Research Article

Color Removal from Dye Wastewater Using Adsorption

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ABSTRACT

Use of various dyes in order to color the products is a common practice in textile industry. The presence of these dyes in water even at low concentration is highly visible and undesirable. The adsorption process is being extensively used for the removal of dyes from dye house effluents by various researchers. The most widely used adsorbent is commercially available activated carbon. Despite the frequent use of adsorption in wastewater treatment systems, commercially available activated carbon remains an expensive material. In recent years, the safe and economical methods are required for the treatment of dye house effluents, which involved researchers to focus towards the preparation of low cost adsorbents from cheapest sources. This study was carried out for the utilization of orange peel as adsorbent for the removal of dyes from wastewater and to establish it as a standard wastewater treatment process for textile dyeing industry. The materials were obtained and treated for the removal of dyes at different doses. These materials also evaluated for different RPM, contact time and pH. This batch adsorption experiment was carried out for finding the effects of adsorbent's dosage, RPM, pH and retention time on the removal of dyes from the wastewater. The experiment showed that the removal percentage is88.04 at pH of 10,dosage of 2.5g/L, retention time of 120 minutes and RPM of 90.

Keywords: Adsorption, Dosage, Dyes, pH, RPM, Time, Wastewater.

INTRODUCTION

Textile dyeing industry is one of the most water consuming industries after thermal, engineering pulp and paper industries. In India water consumed by textile industries in the year of 2014 was around 2300 Mm^3 (Million cubic meters) and effluent water generated was around 75 per cent of its intake. As the textile industry is one of the most water consuming industries in the country, water treatment systems play an important role here.[1]

Wastewater discharged from industries contains contaminants including dyes. Removal of dyes from industrial wastes using different methods has been reviewed. Biological treatment requires large area and also less tractability in operation. Chemical treatment is not cost effective. Adsorption process is simple and effective manner. Activated carbon is found to be more effective because of high specific surface area, high adsorption capacity.[2]

The utilization of economic, reused waste and eco-friendly adsorbent has been researched as an option process for substitution of presently unreasonable methodology for expelling dyes from waste water.[3]

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 cost effective manners.[4]

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.[5] Moreover, recent reports suggests toxic (microtomic) 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 and paper, tanneries are the most.[6]

MATERIALS AND METHODS

Chemical methods: Chemical methods include coagulation or flocculation combined with floatation and filtration, precipitation, electro floatation, electro kinetic coagulation, conventional oxidation methods by oxidizing agents such as ozone, irradiation or electrochemical processes.[7] Though the dyes are removed completely by this process, it is so expensive and also accumulation of concentrated sludge creates a disposal problem.

Excessive chemical use generates secondary pollution problem.[8] Coagulation includes the use of suitable chemicals, through a chemical reaction, forms an insoluble end product. By this product, substances like dyes from the wastewater effluent can be removed. Generally used coagulants were alum, ferric chloride, etc.[9]Although small colloidal particles can be removed by electro kinetic coagulation, it is not suitable for all type of dyes. Recently, new emerging techniques, known as advanced oxidation process, which are based on the generation of very powerful oxidizing agents such as hydroxyl radicals, have been applied with success for the pollutant degradation. But these methods are costly and commercially unattractive.[10] Common problems in these methods are the high electrical energy demand and the consumption of chemical reagents.

Physical methods: Physical methods used commonly are membrane filtration processes (Nano filtration, Reverse osmosis, Electro dialysis) and Adsorption techniques.

Adsorption: In accordance with the very abundant literature data, liquid-phase adsorption is one of the most popular methods for color removal in dyes. Since proper design of the adsorption process will produce a high quality treated effluent. This process provides an attractive alternative for the treatment of contaminated water, especially if the sorbent is inexpensive and does not require an additional pre-treatment step before its application.[11]

In practice, adsorption techniques are versatile and easy to adopt but adsorbent materials are costly and some cannot be regenerated for large-scale applications. There is therefore a clear need to use low-cost, renewable and easily available adsorbent material for such purposes, otherwise environmental protection will be in jeopardy.[12]

Experimental Procedure

Activated carbon is prepared from orange peel. Experiments were conducted to treat dye effluent using activated carbon prepared form agriculture waste (orange peel).

Test dye solution of 100 mg/l was prepared from effluent solution and this solution is taken in the reagent bottles, varying doses of adsorbent is added to study the feasibility of color removal. A number of such reagent bottles containing the test mixture depending upon the requirement were employed.

Then the reagent bottles containing test mixture was placed in an orbital shaker operating at 90 RPM, to facilitate effective mixing and precipitates formation. Then the reagent bottles containing reaction mixture were kept under undisturbed for 1 hr for settlement of precipitation formed. The settled precipitate is separated from the mixture by filtration with the help of a filter paper. The filtrate is analyzed for percentage color removal by using the calibration curve prepared. The procedure is repeated and measured the effect of other parameters like RPM, time and pH.

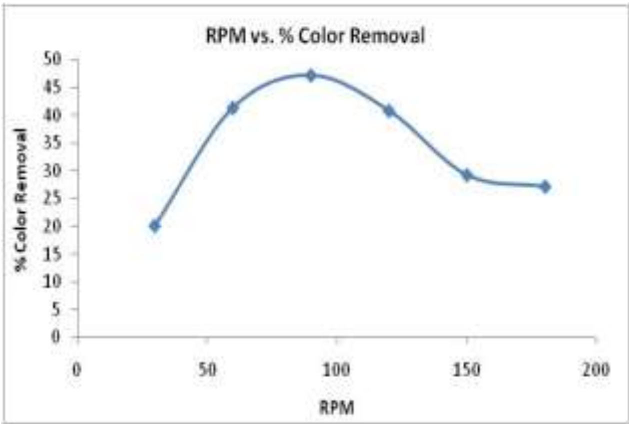
RESULTS AND DISCUSSION

Effect of RPM on % Color Removal

Variation of color removal with RPM for dye effluent is given in Table 1 and Graph 1. Maximum color removal of 47.23 % occurs at optimum RPM of 90.

Table 1: RPM vs. % Color Removal

RPM	% Color Removal
30	20.21
60	41.39
90	**47.23**
120	40.87
150	29.32
180	27.26



Graph 1: RPM vs. % Color Removal

Effect of Time on % Color Removal

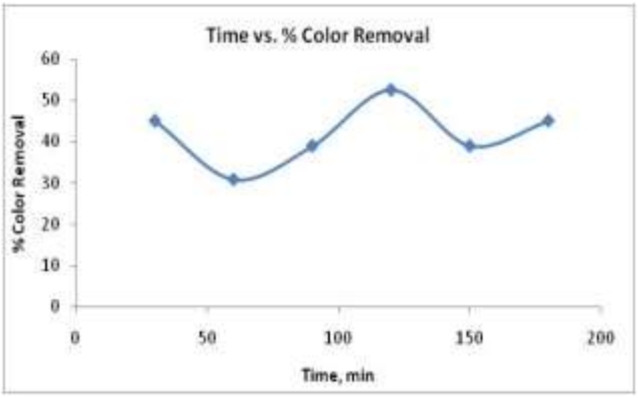
Variation of color removal with time at optimum RPM of 90 for dye effluent is given in Table 2 and Graph 2. Maximum color removal of 52.59 % occurs at optimum time of 120 min.

Table 2: Time vs. % Color Removal

Time	% Color Removal
30	45.12
60	30.89
90	39.02
120	**52.59**
150	39.02
180	45.12

Effect of Dosage on % Color Removal

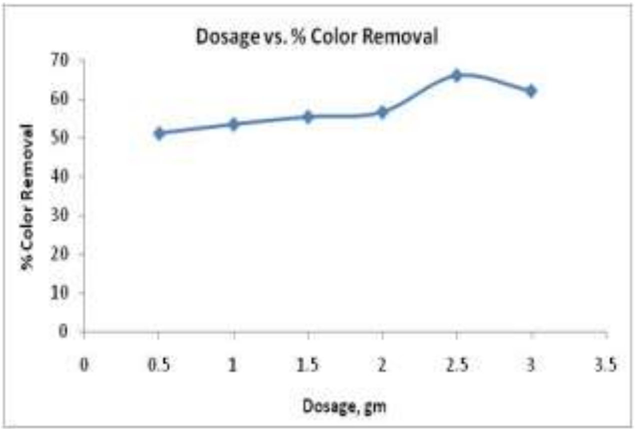
Variation of color removal with dosage at optimum RPM of 90 and optimum time of 120 min for dye effluent is given in Table 3 and Graph 3. Maximum color removal of 66.34 % occurs at optimum dosage of 2.5 gm.



Graph 2: Time vs. % Color Removal

Table 3: Dosage vs. % Color Removal

Dosage, gm	% Color Removal
0.5	51.36
1.0	53.69
1.5	55.63
2.0	56.85
2.5	**66.34**
3.0	62.35



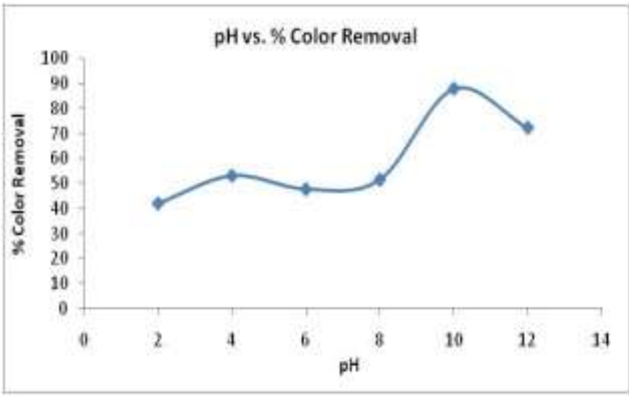
Graph 3: Dosage vs. % Color Removal

Effect of pH on % Color Removal

Variation of color removal with pH at optimum RPM of 90, optimum time of 120 min and at optimum dosage of 2.5 gm for dye effluent is given in Table 4 and Graph 4. Maximum color removal of 88.04 % occurs at optimum pH of 10.

Table 4: pH vs. % Color Removal

pH	% Color Removal
2	42.15
4	53.26
6	47.89
8	51.69
10	**88.04**
12	72.42



Graph 4: pH vs. % Color Removal

CONCLUSION

Maximum percentage of color removal for the textile dyeing industry effluent and optimum values of variables is given in the following table.

Variable	Optimum Value	Maximum % of color removal
RPM	90	47.23
Time	120 min	52.59
Dosage	2.5 gm	66.34
pH	10	88.04

From the results it is concluded that adsorption technique is the most suitable process for treatment of effluent from dyeing industry.

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