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OPTIMIZATION OF ACTIVATED SLUDGE PROCESS SYSTEM FOR DYE WASTEWATER

Dr. Abhipsa R Makwana*
* Assistant Professor
Civil Engineering Department
Faculty of Technology and Engineering
The Maharaja Sayajirao University of Baroda

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ABSTRACT

Treatment of textile wastewater or dye wastewater is little difficult suing biological treatment for wastewater like activated sludge process due to complex nature of the dye. This paper reports pre-feasibility study of activated sludge process for simulated dye waste removal. Activated sludge process involves biomass development, acclimatization if complex waste are to be treated. Here active biomass was developed from domestic sewage and then it was acclimatized for Navy Blue 3G dye and optimized mix system of 70-30 ratio (Dye effluent –sewage) has been suggested with 20 hr as optimum detention time. Optimized system shows 91% of average dye removal.

KEYWORDS: Acclimatization, Optimization, Optimum biomass

INTRODUCTION

Wastewater from dyeing and finishing processes, with a chemical oxygen demand (COD) concentration exceeding 1600 mg/l and a strong dark color, is categorized as high strength wastewater [1,2,4]. It is a significant source of environmental pollution. The combination of strong color and highly suspended solid content results in high turbidity of the waste effluent. Due to the characteristics of textile wastewater, COD and turbidity removals exhibit similar trends. The total volume of wastewater originating from textile dyeing and finishing factories is very high, two-third of which is waste in dye and rinse baths [3]. [5] reported that color is a visible pollutant and from the view point of aesthetics, it is one of the first parameters considered in the field of pollution prevention. Dyes interfere with light penetration in the receiving bodies of water, thereby disturbing biological processes. Furthermore, dye effluent may contain chemicals, which are toxic, carcinogenic, mutagenic, or teratogenic in various microbiologic, fish species. Many surface waters are often colored to the extent that they are not acceptable to domestic or some industrial usage without prior treatment. Surface water may become colored by discharge of highly colored wastewater from textile units, dyestuff manufacturing industries, paper and pulp industries, tanneries, electroplating mills, distilleries and host of many other industries. General methods of treatment of the dyeing wastewater are adsorption, chemical coagulation, electro flotation, ultrafiltration, biological treatment, and ozonation, apart from the recent interest in electrocoagulation. The cost of adsorption, ultrafiltration, electroflotation and ozonation exceeds that of chemical coagulation [4,5] dyes usually present high stability under sunlight and resistance to microbial attack and temperature, the large majority of these compounds are not degradable in conventional wastewater treatment plan EC process is characterized by a fast rate of pollutant removal, compact size of the equipment, simplicity in operation, and low capital and operating costs.

If conventional wastewater treatment like activated sludge process if planned to implement for such wastewater proper treatment system development is necessary. Acclimatization and optimization is necessary to develop efficient treatment plant system. Hence here, feasibility study of activated sludge process for Navy Blue 3G dye has been carried out. This paper reports mix system design for the acclimatization of activated sludge under optimum biomass condition.

MATERIALS AND METHOD

For activated sludge process, aeration tank of 3 lit capacity with compressed air supply at 10 lit/min is used. The characteristics of domestic sewage used for development of activated sludge as well as for acclimatization are shown in Table 01 below. The molecular weight of navy blue 3G dye is 625.38 mole, with chemical composition $C_{23}H_{25}BrN_6O_{10}$.

The study was carried under three phases: initially the biomass was developed using domestic sewage then acclimatization of developed biomass for dye wastewater and finally optimization of detention time. Firstly, the activated sludge was developed using domestic sewage for nearly 60 days. Simulated Navy blue 3G dye effluent with 150 mg/L strength was prepared at laboratory using dry dye powder. For acclimatization, varying concentration of domestic sewage and dye effluent was added in the aeration tank and dye concentration in effluent coming out of aeration tank was measured. Optimization of detention time was done on acclimatized biomass for time ranging from 0- 36 hrs.

Table 01: Characteristics of domestic wastewater used for development and acclimatization of activated sludge

Characteristics	Range (mg/lit)
pH	7.3-8
Temperature	27-32°C
Total Solids	115000-119000
Total Dissolved Solids	90000-94500
Suspended Solids	24500-25000
Chemical Oxygen Demand	31000-34500
Biochemical Oxygen Demand	15750-16500
NH3-N	800-850
Phosphate	150-200
Sulphate	5000-5750
Oil and Grease	7-8

RESULTS AND DISCUSSION

Acclimatization of active biomass

Acclimatization of active biomass was carried on varying the volume of dye and sewage added in the aeration tank (as shown in following table 02) after 65 days of active biomass development. The effluent in the aeration tank was treated for nearly 6 hours. Then effluent dye concentration was analyzed on UV-spectrophotometer.

Looking to the Fig. 01 and from table 02, % dye removal decreased with increase in dye concentration in the aeration tank influent. At 60, 70 and 80 % dye concentration in, % dye removal were observed to be 32.9, 28.5 and 26.6 respectively, which are not showing much difference in effluent dye concentration. Hence, 70 % influent dye concentration with 30 % domestic sewage mix system was considered as optimum for further study.

Table 02: Acclimatization of active biomass for dye effluent

Day	% of domestic sewage	% of Dye waste water	Domestic sewage in ml	Dye waste water in ml	Influent Dye mg/L	Effluent Dye mg/L	% Dye reduction
65	90	10	2250	250	37.5	2.8	92.6
66	80	20	2000	500	75	11.4	84.8
68	70	30	1750	750	112.5	35.1	68.8
69	60	40	1500	1000	150	68.0	54.7
70	50	50	1250	1250	187.5	108.2	42.3
71	40	60	1000	1500	225	151.0	32.9
72	30	70	750	1750	262.5	187.7	28.5
73	20	80	500	2000	300	220.2	26.6
74	10	90	250	2250	337.5	318.3	11.7

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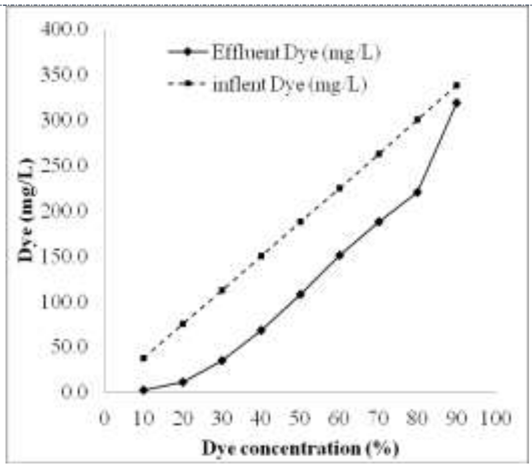
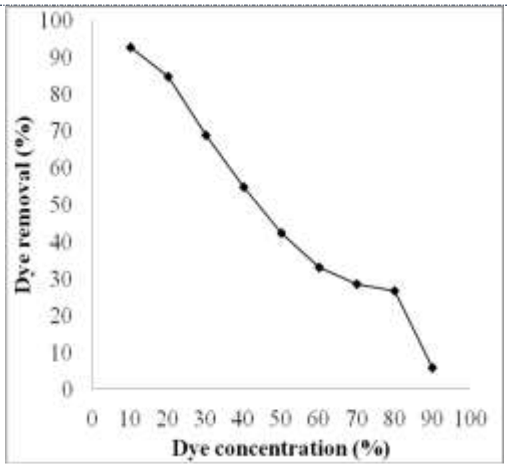


(a)



(b)

Fig. 01 (a) Influent and effluent dye concentration (b) Dye removal % during acclimatization of activated sludge (Detention time 6 hrs)

The developed mixed system was then, kept for few more days for better exposure of microbes to the dye. Then again the efficiency of optimized biomass was checked as shown in table 03. It is evident from the results and fig. 02 that the dame biomass shows different removal percentage for different days of treatment. As number of days increases, removal efficiency of biomass is getting increased.

Table 03: Mixing system after optimum biomass development

Day	% of domestic sewage	% of Dye waste water	Domestic sewage in ml	Dye waste water in ml	Influent Dye mg/L	Effluent Dye mg/L	% Dye reduction
81	50	50	1250	1250	187.5	81.8	56.4
82	40	60	1000	1500	225	122.0	45.8
83	30	70	750	1750	262.5	160.9	38.7
84	20	80	500	2000	300	200.1	33.3
85	10	90	250	2250	337.5	299.0	11.4

Optimization of detention time: - Day 90 & 97 (after 5 days from optimum biomass development)

Optimization of detention time was carried for time range of 4-36 hrs. Looking to the table 04 and Fig. 03, it is observed that for 20, 24 and 30 hrs of detention time dye removal rate was observed to be nearly same hence 20 hrs detention time was considered as optimum detention time for the developed ASP biomass.

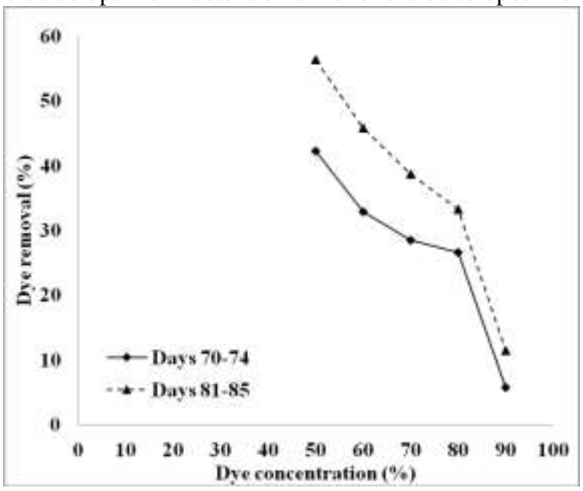


Fig. 02 Dye removal after 70-74 days and 81-85 days at varying influent dye concentration (Detention time 6 hrs)

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. ***Table 04: Optimization of detention time***

Days	Detention time in hours	Influent Dye (mg/L)	Effluent Dye in (mg/L)	Dye removal (%)
90	4	262.5	54.0	79.4
91	8	262.5	46.4	82.3
92	12	262.5	45.2	82.8
93	16	262.5	39.4	85.0
94	20	262.5	34.7	86.8
95	24	262.5	27.4	89.6
96	30	262.5	26.8	89.8
97	36	262.5	17.1	93.5

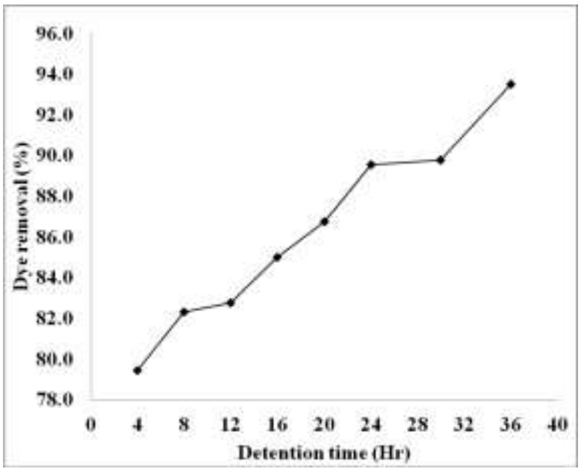

Fig. 03 Optimization of detention time (at 30 % domestic sewge-70 % Dye effluent mix system)

Efficiency Analysis of optimized activated sludge process system

After optimizing dye-sewage mix ratio and detention time, the final efficiency of optimized activated sludge process was measured for days 105 to 110 as shown in table 05 and Fig. 04. It is evident that optimized biomass shows removal of more than 91% on average basis.

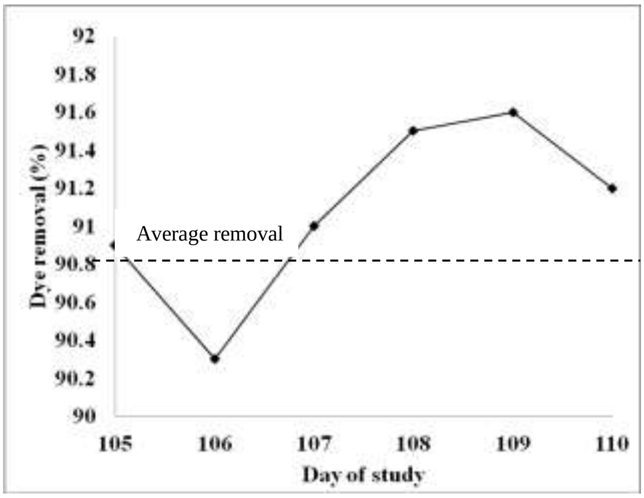

Fig. 04 Dye removal from optimized ASP system

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Table 05: Final efficiency analysis

Day	Influent COD mg/lit	Effluent COD mg/lit	% reduction
105	262.5	23.9	90.9
106	262.5	25.5	90.3
107	262.5	23.6	91
108	262.5	22.3	91.5
109	262.5	22.1	91.6
110	262.5	23.1	91.2

CONCLUSION

The study shows that, removal of dye waste is possible using biological process like activated sludge. It is also revealed that mix system allows only certain percentage of complex waste and needs its origin waste (sewage from which active biomass developed) for better operation, hence 30 % sewage and 70% dye effluent mix system is suggested here. Further system was also optimized at 20 hr detention time. So it can be concluded that the system developed so far is quite applicable with respect to reduction in dye, but if it is found at any stage of treatment that the concentration of dye is beyond the disposal limit then the treated effluent can be land treated and then incinerated.

Higher percentage of acclimatization from 70 % to 100% may be possible by developing genotype biomass by mutation with ultra violet rays or by other radioactive ray mutation system. To better understand the removal efficiency, further work should be carried on real dye wastewater, which will add more complexity of the real waste.

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