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Dairy Wastewater Treatment using Orange Peels as an Adsorbent

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Abstract: An experimental study is done for diary wastewater treatment using low cost adsorbent. The orange peels are adsorbent used in the present Study, the effect of pH, time of contact, adsorbent dosage, in removal of contaminants present in diary wastewater is evaluated. Experiments are conducted for different dosages using water bath shaker with slow mixing Contact time. The present study examines the use of eco-friendly adsorbent like Orange peels which is basically the discarded fruit wastes and is readily available in the market as a source for the treatment of dairy waste-water for various parameters like pH, TDS, TSS, BOD, COD, sulphates, Chlorides & Turbidity with different percentages of dosage of adsorbents so as to determine the efficiency & degree of impurity removed from the waste-water. Results showed that the pH is reduced from 8.4 to 6.2, The BOD & COD removal is observed to be 70.79% & 74.58% respectively. Turbidity and sulphates removal is observed to be 35.53% and 47.61% respectively. There is a superficial increase in the chloride and total suspended solids level by 36.47% and 80.66% respectively. Total dissolved solids removal is observed to be 86.86%. The concept of utilizing Orange peels has proved to optimize the quantity of waste in dairy wastewater and an effective, Economical & a sustainable method to treat the dairy wastewater.

Key words: *Wastewater, Natural Low Cost Adsorbents, Adsorption, Contact time, Water bath shaker.*

1. Introduction

Water is the major source to life. Thehuman body weight is made up of about 75% water. The estimation done by WHO says that about 85% of the rural population lack in potable drinking water. Due to deprived hygiene, malnutrition and polluted drinking water about 15 million infants die every year in developing countries. About 80% of diseases caused in developing countries are directly connected with polluted drinking water (WHO). If the water supply provision is made nearby for consumers in sufficient for their daily needs in turn help greatly in reducing the incidence of skin diseases, eye infections and also reduce water borne diseases, particularly if the bacteriological quality of water. However, major improvements in health conditions can be achieved by providing sufficient safe quality and quantity of water, by practicing domestic hygiene and adopting proper methods of water purification. [1]

Rapid industrialization will lead the waste effluent discharge directly into river or streams thereby causing pollution to the environment. [3]Rapid industrialization contributes large quantity of wastewater and its treatment is a difficult task. Compared to other industrials sectors, the dairy industry uses a much greater amount of water for each ton of product and produce large amount of wastewater. Due to the high contamination load of wastewater, the milk processing industries discharge raw or partially treated wastewater causing a serious environmental problem, thus appropriate treatments are required. Reducing the wastewater treatment cost is gaining importance in recent years in vision of environmental sustainability. Biological methods are usually used for the treatment of dairy wastewater due to its biodegradable nature. But these methods consumes large amount of energy and also they are very complex. It is necessary to pre-treat dairy wastewater in prior to biological treatment. [5] The effluents generated from dairy industries are the main source for pollution to the environment. The wastewater arising from dairy products contains high organic matter. The dairy industry in India generates 6-10 litres of wastewater per litre of the milk processed. [6]

The raw milk is processed into various dairy products such as milk, yogurt, cheese, butter, ghee etc. and leads to generation of large quantity of wastewater which contains very high concentration of organic substances such as proteins, carbohydrates and lipids. [7]There are many techniques in practice to treat the dairy wastewater, in the present study; an attempt has been made to examine the application of low cost adsorbents like orange peels for the treatment of wastewater from local dairy farm in Mysuru, Karnataka, India and also to evaluate the optimum dosage of adsorbent and its contact time for efficient removal of study parameters.

2. Materials and Methods

2.1 Description of MYMUL

Karnataka Milk Federation (KMF) Limited is the crest body for the dairy co-operative movement in Karnataka. KMF is the second largest dairy co-operative among all the dairy cooperatives in India. In South India, KMF stands in first position in terms of sales as well as procurement. The basic mission of the Federation is marketing Milk and it's by Products. The Brand "Nandini" is the name for Pure and Fresh milk and its products. KMF comprises of 14 Milk Unions covering the entire State, which obtain milk from Primary Dairy Cooperative Societies (DCS) and distribute milk to the patrons in various Towns/Cities/Rural markets in Karnataka. The activities on Dairy Development were taken up in the year 1975Under the World Bank aided Karnataka Dairy Development Projects. On 23.11.1976 The Mysore District Co-operative Milk Producers Societies Union Ltd was registered, having the jurisdiction extended to the entire Mysore District and Five Taluks of Mandya District.Mysore Dairy which is known as MYMUL (Mysore Milk Union Limited) having capacity of 10 TLPD started in the year 1965 under the control of the Department of Animal Husbandry and Veterinary Services of Karnataka State later in the year 1974 it was transferred to Karnataka Dairy Development Corporation. In 1980 the volume was expanded to 60 TLPD under the scheme operation flood and transferred to the KMF in 1984. On 01.06.1987 as per the Government policy the Dairy and its Centres were handed over to MYMUL. The volume was expanded to 100 TLPD under the Operation Flood II and further expanded to 180 TLPD under Perspective Plan I Programme. Later capacity was expanded to 300 TLPD.

2.2 Description of Natural Low Cost Adsorbents (Orange Peels)

Recent investigation has proved that orange peel waste is a hypothetically valuable resource that can be established into high value products such as methane. Orange peels which control the following parameters in the industrial waste water such as pH, COD, TSS (Total suspended Solids), TDS (Total suspended Solids), Chloride, Volatile acidity, Sulphate and total nitrogen, nitrate and nitrite, total phosphorous. Extremely coloured industrial wastewater is a serious environmental problem as it seriously affects the aesthetic appearance of waterways and also stops the penetration of sunlight thereby affecting the photosynthesizing plant species in the water. Orange peels could be used to remove acid dyes from industrial effluent. Orange peels are considered in this study as raw material for the production of citric acid by solid state fermentation. Orange peels contain pectin and soluble sugars as the main constituents. The orange peels contain 16.9% soluble sugars, 3.75% starch, 1.95% fats, 6.5% proteins and 10.5% hemicelluloses 10.5%. [4]

2.3 Preparation of Orange peels for experimental investigation (De –Hydrated Method)

Orange peels were collected from local markets & juice centres and washed numerous times with tap water to remove the observing dirt. Further, peels were kept open area to dry itunder sunlight for 3-4days, then kept in an Oven for 2hours at 75^0C and preserved in a desiccator for half an hour. Later the orange peels were chopped into smaller pieces and finally grinded into a fine powder, sieved through a 300μ sieve and the powder was stored in a container which is airtight before starting the experimental investigations. Figure 2.1 and 2.2 shows the orange peels and orange peel powder used for treatment process.

Fig 2.1: Orange Peels

Fig 2.2: Orange Peel Powder

2.4 Water Bath Shaker

Water bath shaker shown in figure 2.3, the purpose of this is to shake steadily and mix samples while maintaining a temperature at constant. Water bath shaker are used in application like culturing cells, hybridization, adsorption and molecular biological assays. Three conical flasks were taken with 500ml of dairy wastewater samples each, 0.2g of orange peel powder was added into all the flasks and kept in an Water bath shaker for different contact times of 0 to 2hours (i.e., 0, 60, 120 minutes each respectively) after which the samples were analysed for various study parameters like pH, BOD, COD, sulphates, TDS, TSS, chlorides & turbidity and the tests were repeated for dosages of 0.4, 0.6 &0.8 g respectively.

Fig 2.3: Water Bath Shaker

2.5 Dairy Wastewater Characteristics

The characteristics parameters of dairy wastewater generated are high due to floor washing, washing cans and equipment's. Plastic cans of 5 litres capacity were used for sampling. The cans were rinsed several times with distilled water. The samples were collected using the grab sampling technique. The collected samples were transported to the laboratory and various parameters where analysed by Standard Method (American water works Association (AWWA).[1] The result showed that Total dissolved Solids is in the range of 9742 mg/L and the turbidity is in the range of 1801 NTU where BOD and COD was very high as 2780 mg/L and 4474 mg/L respectively.

3. Results and Discussion

3.1 Initial Characteristics of Wastewater

Table 3.1 shows the initial characteristics of dairy wastewater.

Table 3.1: Initial Characteristics of Dairy Wastewater

PARAMETERS	CHARECTERISTICS VALUES (mg/L)
pH	8.4
BOD	2780
COD	4474
Total Dissolved Solids	9742
Total Suspended Solids	154.7
Turbidity	1801
Chlorides	169.2
Sulphates	3150

3.2 Effects on pH

It is observed that, as the dosage and the contact time are increased, the pH of the water sample gradually decreased. This could be attributed to the citrus nature of Orange peels, as the dosage is increased; the acidity of the water sample also increased there by decreasing the pH of sample. The corresponding results are plotted (fig 3.1) and tabulated in table 3.2.

Table 3.2: pH results with different dosage and contact time

Dosage (gm)	Contact Time (min)		
	0	60	120
0.2	8.4	8.0	7.0
0.4	8.4	7.5	6.7
0.6	8.4	6.8	6.4
0.8	8.4	6.6	6.2

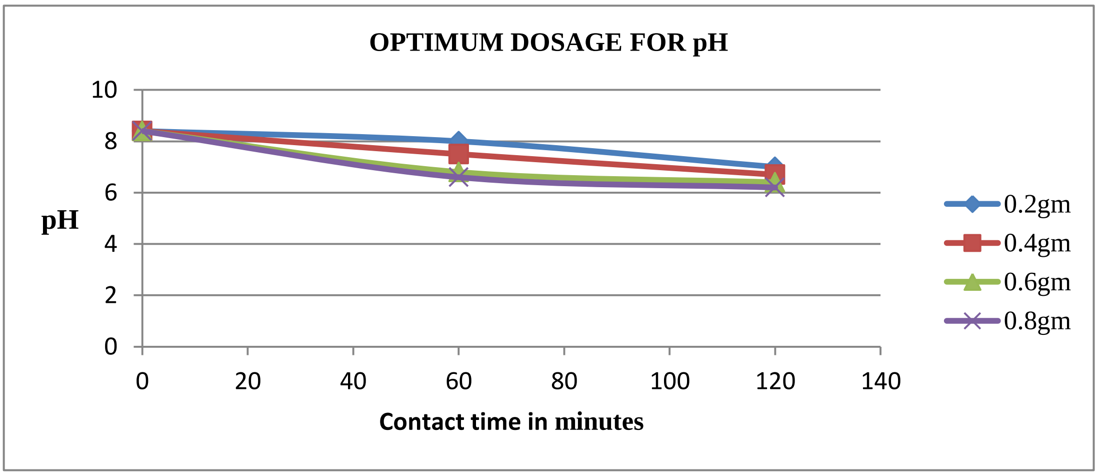

Fig 3.1: pH variation for different dosage v/s contact time

3.3 Effects on chlorides

As the contact time and the dosage increases, the demand of chlorine by the organic matter in the water sample also increases. As the reaction starts, chlorine demand decreases at some point called break point.Hence, to stabilize the organic matter thedemand for chlorine ceasesand the chlorine ions increase linearly. The corresponding results and plotted graph is as shown in table 3.3 and figure 3.2 respectively.

Table 3.3: Chlorides results for different dosage and contact time

Dosage (gm)	Contact Time (min)		
	0	60	120
0.2	169.2	176.59	189.33
0.4	169.2	197.82	225.30
0.6	169.2	225.05	229.7
0.8	169.2	236.54	266.35

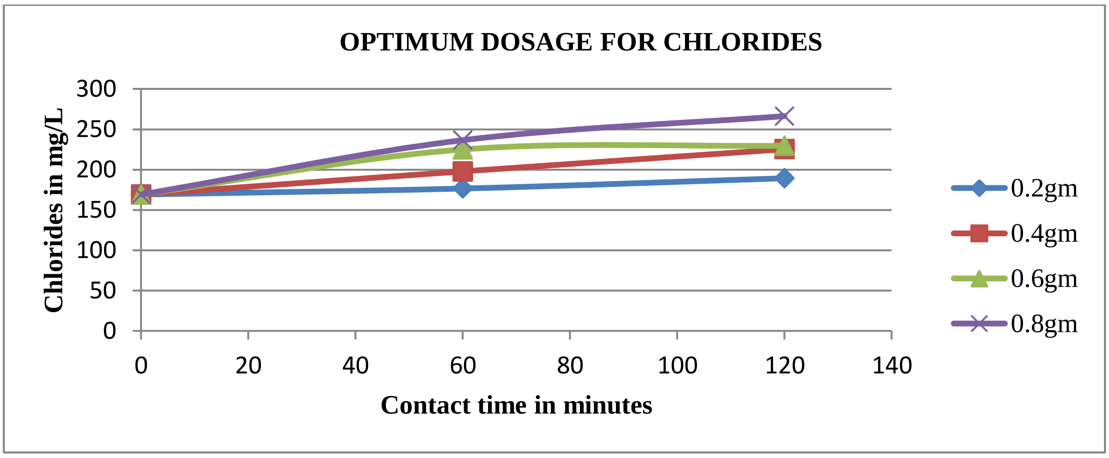

Fig 3.3: Chlorides variation for different dosage v/s contact time

3.4 Effects on Sulphates

It is observed that, with increasing contact time there is a great decrease in the concentration of sulphate ions. The rate of oxidation of ions will be slower initially and increase with time. Due to the presence of higher initial bacterial density and other pollutants, the oxidized chloride and sulphate ions will be utilized at a fast rate and thus concentration decreases. The corresponding results and plotted graph is as shown in table 3.4 and figure 3.3 respectively.

Table 3.4: Sulphates results for different dosage and contact time

Dosage (gm)	Contact Time (min)		
	0	60	120
0.2	3150	3120	3118
0.4	3150	3118.2	3114
0.6	3150	3110.9	3080
0.8	3150	3100	3000

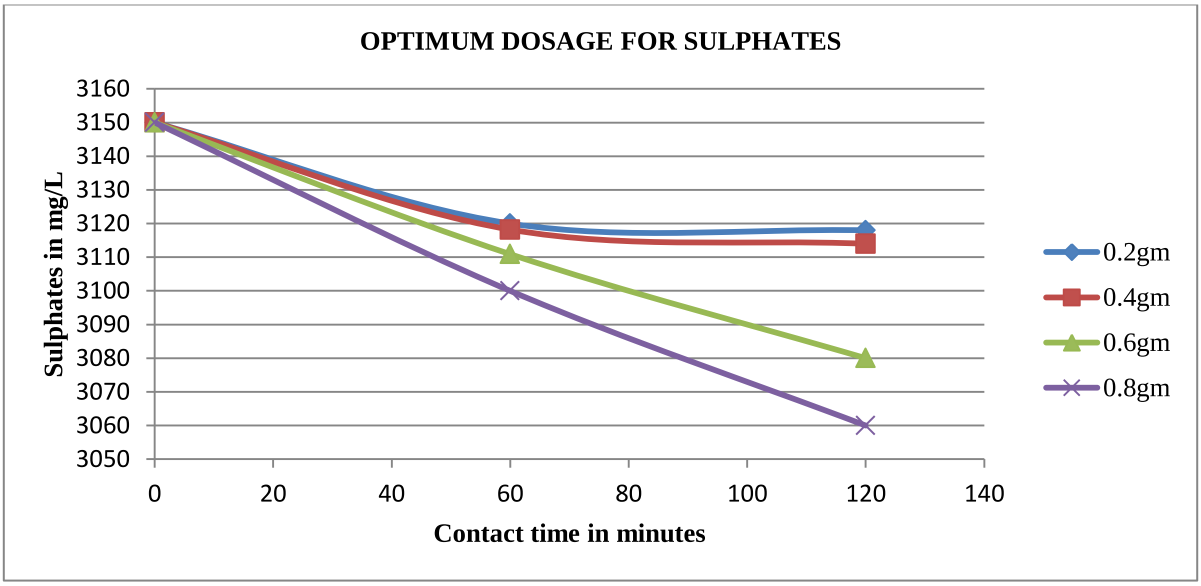

Fig 3.3: Sulphates variation for different dosage v/s contact time

3.5 Effects on Turbidity

As the dosage and the contact time are increased, the turbidity of the water sample is found to be reduced. The positive & the negative ions lose their charge and nullify each other. This reducestheturbidity making the water more clear. The corresponding results and plotted graph is as shown in table 3.5 and figure 3.4 respectively.

Table 3.5: Turbidity results for different dosage and contact time

Dosage (gm)	Contact Time (min)		
	0	60	120
0.2	1801	1350	1230
0.4	1801	1345	1233
0.6	1801	1332	1182
0.8	1801	1301	1161

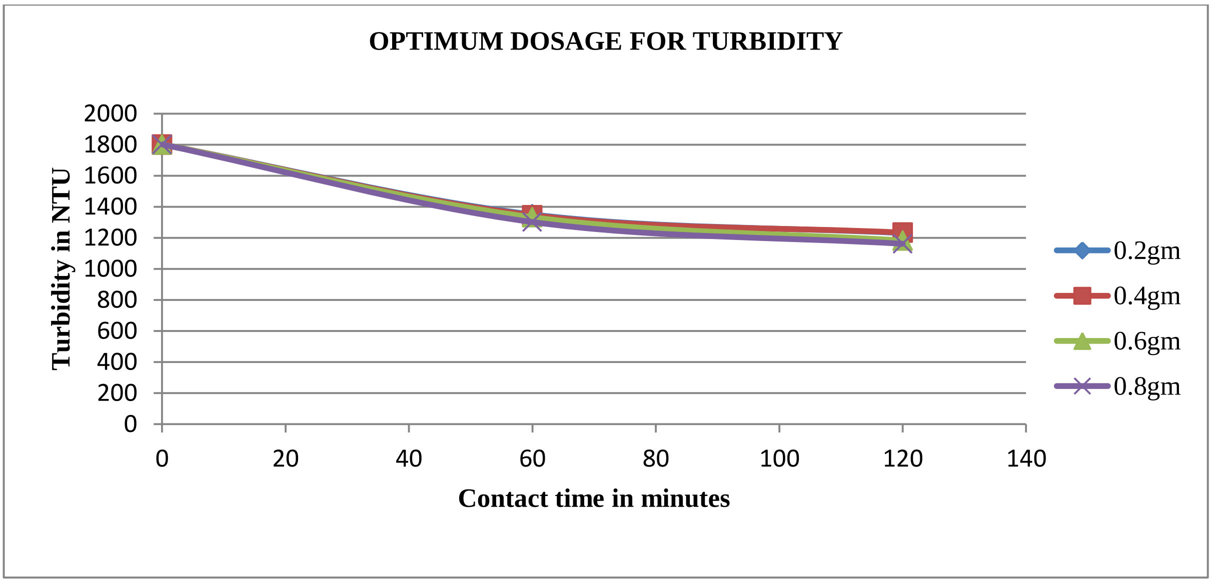

Fig 3.4: **Turbidity variation for different dosage v/s contact time**

3.6 Effects on Total Dissolved Solids

With the increase in the dosage and the contact time, the amount of total dissolved solids is found to reduce by 86.86%. This willcontribute to various environmental factors, decreasing the diversity of aquatic life and ultimately resulting in depletion of oxygen. The corresponding results and plotted graph is as shown in table 3.6 and figure 3.5 respectively.

Table 3.6: Total Dissolved Solids results for different dosage and contact time

Dosage (gm)	Contact Time (min)		
	0	60	120
0.2	9742	9600	4800
0.4	9742	4800	1800
0.6	9742	4600	1600
0.8	9742	3200	1280

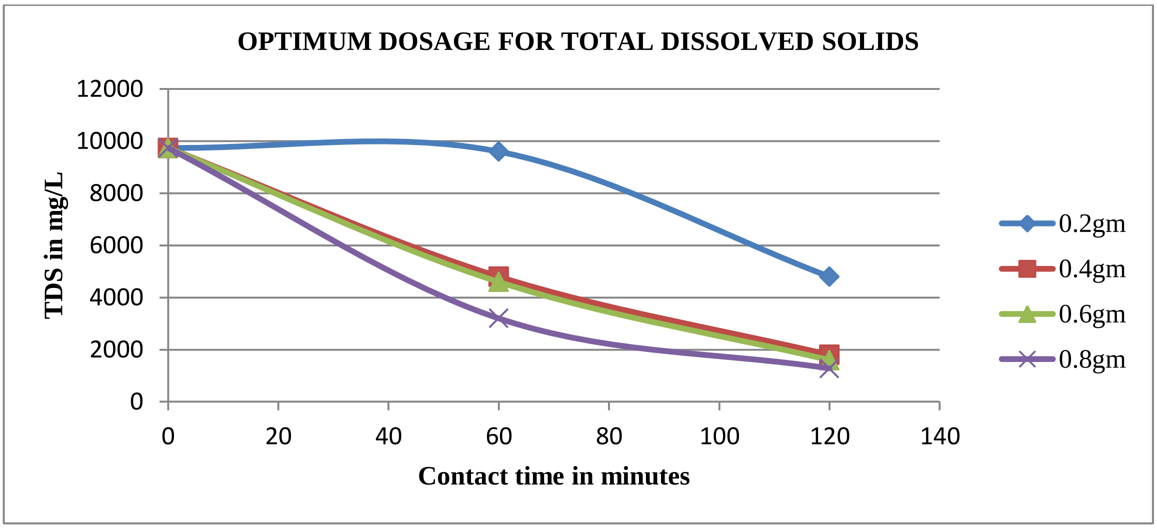

Fig 3.5: **Total Dissolved Solids variation for different dosage v/s contact time**

3.7 Effects on Total Suspended Solids

With the increase in the dosage and the contact time, the amount of total dissolved solids is found to increase by 80.66%. The corresponding results and plotted graph is as shown in table 3.7 and figure 3.6 respectively.

Table 3.7: Total Suspended Solids results for different dosage and contact time

Dosage (gm)	Contact Time (min)		
	0	60	120
0.2	154.7	160	400
0.4	154.7	240	480
0.6	154.7	320	640
0.8	154.7	480	800

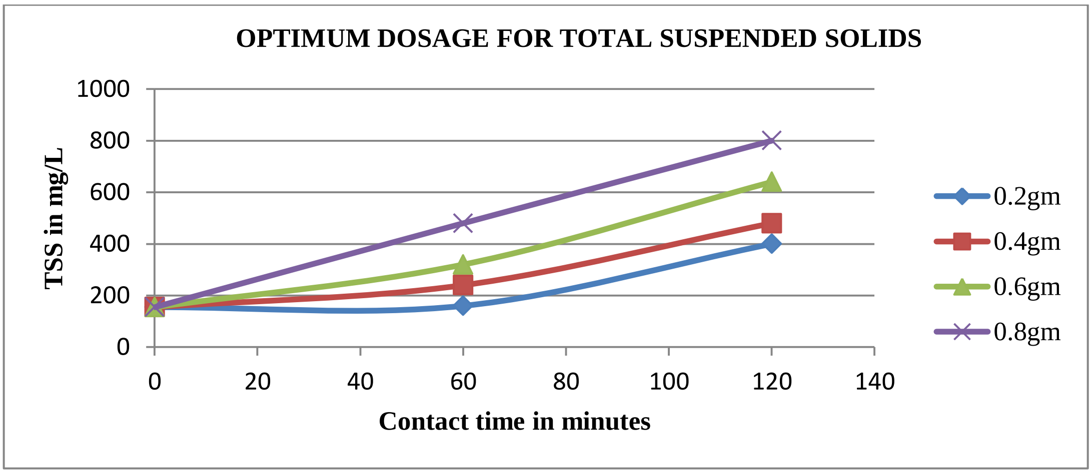

Fig 3.6: **Total Suspended Solids variation for different dosage v/s contact time**

3.8 Effects on BOD

As the dosage and the contact time are subsequently increased, the DO in the water sample increased due to which the BOD of the water sample is decreased. Due to this the oxygen demand is lowered by the bacteria andif there is no organic waste present in the water sample, there won't be as many bacteria present to decompose it and thus the BOD will tend to be lower with gradual increase in the DO levels. The corresponding results and plotted graph is as shown in table 3.8 and figure 3.7 respectively.

Table 3.8: BOD results for different dosage and contact time

Dosage (gm)	Contact Time (min)		
	0	60	120
0.2	2780	2700	2175
0.4	2780	2650	1848
0.6	2780	1271	1150
0.8	2780	1018	812

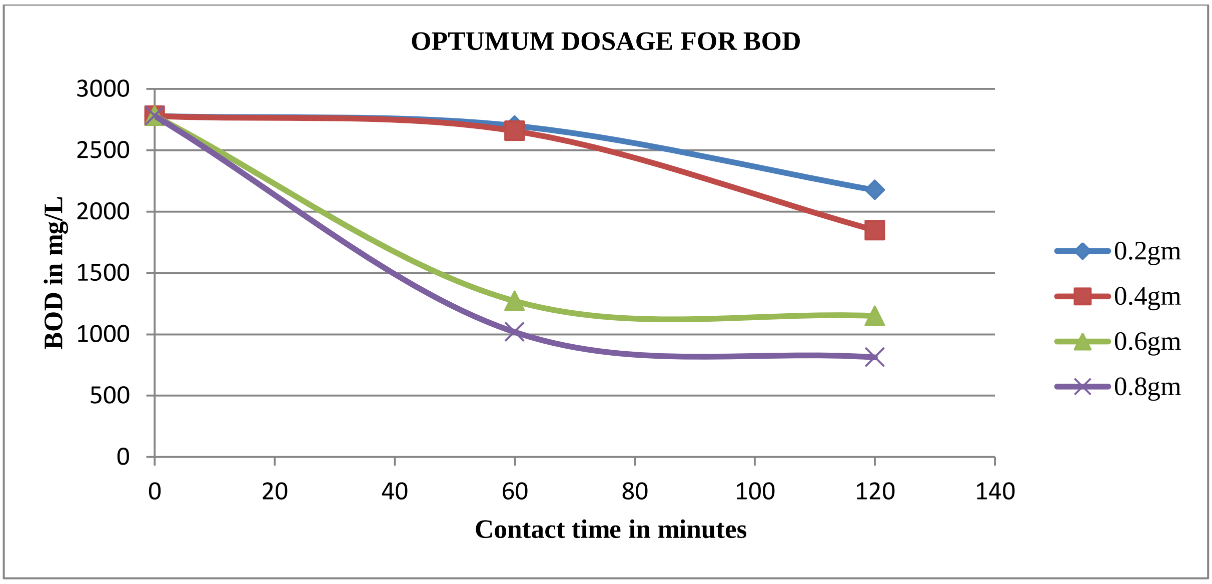

Fig 3.7: **BOD variation for different dosage v/s contact time**

3.9 Effects on COD

From the graph below it is clear that COD decreases with increase in contact time. This could cause oxidization of organic matter and emergence of oxygen ions. Generally all organic compounds with few exceptions can be oxidizing agents under acidic conditions. The corresponding results and plotted graph is as shown in table 3.9 and figure 3.8 respectively.

Table 3.9: COD results for different dosage and contact time

Dosage (gm)	Contact Time (min)		
	0	60	120
0.2	4474	4416	2937
0.4	4474	2330	2253

0.6	4474	1730	1841
0.8	4474	1613	1137

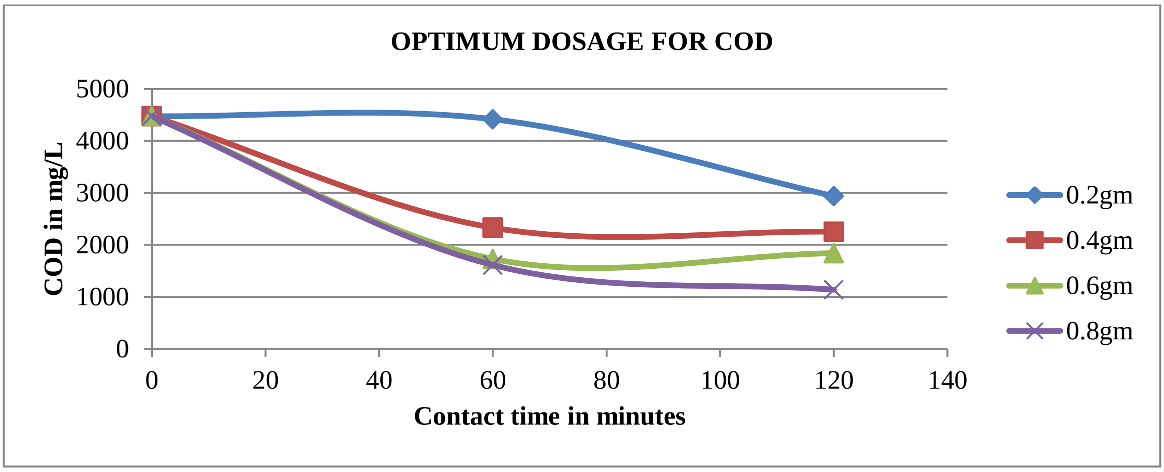

Fig 3.8: **COD variation for different dosage v/s contact time**

4. CONCLUSION

For the growth and development of rural India Dairy industry being one of the big industriesshould contribute to the growth. A dairy consumes huge quantity of water for various purposes and the wastewater generated from a dairy is also equally huge in volume with highly variable contamination characteristics. Wastewaters from dairy plants is a-raised from washings of cans, dairy equipment's, floors etc. and therefore resulting in high organic solid concentrations particularly milk suspensions. This experiment was done to determine efficiency of orange peel powderwhich is a natural adsorbentand an effective adsorbent in treating dairy wastewater. From the result obtained it is clear that the orange peel can be used as an excellent adsorbing medium in treating dairy wastewater.The results showed that the pH was reduced to 6.2 from 8.4, The BOD & COD removal was observed to be 70.79% & 74.58% respectively. Turbidity and sulphates removal was observed to be 35.53% and 47.61% respectively. There was a superficial increase in the chloride and total suspended solids level by 36.47% and 80.66% respectively. Total dissolved solids removal was observed to be 86.86%. The concept of utilizing Orange peels has proved to optimize the quantity of waste in dairy wastewater and an effective, Economical & a sustainable method to treat the dairy wastewater.

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