

# Experimental Investigations on k/s values of Remazol reactive dyes used for dyeing of cotton fabric with recycled wastewater

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## ABSTRACT

*Textile industry is water intensive due to varied operations in processing of fabric. Many of textile's operations like bleaching, Mercerizing, dyeing etc. require abundant water to process it. In present study attempt has been made to use the recycled municipal wastewater for dyeing operation in cotton fabric. As textile processing operations are using more water, it is necessary to have required water source. Now a days fresh water sources have to be utilized very carefully due to increasing urbanization. Treated Municipal wastewater which is disposed to any water body on optry land. This water can be further treated and used for textile processing. In this research treated municipal wastewater was given treatment in pilot scale plant and dyeing of cotton fabric was carried out with reactive dyes. This paper encompasses ANOVA study of the k/s values of all dyed fabric samples using pilot plant water*

**Keywords:** k/s values, recycled municipal wastewater, Remazol dyes, cotton fabric, ANNOVA

## 1. INTRODUCTION

Water treated from pilot treatment plant is to be checked with various criteria. Treated pilot plant water is compared with I.S. standard 201:1992. Feasibility analysis carried out to check whether pilot plant water is suitable for all cotton textile wet processing operations. It includes analysis of treated water from pilot treatment plant, analysis by t-test: paired two sample for means, disinfection of treated water by chlorination, properties and quality of cotton fabric processed, details of samples, equipments and procedure used in textile testing, process used for dyeing, desizing, scouring and bleaching etc. Feasibility analysis also comprises detailed analysis of k/s values of fabric dyed with various types of water, analysis by ANOVA: two-factor without replication and washing and rubbing Fastness Results.

## 2. PILOT TREATMENT PLANT

### 2.1 Details of pilot treatment plant

View of laboratory scale pilot treatment plant is shown in Figure 1. Pilot treatment plant comprises various treatment processes and units as municipal treated wastewater storage tank, oil and grease removal unit, slow sand filter (SSF), granular activated carbon (GAC) treatment, chlorination unit, Ion exchange processes using cationic exchange resin (SAC), Anionic exchange resin unit (SBA), and treated wastewater collection tank.



**Fig 1: Photograph of actual pilot treatment plant**

### 2.2 Types of dyes used in the analysis

The industries 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. Table 1 shows types of dyes used in the analysis. Fig. 2 shows photograph of various dyes used in the experimentation.

**Table 1: Types of dyes used in the process**

S. N.	Category	Type of dye
1	Remazol brand	Remazol red RB
2		Remazol golden yellow RNL
3		Remazol turquoise blue G



**Fig 2: Photograph of various dyes used in the experimentation**

### 2.3 k/s values of fabric dyed with various types of water

It is observed that k/s values of cotton fabric dyed by using pilot plant water are higher than other two types of water used for dyeing i.e., ground water and tap water. k/s values found increasing with increase in dye percentage. Analysis is carried out using computer colour matching machine. Percentage shade was checked for dye shade interval of 0.5%. Percentage shades were within range 0.5% to 3.0%.

## 4. GRAPHICAL REPRESENTATION OF PERCENTAGE DYE SHADE AND K/S VALUES

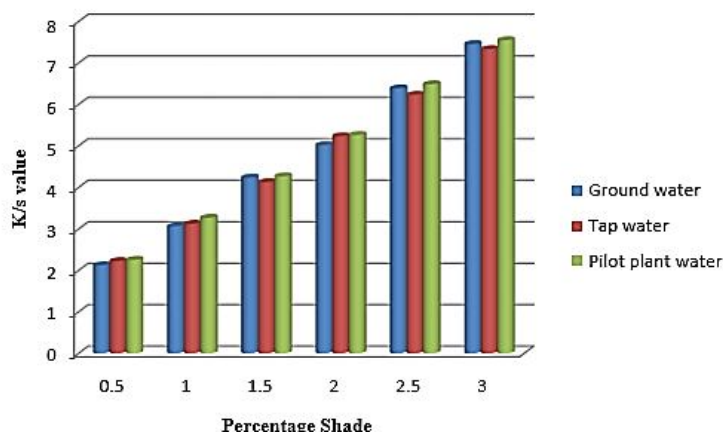
Following Graphs 1 to 3 shows performance of k/s value of ground water, tap water and pilot plant water. k/s values are increasing with percentage dye shade. On x-axis percentage dye shade is taken from 0.5 % to 3.0%. On y-axis k/s value is taken. k/s values of pilot plant water found superior to ground water and tap water.

### 4.1 Analysis by ANOVA: two-factor without replication

Analysis of variance (ANOVA) allows researchers to test for differences in the means of several different groups or populations. ANOVA tests the null hypothesis that the means for all of the groups are equal. The name ANOVA stands for Analysis of Variance is used because the original thinking was to try to partition the overall variance in the response to that due to each of the factors and the error. Predictors are now typically called factors which have some number of levels. (Ref: <http://www.real-statistics.com>.) In following Tables 3, 5 and 7 shows that average k/s values of all dyed fabric samples using pilot plant water are greater than k/s values of other dyed fabric samples using tap water and ground water. P-values of all dyed fabric samples using treated pilot plant water are smaller than 0.05 and positive F values for all samples i.e., for percentage dye shade and water samples indicate that there is significant change in k/s values when used different dyes and water samples. Tables 3, 5 and 7 shows k/s values of cotton fabric dyed with various dyes using percentage shade in evaluation ranges from 0.5 % to 3.0 % with an interval of 0.5 %. From the results obtained it is clear that k/s values fabric samples dyed by using pilot plant water are higher than other two types of water.

**Table 3: Dye category: Remazol brand, type of dye: Remazol red RB**

S. N.	% Shade	k/s values of Remazol reactive dyes		
		Remazol red RB		
		Fabric sample		
		Ground water	Tap water	Pilot plant water
1	0.5	2.1254	2.2256	2.2542
2	1.0	3.0623	3.1215	3.2654
3	1.5	4.2356	4.1253	4.2654
4	2.0	5.0213	5.2352	5.2652
5	2.5	6.3875	6.2353	6.4852
6	3.0	7.4525	7.3325	7.5462



**Graph 1: k/s values of Remazol red RB**

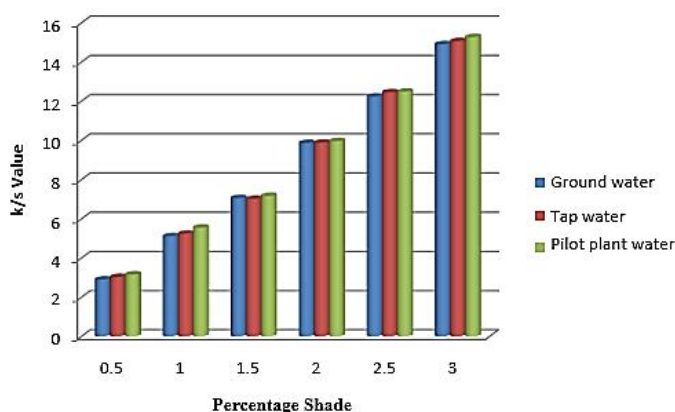
**Table 4: P and F-values for Remazol red RB**

Summary	Count	Sum	Average	Variance		
0.5	3	6.605	2.201	0.004		
1	3	9.449	3.149	0.010		
1.5	3	12.626	4.208	0.005		
2	3	15.521	5.173	0.017		
2.5	3	19.108	6.369	0.016		
3	3	22.331	7.443	0.011		
Ground water	6	28.284	4.714	4.010		
Tap water	6	28.275	4.712	3.703		
Pilot plant water	6	29.081	4.846	3.941		
ANOVA						
Source of Variation	SS	df	MS	F	P-value	F crit
Percentage dye Shade	58.215	5	11.643	1924.162	1.414E-14	3.325
Water samples	0.071	2	0.035	5.900	0.020	4.102
Error	0.060	10	0.006			
Total	58.347	17				

In above Table 4, P-values 1.414E-14 and 0.020 of all dyed fabric samples using water samples are smaller than 0.05 and positive F-values are 1924.162 and 5.900 for percentage dye shade and water samples indicate that there is significant change in k/s values when used different dyes and water samples.

**Table 5: Dye category: Remazol brand, type of dye: Remazol golden yellow RNL**

S. N.	% Shade	k/s values of Remazol reactive dyes		
		Remazol golden yellow NL		
		Fabric sample		
		Ground water	Tap water	Pilot plant water
1	0.5	2.8955	3.0254	3.1542
2	1.0	5.1022	5.2352	5.5495
3	1.5	7.0546	7.0125	7.1651
4	2.0	9.8574	9.8754	9.9565
5	2.5	12.2351	12.4525	12.4865
6	3.0	14.8985	15.0545	15.2656



**Graph 2: k/s values of Remazol golden yellow RNL**

**Table 6: P and F-values for Remazol golden yellow RNL**

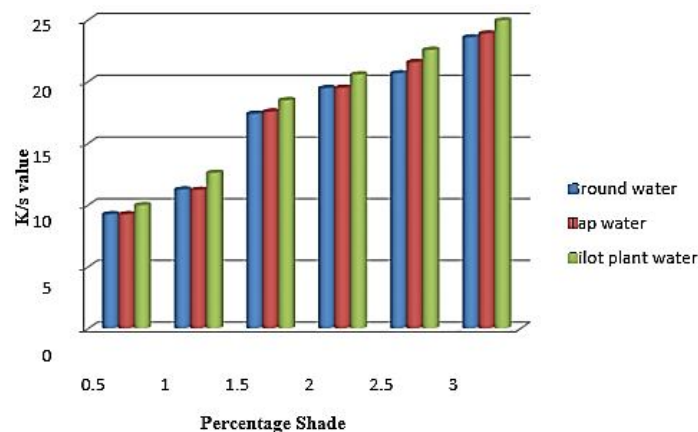
Summary	Count	Sum	Average	Variance		
0.5	3	9.075	3.025	0.016		
1	3	15.886	5.295	0.052		
1.5	3	21.232	7.077	0.006		
2	3	29.689	9.896	0.002		
2.5	3	37.174	12.391	0.018		
3	3	45.218	15.072	0.033		
Ground water	6	52.043	8.673	20.319		
Tap water	6	52.655	8.775	20.572		
Pilot plant water	6	53.577	8.929	20.348		
ANOVA						
Source of Variation	SS	df	MS	F	P-value	F crit
Percentage dye Shade	306.140	5	61.228	9674.969	4.422E-18	3.325
Water samples	0.198	2	0.099	15.705	0.000	4.102
Error	0.063	10	0.006			
Total	306.402	17				

In above Table 6, P-values 4.422E-18 and 0.000 of all dyed fabric samples using water samples are smaller than 0.05 and positive F-values are 9674.969 and 15.705 for percentage dye shade and water samples indicate that there is significant change in k/s values when used different dyes and water samples.

**Table 7: Dye category: Remazol brand, type of dye: Remazol turquoise blue G**

	%	k/s values of Remazol reactive dyes
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S. N.	Shade	Remazol turquoise blue G		
		Fabric sample		
		Ground water	Tap water	Pilot plant water
1	0.5	9.2547	9.2524	9.9852
2	1.0	11.2514	11.2252	12.5956
3	1.5	17.3845	17.5552	18.4825
4	2.0	19.4578	19.4879	20.5693
5	2.5	20.6654	21.5652	22.5648
6	3.0	23.5825	23.8989	24.9556



**Graph 3: k/s values of Remazol turquoise blue G**

**Table 8: P and F-values for Remazol turquoise blue G**

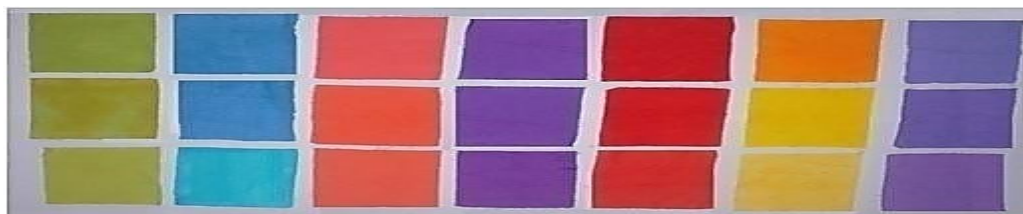
Summary	Count	Sum	Average	Variance		
0.5	3	28.492	9.497	0.178		
1	3	35.072	11.690	0.614		
1.5	3	53.422	17.807	0.349		
2	3	59.515	19.838	0.400		
2.5	3	64.795	21.598	0.902		
3	3	72.437	24.145	0.517		
Ground water	6	101.596	16.932	31.192		
Tap water	6	102.984	17.164	33.629		
Pilot plant water	6	109.153	18.192	33.854		
ANOVA						
Source of Variation	SS	df	MS	F	P-value	F crit
Percentage dye Shade	492.850	5	98.570	1853.351	1.705E-14	3.325
Water samples	5.393	2	2.696	50.702	5.827E-06	4.102
Error	0.531	10	0.053			
Total	498.775	17				

In above Table 8, P-values 1.705E-14 and 5.827E-06 of all dyed fabric samples using water samples are smaller than 0.05 and positive F-values are 1853.351 and 50.702 for percentage dye shade and water samples indicate that there is significant change in k/s values when used different dyes and water samples.

Following Table 9 shows type of dye and comparison of colour shades of fabric processed with ground water, tap water and pilot plant water. Fig 3 shows photograph of fabric samples dyed with various dyes.

**Table 9: Colour shades of fabric**

S. N.	Type of dye	Ground water	Tap water	Pilot plant water
Category: Cold brand				
1	Reactive red M8B			
2	Procion brill yellow-M4G			
3	Procion blue MG MR			
Category: Hot brand				
1	Reactive red HE8B			
2	Procion yellow HE4G			
3	Reactive navy blue HER			
Category: Remazol brand				
1	Remazol red RB			
2	Remazol golden yellow RNL			
3	Remazol turquoise blue G			



**Fig 3: Photograph of fabric samples dyed with various dyes.**

**5. CONCLUSION**

Tables 3, 5 and 7 show k/s values of cotton fabric dyed with various dyes using percentage shade in evaluation ranges from 0.5 % to 3.0 % with an interval of 0.5 %. From the results obtained it is clear that k/s values fabric samples dyed by using pilot plant water are higher than other two types of water. Average dye depth increases of 5% to 10% can be observed in case of pilot plant water compared with other two. This ultimately results in saving in quantity of dye of the textile industry. Tables 3, 5 and 7 shows that average k/s values of fabric sample dyed by using pilot plant water are greater than k/s values of fabric sample dyed by using ground water and tap water.

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