

## Development of Environmental Friendly Approach for Treatment of Azo Dyes in Textile Effluent

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**Abstract:** Increasing urbanization and industrialization have thus resulted in a dramatic increase in the volume of wastewater. Global water pollution scenario suggests that nearly 1.5 billion people lack safe drinking water and at least 5 million deaths are attributed to waterborne diseases such as cholera, hepatitis every year. The major industries contributing to water pollution are – textile mills, electroplating industry, metal processing industry, pulp and paper mill and tannery industry. In the present study, industrial effluents were collected from textile mills and its evaluation was done by measuring pH, EC, hardness, chlorides, Color intensity etc. Natural adsorbent Red Brick dust was used for removal of color from waste effluent of textile industry. This material evaluated for the removal of color at different pH and time. The material is capable of removing color from waste water; color removal capacity of red brick dust is 80% at 7.00 pH and normal temperature. The experimental result shows that the material has good potential to remove color from effluent and good potential as an alternate low cost adsorbent. There are many physical and chemical treatment methods available for the removal of color but all these methods have problems associated such as secondary effluent, hazardous and harmful end products, high energy consuming, non-economic etc. These problems can be overcome by the use of physical treatment method (Adsorption method) which is simple as well as eco-friendly.

**Key words:** Textile effluent • Azo Dyes • Brick dust • Physical treatment

### INTRODUCTION

From a global perspective the benefits from investments in water have exceeded the costs, but the gains could have been more equitably distributed [1]. 850 million people were undernourished, most of whom live in rural areas in developing countries FAO [2]. Water is an essential element for life. Fresh water comprises 3% of the total water on earth. Only a small percentage (0.01%) of this fresh water is available for human use [3].

**Wastewater Status and Trends:** Like other developed countries of the world, Pakistan is also facing critical water shortage and pollution. The country has essentially exhausted its available water resources PCRWR [4]. It is

considered as water stressed and is likely to have a water scarcity in the near future [5]. Wastewater is any water that has been adversely affected in quality by anthropogenic influence, which most commonly includes a combination of one or more of: domestic effluent consisting of black water (excreta, urine and faecal sludge) and greywater (kitchen and bathing wastewater); water from commercial establishments and institutions, including hospitals, industrial effluent, storm water and other urban runoff, agricultural, horticultural and aquaculture effluent, either dissolved or as suspended matter. Sewage is the subset of wastewater that is contaminated with faeces or urine but it is sometimes used to mean any wastewater. Wastewater management encompasses a broad range of efforts that promote

effective and responsible water use reuse and recycling. Wastewater management is crucial to ensure the quality of water both for human consumption and ecosystems. [6].

The textile industry generates effluents with an extremely heterogeneous composition and a great quantity of toxic and recalcitrant material which makes its treatment more difficult. The effluents have a strong coloration, a great quantity of suspended solids, a highly fluctuating pH, high temperatures, high concentrations of COD and considerable quantities of heavy metals (Cr, Ni, Cu) and chlorinated organic compounds [7].

Water pollution is one of the most undesirable environmental problems in the world and it requires solutions. Textile industries produce a lot of wastewater, which contains a number of contaminants, including acidic or caustic dissolved solids, toxic compounds and any different dyes, many of these dyes are carcinogenic, mutagenic & teratogenic and also toxic to human beings, fish species and microorganisms. Hence their removal from aquatic wastewater becomes environmentally important [8].

**Methods of Treatment of Dyes:** The removal of dyes from these effluents is desired, aesthetic reasons but also because many azo dyes and their breakdown products are toxic to aquatic life [9]. Different physical, chemical and biological techniques can be applied to remove dyes from waste water [10]. Each technique has its technical and economical limitations.

Adsorption has gained a favorable interest due to the efficient pollutant removal, quality Product and economic feasibility. It is influenced by many physio-chemical factors, e.g. dye-sorbent interaction, adsorbent surface area, particle size, temperature, pH and contact time. Materials like activated carbon, peat, wood chips, fly ash and coal, silica gel, Microbial biomass and other inexpensive materials (e.g. natural clay, corn cobs and rice hulls) are used since they do not require regeneration. Sedimentation is a solid-liquid separation method. In the case of dye solutions, it can be used in combination of chemical or biological methods. The disadvantage here is a high sludge production. Flotation is a foam separation technique. Generally, it is performed by adding a surface active ion of the opposite charge to the ion to be separated from the solution. The solid product which appears on the gas-liquid surface is levitated to the Surface of the solution by means of a gentle stream of fine gas bubbles. Coagulation can be induced by an

electrolytic reaction at electrode surface or by changing pH or adding Coagulants [11]. Adsorption techniques for wastewater treatment have become more popular in recent years. Owing to their efficiency in the removal of pollutants, which is difficult to treat with biological method? Adsorption can produce high quality water while also being a process that is economically feasible. Decolourisation is a result of two mechanisms (adsorption and ion Exchange) and is influenced by many factors including dye/adsorbent interaction, adsorbent's surface area, particle size, temperature, pH and contact time. Physical adsorption occurs when weak interparticle bonds exist between the adsorbate and adsorbent. Examples of such bonds are van der Waals, Hydrogen bonding and dipole-dipole movement. In the majority of cases physical adsorption is easily reversible [12].

**Research Background:** Main focus during this research was not only to find a viable treatment approach but it was really desired to utilize immense quantities of waste produced in the Brick kilns in the form of brick dust. The research was planned in order to investigate the performance efficiency of brick dust as an adsorbant as part of physical treatment. Therefore the main objective of the research was to conduct series of experimentation to investigate the removal of Azo Dyes with a significant change in colour with reference to pH variability.

## MATERIAL AND METHODS

**Adsorbent:** The fresh red brick dust was taken from a kiln as residue waste of red brick preparation. The chemical composition on dry weight is Fe<sub>2</sub>O<sub>3</sub> (55%) Al<sub>2</sub>O<sub>3</sub> (13%) SiO<sub>2</sub> (7%) Na<sub>2</sub>O (9%) TiO<sub>2</sub> (3.5%). Red brick dust is used as adsorbent for dye removal. It is a form of filter media that has been processed to make it extremely porous and thus to have a very large surface area available for adsorption or chemical reactions.

**Adsorbate:** The textile dyes effluent collected from the textile drainage treated as adsorbate. pH of the solution maintained at 4, 6, 7 and 9 and passed through the red brick dust.

**Methodology:** Red brick dust is taken in a pipe having a hole for extraction of treated dye solution. 4 liters of Yellow Azo dye effluent passed through the red brick dust used as adsorbent.

**Dimensions:** Diameter of pipe = 3 inches      Length of pipe = 4 ft.      Height of red brick dust in pipe = 1 ft.

## RESULTS AND DISCUSSION

**Before Treatment:** The pH of 4 liter solution maintained at 4, 6, 7 and 9 before treatment. 4 liter dye poured in pipe

of 4 feet height that was filled with red brick dust up to 1 feet height. After that following parameters were measured of dye before passing it through adsorbent. Chloride, EC, Hardness and Color intensity.

### After Treatment:

Table 1: Changing Patterns of different parameters before and after treatment at pH 4

Parameter		Before Treatment	After treatment		
			1hr	2hr	3hr
EC ( $\mu\text{S}/\text{cm}$ )		206	5020	4440	4240
pH		4	5.51	5.58	6.23
$\text{Cl}^-$ (ppm)		62.97	198.87	198.87	265.165
Hardness (ppm)		10	2100	1900	1800
Color intensity (PtCo)	455nm	273	90	60	35
	465nm	222	75	35	26

Table 2: Changing Patterns of different parameters before and after treatment at pH 6

Parameter		Before Treatment	After treatment		
			1hr	2hr	3hr
EC ( $\mu\text{S}/\text{cm}$ )		174	4410	3790	3360
pH		6	5.57	5.17	5.07
$\text{Cl}^-$ (ppm)		36.46	185.72	198.87	232.0
Hardness (ppm)		20	1100	1500	1700
Color intensity (PtCo)	455nm	282	139	62	55
	465nm	237	57	48	38

Table 3: Changing Patterns of different parameters before and after treatment at pH 7

Parameter		Before Treatment	After treatment		
			1hr	2hr	3hr
EC ( $\mu\text{S}/\text{cm}$ )		131	4550	4370	4020
pH		7	6.3016	6.186	6.02
$\text{Cl}^-$ (ppm)		33.1457	331.457	132.58	132.58
Hardness (ppm)		10	1900	1900	1800
Color intensity (PtCo)	455nm	311	15	65	33
	465nm	239	132	30	-4

Table 4: Changing Patterns of different parameters before and after treatment at pH 9

Parameter		Before Treatment	After treatment		
			1hr	2hr	3hr
EC ( $\mu\text{S}/\text{cm}$ )		332	4060	3900	3680
pH		9	5.44	5.37	5.34
$\text{Cl}^-$ (ppm)		36.46	165.7	265.165	272.01
Hardness (ppm)		10	1900	2100	2100
Color intensity (PtCo)	455nm	329	79	84	126
	465nm	273	88	21	18

### Effect on EC:

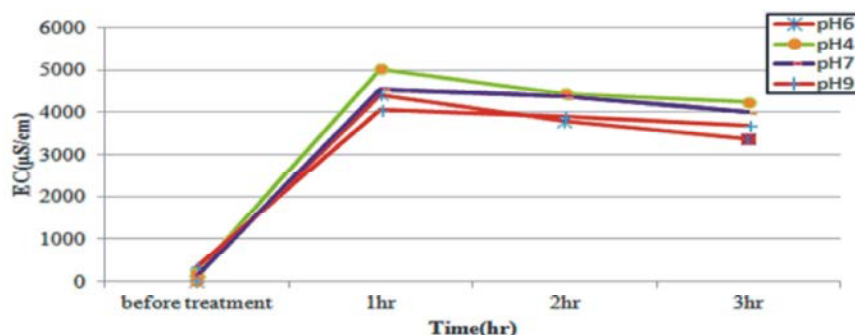


Fig. 1: Contact time vs. EC at diff.pH

The trend of EC was going to decrease at high rate with respect to time. EC is lowest at pH 6.

### Effect on pH:

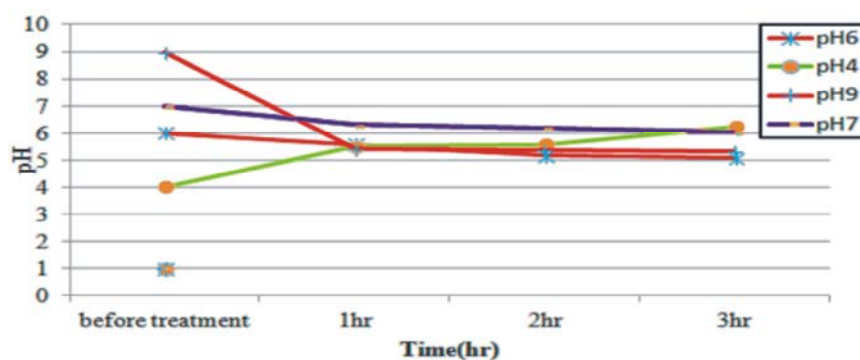


Fig. 2: Contact time vs. pH

The trend of pH was going to decrease in most cases with increase in time and have trend towards acidic solution with pH 7 showed most stable result than other solution of 6, 4 and 9 pH.

### Effect on Chloride:

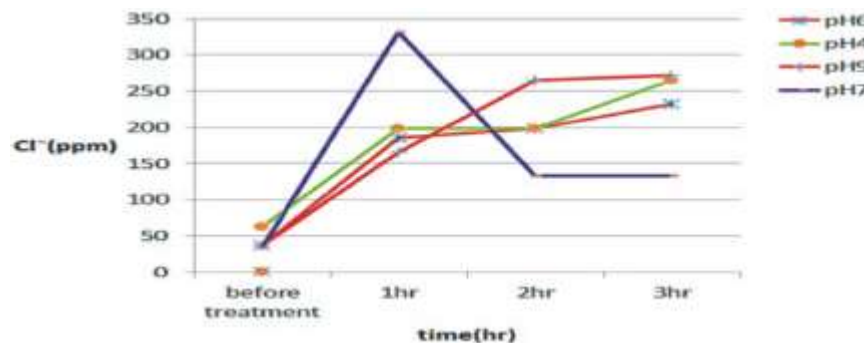


Fig. 3: Contact time vs. chloride at diff.pH

Chloride was also going to increase with increase in contact time with red brick dust. Cl⁻ shows max. value at pH 7 the beginning of treatment at time 1 hour and then abruptly decreased to constant trend.

### Effect on Hardness:

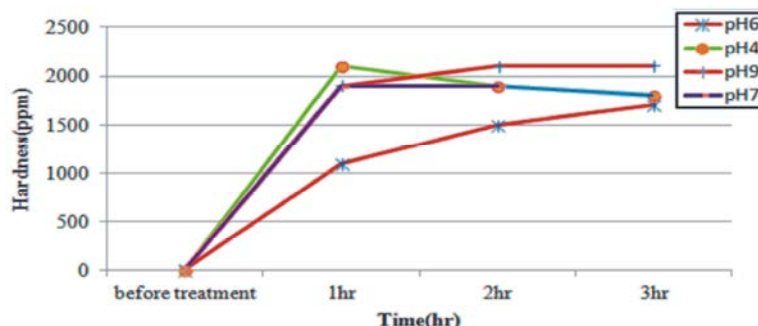


Fig. 4: Contact time vs. hardness at diff. pH

With increasing contact time hardness of solution with pH 6 and 9 increased, but at pH4 and 7 hardness going to decreased markedly.

### Effect on Color:

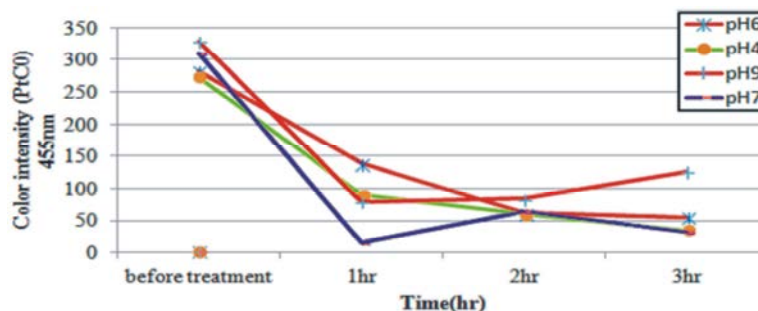


Fig. 5: Contact time vs. color (455nm) at diff. pH

As shown red brick dust has tremendous ability to Adsorbed color, color is removed at pH 7 is max.

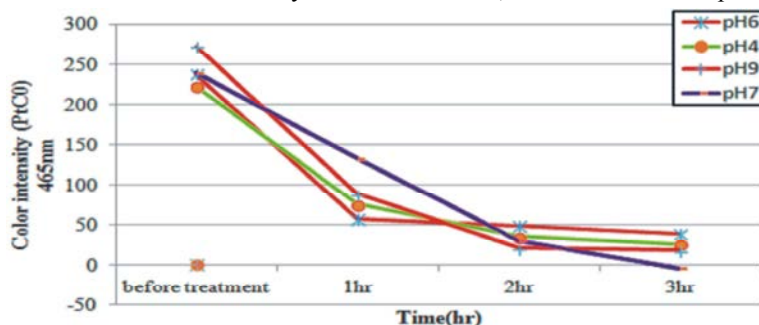


Fig. 6: Contact time vs. color (465nm) at diff. pH

The color intensity shows negative value at pH7 contact time 3hr. its shows at this pH Azo dye is almost decolorized and showed most appropriate result.

### CONCLUSION AND RECOMMENDATIONS

The results of present study shows that red brick dust have suitable adsorption capacity with regard to the

removal of Yellow azo dye from its aqueous solution. Red brick dust is good adsorbent and the adsorption is highly dependent to contact time and pH of aqueous solution of azo dye. The optimal pH for favorable adsorption of Yellow azo dyes is 7. As pH of aqueous solution increases Hardness, chloride and EC tends to increase. It infers that the red brick dust is good adsorbent for the removal of yellow dye. This project can be further

continued by making further studies on the color removal of Direct yellow azo dye by adopting other processes such as flocculation, chemical precipitation, ion exchange, membrane separation. Further studies is also to be continued on increasing the adsorption capacity of the red brick dust by treating it with other acids. Studies have to be further continued to find out if red brick dust can also be used for removal of other dyes. Conclusively, the expanding of red brick dust in field of adsorption science represents a viable and powerful tool, leading to the superior improvement of pollution control and environmental preservation. After such a successful series of experimentation for treatment by using Brick dust as adsorbent, an environmental friendly approach to cope with textile effluent treatment is being proposed and addressed in a very efficient manner.

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