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Reuse of effluent treated water for dyeing

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Abstract

The textile industry occupies a unique place in the economy of India by virtue of its contribution to the industrial output, employment generation and foreign exchange earnings. Environmental protection has become a universal concern. In industrial countries, there is an increasing demand for eco textiles and eco garments. Eco textiles are those which do not contain any hazardous or toxic substances and which are biologically degradable so that they do not cause any damage to the environment and ecology. Concern for environment and desire for eco-friendly products and processes have compelled scientists and technologists all over the world to develop products and processes, which are eco-friendly. The popular saying “do not waste money like water” reveals our ignorance and lack of vision. Water is probably the most important natural resource in the world, since without it life cannot exist and industry cannot operate.

Keywords: DYE, treated water for dyeing

1. Introduction

The various textile items used by consumers are treated with a number of dyestuff and chemicals. This is done for improving the aesthetic appeal of the product and for imparting different performance characteristics to the product. A number of dyestuff and chemicals being used contain certain hazardous substances which cause irreparable damage not only to the environment but also to the person who uses the product. More importantly there is no substitute of water. It is therefore important to control the quality of water and also take a rational approach to its utilization for economy. The textile industry is one of the oldest and largest and consumes large quantities of water for processing of fabrics. A processor should always remember that better the quality of water, richer would be the finish. Depleting fresh water supplies, increasing pollution of our surface and ground water resources and escalating costs of fresh water are compelling the industries to implement measures to conserve and reuse water to the extent feasible. Hence the major objective of the study is

1. To reuse effluent treated water for dyeing
2. To compare the properties of fabric dyed using soft water, well water and effluent treated water
3. To evaluate the feasibility of using effluent treated water in place of soft water or well water for the chemical processing of textiles.

2. Review of literature

2.1 Dyeing

Colour is very subjective to each individual’s perception. According to “standard methods for the examination of water and waste water” colour is defined as the true colour that is the colour of the water after turbidity has been removed says WY. Kwok, JH. Xin and KM. Sin (2003).

The fabric after bleaching may either be dyed or printed. Dyeing and printing are the most complex of the wet processes and includes hundreds of dyes, chemicals such as mordants, fixing agents, acids and alkalies opines Manivasakam (1995) [11, 12].

Dyes are water soluble colours or they can be converted into water soluble compounds, and under the prerequisite conditions for the class of dye the colour is absorbed and retained by the textile fibre says David Green (1972) [3].

In India, most of the dyes consumed are reactive dyes for dyeing cellulosic fibres, because they have a broad spectrum of bright colors, have good wet fastness properties and a reasonable light fastness besides being cheap, can be applied to sliver, yarns and fabrics. Reactive dyes normally donot contain any toxic component says Sole and Jaideep (2003).

The introduction of procion dyes by I.C.I. for cellulosic fibre in 1956 provided a range of dyes in which covalent bonding of the cellulosic fibres of the reactive system of the dye was an important feature. The structure of reactive dyes consist of two parts, the chromogen and the reactive system. The dye chromophore could be azo, anthraquinone or phthalocyanine says Arun Rajan (2003).

Reactive dyes react chemically with hydroxyl groups of cellulose in the presence of alkali. Depending on the dye, fixation varies from 50-95% regards Pitchai (2003).

Reactive dyes had been introduced by ICI in the mid-1950s says Shenai (2003). Reactive dyes are the single most important dyestuff of dyeing cotton substrates, with the exhaust method accounting for 60% of all reactive dye application.

Sekar (2001) views that reactive dyes are more popularly used for the colouration of cellulose as they provide fast dyeings in a relatively simple manner and are able to give almost the whole gamut of hues required.

Reactive dyes react and combine chemically with cellulose and have moderate to good light and washing fastness opines Koushik and Antao (2003) [13].

Dye houses select reactive dyestuffs as their preferred choice based upon considerations of the wide and bright colour gamut available, the ability to apply and control the reactive dyeing system on conventional dyeing machinery and the ability to achieve pale, medium and heavy depths of colour with excellent all-round colour fastness properties opines Ian Holme (2003).

Reactive dyes for cellulose are invariably applied from an aqueous medium solubility in water is conferred by the sulphonate groups in the dye structure says at Kawabata and Taylor (2004)
Reactive dyes react with the fibre to form a covalent bond. They possess in their dye molecule, a reactive group which reacts with the hydroxyl group of the cellulose to form a stable chemical linkage. The dyestuff becomes a part of the fibre views Prayag (2000).

3. Experimental Procedure
3.1 Selection of DYE
The investigator has selected reactive dyes to dye the mercerised fabric.

3.2 Selection of Colour
The dye powder reactive Blue HEGNI was selected for dyeing process.

3.3 Process Parameters

Fabric Weight	-	173 gms.
Shade	-	1.6%
Dye Powder (Blue HEGNI)	-	2.7 g
Dye Liquor	-	865 ml
Sodium Chloride	-	21.69
Soda Ash	-	3.3 g.
Time	-	1hour

Cold Wash → Acetic Acid 5 cc/l. (To neutral) → Soaping → Hot wash
↓
Cold Wash → Fixing Agent 3ml

3.4 Method of Dyeing
The dye bath pH was adjusted to 6.5 to 7.0 with acetic acid and suitable liquor ratio, the material was treated for ten minutes at room temperature. After 15 minutes, the dissolved common salt or Glauber's salt was added and dyed for another 30 minutes. The alkali was added and dyeing was continued for another 30 minutes.

3.5 After Treatment
The dyed material was neutralized with acetic acid and was treated with neutral soap at the boil for 5 minutes and washed free from soap with hot, then with cold water. A dye fixing agent was added finally to fix the dye.

3.6 Characteristics of a dye – house effluent

Table 1: Characteristics of a dye – house effluent

S. No.	Characteristics	Result
1.	Temperature ^{0}C	50
2.	pH Value	10.5
3.	Phenolphthalein alkalinity (as $CaCO_3$) mg/1	13600
4.	Total alkalinity (as $CaCO_3$) mg/1	16100
5.	Total suspended solids mg/1	10200
6.	Dissolved fixed solids mg/1	24060
7.	Total dissolved solids mg/1	29800
8.	Chlorides (as Cl) mg/1	1800
9.	Permanganate value (4 hrs) mg/1	376
10.	Chemical oxygen demand (COD) mg/1	1490

The quantity of effluent generated per 1000 kg of product is about 166500 litres.

4. Results and Discussion
4.1 Evaluation of dyed samples
The dyed samples were evaluated for general appearance, evenness in dyeing, texture, brightness of colour and luster.

Table 2: Evaluation of dyed samples

S. No.	Particulars		Judges Rating (in percentage)		
			DYS	DYW	DYET
1.	General appearance	G	90	85	95
		F	8	10	3
		P	2	5	2
2.	Evenness in dyeing	ED	96	94	94
		MD	4	4	6
		UD	-	2	-
3.	Texture	S	92	88	90
		M	8	6	10
		R	-	6	-
4.	Brightness of colour	B	95	90	95
		M	5	10	5
		D	-	-	-
5.	Luster	L	85	80	85
		M	15	10	10
		D	-	10	5

Key
G - Good
F - Fair
P - Poor
B - Bright
M - Medium
D - Dull
ED - Even Dyeing
MD - Medium Dyeing
UD - Uneven Dyeing
L - Luster
S - Smooth
R - Rough
DYS - Dyeing Using Soft Water
DYW - Dyeing Using Well Water
DTET - Dyeing Using Effluent Treated Water
UTF - Untreated Fabric

From Table-2 it is clearly evident that the general appearance, evenness in dyeing, texture, brightness of colour and luster of the samples dyed with the three kinds of process water were rated uniformly by all the judges. Hence it could be concluded that the samples dyed with effluent treated water are as good in all the observed characteristics. In other words, similar results are obtained with soft water, well water and effluent treated water.

4.2 Dyeing
The physical properties of the fabric dyed in the three kinds of water are given in Table-15. The samples are included in Appendix-VI.

Table 3: Process – Dyeing

S. No.	Fabric Properties		UTF	DYS	DYW	DYET
1	Fabric Weight in gsm		230.4	228.6	219.6	214.2
2	Bending length in inches		8.20	12.76	11.52	11.36
3.	Crease Recovery angle		90	100	96.2	95.4
4.	Abrasion resistance (weight loss)		0.02	0.022	0.018	0.014
5.	Tear strength inch x lb		44.9	42.3	47.7	43.4
6.	Breaking Strength	Load in lb	57.2	55.7	56	56.8
		Elongation in inches	1.54	1.44	2.34	2.5

Table-3 show that sample DYS has got increased fabric weight, bending length, crease recovery angle, weight loss due to abrasion, than samples DYW and DYET. Sample DYW has shown increased value for tear strength and sample DYET has increased value for breaking strength. The marginal differences in physical properties caused due to dyeing using various types of water can be clearly viewed in Figure 3. The values for weight loss due to abrasion and elongation are too low to be visible in the bar chart.

5. Summary and Conclusion

The need for water conservation is accepted regionally as well as globally. Textile Processing has a very high water consumption, which may vary from 30 to 50 m^3/l depending on the product and processing stages required. Hence steps have been taken to reduce the liquor/material ratio, increase the dye bath exhaustion, production modification and reuse of wash baths with or without intermediate precipitation filtration which has resulted in considerable reduction in water treatment cost and has led to enable repeated reuse of dye bath and wash water.

1. Fabrics processed with effluent treated water do not show any properties visual, physical or colour fastness that are lesser than those treated by soft water and well water. The differences if any, found in this study are only marginal.
2. The use of effluent treated water in place of well water or soft water is a feasible and economical alternative in chemical processing.
3. The use of effluent treated water in dye houses will serve two purposes. One is that it will conserve the use of well water in these days of acute water shortage. The other and more important purpose is that it would result in large savings for dye houses that buy water in tankers, especially during the dry summer months, or if they do not have their own wells.
4. The process of dyeing requires the use of soft water to get the maximum colour yield and money value from the processes. The use of effluent treated water, which has better characteristics than well water, will obviate the need for dye houses to establish expensive water softening plants.

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