taken in ten 250 ml conical flask. The prepared adsorbent were added to each conical flask the dosage of 1,2,3,4,5,6,7,8,9,10 grams. The solution was stirred in a shaker for 20 minutes and allowed to react. after 20 minutes contact time the supernatant liquid from each conical flask was collected through syringes in the time interval of 10 minutes. The collected sample was analysed for the COD concentration using standard procedure. The results obtained through the COD analysis were tabulated in table no 4.1

Table no 4.1 COD Reduction of Cashew nut Shell at different time for different adsorbent dosage.

S.no	Dosage of adsorbent (gm)	Remaining COD in Waste Water (mg/L)						
		Contact Time						
		0 min	10 min	20 min	30 min	40 min	50 min	60 min
1	1	64000	64000	56000	56000	52000	44000	36000
2	2	64000	64000	56000	56000	52000	40000	36000
3	3	64000	60000	56000	52000	48000	40000	32000
4	4	60000	60000	56000	52000	48000	36000	32000
5	5	60000	56000	52000	52000	44000	36000	28000
6	6	60000	56000	52000	48000	44000	36000	28000
7	7	60000	56000	48000	48000	44000	32000	24000
8	8	60000	56000	48000	48000	40000	32000	24000
9	9	60000	52000	48000	44000	40000	32000	20000
10	10	60000	52000	48000	44000	36000	28000	20000

A graph was plotted for the remaining COD in the waste water between the different adsorbent dosage and contact time for Cashew Nut Shell adsorbent as shown in Fig 4.1.

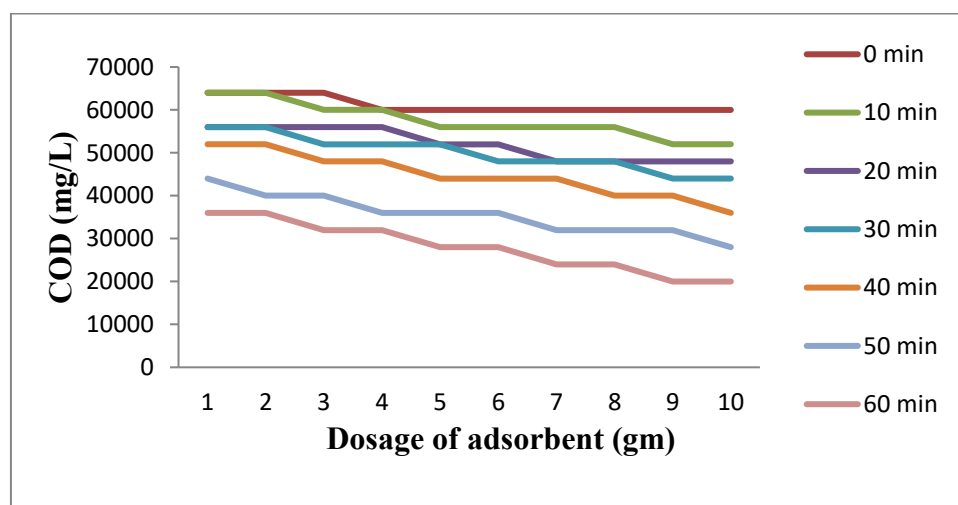


Fig 4.1 COD Reduction of Cashew nut Shell at different time for different adsorbent dosage.



4.1.b. Performance Evaluation of Date Seed

Date Seed powder is used for adsorption study. Date seeds were dried and grounded into small particles. Then they were boiled with distilled water to remove water-soluble impurities. The supernatant solution was filtered off. This process was repeated several times until a clear supernatant solution was obtained. The completely dried powder free from water-soluble impurities was then used for preparation of Date Seed powder. Date Seed powder was prepared by drying the date seeds at 105°C for one hour in hot air oven. Then Date Seed are grinded into very fine powder. After sieving through a 100µ size the date seed powder is used as an adsorbent. The sample textile wastewater of known COD concentration were taken in ten 250 ml conical flask. The prepared adsorbent were added to each conical flask the dosage of 1,2,3,4,5,6,7,8,9,10 grams. The solution was stirred in a shaker for 20 minutes and allowed to react. after 20 minutes contact time the supernatant liquid from each conical flask was collected through syringes in the time interval of 10 minutes. The collected sample was analysed for the COD concentration using standard procedure. The results obtained through the COD analysis were tabulated in table no 4.2

Table no 4.2 COD Reduction of Date Seed at different time for different adsorbent dosage.

S.no	Dosage of adsorbent(gm)	Remaining COD in Waste Water (mg/L)						
		Contact Time						
		0 min	10 min	20 min	30 min	40 min	50 min	60 min
1	1	64000	56000	56000	52000	48000	48000	36000
2	2	64000	56000	56000	52000	44000	44000	32000
3	3	64000	56000	56000	48000	44000	40000	32000
4	4	64000	56000	52000	48000	44000	40000	28000
5	5	60000	56000	52000	48000	40000	36000	28000
6	6	60000	56000	52000	52000	40000	36000	28000
7	7	60000	54000	48000	48000	40000	32000	24000
8	8	60000	54000	48000	44000	40000	32000	24000
9	9	60000	54000	48000	44000	36000	32000	20000
10	10	56000	54000	48000	44000	36000	28000	20000

A graph was plotted for the remaining COD in the waste water between the different adsorbent dosage and contact time for Date Seed adsorbent as shown in Fig 4.1.

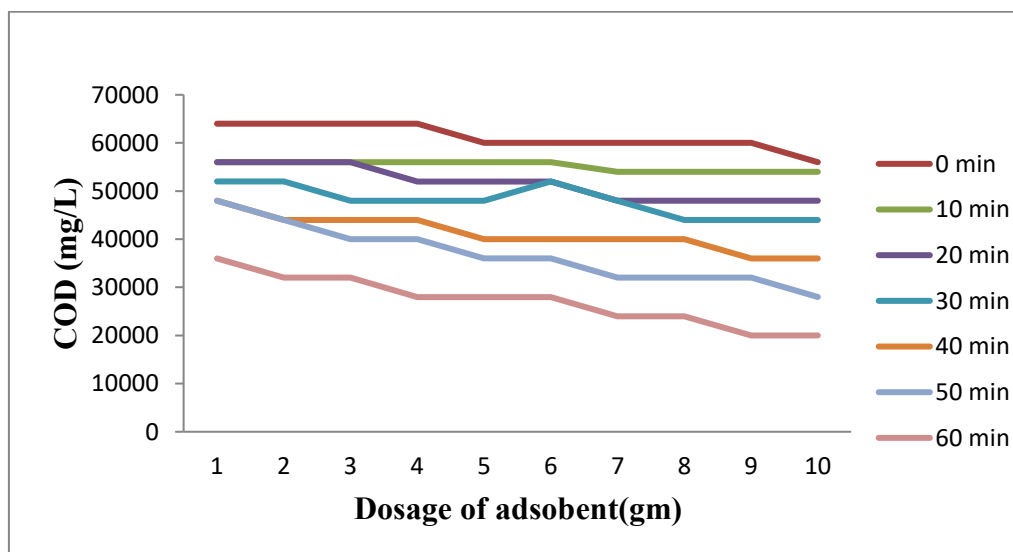


Fig 4.2 COD Reduction of Date Seed at different time for different adsorbent dosage.



4.1.c. Performance Evaluation of Coir Pith

Coconut fibers was collected from nearby shop and were washed thoroughly with distilled water and dried at 55°C for four hours in oven. Some portion of the fibre were grounded and sieved to the particle size of 150 mm and the rest of the fibre were cut into the filament form with uniform length at 2.0 cm. The sample textile wastewater of known COD concentration were taken in ten 250 ml conical flask. The prepared adsorbent were added to each conical flask the dosage of 1,2,3,4,5,6,7,8,9,10 grams. The solution was stirred in a shaker for 20 minutes and allowed to react. After 20 minutes contact time the supernatant liquid from each conical flask was collected through syringes in the time interval of 10 minutes. The collected sample was analysed for the COD concentration using standard procedure. The results obtained through the COD analysis were tabulated in table no 4.3

Table no 4.3 COD Reduction of Coir Pith at different time for different adsorbent dosage.

S.no	Dosage of adsorbent (gm)	Remaining COD in Waste Water (mg/L)						
		Contact Time						
		0 min	10 min	20 min	30 min	40 min	50 min	60 min
1	1	64000	64000	64000	60000	56000	52000	44000
2	2	64000	64000	60000	60000	56000	52000	44000
3	3	64000	60000	60000	60000	56000	52000	40000
4	4	64000	60000	56000	60000	52000	48000	40000
5	5	64000	60000	56000	56000	52000	48000	40000
6	6	60000	60000	56000	56000	52000	48000	36000
7	7	60000	56000	52000	56000	52000	48000	36000
8	8	60000	56000	52000	52000	52000	44000	36000
9	9	60000	56000	52000	52000	48000	44000	32000
10	10	60000	56000	48000	52000	48000	44000	32000

A graph was plotted for the remaining COD in the waste water between the different adsorbent dosage and contact time for Coir Pith adsorbent as shown in Fig 4.3.

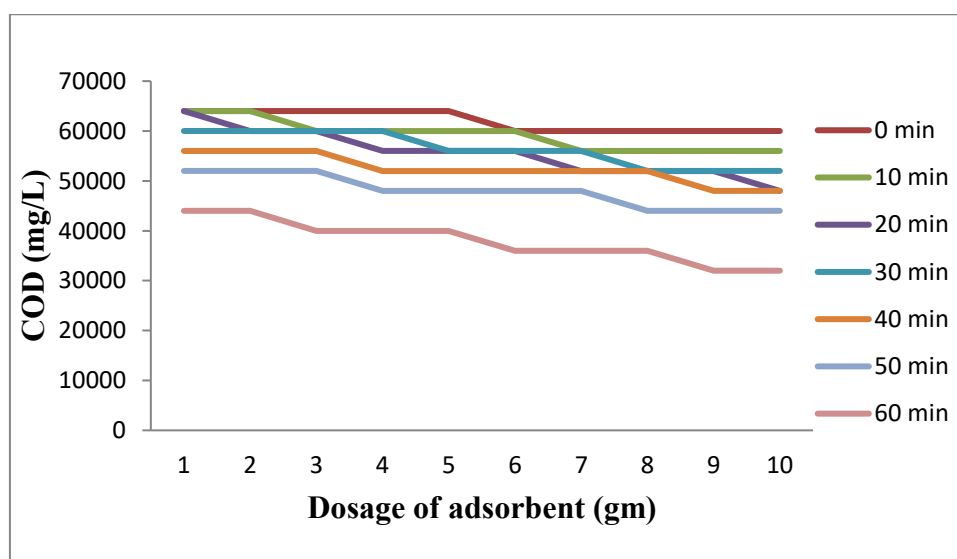


Fig 4.3 COD Reduction of Coir Pith at different time for different adsorbent dosage.



4.1.d .Performance Evaluation of Orange Peel

Orange peels are collected from the local areas. The peels are dried at temperature of 105°C for 48 hrs to remove moisture content. After drying process, peels were grinded to fine powder and sieved through 600µ size. The sample textile wastewater of known COD concentration were taken in ten 250 ml conical flask. The prepared adsorbent were added to each conical flask the dosage of 1,2,3,4,5,6,7,8,9,10 grams. The solution was stirred in a shaker for 20 minutes and allowed to react. After 20 minutes contact time the supernatant liquid from each conical flask was collected through syringes in the time interval of 10 minutes. The collected sample was analysed for the COD concentration using standard procedure. The results obtained through the COD analysis were tabulated in table no 4.4

Table no 4.4 COD Reduction of Orange Peel at different time for different adsorbent dosage.

S.no	Dosage of adsorbent (gm)	Remaining COD in Waste Water (mg/L)						
		Contact Time						
		0 min	10 min	20 min	30 min	40 min	50 min	60 min
1	1	64000	64000	60000	60000	56000	52000	48000
2	2	64000	60000	60000	56000	52000	52000	48000
3	3	64000	60000	60000	56000	52000	52000	44000
4	4	60000	60000	60000	56000	52000	52000	44000
5	5	60000	60000	56000	56000	48000	48000	40000
6	6	60000	60000	56000	52000	48000	48000	40000
7	7	56000	56000	56000	52000	44000	48000	36000
8	8	56000	56000	56000	52000	44000	44000	36000
9	9	56000	56000	52000	48000	44000	40000	32000
10	10	56000	56000	52000	48000	44000	40000	32000

A graph was plotted for the remaining COD in the waste water between the different adsorbent dosage and contact time for Orange Peel adsorbent as shown in Fig 4.4.

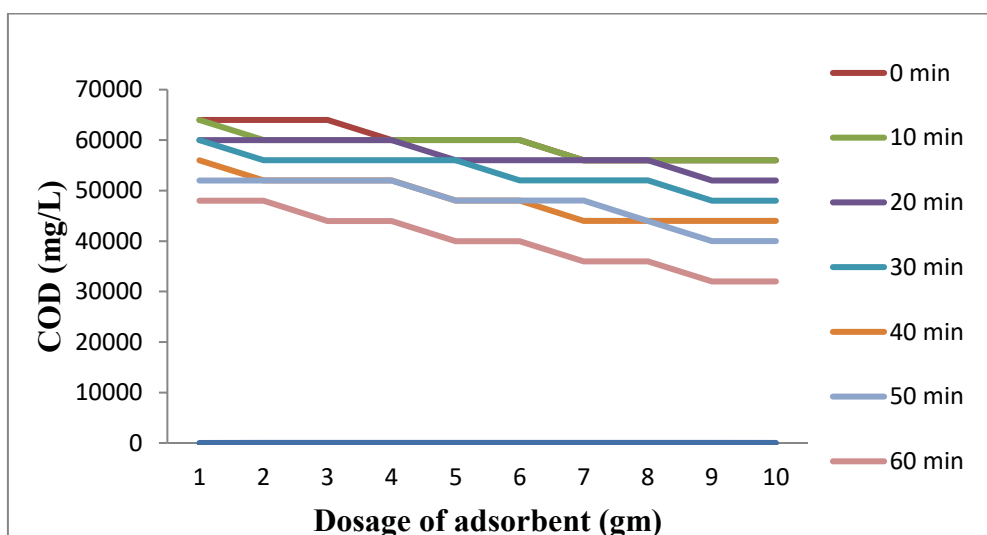


Fig 4.4 COD Reduction of Orange Peel at different time for different adsorbent dosage.

4.2 Determination of effective adsorbent

The sample waste water was taken in four 250 ml conical flask. The initial concentration of the COD of the textile waste water is kept same as initial concentration of the dye. 10 g of cashew net shell adsorbent is added to the first conical flask. 10 g of Date Seed adsorbent is added to the Second conical flask. 10 g of Coir Pith adsorbent is added to



the third conical flask and 10 g of Orange Peel adsorbent is added to the fourth conical flask. 60 minute contact time was given after the adsorbent dosage were added to each conical flask. After 60 minutes contact time the supernatant liquid from each conical flask was collected through syringes in the time interval of 10 minutes. The collected sample was analysed for the COD concentration using standard procedure. The results obtained through the COD analysis were tabulated in table no 4.5.

Table no 4.5 COD reduction of the various adsorbent at various time intervals for the adsorbent dosage of 10 gram.

S.No	Contact Time(min)	Adsorbent Dosage of 10g			
		Remaining COD in Waste Water (mg/L)			
		Cashew Nut Shell	Date Seed	Coir Pith	Orange Peel
1	0	60000	60000	60000	60000
2	10	52000	54000	56000	56000
3	20	48000	48000	48000	52000
4	30	44000	44000	52000	48000
5	40	36000	36000	48000	44000
6	50	28000	28000	44000	40000
7	60	20000	20000	32000	32000

A graph was plotted between the different adsorbent at a adsorbent dosage of 10 gram at various time interval for percentage reduction in COD as shown in Fig 4.5.

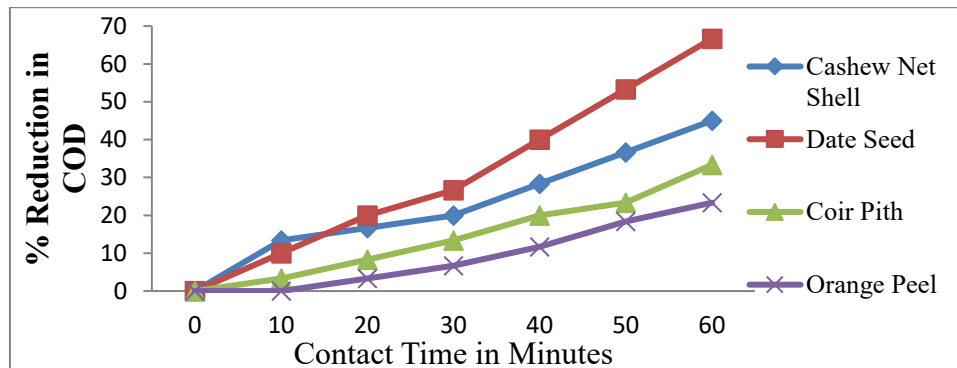


Fig 4.5 Percentage of COD reduction of various adsorbent at a adsorbent dosage of 10 grams at different time

The highest Percentage removal shown by Date seed was 67%, the highest Percentage removal shown by Cashew nut Shell was 45%, the highest Percentage removal shown by Coir Pith was 33%, and the highest Percentage removal shown by Orange Peel was 23%. From the graph plotted above it is clear the date seed shows highest percentage of COD removal followed Cashew net shell. Lowest COD reduction was shown by the Orange Peel adsorbent. So Date seed can be used as an effective adsorbent for the reduction of COD in the treatment of textile waste water.

V. CONCLUSION

In this work an attempt is made to study the feasibility of natural adsorbent like Cashew Nut Shell, Date Seeds, Orange Peel and Coir pith on the reduction of COD of textile waste water. The sample textile waste water was collected from the textile industry located at Salem. The collected waste water was kept as stock solution and the sample used for the studies was prepared by diluting the stock solution for avoiding fault results. Four different natural adsorbents are selected based on the literature reviewed in the previous chapter. Cashew nut Shell, Date seeds, Orange peel and the Coir Pith are selected as natural adsorbent for this present study. Batch studies were carried out with the selected adsorbents of cashew net shell, date seed, coir pith and orange peel to analyse the COD reduction of each adsorbent, to determine the effective adsorbent out of the selected four adsorbents and to optimize the parameter affects the



adsorption process. The performance of the four selected adsorbent of Cashew nut shell, date Seed, Coir Pith and the Orange Peel was evaluated in terms of the COD reduction after specified contact time in this studies. Then batch studies to determine effective adsorbent was carried by the initial concentration of the COD of the textile waste water is kept same as initial concentration of the dye. 10 g of each adsorbent was added to the conical flask. After 20 minutes contact time the supernatant liquid from each conical flask was collected through syringes in the time interval of 10 minutes. The collected sample was analysed for the COD concentration using standard procedure. The highest Percentage removal shown by Date seed was 67%, the highest Percentage removal shown by Cashew nut Shell was 45%, the highest Percentage removal shown by Coir Pith was 33%, and the highest Percentage removal shown by Orange Peel was 23%. From the graph plotted above it is clear the date seed shows highest percentage of COD removal followed Cashew net shell. Lowest COD reduction was shown by the Orange Peel adsorbent. So Date seed can be used as an effective adsorbent for the reduction of COD in the treatment of textile waste water.

VI. SUGGESTIONS

- Batch studies have to be carried out to optimize the parameters affecting the Adsorption of date seed in the reduction of COD from textile waste water.
- Isotherm studies have to be carried out to determine the reaction constants.

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