Usage of Agricultural Waste for Treatment of Dye House Effluent

Dr. Kirpal Singh Bhullar
Email id:kirpalsinghbhullar@gmail.com
Govt. Institute of Textile Chemistry & Knitting Technology, Ludhiana.

Abstract- The textile industry is one of the largest industries in world & is among the major waste generating industries. Number of physical and chemical treatments is followed by industries to control the waste water effluent. But the functional and operational cost for the processes is high. So continuous efforts are being done by scholars to search the alternatives. In the present study efforts have been made to evaluate whether any improvement in treatment of dye house effluent is possible through use of adsorption technique followed by biological process. Batch studies & column studies were conducted using low cost adsorbents such as Sugarcane baggase, Rice husk and Saw dust without activation. Colors used were C.I. Reactive Red 120, C.I. Reactive Blue 198 and C.I. Reactive Yellow 135.Simulated effluent were treated using adsorption technique followed by aerobic/anaerobic treatments and results were compared with the standard norms of Pollution Board. Application of this technique was also subjected to textile industries dye house effluent & results were compared with the standard norms. Cost benefit analysis was also carried out which show that there is huge savings if the textile industries opt the adsorption followed by biological process for the treatment of dye house effluent.

Keywords**:** *Simulated dye house effluents, adsorption, low cost adsorbents.*

I. INTRODUCTION

Dyes are used in many industries such as food, paper, carpets, rubbers, plastics, cosmetics, and textiles in order to color their products [1-3]. Effluents of these industries are highly colored with high Biochemical Oxygen Demand(BOD) as well as Chemical Oxygen Demand(COD) [4] .The disposal of these wastes into receiving water causes damage to the environment as they significantly affect photosynthetic activity in aquatic life[5-6] due to reduced light penetration. Color removal had been the target of significant attention in the last few years, not only because of its toxicity, but mainly due to its visibility problems. Equally, disposal of dye house effluent pose a major environmental problem because they may contain microbial population and may be toxic to the micro-organisms present in treatment plants. If the adsorption system is designed correctly it will produce a high-quality treated effluent [7].Most commercial systems currently use activated carbon as sorbent to remove dyes in wastewater because of its excellent adsorption ability [8]. Adsorption techniques have gained favor in recent years because of their proven efficiency in the removal of pollutants from effluent. Utilizing wastes and bio-wastes of environment as adsorbents for removal of dyes from wastewater is of interest .Number of materials such as saw dust, coconut coir, baggase pith, rice husk , neem tree leaves, and orange peel have been used as low cost adsorbent materials for the removal of dyes from wastewater.[9-13].

The purpose of this study is to investigate adsorption capacity of agricultural waste which is available in abundance at negligible cost for the treatment of effluent of textile industries.

II. MATERIALS AND METHODS

Colors used for experimental work were C.I. Reactive Red 120, C.I. Reactive Blue 198, C.I. Reactive Yellow 135. Stock solution was prepared by taking 100 mg/litre dye in each case. Adsorbents were Sugarcane baggase , Rice husk and Saw dust. Saw dust & rice husk used in the present investigation are procured locally. The bagasse pith is a sugar industry waste by-product, which is available in large quantities at no cost. The sieve analysis was carried out to get the various particle size of adsorbents such as 4.76 microns, 2.36 microns, 1.18microns, 0.710 microns, 0.425microns, 0.200 microns. Pore size of 0.425microns is taken as standard one for experimental work. The adsorbent was washed in distilled water and dried in standard norms.

III. EXPERIMENTAL STUDIES

A. Batch Studies

Dye solution from stock solution (100mg/L) was taken in a flask and adsorbent was added and operated in a rotary shaker at 150 rpm for 15, 30, 60, 120 & 150min.After proper intervals take out the solution in fresh aliquot, centrifuged at 12000rpm for 5min & then 1-2 ml of supernatant is taken in fresh aliquot & subjected to spectrophotometer (Data Vision-Model 600) for residual color evaluation.

B. Column Studies

The glass columns were fabricated for carrying out the column studies at lab scale. The columns were fitted with stop cock at the bottom for controlling flow rate.

The glass columns were supported by iron stand. The input of effluent in glass columns was given in upward direction for providing proper flow distribution and avoiding channeling effect. The outlet of each column has a socket, which facilitates withdrawal of samples without disturbing the main flow. The flow through the columns was maintained by using centrifugal pump. Rota-meter was employed to measure the flow through these columns.

The adsorbents were made up into slurry with distilled water and fed slowly into the column. The depth of the adsorbent was kept 70 percent in the column reactor. The stock solution were prepared for each CI reactive red120, CI reactive yellow 135 and CI reactive blue 198 using 500 mg of dye per liter of soft water to perform the experiments at lab scale. Cotton fabric was dyed at lab scale for 2.5 percent shades by calculating dye from stock solution of each selected dye for research. Analytical grade chemicals were used for dyeing. After dyeing of fabric at lab scale the effluent was collected for treatment. The real dye house effluent was collected from equalization tank of the composite dye house. The treatment was given to simulated and real dye house effluent using specific and mixed adsorbents in following proposed model:

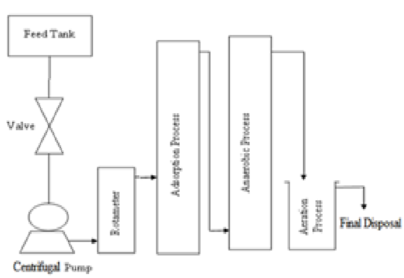

Fig.1 Line diagram of column studies

Different replicates through columns were managed to adjust the flow rate @ 5 mL/ minute. Retention period of effluent through adsorbent unit was 3 hours. It was then fed to the anaerobic unit loaded with activated microorganisms. Retention period for anaerobic process was 5 hours. It was then subjected to aeration process. Retention period for aeration process was 2 hours. Then it was forwarded for recycling / final disposal. The samples were collected at each stage after intervals of 30, 60, 90, and 120 minutes for assessment of various effluent parameters.

IV. OBSERVATIONS

A. Batch Studies

Sr. no.	Control sample (mg)	Sample collection time (min)	Residual colour (mg)	Rate of adsorption against residual colour (%)	Rate of adsorption against control sample (%)
1	5	15	4.5	10	10
2		30	3.95	12.22	21
3		60	3.45	12.65	30.6
4		120	2.97	13.91	40.6
5		150	2.8	5.72	44
6		180	2.65	5.35	47

Tab. 1 Absorption of CI Reactive Red 120 (5mg) on rice husk (2gm)

Similarly, Reactive Blue 198 and Reactive Yellow 135 were treated by varying the dye and absorbent dose.

B. Column study for simulated/real dye house effluent using specific/mixed absorbent

Simulated effluent of reactive dyes was treated in the proposed model using specific mixed absorbents. Similarly, real dye house effluent was treated in the proposed model using specific mixed absorbents.

Sr. No.	Parameters	After dyeing process (A)	After adsorption	After anaerobic	After aeration process (D)
1	Colour	43.2 mg/L	22 mg/L	colourless	colourless
2	BOD_5	289 mg/L	119 mg/L	24.60 mg/L	20mg/L
3	COD	678mg/L	337mg/L	171mg/L	91mg/L
4	TDS	2050mg/L	1406mg/L	1385mg/L	1302mg/L
5	TSS	90mg/L	65mg/L	50mg/L	35mg/L
6	pH	9.0-9.5	8.0-9.0	6.5-8.5	6.5-8.5

Tab. 2 Assessment of parameters for CI Reactive Red 120 effluent using rice husk

Similarly, assessment of parameters for other selected dyes for research and also real dye house effluent were assessed using specific/ mixed absorbents.

C. Recycling of treated effluent

It was observed that the parameters of simulated and real dye house effluent which was treated in proposed model were within the prescribed limits of Punjab Pollution Control Board. The treated effluent was free from any traces of color i.e why there was a high possibility for its reuse in dye house.

It was proved at lab scale by dyeing hundred percent cotton, wool, polyester and acrylic fabric by using reactive dyes, sulphur dyes, vat dyes, acid dyes, acid mordant dyes, disperse dyes and modified basic dyes respectively using zero percent, twenty five percent and fifty percent of treated effluent with soft water.

Properties	Sample I (soft water: treated effluent) 100: 0	Sample II (soft water : treated effluent) 75:25	Sample III (soft water : treated effluent) 50:50	Sample IV (soft water : treated effluent) 40:60
Colour matching	100%	100%	100%	90%
Washing fastness				
- change in shade	4-5 on scale of 5	4-5 on scale of 5	4-5 on scale of 5	3-4 on scale of 5
- staining on white cloth	4-5 on scale of 5	4-5 on scale of 5	4-5 on scale of 5	3-4 on scale of 5
Rubbing fastness				
- Dry	4 on scale of 5	4 on scale of 5	4 on scale of 5	3 on scale of 5
-Wet	3-4 on scale of 5	3-4 on scale of 5	3-4 on scale of 5	2-3 on scale of 5
Light fastness	5-6 on scale of 8	5-6 on scale of 8	5-6 on scale of 8	4-5 on scale of 8

Tab.3 Properties of cotton, acrylic woolen and polyester fabric dyed by fresh soft water along with treated effluent

It was observed that there is significant improvement in net wastage, reduction in sludge wastage and significant reduction in cess, auxiliaries, electricity, soft water production and sludge handling charges by opting the proposed model for treatment of effluent.

V. Results and discussions

It was concluded while using biological process after adsorption, the dye removal was nearly 100 percent with no traces of colour.

It was concluded that the parameters of treated simulated / real dye house effluent using specific / mixed adsorbents were within the prescribed norms of Pollution Control Board. It may due to the adsorption of dyes and auxiliaries by adsorbents and complete breakdown of dyes and intermediates by biological process.

It was concluded that the fastness parameters of fabric dyed with soft water in proportion of 50:50 with treated effluent were not affected however it deviated from the prescribed norms if soft water used with treated effluent in 40:60 ratio.

It was concluded that the net wastage of treated effluent will be improved up to 50 percent. It was due to recycling of treated effluent in dye house.

It was concluded that there may be a successful improvement in sludge reduction. It may be due to the fact that bio mass in the anaerobic process was getting sufficient food only at the initial stages. During the rest of period they were starved of food. It resulted in the decrease in the bio mass population due to endogenous respiration.

It was also concluded that there will be huge savings by replacing the existing process for treatment of effluent with proposed model.

Statistical Analysis of batch and column studies imply that the proposed model is best suitable for treatment of dye house effluent which is technically and economically feasible and socially acceptable.

VI. Conclusion and Scope for Future Study

- Batch and column studies results reveal that parameters of treated effluent by proposed model were within the prescribed norms of Pollution Control Board.
- The percent color removal is almost independent of dyeing loading rate.
- The treated effluent may successfully be recycled in the dye house without any deterioration in the dyeing quality and fastness properties of dyed fabric.
- There may be significant improvement in net wastage.
- There was significant reduction in cess, auxiliaries, electricity, soft water production and sludge handling charges and huge saving of capital per annum.

The following are the areas in which there is future scope of research with reference to present study:

- A research can be conducted to setup pilot plant in dye house industry.
- A research can be conducted to regenerate the adsorbent bed.

- A research can be conducted to analyze the toxicity of treated effluent.

REFERENCES

[1] Aksu Z., "Application of biosorption for the removal of organic pollutants;," A review. Process Biochem 2005;40:997-1026.

[2] Malik P.K.,"Use of activated carbons prepared from sawdust and rice husk for adsorption of acid dyes: a case study of Acid Yellow 36, Journal of Dyes & Pigments," volume 56, pp239-249,2003.

[3] Robinson T,Chandran B,Nigam P, ".Removal of dyes from artificial textile dye effluents by two agricultural waste residues, corncob and barbley husk", Environ Int 2002;28:29-33.

[4] Lee CK, Low KS, Gan PY "Removal of some organic dyes by acid treat spent bleaching earth", Environment Technol 1999;20:99-104

[5] Kadirvely K. et al, "Removal of Cu(II),Pb(II) and Ni(II) by adsorption onto activated carbon cloths.Langmuir", 16:8404-8409.

[6] k Kadirvelu K. et al ,"Utilization of various agricultural wastes for activated carbon preparation & application for the aqueous solution", Bioresourse Technology 87:129-132.

[7] Nigarn P,Banat C.M et al, "Microbial Process for decolourisation of textle effluents containing azo, diazo & reactive dyes", Process Blochem 3,435-442.

[8] C.Faur-Brasquet et al, Adsorption of dyes onto activated carbon cloth, Sep. Purif.Technol.,31(2003)3-11.

[9] Hameed BH,Mohd Din At, "Adsorption of Methylene Blue onto bamboo based activated carbon.", J Hazard Meter 2007;141;819-25.

[10] Prakash KBG et al." Preparation of steam activated carbon from rubber wood sawdust", J Hazard Meter 2006;136;922-9.

[11] Adinata D,Wan Daud WMA, "Preparation and characterization of activated carbon from palm shell by chemical activation" , Bioresourse Technology 2007:98:145-9.

[12] Hameed BH,Hakimi H, "Utilization of durian peel as low cost adsorbent for removal of acid dyes from aqueous solutions," Biochem Eng J 2008;39;338-43.

[13] Beke Z,Zveri I C O,Seki et al ,"Sorption of malachite geeen on chitosan bead,",Hazard meter 2008:154:254-61.

ISSN: 2229-6913 (Print), ISSN: 2320-0332 (Online) © 2016 MID Publications in association with Vidya Publications.
Authors are responsible for any plagiarism issues.