

# Dye Waste Water Treatment Using Agro Waste: Green Adsorption

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**ABSTRACT:** Residual colour removal from wastewater of various industries is one of the biggest challenge in front of researchers because of ill effects of these recalcitrant organic molecules. Adsorption is one of the most effective treatment option for dye removal. Currently research is going on for development of effective and inexpensive low cost adsorbent. The objective of this research was to study waste water characteristics from some small scale tie-dye industries from Kutch, Bhuj region and to check suitability of raw low cost adsorbents for removal of colour from effluent of these industries.

**KEYWORDS:** Dyes, Low cost adsorbents, Green technology, Textile waste water.

## I. INTRODUCTION

Residual colour removal from the waste water of various dye user industries such as textile, paper, leather industries, is major cause of concern in recent times since synthetic dyes are designed in such a manner that these are resistant to chemical, photochemical or microbial degradation. Presence of dyes in water bodies, even in small quantity is not tolerable, not only in the aesthetic sense but because of reported carcinogenic, mutagenic and allergenic effects reported in number of research studies. [1-2]. It has been documented that residual colour is usually due to insoluble dyes which are non biodegradable like reactive blue 21, direct blue 80 and vat violet with COD/BOD ratio of 59.0, 17.7, and 10.8, respectively [3]. A number of methods such as coagulation, filtration with coagulation, precipitation, ozonation, adsorption, R.O., ion exchange and AOP's have been used for the removal of dyes and other organic pollutant from wastewater. These methods have been proved to be of limited use to small and medium scale industries, because of high costs involved. Hence there is a need to search for inexpensive techniques which have ease of operation, economic feasibility, design simplicity, easy to maintain, requires no complex skills to operate and be locally or readily available.

The adsorption process for removal of dyes was first attempted in 1912[4] since then the technique is proved to be the most efficient technique for the dye removal. Biosorption i.e. the adsorption of pollutants by inactive, non-living biomass has been used and recommended by various researchers in recent times as an efficient and economically sustainable technology for the removal of synthetic dyes from industrial effluents in recent time.

Low cost adsorbents are derived mainly from cheap waste which is available locally including agricultural waste, such as, coir pith, pine tree bark, neem bark powder, mangroves, acacia, tea waste, dehydrated wheat bran carbon, dehydrated peanut hull etc. may be used as adsorbent for dye removal. This presents a dual purpose solving technique i.e. waste management and wastewater treatment and this would pave the way for green chemistry. Besides this, use of low cost adsorbent makes it suitable for small scale entrepreneurs. Right from synthesis process to treatment technology, green chemistry is finding a firm foothold in all walks of scientific and technological research.

Kutch is one of the most prolific regions in India in the area of textile art. It is a Handicraft and Handloom hub. It comprises large number of small scale industries involved in Bandhani, which is one of the best tie and dye fabrics in India. The waste water from these industries is characterized by intense colour, High pH, COD, BOD, TDS and TSS values. Wastewater from tie-dye contains azo, reactive or vat dyes, these dyes consist complex organic moieties which are very difficult to degrade. The isolation of synthetic organic dyes by adsorption on low cost agricultural adsorbents

has recently become the subject of considerable interest by researchers since these solid wastes are inexpensive and available locally. Thus this approach has the potential to provide a low cost alternative solution to the challenge of management of textile waste water.

## II. LITERATURE SURVEY

An exhaustive survey of literature involving various agro based adsorbents and the dye removal studies have been done which is summarized in table number 1. The agricultural waste materials basically consist chemical compounds like cellulose, hemicelluloses, lignin, and some other bio-organic molecules. containing a variety of functional groups playing important role for binding dyes through different mechanisms.

TABLE 1: DYE REMOVAL USING AGRICULTURAL ADSORBENTS

Adsorbent	Dye	Maximum Adsorption capacity mg/g)	References
Bark	Basic red 2	1119	[5]
Bark	Basic blue 9	914	[5]
Rice husk	Basic red 2	838	[5]
Rice husk	Basic blue 9	312	[5]
Rice husk	Acid yellow 36	86.9	[6]
Rice hull ash	Direct red 28	171	[7]
Pine sawdust	Acid yellow 132	398.8	[8]
Pine sawdust	Acid blue 256	280.3	[8]
Wood sawdust	Basic blue 69	74.4	[14]
Wood sawdust	Acid blue 25	5.99	[14]
Banana peel	Methyl orange	21	[15]
Banana peel	Basic blue 9	20.8	[15]
Banana peel	Basic violet 10	20.6	[15]
Orange peel	Methyl orange	20.5	[15]
Orange peel	Acid violet	19.88	[16]
Orange peel	Basic blue 9	18.6	[15]
Orange peel	Basic violet 10	14.3	[15]
Sugar cane dust	Basic green 4	4.88	[17]
Banana pith	Direct red 28	5.92	[18]
Neem sawdust	Basic violet	3.78	[18]
Wheat bran	Reactive red 180	39.42	[19]
Wheat bran	Reactive red 16	34.03	[19]
Wheat bran	Reactive red 5	36.03	[19]
Wheat bran	Direct red	39.15	[19]
Wheat bran	Acid red	37.76	[19]
Wheat bran	Acid Yellow	199	[19]

The functional groups present on the surface of these adsorbents can form complexes or chelates that immobilize the dye molecules through chemisorption. Generally the adsorption takes place by complexation, ion exchange and hydrogen bonding, diffusion through pores etc. The adsorption is influenced by many process variables, such as dye/adsorbent interaction, surface properties of adsorbent like pore size, pore diameter, surface area, size of adsorbent particle, pH, contact time and temperature etc. The agricultural solid wastes from various cheap and readily available resources such as fruit peels, saw dust, bark of the trees, fallen leaves, seeds, baggase etc. have been investigated for the removal of pollutants from aqueous solutions. The main advantage of adsorption using the low-cost materials as adsorbent is lowering of the procedure cost. The agricultural waste materials have been used in their natural form or after some physical or chemical modification or by conversion into activated carbon. Pretreatment methods using different kinds of modifying agents such as base solutions (sodium hydroxide, calcium hydroxide, sodium carbonate) mineral and organic acid solutions (hydrochloric acid, nitric acid, sulfuric acid, tartaric acid, citric acid), organic compounds (ethylenediamine, formaldehyde, epichlorohydrin, methanol), oxidizing agent (hydrogen peroxide), etc. have been used for the purpose of removing soluble organic compounds like dyes.

### III. OBJECTIVES OF THE STUDY

This study aims to carry out preliminary study for finding suitability of some agro waste for treatment of waste water from tie and dye industries. And to determine physiochemical parameters of waste water from these tie and dye units.

### IV. MATERIALS AND METHODS

- a. Study Area Selected: The area taken for the current study was villages of Bhuj taluka, Kachchh district of Gujarat state. Some 50 dyeing units of this area have been surveyed and by informal interview and using unstructured questionnaire, relevant information has been gathered. The information revealed that on an average 1500 litre of waste effluent is generated per unit and this is discharged directly to drainage without any proper treatment. Each unit produces 40-50 pieces per day and the fabric used are cotton, silk and synthetic while the dye used are direct, azo and vat dye. Our results indicate that almost all the dyeing units are using the hot process, which involves the dissolution of dye powder in water at the required-ratio, boiling it at 80-100 ° C, and then soaking a fabric with this solution for 5 minutes. The synthetic dyes covalently bind with OH-, NH-, or SH- groups in the fibres.
- b. Waste Water Characteristics: The waste water sample were collected from various tie-dye industries in thoroughly washed plastic containers and stored in refrigerated conditions for further physic-chemical analysis. In order to study the characteristics of the tie-dye wastewater, laboratory tests were conducted to determine COD, TDS, TSS, TS and pH.
- c. Selection of adsorbent: Activated carbon is the most popular adsorbent for the removal of pollutants from wastewater, in particular for dye removal. The great capacity of activated carbon to adsorb dyes, is mainly due to its porous texture, which gives it large surface area, and its chemical nature, which can be easily modified by chemical treatment in order to increase its properties. Another source of activated carbon is agricultural waste. Various unused plant parts and some plentiful agricultural wastes have been reported as an additional source of activated carbon. [20]. However agricultural wastes can be used as adsorbent in its raw form also without or with a minimum of processing (washing, drying, grinding) and, thus, reduce production costs by using a cheap raw material and eliminating energy costs associated with thermal treatment [21]. The present study involved neem leaf and neem bark as adsorbents.
- d. Preparation of Adsorbent: Neem tree is native to Indian sub-continent and its botanical name is *Azadirachta indica*. The mature neem leaves and bark used in the present investigation are collected locally from the area around the govt. polytechnic in Bhuj, kutch region. Neem bark pieces collected locally were, first washed with water and air dried in oven at 70°C for 24 hrs. After drying they were grinded and the powder was collected in clean glass bottle

after sieving through sieves of two sieve size (90 & 150 micron). The mature dried leaves were collected, powdered and further washed with distilled water till the washings are free of water soluble impurities and turbidity. Then the neem leaf powder is dried and sieved to different (90 to 150 micron) size fractions. The resulting neem leaf powder fractions are preserved in glass bottles for use as adsorbent.

- e. Experimental Procedure; All the chemicals used for the study were of analytical grade, all the tests are done for multiple number of trials until concordant readings are obtained. The pH was determined using pH meter after calibration using buffers of pH 4.0, 7.0 and 10.0. TDS, TSS, TS and COD has been measured by standard method of water analysis. The original waste water sample (100 ml) from the tie and dye industry was taken in a clean, dry 250ml volumetric flask and its initial pH value is fixed at 7. A fixed dose of already pre-prepared adsorbents were added to the sample( 1 gm) The flask were initially stirred with a glass rod followed by stirring in an orbital shaker for 24 hours at a speed of 150 rpm. Samples were drawn at regular intervals and checked for pH, TDS, COD and colour as per standard methods of waste water analysis. (APHA, 2000).

## V. RESULT AND DISCUSSION

The results of waste water analysis are tabulated in table 2.

TABLE2: WASTE WATER CHARSCTERISTICS

Sample No.	p <sup>H</sup>	TDS	TSS	Colour	COD
S1	9	2387	144	Blue black	439
S2	10	3298		Light yellow	
S3	8	3216	124	Red	390
S4	8.3	1800	120	Light yellow	340
S5	9.8	2354	134	Orange	432
S6	11	3287	176	Pale yellow	480
S7	7	1973	128	Red	400
S8	7.9	2165	130	Blue black	428
S9	8.9	3017	167	Yellow	501
S10	8.4	2891	150	Brown	500
S11	9.7	2651	145	Blue black	480
S12	11	1902	129	Light yellow	390
S13	10.3	1892	122	Orange	355
S14	10	1302	96	Black	304
S15	9.3	1883	110	Orange	358

The decrease in colour and 70-90% decrease in COD, TDS, TSS of various samples has been observed at the end of experiments. The experiment have shown that time plays an important role in removal of colour form waste water and maximum removal was seen with neem leaf powder for a time interval of 18 hrs.

## VI.CONCLUSION

In present work attempt has been made for studying the colour removal efficiency of neem bark powder and neem leaf powder. The medicinal and germicidal role of the neem tree has already been established in number of research studies. This study favors its role as an effective adsorbent material which can be used successfully for removal of colour. The presence of niacin, proline, glutamic acid, aspartic acid, glutamine, tyrosine and alanine which contain polar groups like -NH<sub>2</sub>, -COOH, -OH etc. in neem powder [22] contribute to the negative surface charge.

The maximum color removal efficiency was observed up to 70% for prepared neem leaves. The neem bark powder gives its own colour in the experiment which may be due to tannin content. It was found that colour removal efficiency was achieved maximum under the experimental condition with retention time of 18 hours. The reduction in colour intensity as well COD, TDS, TSS is seen with neem waste adsorbents.. So it can be used as an effective adsorbent. It is further advised to carry out surface characterization and study of the process variables for this treatment system.

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