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Experimental Analysis of Washing and Rubbing Fastness of Cotton Fabric Processed With Recycled Wastewater Using Different Dyes

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Abstract*-Water is essential natural resource for sustaining life and environment, which is always thought to be available in abundance and free gift of nature. Textile industries are one of the major consumers of water and disposing large volumes of effluent to the environment. The textile industry utilizes abundant water in dyeing and finishing processes. There is need to adopt economical practices for the use of water in textile industries. It has been estimated that 3.5 % of the total cost of running the industry is required for water utilization in textile industry. In India textile units are developed all over the country in the form of small industrial estates. Textiles are manufactured to perform a multitude of functions. They are produced to a range of specifications using a variety of fibers, resulting in a complex waste or effluent. Textile waste occurs in a variety of forms throughout production process. Therefore, the cost of water is rising steeply and the textile mills, which need a large quantity of water, have started taking measures to conserve and recycling. Wastewater can be recycled and used in textile wet processing. This paper focuses on Experimental analysis of Washing and Rubbing fastness of cotton fabric processed with recycled municipal wastewater using different dyes. Fastness values of fabric are compared with fabric processed with recycled water, ground water and municipal tap water.

***Index Terms*— washing fastness, rubbing fastness, cotton fabric, recycled municipal wastewater.**

I. INTRODUCTION

When a consumer buys textiles such as clothing fabric, bed linen, home furnishings or any other related material, he or she expects it to perform satisfactorily during use in terms of colour stability and appearance retention, including shape, pilling and fuzziness etc. The problems associated with durability of colour and appearance on wet treatments such as washing and wet rubbing are of global nature, which in turn frequently leads to consumer dissatisfaction and complaints.

Rubbing fastness, wet Tests were carried out with a crockmeter to investigate the force required when rubbing. The rubbing strength for dry rubbing fastness depends more on the fibre material than the profile of the fabric. With cotton textiles the spread of results obtained is significant, while the spread is less with woolen textiles and negligible with man-made fibres. With wet rubbing fastness, almost double the rubbing force is required as with dry rubbing fastness across all fibre types. With wet, in contrast to dry, rubbing fastness, the spread of results is remarkably low, although again it is highest with cotton textiles.

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Test to establish the resistance to all types of industrial and domestic washing. The specimen is treated together with control fabric samples in a suitable mechanical washing device. After the test is completed, the specimen is rinsed twice in cold distilled water, squeezed, rinsed for 10 min in flowing water, the specimen is opened on 3 sides, dried at max. 60°C and then assessed (using grey scales to check the colour change and level of bleeding).

II. WATER USAGE IN TEXTILE INDUSTRY

There are many sources of water, the most common being: Surface sources, such as rivers, Deep wells and shallow wells, Municipal or public water systems, Reclaimed waste streams [5]. The textile industry in India has been pioneer industry. Indian textile industry is the 2nd largest in the world. Overall India is world's 8th largest economy and among the 10 industrialized countries [4]. If global break up of fresh water is seen then from 100 % of freshwater, 20 % is being used by the industries which are responsible for large production of effluents [20]. The rapid growth in population and particularly in urbanization has resulted in sharp increase in generation of these two wastes. In India alone 19000 million liters of sewage is generated every day of which more than 25% is attributed to class I cities. Out of this quantity of sewage 13000 million liters per day (MLD) is collected out of which at the most half is treated to some extent. In terms of nutrients and water availability, economic value of this quantity of domestic sewage has been estimated as Rs. One crore per day. As regards industrial wastewater generation, the same is estimated 10000 MLD, 40% is from small scale industries [3]. Wastewater reclamation and reuse is one element of water resources development and management which provides an innovative and alternative option for agriculture, municipalities and industries [1]. The availability of alternative water sources such as reclaimed municipal waste water or recycled process water can foster more efficient water use practices that translate in to significant cost savings in industries [6].

Experience has shown that the amount of water required in textile processing varies widely, even between similar wet processing at different sites. The quantities water used for various types of processes is of site-specific nature and various processing situations. Many mills have very high water costs, especially when the water is being purchased from a municipal system. These operations usually are much more conservative with water than others with less costly sources [5].

The quantity of water required for textile processing is large and varies from mill to mill depending on the fabrics produced and processed, the quantity and quality of the fabric, processes carried out and the sources of water. The longer the processing sequences, the higher will be the quantity of water required. Bulk of the water is utilized in washing at the end of each process. The processing of yarns also requires large volumes of water [22].

The water usage for different purposes in a typical cotton mill and synthetic textile processing mill is given in table 1.

Table1. Water usage in textile mills

Sr. No.	Purpose	Percentage water use	
		Cotton Textiles	Synthetic Textiles
1	Steam generation	5.3	8.2
2	Cooling water	6.4	-
3	Deminerelized water for specific purpose	7.8	30.6
4	Process water (Raw water)	12.3	28.3
5	Sanitary use	7.6	4.9
6	Miscellaneous and Fire fighting	0.6	28.0

Every textile processor should have knowledge of quantity of water used for processing. Certain simple operations such as sizing requires less water, while others with sequential operations such as dyeing many washings and rinsing, requires large quantities. The quantity of water will vary depending on the material processed and requirements of finish.

Resource recovery contributes to environmental as well as to financial sustainability. It can include agricultural irrigation, aqua- and pisci culture, industrial cooling and process water re-use, or low-quality applications such as toilet flushing [23].

The textile Industry is in no way different than other chemical industries, which causes pollution of one or the other type. The textile industry consumes large amount of water in its varied processing operations. In the mechanical processes of spinning and weaving, water consumed is very small as compared to textile wet processing operations, where water is used extensively. Almost all dyes, specialty chemicals, and finishing chemicals are applied to textile substrates from water baths. In addition, most fabric preparation steps, including desizing, scouring, bleaching, and mercerizing use aqueous systems. According to USEPA a unit producing 20,000 Ib / day of fabric consume 36000 liters of water [24].

Water pollution is of grave consequence because both terrestrial and aquatic life may be poisoned; it may cause disease due to the presence of some hazardous substance, may distort the water quality, add odours and significantly, hinders economic activities. If textile waste water, not properly treated is released into the environment, it can introduce metals (Cr and Cd) and organ chlorine compounds which can bio-accumulate in fishes in receiving streams. These fishes can have harmful effect on human when consumed. Dye residue and degraded starch render the water unfit for drinking because they reduce its quality by imposing colour and odour on water. Hot effluent also affects dissolved oxygen (DO), which in turn affects the aquatic environment of living organisms in such streams [25].

Water is most essential but scarce resource in our country. Presently the quality & the availability of the fresh water resources is the most pressing of the many environmental challenges on the national horizon. The stress on water resources is from multiple sources and the impacts can take diverse forms. Geometric increase in population coupled with rapid urbanization, industrialization and agricultural development has resulted in high impact on quality and quantity of water in our country. The situation warrants immediate redressal through radically improved water resource and water quality management strategies [26].

Study has confirmed that the wastewaters discharged from wet processing textile mills are harmful to the environment. On an average about one million litres of effluent is discharged per day by an average sized textile mill having a daily production of 8000 kg. The industrial owners should implement cleaner technology in the processing stage, so that the waste will be minimized in the initial stage itself [27].

Textile industry is a very diverse sector in terms of raw materials, processes, products and equipment and has very complicated industrial chain. Although there is a large variety of processes and technologies within the textile industry, this sector can be categorized into dry and wet processes. Dry processing includes yarn manufacturing, fabric weaving and knitting while wet processing includes preparation, dyeing and finishing. The textile industry has always been regarded as water intensive sector. The main environmental concern is, therefore, about the amount of water discharged and the chemical load it carries [28].

Due to the various processing steps, such as de-sizing, bleaching, dyeing or finishing in aqueous solutions, the water consumption and chemicals used will differ. The variations also dictate the amount of wastewater that needs to be treated and the different treatment processes that are necessary and feasible. Generally speaking, a textile factory manager's objective should be to recycle internally and to cut down the amount, as well as the chemical load, before releasing wastewater into the environment. Before its release, the water is typically treated again by different means [29].

Main pollution in textile wastewater came from dyeing and finishing processes. These processes require the input of a wide range of chemicals and dyestuffs, which generally are organic compounds of complex structure. Because all of them are not contained in the final product, became waste and caused disposal problems. Major pollutants in textile wastewaters are high suspended solids, chemical oxygen demand, heat, colour, acidity, and other soluble substances [30].

A substantial reduction in water flow can produce corresponding savings in treatment water costs. However, small or token reductions will yield very few, if any, savings [31].

As yet, in the textile areas of Great Britain, there is no shortage of water generally, nor will there be for a long time to come, although there may be local limitations arising from undue abstraction of water. There have been large increases in water charges, however, and these will rise still more in the future, so that it may be economical to limit water consumption and to consider how water may be saved by recycling or reuse after purification [32].

III. NEED OF RECYCLING OF WASTEWATER

The increasing demand for water in combination with frequent drought periods, even in areas traditionally rich in water resources, puts at risk the sustainability of current living standards. The continuous withdrawal of ground water is responsible for the depletion of our underground water resource and this continuous lowering of the underground water level is threatening our existence. Nowadays, many experts are raising awareness among the government and the general people for the upcoming danger of underground water level lowering problem [13].

Various terms are used in water utilization. **Recycle-** Using harvested water for the same or a different function, after treatment or the reuse of treated wastewater [21].

Reclaimed water -Treated wastewater suitable for beneficial purposes such as irrigation.

Reuse - The utilization of appropriately treated wastewater (reclaimed water) for some further beneficial purpose.

The trend is to consider wastewater reclamation and reuse as an essential component of sustainable and integrated water-resource management [14].

IV. MATERIALS AND EXPERIMENTAL METHODS

Pilot treatment plant was prepared and treatment was given to treated municipal wastewater. Units in recycling plant are described below.

1. Municipal treated water storage tank: To store the treated wastewater for further treatments. Also acts as a sedimentation tank.

2. Oil & Grease removal unit: Oil & Grease can be removed with this unit.

3. Slow Sand filter (SSF): Slow sand filter is provided with various layers of sand of different particle size.

4. Granular Activated Carbon filter (GAC): Through this the color and odor from the wastewater is removed.

5. Chlorination unit: This is carried out to disinfect the sewage. For this sodium hypochlorite solution (22 GPL) with various dosages was used.

6. Cationic Exchange Resin (SAC): Here cations like Na^{+} Mg^{++}, Ca^{++} etc was exchanged with H^{+} ions. The cationic exchange resin used was strong acid type

7. Anionic Exchange Resin (SBA): Here anions like $S04^{--}$, $CO3^{--}$, Cl^{-} etc was exchanged with OH^{-} ions. The anionic exchange rein used was strong base type. It is a strong base anion exchange resin based on polystyrene matrix, containing quaternary Ammonium group

Cotton fabric was used for processing. In experiment cold brand, Hot brand and Remazol dyes were used for analysis. Fabric sample was processed with Treated water from pilot treatment plant, Municipal Tap Water and Ground water or Bore water.

V. DYEING PROCESS: SEQUENCE ADOPTED

The industries which are visited in Ichalkaranji are mostly using Reactive Dyes for cotton fabric. In this work three types of reactive dyes are used which are used in actual practice. Reactive dyes used of three categories Cold brand, Hot brand and Remazol brand. Material to Liquor ratio (MLR) used for the process is 1:20.

Dyeing process was carried out with dyes mentioned here with 0.5%, 1.5% and 2.5% shades. For fixation of dyes in the process Sodium Carbonate is used in cold and hot brand dyes. Sodium hydroxide is used for fixation of Remazol reactive dyes.

Commercially reactive dyes were used for the first time over. Their structure is attributed to chemical bonding between suitable groups in the dye molecule and hydroxyl groups in the cellulose fibre. Before the introduction of reactive dyes, cotton was often dyed with direct, vat, sulphur and azoic dyes. For about four decades before the use of reactive dyes, these dyes remained the only feasible method of achieving dyeing of high fastness to wash cellulose textiles. Many industries, such as the textile, leather, paper and plastics industries, are extensive dye users. Among them, the textile industry is the first by quantity and quality of dyes used for the dyeing of various fiber types [15].

Dyeing of cloth has the economic advantage of avoiding storage of fibers and yarns of varied colors. It makes easier to meet demands of the customer for a wide variety of shades, which are subject to rapid changes dictated by fashion [17].

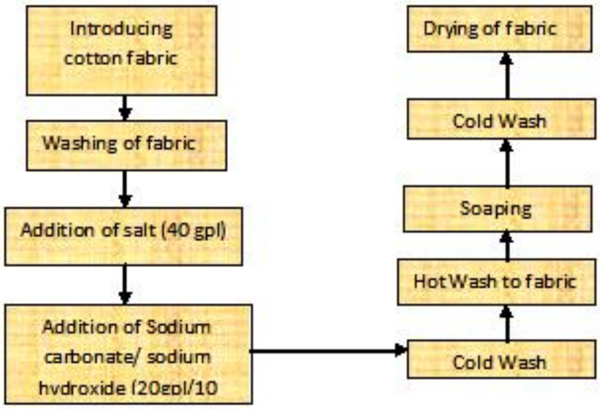

Fig1: Dyeing Process: Sequence adopted

STANDARDS REFERRED

Fastness is the resistance of a dye to removal or destruction. In both industrial processing (finishing, for example) and in ultimate use, a textile might meet a range of challenges. Standard laboratory tests put forth by e.g. ISO. [19]

ISO 105 specifies a method for determining the resistance of the colour of textiles of all kinds, including textile floor coverings and other pile fabrics, to rubbing off and staining other materials. The method is applicable to textiles made from all fibres in the form of yarn or fabric, including textile floor coverings, whether dyed or printed.

ISO 105 specifies five methods intended for determining the resistance of the colour of textiles of all kinds and in all forms to washing procedures, from mild to severe, used for normal household articles.

This part of ISO 105 is designed to determine the effect of washing only on the colour fastness of the textile. It is not intended to reflect the result of the comprehensive laundering procedure.

The quantity of water required for textile processing is large and varies from mill to mill depending on the fabrics produced and processed, the quantity and quality of the fabric, processes carried out and the sources of water. The longer the processing sequences, the higher will be the quantity of water required. Bulk of the water is utilized in washing at the end of each process. The processing of yarns also requires large volumes of water [33].

The water usage for different purposes in a typical cotton mill and synthetic textile processing mill is given in table 2.

Sr. No.	**Purpose**	**Percentage water use**	
		Cotton Textiles	**Synthetic Textiles**
1	Steam generation	5.3	8.2
2	Cooling water	6.4	-
3	Deminerelized water for specific purpose	7.8	30.6
4	Process water (Raw	12.3	28.3

	water)		
5	Sanitary use	7.6	4.9
6	Miscellaneous and Fire fighting	0.6	28.0

Table2. Water usage in textile mills

Every textile processor should have knowledge of quantity of water used for processing. Certain simple operations such as sizing requires less water, while others with sequential operations such as dyeing many washings and rinsing, requires large quantities. The quantity of water will vary depending on the material processed and requirements of finish. The volume of water required for each process is tabulated in table No. 3, 4 and 5.

Sr. No.	**Process**	**Requirements in litres/1000 kg of product**
1	Sizing	500-8200
2	De Sizing	2500-21000
3	Scouring	20000-45000
4	Bleaching	2500-25000
5	Mercerizing	17000-32000
6	Dyeing	10000-300000
7	Printing	8000-16000

Table 3. Water requirements for cotton Textile wet finishing operations.

Note: These quantities may vary in certain mills, depending on the techniques and chemicals employed.

Process	**Water Requirements in litres/1000 kg of product**			
	Rayon	**Acetate**	**Nylon**	**Acrylic**
Scouring	17000-34000	25000-84000	50000 -67000	50000 -67000
Salt bath	4000-12000	-	-	-
Bleaching	-	33000-50000	-	-
Dyeing	17000-	34000-50000	17000-34000	17000-34000
Special finishing	4000-12000	24000-40000	32000-48000	40000-56000

Table 4. Water requirements for synthetic Textiles wet finishing operations

Note: These quantities may vary in certain mills, depending on the techniques and chemicals employed.

Material	**Process**	**Water usages (Litres/ kg)**
Cotton	Desing – continuous	20-92
Cotton	Scouring – continuous	3-94
Cotton	Scouring - Jig	1-48
Cotton	Bleaching – hypochlorite - continuous	4-13
Cotton	Bleaching – hypochlorite - batch	21-173
Cotton	Bleaching – Peroxide - continuous	13-64
Cotton	Bleaching – Peroxide - kier	8-30
Cotton	Bleaching - chlorite - continuous	10-13
Cotton and man-made fibres	Dyeing - continuous	9-63
Cotton and man-made fibres	Dyeing - Jig	4-298
Cotton and man-made fibres	Dyeing - Winch	28-451
Cotton and man-made fibres	Dyeing - Beam	31-166

Table 5. Quantities of water used in Textile processing

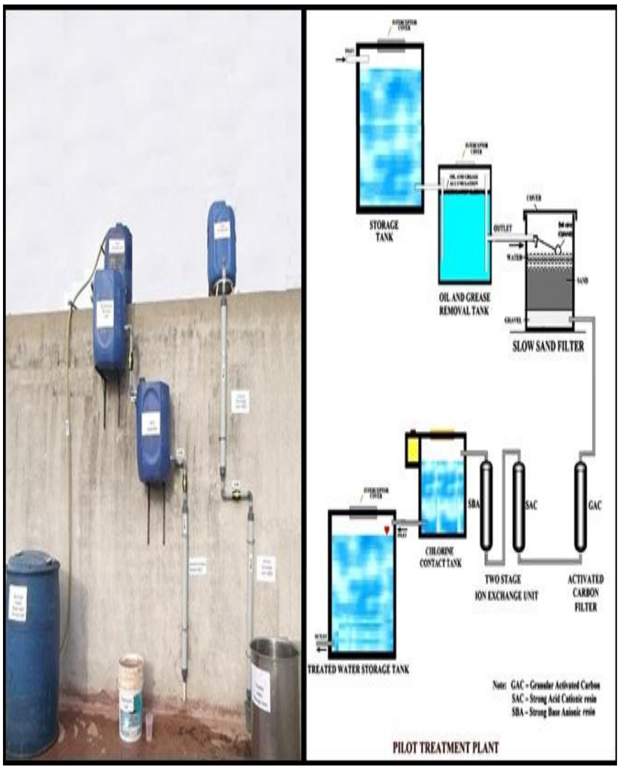

Fig.2 Experimental setup of Pilot Treatment Plant

Washing and Rubbing fastness results:

Table 6 to 14 show fastness ratings Cold brand, Hot brand and Remazol dyes.

Name of Dye	Sr. No.	Perce-ntage	Water sample	Fastness Ratings					
				Washing fastness		Rubbing fastness		Rubbing fastness	
				AATCC	ISO-105	AATCC DRY	AATCC WET	ISO-105 DRY	ISO-105 WET
REACTIVE RED M8B	1	0.5	A	3	3	4	4	4	4
	2	0.5	B	3	3	4	4	4	4
	3	0.5	C	3	3	4	4	4	4
	4	1.0	A	3	3	4	4	4	4
	5	1.0	B	3	3	4	4	4	4
	6	1.0	C	3	3	4	4	4	4
	7	1.5	A	3	3	4	4	4	4
	8	1.5	B	3	3	4	4	4	4
	9	1.5	C	3	3	4	4	4	4
	10	2.0	A	3	3	4	4	4	4
	11	2.0	B	3	3	4	4	4	4
	12	2.0	C	3	3	4	4	4	4
	13	2.5	A	3	2-3	4	4	4	3-4
	14	2.5	B	3	3	4	4	4	4
	15	2.5	C	3	3	4	4	4	4
	16	3.0	A	3	3	4	4	4	3-4
	17	3.0	B	3	3	4	4	4	3-4
	18	3.0	C	3	2-3	4	4	4	3-4

Table 6: Dye Category: COLD BRAND **Type of Dye:** REACTIVE RED M8B

Name of Dye	Sr. No.	Perce-ntage	Water sample	Fastness Ratings					
				Washing fastness		Rubbing fastness		Rubbing fastness	
				AATCC	ISO-105	AATCC DRY	AATCC WET	ISO-105 DRY	ISO-105 WET
PROCION BRILL YELLOW-M4G	1	0.5	A	3	3	4	4	4	4
	2	0.5	B	3	3	4	4	4	4
	3	0.5	C	3	3	4	4	4	4
	4	1.0	A	3	3	4	4	4	3-4
	5	1.0	B	3	3	4	4	4	4
	6	1.0	C	3	3	4	4	4	4
	7	1.5	A	3	3	4	4	4	4
	8	1.5	B	3	3	4	4	4	4
	9	1.5	C	3	3	4	4	4	4
	10	2.0	A	3	3	4	4	4	4
	11	2.0	B	3	3	4	4	4	4
	12	2.0	C	3	2-3	4	4	4	4
	13	2.5	A	3	3	4	4	4	4
	14	2.5	B	3	3	4	4	4	4
	15	2.5	C	3	3	4	4	4	4
	16	3.0	A	3	3	4	4	4	4
	17	3.0	B	3	3	4	4	4	4
	18	3.0	C	3	3	4	4	4	4

Table 7: Dye Category: COLD BRAND **Type of Dye:** PROCION BRILL YELLOW-M4G

Name of Dye	Sr. No.	Perce-ntage	Water sample	Fastness Ratings					
				Washing fastness		Rubbing fastness		Rubbing fastness	
				AATCC	ISO-105	AATCC DRY	AATCC WET	ISO-105 DRY	ISO-105 WET
PROCION BLUE MG MR	1	0.5	A	3	3	4	4	4	4
	2	0.5	B	3	3	4	4	4	3-4
	3	0.5	C	3	3	4	4	4	4
	4	1.0	A	3	3	4	4	4	4
	5	1.0	B	3	3	4	4	4	4
	6	1.0	C	3	3	4	4	4	4
	7	1.5	A	3	3	4	4	4	4

	8	1.5	B	3	3	4	4	4	4
	9	1.5	C	2-3	3	4	4	4	4
	10	2.0	A	3	3	4	4	4	4
	11	2.0	B	3	3	4	4	4	4
	12	2.0	C	3	3	4	4	4	4
	13	2.5	A	3	3	4	4	4	3-4
	14	2.5	B	3	3	4	4	4	4
	15	2.5	C	3	3	4	4	4	4
	16	3.0	A	3	3	4	4	4	4
	17	3.0	B	3	3	4	4	4	4
	18	3.0	C	3	3	4	4	4	4

Table 8: Dye Category: COLD BRAND **Type of Dye:** PROCION BLUE MG MR

Name of Dye	Sr. No.	Perce-ntage	Water sample	Fastness Ratings					
				Washing fastness		Rubbing fastness		Rubbing fastness	
				AATCC	ISO-105	AATCC DRY	AATCC WET	ISO-105 DRY	ISO-105 WET
REACTIVE RED HE8B	1	0.5	A	3	3	4	4	4	4
	2	0.5	B	3	3	4	4	4	4
	3	0.5	C	3	3	4	4	4	4
	4	1.0	A	2-3	3	4	4	4	4
	5	1.0	B	3	3	4	4	4	4
	6	1.0	C	3	3	4	4	4	4
	7	1.5	A	3	3	4	4	4	4
	8	1.5	B	3	3	4	4	4	4
	9	1.5	C	3	3	4	4	4	4
	10	2.0	A	3	3	4	4	4	3-4
	11	2.0	B	3	3	4	4	4	4
	12	2.0	C	3	3	4	4	4	4
	13	2.5	A	3	3	4	4	4	4
	14	2.5	B	3	3	4	4	4	4
	15	2.5	C	3	3	4	4	4	4
	16	3.0	A	3	3	4	4	4	3-4
	17	3.0	B	3	3	4	4	4	4
	18	3.0	C	3	3	4	4	4	4

Table 9: Dye Category: HOT BRAND **Type of Dye:** REACTIVE RED HE8B

Name of Dye	Sr. No.	Perce-ntage	Water sample	Fastness Ratings					
				Washing fastness		Rubbing fastness		Rubbing fastness	
				AATCC	ISO-105	AATCC DRY	AATCC WET	ISO-105 DRY	ISO-105 WET
PROCION YELLOW HE4G	1	0.5	A	3	3	4	4	4	4
	2	0.5	B	3	3	4	4	4	4
	3	0.5	C	3	3	4	4	4	4
	4	1.0	A	3	3	4	4	4	4
	5	1.0	B	3	3	4	4	4	4
	6	1.0	C	3	3	4	4	4	4
	7	1.5	A	3	3	4	4	4	4
	8	1.5	B	3	3	4	4	4	4
	9	1.5	C	3	3	4	4	4	4
	10	2.0	A	3	3	4	4	4	4
	11	2.0	B	3	3	4	4	4	4
	12	2.0	C	3	3	4	4	4	4
	13	2.5	A	3	3	4	4	4	3-4
	14	2.5	B	3	3	4	4	4	4
	15	2.5	C	3	3	4	4	4	4
	16	3.0	A	3	3	4	4	4	4
	17	3.0	B	2-3	3	4	4	4	4
	18	3.0	C	3	3	4	4	4	4

Table 10: Dye Category: HOT BRAND **Type of Dye:** PROCION YELLOW HE4G

Name of Dye	Sr. No.	Perce-ntage	Water sample	Fastness Ratings					
				Washing fastness		Rubbing fastness		Rubbing fastness	
				AATCC	ISO-105	AATCC DRY	AATCC WET	ISO-105 DRY	ISO-105 WET
REACTIVE NAVY BLUE HER	1	0.5	A	3	3	4	4	4	4
	2	0.5	B	3	2-3	4	4	4	4
	3	0.5	C	3	3	4	4	4	4
	4	1.0	A	3	3	4	4	4	4
	5	1.0	B	3	3	4	4	4	3-4
	6	1.0	C	3	3	4	4	4	4
	7	1.5	A	3	3	4	4	4	4
	8	1.5	B	3	3	4	4	4	4
	9	1.5	C	3	3	4	4	4	4
	10	2.0	A	3	3	4	4	4	4
	11	2.0	B	3	3	4	4	4	4
	12	2.0	C	3	3	4	4	4	4
	13	2.5	A	3	3	4	4	4	4
	14	2.5	B	3	3	4	4	4	4
	15	2.5	C	3	3	4	4	4	4
	16	3.0	A	3	3	4	4	4	4
	17	3.0	B	3	3	4	4	4	4
	18	3.0	C	3	3	4	4	4	3-4

Table 11: Dye Category: HOT BRAND **Type of Dye:** REACTIVE NAVY BLUE HER

Name of Dye	Sr. No.	Perce-n tage	Water sample	Fastness Ratings					
				Washing fastness		Rubbing fastness		Rubbing fastness	
				AATCC	ISO-105	AATCC DRY	AATCC WET	ISO-105 DRY	ISO-105 WET
REMAZOL RED RB	1	0.5	A	3	3	4	4	4	4
	2	0.5	B	3	3	4	4	4	4
	3	0.5	C	3	3	4	4	4	3-4
	4	1.0	A	3	2-3	4	4	4	4
	5	1.0	B	3	3	4	4	4	4
	6	1.0	C	3	3	4	4	4	4
	7	1.5	A	3	3	4	4	4	4
	8	1.5	B	3	3	4	4	4	4
	9	1.5	C	3	3	4	4	4	4
	10	2.0	A	3	3	4	4	4	4
	11	2.0	B	3	3	4	4	4	4
	12	2.0	C	3	3	4	4	4	4
	13	2.5	A	3	3	4	4	4	4
	14	2.5	B	3	3	4	4	4	4
	15	2.5	C	3	3	4	4	4	4
	16	3.0	A	3	3	4	4	4	4
	17	3.0	B	3	3	4	4	4	4
	18	3.0	C	3	2-3	4	4	4	4

Table 12: Dye Category: REMAZOL BRAND **Type of Dye:** REMAZOL RED RB

Name of Dye	Sr. No.	Perce-ntage	Water sample	Fastness Ratings					
				Washing fastness		Rubbing fastness		Rubbing fastness	
				AATCC	ISO-105	AATCC DRY	AATCC WET	ISO-105 DRY	ISO-105 WET
REMAZOL GOLDEN YELLOW RNL	1	0.5	A	3	3	4	4	4	4
	2	0.5	B	3	3	4	4	4	4
	3	0.5	C	3	3	4	4	4	4
	4	1.0	A	3	3	4	4	4	4
	5	1.0	B	3	3	4	4	4	4
	6	1.0	C	3	3	4	4	4	4
	7	1.5	A	3	3	4	4	4	4
	8	1.5	B	3	3	4	4	4	4

	9	1.5	C	3	3	4	4	4	4
	10	2.0	A	3	3	4	4	4	4
	11	2.0	B	3	3	4	4	4	4
	12	2.0	C	3	2-3	4	4	4	4
	13	2.5	A	3	3	4	4	4	4
	14	2.5	B	3	3	4	4	4	4
	15	2.5	C	3	3	4	4	4	3-4
	16	3.0	A	3	3	4	4	4	4
	17	3.0	B	3	3	4	4	4	4
	18	3.0	C	3	3	4	4	4	4

Table 13: Dye Category: REMAZOL BRAND **Type of Dye:** REMAZOL GOLDEN YELLOW RNL

Name of Dye	**Sr. No.**	**Perce-ntage**	**Water sample**	**Fastness Ratings**					
				Washing fastness		**Rubbing fastness**		**Rubbing fastness**	
				AATCC	**ISO-105**	**AATCC DRY**	**AATCC WET**	**ISO-105 DRY**	**ISO-105 WET**
REMAZOL TURQUOISE BLUE G	1	0.5	A	3	3	4	4	4	4
	2	0.5	B	3	3	4	4	4	4
	3	0.5	C	3	3	4	4	4	4
	4	1.0	A	3	3	4	4	4	4
	5	1.0	B	3	3	4	4	4	4
	6	1.0	C	3	3	4	4	4	4
	7	1.5	A	3	3	4	4	4	4
	8	1.5	B	3	2-3	4	4	4	4
	9	1.5	C	3	3	4	4	4	4
	10	2.0	A	3	3	4	4	4	4
	11	2.0	B	3	3	4	4	4	3-4
	12	2.0	C	3	3	4	4	4	4
	13	2.5	A	3	3	4	4	4	4
	14	2.5	B	3	3	4	4	4	4
	15	2.5	C	3	3	4	4	4	4
	16	3.0	A	3	3	4	4	3-4	4
	17	3.0	B	3	3	4	4	4	4
	18	3.0	C	3	3	4	4	4	4

Table 14: Dye Category: REMAZOL BRAND **Type of Dye:** REMAZOL TURQUOISE BLUE G

VI. CONCLUSION

Nine dyes were utilized on experimental basis, for the processing purpose. These dyes are mostly used in the industry. Cold brand dyes REACTIVE RED M8B, PROCION BRILL YELLOW-M4G, PROCION BLUE MG MR show Average-good rating. All fastness ratings found above 3.

Similarly Hot brand dyes REACTIVE RED HE8B, PROCION YELLOW HE4G, and REACTIVE NAVY BLUE HER Show fastness rating above 3.

Remazol dyes REMAZOL RED RB, REMAZOL GOLDEN YELLOW RNL, and REMAZOL TURQUOISE BLUE G show average-good performance.

Washing fastness values of all samples have shown satisfactory results as per AATCC and ISO-105.

Rubbing fastness values of all samples as per AATCC and ISO-105 in Dry and Wet condition gave good results.

Cotton fabric should have better washing and rubbing fastness for its resilience in its normal use. Tests performed here shown good results.

Recycled water can be utilized in textile wet processing with same quality of fabric received by utilizing fresh water as Ground water or municipal tap water.

This shows that there is wide scope of utilizing treated wastewater in textile processing, which is water intensive industry.

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