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TREATMENT OF EFFLUENT FROM DYEING INDUSTRY USING ADSORPTION TECHNIQUE

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ABSTRACT

Rapid industrialization coupled inadequate environmental management in the developed countries resulted in large scale pollution of the environment especially the aquatic environment with a multitude of contaminants. Increasing complexities of the contaminants rendered the conventional treatment systems ineffective and warrants a more sophisticated plan of attack for removal of specific pollutants. Recent advances in contemporary environmental engineering focus attention on effective treatment methodologies to meet the requirements in both environmentally acceptable and cost effective manners. Discharge of colored effluent is dissented even by the general public on the presumption that the color is indicative of the pollution. Discharge of such partially treated effluent, in addition to imparting color to the receiving waters, also renders them unfit for its intended beneficial use. Moreover, recent reports suggests toxic nature of color causing substances serve as carriers of heavy metals since they have a tendency to form a chelate complex with most of the heavy metal ions. Recognition of color levels coupled with the public awareness calls for a comprehensive approach and research efforts to solve the problem of color pollution and control. Among several industries that contribute colored effluent, textile, dye manufacturing, pulp & paper, tanneries are the most. Adsorption onto different adsorbents which is a sludge free process is recommended.

KEYWORDS: Activated alumina, azoic dye, colorimeter, synthetic dye.

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1. INTRODUCTION

Many industrial wastes are highly colored and are still detectable even after high dilution. Wastes from dye manufacturing plants, textile wastes and flax cooking wastes, fermentation wastes, pickling liquor wastes are particularly objectionable from the stand point of color.

1.1. Significance of Color Removal

Among the pollutants, color appears to have a wide impact on the environment. Color is a visible pollutant and is caused due to the presence of coloring matter, synthetic organic substances, inorganic substances or animal and vegetable derived or degraded compounds. Color acquired by a river through the discharge of dye industrial effluent reduces the penetration of sunlight and consequent reduction in photosynthetic activity, inhibits the growth of desirable aquatic system. The re-aeration capacity of river water gets reduced due to the presence of coloring bodies. Though color may not be toxic for human beings, it has a tendency to chelate metal ions and thus to become micro toxic to fish and other organisms. Dyes are confirmed heavy metal carriers, since some heavy metals like Cr, Cu, Co may for an intrinsic part of the dye molecule.[1] The processing of certain goods like paper, textile etc. needs clear water to avoid staining of the products. So the industries which manufacture these goods may have to spend more money on the removal of color. Because of these reasons color in waste liquid effluent has to be removed, before it is discharged into a water body or on to land. Research on the color removal is very limited. Attempts have been made to remove the color by biological methods, coagulation and oxidation etc. Another important technique that can be employed for color removal is by adsorption. Using this technique for many effluents from dye using units, textile industries etc. can be successfully decolorized. Much work at laboratory level and industrial level is being done in this regard. The present investigation aims at removal of color from synthetic dye solutions .[1]

1.2 Adsorbents

Depending on the requirements we have to select the appropriate adsorbent. For this let us see the various types of absorbents which are used industrially. Among these types activated carbons have been used widely in the following aspects.

1. Activated carbons
2. Bituminous coal
3. Fuller earth
4. Activated alumina
5. Activated clays
6. Bone char
7. Decolorizing carbons
8. Molecular sieves
9. Synthetic polymers
10. Silica gel
11. Saw dust
12. Flyash

2. MATERIALS AND METHODS

To investigate the feasibility of acid dyes for color removal by chemical treatment with alum, ferric chloride and barium chloride the following materials and methods were used in the present study.

2.1. Materials.

Water: The pH of water is in the range of 6.8 to 7.1 and the specific conductivity is 2 to 5 μ semen's/cm.

2.2. Instruments

pH Meter, Colorimeter and Orbital Shaker.

2.3. Photo Electric Colorimeters

Photo-electric colorimeters are of 2 types
1. Single beam; 2. Double beam

2.4. Single Beam Instrument

The Evelyn photo-electric colorimeter is an example. The essential parts of a single beam instrument are: (a) a source of light with a concave reflector; (b) an adjustable diaphragm; (c) a colored-glass filter for monochromatic light; (d) cuvette for holding the absorbing solution; e) a single photocell to receive the radiation and (f) a directly connected galvanometer. The current out-put of the cell is directly proportional to the radiant power falling upon it at a given wave length .[2] In order to determine the absorbance of a solution the cuvette is filled up with pure solvent. Then the diaphragm is adjusted so that the meter reads full scale (100 percent) now the solvent is replaced by solution without disturbing the diaphragm. Then the meter will read the percent transmittance from which the absorbance of the solution can be evaluated. The single beam colorimeter possesses the fault the reading fluctuates with variations in the source intensity. This defect can be minimized by using a storage battery as a current supply or by using a more expensive constant-voltage transformer. A better remedy is to use two photo cells in a double-beam circuit. In this arrangement fluctuations being observed equally by both cells, are cancelled out.[3]

2.5. Electrodes

The several secondary or subsidiary reference electrodes are employed. The most important of these is calomel electrode. Various types of vessels have been used for the purpose of setting up calomel electrode. It consists of glass tube at each end. A small amount of pure mercury is placed at the bottom of the glass tube and covered by a paste of mercury chloride and potassium chloride solution. The vessel is then filled with potassium chloride solution by introducing the latter from the small side tube shown on the right. The solution so filled in the side tube on the left helps to make connections though a salt bridge, if the other electrode are half cell, the potential of which is to be determined. The electrical 8. connection with mercury is made by means of platinum wire sealed in a glass tube the potential of calomel electrode depends upon the concentration of KCl solution used .[4]

2.6. Preparation of Stock Dye Solution

Required amount of accurately weighted water soluble dyes (acid, basic, direct) were dissolved directly in distilled water to prepare synthetic stock dye solution. In the case of other dyes which are not water soluble additives like acetic acid caustic soda, soda ash, surface active agents etc were added at appropriate quantities .[5]

3. EXPERIMENTAL PROCEDURE

1. By using calorimeter initial percentage Transmissivity of the dye effluents are noted.
2. 100 ml of same dye effluent in three reagent bottles was taken.
3. Added one gram of different adsorbents to the reagent bottles and selected the best adsorbent, where the percentage Transmissivity is high.
4. After choosing the correct combination of different adsorbent for different dye effluents, amount of adsorbent is varied for same amount of dye effluent.
5. After choosing the optimal amount of adsorbent, pH is varied.
6. Optimal amounts of adsorbent and optimal values of pH are selected by calculating the transmissivity using calorimeter.
7. Optimal amounts of adsorbent, optimal values of pH and optimal amounts of color removal are noted.

4. RESULTS AND DISCUSSION

Step:1

For various concentrations of Azoic dye ,the absorbance was measured and tabulated in Table-1.
Initial concentration = 13.5mg/100ml   Final concentration = 0.004mg/100ml

Table-1
Concentration Vs Absorbance for Azoic dye

Concentration (mg/100ml)	Absorbance
0.01	0.036
0.05	0.12
0.5	0.22
1	0.38
5	0.62
15	1.52

Adsorbents used:
1. Charcoal 2. Activated alumina 3. Fly ash
Initial percentage Transmissivity (%T) = 4; Initial absorbance = 1.3979
The Percentage color removal of Azoic dye for different adsorbents is carried out. See Table-2
From table-2 we can choose activated alumina is the best adsorbent for azoic dye.

Table- 2
Percentage color removal of Azoic dye for different adsorbents

Dye name	Adsorbent (1gm/100ml)	% T	Optical density	% Color removal
Azoic	Charcoal	65	0.187	88.88
Azoic	Activated alumina	81	0.0915	95.55
Azoic	Fly ash	68	0.1675	91.11

Dye: Azoic (100ml), Adsorbent: Activated alumina
The Percentage color removal for different adsorbent dosages is calculated and tabulated in Table-3 & Table-4. From Table.3, 40 mg/100ml of adsorbent is taken as optimum, because the % color removal is high. Fig.1 shows that as adsorbent dosage increases color removal is decreases and the optimum dosage is 40 mg.
Note: From Table .3 and Table .4, we can conclude that the color removal of azoic dye at 40mg/100ml of adsorbent is high. So, the 40mg of adsorbent is taken as optimal value for azoic dye.

Table -3
Percentage color removal for different adsorbent dosages

Quantity of adsorbent (mg)	% T	Optical density	% Color removal
10	87	0.0605	95.67
20	85	0.0706	94.94
30	84	0.0757	94.58
40	90	0.0458	96.72
50	84	0.0757	94.58
60	88	0.0555	96.02

Table -4
Percentage color removal of azoic dye for different adsorbent dosages

Quantity of adsorbent	%T	O.D.	% Color removal
34	82	0.0862	93.83
36	74	0.1307	90.65
38	81	0.0915	93.45
42	79	0.1023	92.68
44	80	0.0969	93.06
46	79	0.1023	92.68

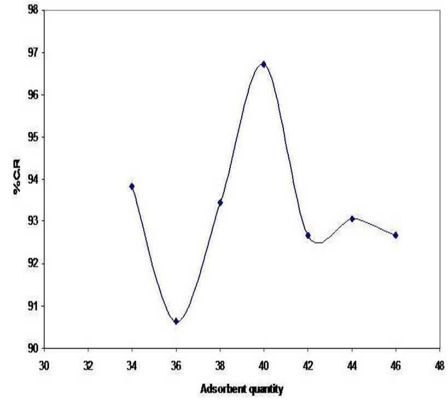

Figure. 1
Effect of adsorbent dosage on azoic dye

Dye: Azoic, Adsorbent: Activated Alumina
Initial pH of the azoic dye: 7.07 Optimal value of the adsorbent: 40 mg/100ml The Percentage color removal of azoic dye for different pH values is calculated and tabulated in Table-5 & Table-6 Note: From Table.5 and Table.6, indicate that optimal pH is 3 and optimum concentration is 40mg/100ml. Fig.2 indicates that as pH increases % color removal is decreases and the optimum pH is 3

Table -5
Percentage color removal of azoic dye for different pH values

Solution pH	% T	O.D	% C.R
2	95	0.0223	98.40
4	95	0.0223	98.40
6	86	0.0655	95.31
8	69	0.1611	88.47
10	71	0.1487	89.36
12	53	0.2757	80.27

Table- 6
Percentage color removal of azoic dye for different pH values

Solution pH	**% T**	**O.D**	**% C.R**
3	97	0.0132	99.05
5	84	0.0757	94.58

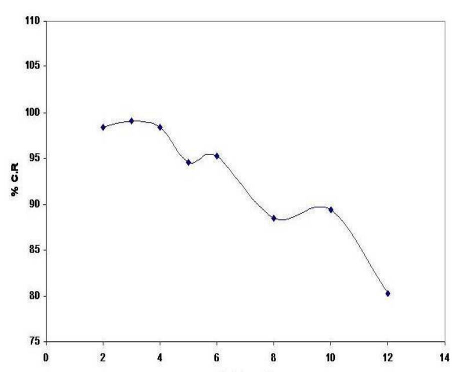

Figure.2
Effect of pH on azoic dye

Dye: Topaz,   Adsorbent: Charcoal

Table -7 &Table-8 Gives The Percentage color removal of Topaz dye for different adsorbent dosages

Note: From Table. 7 and Table.8, the optimal adsorbent quantity is 64mg/100ml, and it also showed in Fig.3.

Table 7

Percentage color removal of Topaz dye for different adsorbent dosages

Adsorbent quantity (mg/100ml)	% T	O.D	% C.R
10	68	0.1675	91.62
20	67	0.1739	91.30
30	73	0.1366	93.17
40	80	0.0969	95.15
50	73	0.1366	93.17
60	83	0.0809	95.95

Table 8

Percentage color removal of Topaz dye for different adsorbent dosages

Quantity of adsorbent (mg/100ml)	% T	O.D	% C.R
54	98	0.0088	99.56
56	98	0.0088	99.56
58	98	0.0088	99.56
62	98	0.0088	99.56
64	99	0.0044	99.78
66	98	0.0088	99.56

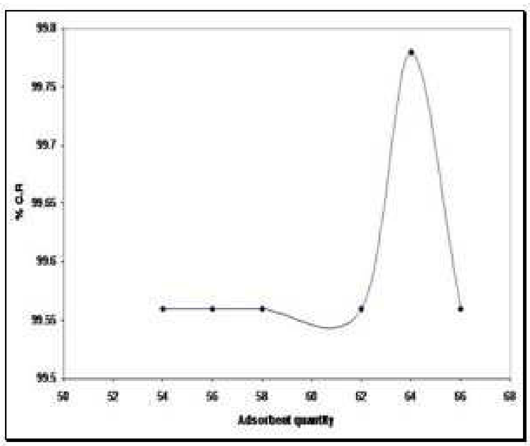

Figure. 3

Effect of adsorbent dosage on Topaz dye

Dye: Topaz,   Adsorbent: Charcoal

Initial pH: 5.78

Optimal value of the adsorbent = 64mg/100ml

Table 9 & Table-10 Gives The Percentage color removal of azoic dye for different pH values

Note: From Table. 9 and Table.10 indicate that optimal pH is 5, and it showed in Fig.4.

Table 9
Percentage color removal of azoic dye for different pH values

Solution pH	% T	O.D	% C.R
2	90	0.0457	97.71
4	90	0.0457	97.71
6	88	0.0555	97.22
8	88	0.0555	97.22
10	87	0.0604	96.98
12	76	0.1191	94.04

Table 10
Percentage color removal of azoic dye for different pH values

Solution pH	% T	O.D	% C.R
3	97	0.0132	99.34
5	99	0.0044	99.78

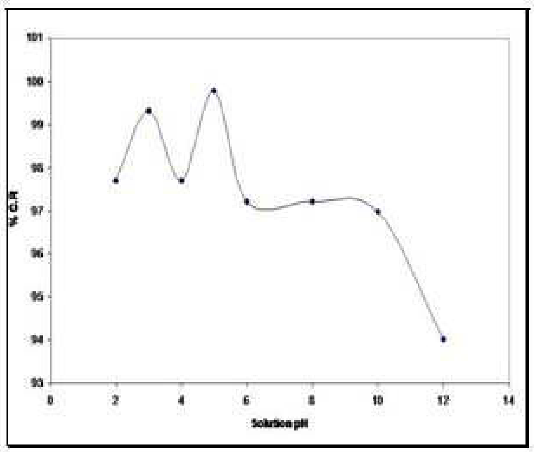

Figure. 4
Effect of pH on Topaz dye

5. CONCLUSION

From the results of the experiments we can propose that for Azoic dye the activated alumina suites better than the other adsorbents. By using this adsorbent at a pH value around 3.0, we observed that 99.97% of color is removed. Similarly for Topaz dye charcoal is suitable. By using charcoal at a pH value around 5.0 and at concentration of 64 mg/100ml dye effluent we observed that 99.9% color is removed. For Emerald dye the fly ash suites as better adsorbent. By using Fly ash at a pH value around 12.0 and at a concentration of 12mg/100ml dye effluent we observed that 99.8 % color is removed. So from the results we conclude that adsorption is the most suitable process for treatment of effluent from dyeing industry.

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