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COD AND COLOR REDUCTION BY CATALYTIC TREATMENT OF DISPERSE DYE WASTE WATERFROM TEXTILE INDUSTRY

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Abstract*: Water is the most important thing of any life. We are using water in houses, offices, industry etc. After using it, if we recycle it then it can be further use. Nowadays there are many dye manufacture industries manufacturing dyes, as a result wastewater is generated. The current work aims at reduction of Disperse dye from synthetic as well as industrial wastewater using catalytic thermal treatment. Different Catalysts are used in this study. Experiments were performed at various pH, temperature, time periods, catalyst loading and catalyst variety. A removal of COD 93.75% and 85.71% and a removal of color 86% and 83% for synthetic wastewater and industrial wastewater respectively were achievable with $CuSO_4.5H_2O$ loading of 4gm/L at 60 ± 2 ˚C for pH 8, for time 90min and 100 mg/L of initial concentration of dye when the run is taken for this study.

***Keywords*: Catalyst, COD reduction, Color reduction, Disperse dye, Wastewater.**

I. INTRODUCTION

The biggest issue of textile industries is the presence of dyes in waste water stream beyond discharge limits. Appropriate treatment technology is requiring for wastewater generated from textile industries as the process of dying tends to lose dye to effluent discharge directly [1]. As wastewater from textile industries contains high amount of dyestuffs, complex structured organics and surfactants, it is becomes non-biodegradable [2]. These industries are thus facing problems in maintaining a profitable level of production while reducing the intake of fresh water. Another problem is the disposal of large volumes of effluents which abides by environmental standards. These are generally amenable to conventional biological, physical and chemical treatment processes due to their recalcitrant and complex nature [3].

Presence of colour and its causative compounds has always been undesirable in water used for either industrial or domestic needs. Colour is a visible pollutant. Common man may not object to the discharge of colourless effluents with toxic and hazardous pollutants [4].

So, it is obvious to find ample amount of unreacted dye in dye bath run-off. To mitigate dye content in textile effluent adsorption is an authentic procedure which is followed but the success rate is not commendable. So there are different chemical processes such as Fenton's reagent, ozonation and photochemical NaOCl but high cost and toxic by products are constraints. Membranes are effective only when dyes are insoluble in an effluent. [5]

The significance of introducing catalytic thermolysis, a cheaper and hassle-free method can sufficiently fight the load of dyes before treating it with conventional adsorption process.

Many researchers have performed thermolysis on cotton textile mill wastewater and pulp and paper mill wastewater [6-8]. The decolourization and reduction of chemical oxygen demand of dyeing wastewater from a cotton textile mill was conducted using catalytic thermal treatment accompanied with coagulation. A maximum reduction of COD and Colour of dyeing wastewater of 66.85% and 71.4% is observed [5].

Catalytic thermal treatment is usually known as catalytic thermolysis. It is a chemical process by which a substance is decomposed into other substance by the application of heat in the presence of catalyst. The advantage of this process is it requires lower temperature and pressure for treatment.

II. MATERIALS AND METHODS

The synthetic dye wastewater sample was generated by using Disperse Violet 33 with cold brand type dye was purchased from our college's Textile department. The dye was dissolved in distilled water to have different concentrations. The chemicals used for COD and Colour measurement are available in our chemical department. The different catalysts used in this study are cupric sulphate penta-hydrate ($CuSO_4.5H_2O$), magnesium sulphate hepta- hydrate ($MgSO_4.7H_2O$), ferric chloride ($FeCl_3$), calcium chloride ($CaCl_2$) and Ferrous sulphate hepta-hydrate ($FeSO_4.7H_2O$).

Table 1: Physical Properties of Disperse Violet 33

Properties	Description
C.I. Name	Disperse violet 33
Physical State	Powder
Colour	Violet
Odour	Odourless
Density	1.31 gm/cm³

Experimental procedure

The experimental studies at temperature higher than ambient temperature were carried out in a 500ml three necked glass reactor. Waste water of 100mg/l concentration was generated. Initially the pH of the wastewater was adjusted by adding HCL or NaOH solution where synthetic wastewater was fed to reactor. Catalyst was added as per requirement. Heating mental with magnetic stirrer was used to raise temperature and thermometer for temperature monitor.

Figure 1: Experimental setup

A vertical water cooled condenser was attached to the middle neck of the reactor to prevent any loss of vapour. While performing the experiment the reactor samples were taken at periodic intervals for the measurement of COD and Colour. The effect of Reaction parameters such as pH, temperature, time, catalyst mass loading, initial concentration of dye and effect of different catalysts were studied.

III. RESULT AND DISCUSSION

Effect of Temperature

Homogenous catalyst is observed to be very reacting between temperature range from 40 to 70˚C (as per Table 2). Keeping the catalyst loading to 4gm/l, pH 8 and time 90min for estimating effect , temperature was varied from 40 to 70˚C. It seems that as the temperature is approaching boiling point the amount of precipitates formed reduces. The results were found best at 60˚C where reduction in COD is 93.75% for synthetic wastewater and 85.71% for industrial wastewater and reduction in Colour is 86% for synthetic wastewater and 83% for industrial wastewater. Fig.2. indicates % COD reduction with change in temperature for both synthetic and industrial waste water. It was observed that maximum COD reduction achieved at 60^{o}C.

Table 2: Effect of Temperature on Dye Waste Water

Sr. No.	Temperature (˚C)	Synthetic wastewater (%COD Reduction)	Industrial wastewater (%COD Reduction)
1	40	60.23	71.42
2	60	93.75	85.71
3	70	70.43	65.12

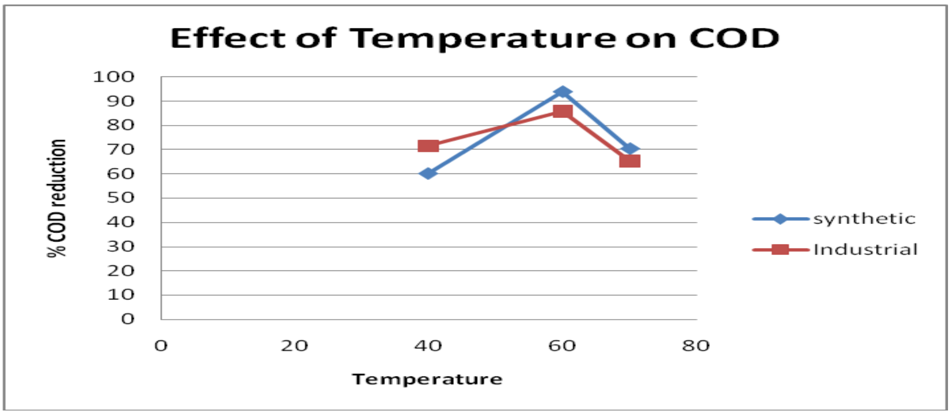

Figure 2: Effect of Temperature on Dye Waste Water

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Effect of time

For study of behaviour of dye reduction, in terms of reduced COD and Colour, a range of 0-3h time (as per Table 3 and Table 4) was taken. The COD and Colour reduction are visibly present even during heating time. Sample was withdrawn at interval of 45min, 90min, 120min, 150min, 180min.other parameters are taken same as prior. Fig. 3 and Fig. 4. Indicate that the time found for maximum COD reduction is 90min. At this time the COD reduction is 93.75% for synthetic wastewater and 85.71% for industrial wastewater and Colour reduction is 86% for synthetic wastewater and 83% for industrial wastewater.

Table 3: Effect of Time on synthetic Waste Water

Sr. no	Time (min)	Synthetic wastewater (%COD reduction)	Synthetic wastewater (% Colour reduction)
1	45	6.25	40
2	90	93.75	86
3	120	56.25	51.6
4	150	50	41
5	180	43.75	40.13

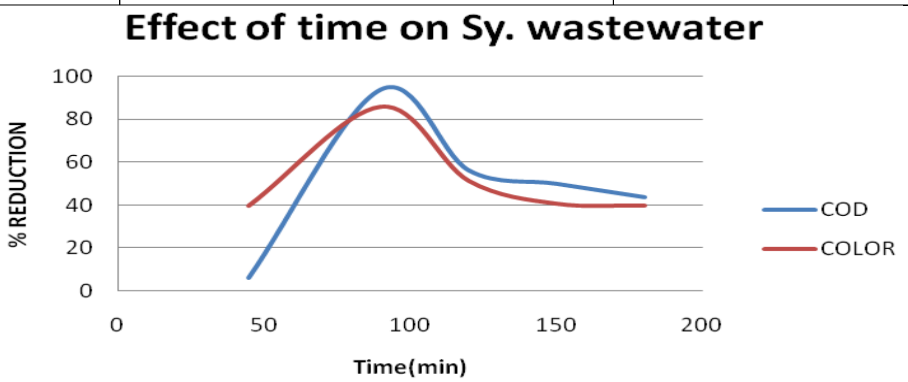

Figure 3: Effect of Time on Synthetic Waste Water

Table 4: Effect of Time on Industrial Waste Water

Sr. No.	Time (min.)	Industrial wastewater (% COD reduction)	Industrial wastewater (% Color reduction)
1	45	64.28	35
2	90	85.71	83
3	120	67.85	65.7
4	150	50	45
5	180	43.75	42.37

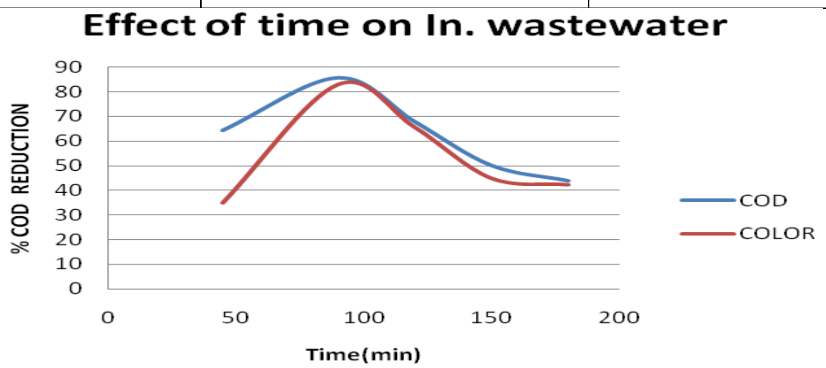

Figure 4: Effect of Time on Industrial Waste Water

Effect of Different Catalyst on COD and Colour

The chemicals used for this study are cupric sulphate penta-hydrate ($CuSO_4.5H_2O$), magnesium sulphate hepta-hydrate ($MgSO_4.7H_2O$), ferric chloride ($FeCl_3$), calcium chloride ($CaCl_2$) and ferrous sulphate hepta- hydrate ($FeSO_4.7H_2O$). All previous conditions were maintained same i.e. pH 8, catalyst does 4 g/L, temperature 60 ± 2˚C, initial dye concentration as 100mg/L for 90min. Fig. 5. Showed that for cupric sulphate penta hydrate ($CuSO_4.5H_2O$) maximum COD reduction is 93.75%. for Other catalysts magnesium sulphate hepta hydrate($MgSO_4.7H_2O$) , ferric chloride($FeCl_3$) , calcium chloride($CaCl_2$) , Ferrous sulphate hepta hydrate($FeSO_4.7H_2O$) COD reduction is 56.25%, 20% , 15.25% and 50% respectively. But maximum colour reduction made in ferrous sulphate hepta hydrate. The maximum COD reduction is by cupric sulphate penta hydrate because of its highest affinity to forming complexes with dye wastewater.

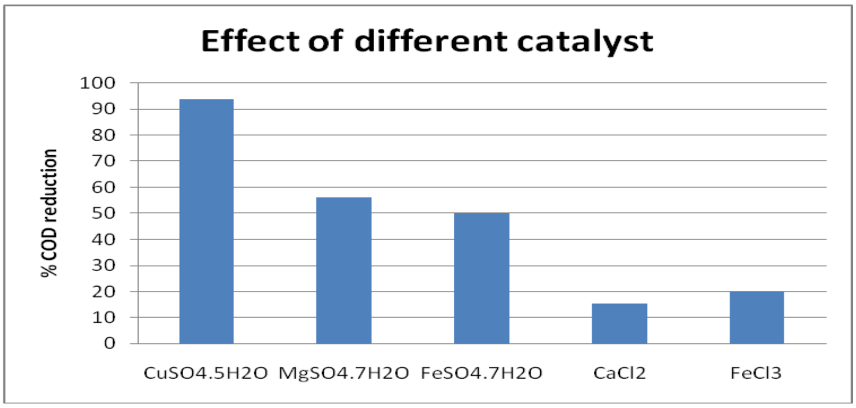

Figure 5: Effect of different catalyst on dye waste water

Effect of catalyst mass loading on COD and colour

Fig. 6. shows the effect of catalyst mass loading on COD and Colour reduction of Disperse dye wastewater. At time duration of 90min. and temperature 60 ±2˚C and pH 8 the catalyst mass loading varies from 2-5gm/l (as per Table 5). Here for 2-4 gm/l the % COD and % Colour reduction is increases and beyond that it is decreases. So, it is concluded that the 4gm/l considered as best mass loading for COD and Colour reduction. The %COD reduction is 93.75% and 85.71% for synthetic and industrial wastewater respectively. The % colour reduction is 86% and 83% for synthetic and industrial wastewater respectively.

Table 5: Effect of Catalyst Mass Loading on COD

Sr.No.	Catalyst Loading (gm/L)	% COD reduction	
		Synthetic wastewater	Industrial wastewater
1	2	65	55
2	3	68	60
3	4	93.75	85.71
4	5	50	60

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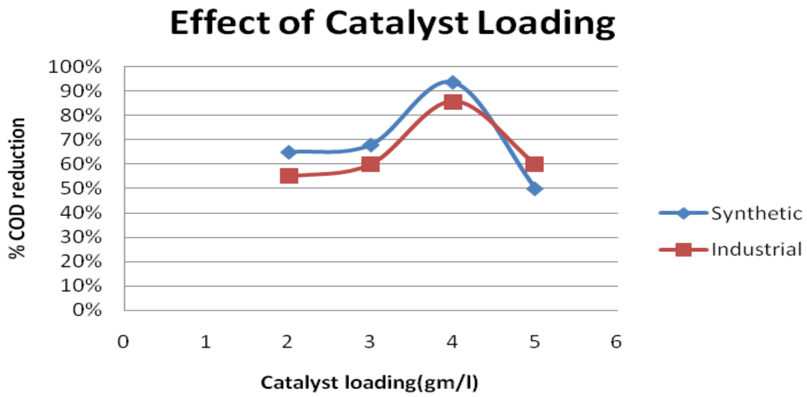

Figure 6: Effect of Catalyst Mass Loading on COD

IV. CONCLUSION

Above study shows the reduction of COD and Colour for Synthetic Wastewater and Industrial Wastewater for Disperse dye by catalytic thermal treatment method. During this study we found $CuSO_4.5H_2O$ as best catalyst as compared to other catalyst used in study. The better results for % COD and % Colour reduction was observed during catalytic process at pH 8, initial dye concentration of 100mg/l, catalyst mass loading of 4gm/l, temperature 60 ± 2 ˚C and for time duration of 90min. The % COD and % Colour reduction is 93.57%, 85.71% and 86%, 83% for Synthetic wastewater and Industrial wastewater respectively.

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