ISSN: 1999-1630

SEU Journal of Science and Engineering, Vol. 11, No. 1, June 2017

Dyeing of Cotton Fabric with Usual Water and Rain Water

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Abstract

The aim of this work is to determine the dyeing effect of 100% cotton fabric using normal water and rain water. In this paper, we focused on the shade differences, spectrophotometric evaluation, wash fastness and rubbing fastness. The illustrated quality parameters of both type of dyed samples have been compared and found that the results are almost same for 0.5%, 1% and 2% shade.

Keywords: Rain Water, Normal Water, Rain Water Harvesting.

I. Introduction

The main sources of water for the textile industries in Bangladesh are municipal water and/or ground water. Knit fabric wet processing requires extensive amount of water consumption. Almost all of the export oriented textile industries are using the ground water for the better quality of products. But recent studies (AIW 2017) depict that the ground water level is declining over the years. Now it is the prime time to find other alternative sources of water for textile wet processing. Rain water can be a viable alternative to ground water in this regard. In simple terms, rain water can be harvested by collecting rainwater that falls onto roofs or other collectable surfaces within the vicinity of the factory and storing it for later use on-site with the installation of relatively simple technologies.

Some precautionary measures (such as filtering, cleaning and monitoring of reservoir, temperature etc., elimination of contamination and other foreign matters, cleaning of surface from where the water is collected etc.) may be taken prior to using the collected rain water in the textile industry. More complex installations can be implemented collecting water from a cluster of buildings and factories or even renting public/private property in this regard. The use of rain water is also linked to urban sustainability which recognizes the importance of local solutions and the key role of local governments, industries and the society in the search of sustainable development. The main inconvenience of rainwater harvesting is the unpredictability in the amount of rainfall in a fiscal year. However, even if rain water harvesting may not be an absolute solution for the industries, it could meet part of the water demand, especially during the wet season (S. Yeasmin*et. al.* 2013, A. Tabassum 2013, S.A. Nahian *et. al.* 2013, S. A. Haq 2013, C. Kloss 2008).

In this study, we investigated the effects of dyeing of cotton fabric in different shade% (0.5%, 1% & 2%) with reactive dyes using normal water and rain water. The effects of various fastness (color fastness to wash, rubbing fastness etc.) properties of dyed fabrics were also studied and reported in this paper.

II. Materials and Methods

Working Procedure

At first, we collected 5 g of each sample of 100% cotton fabric and calculated the chemicals and auxiliaries according to the recipe for the dyeing of the sample. Then we kept all the chemicals and auxiliaries in the dye pot and set it in burner. The temperature was gradually raised and fixed at 60°C. Dyeing was carried out for 20 min then soda ash was added. The dyeing procedure was again continued for 40 min at same temperature. After dyeing the fabric; it was washed with cold water. Finally, the samples were washed again with hot water and it was dried.

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Required chemicals

Table1: Dyes and chemicals used for dyeing of fabrics

Bezaktiv Red S-3B	0.5%	1%	2%
Wetting Agent (g/L)	1	1	1
Sequestering Agent (g/L)	1	1	1
Anti creasing agent (g/L)	1	1	1
Leveling Agent (g/L)	1	1	1
Glauber Salt (g/L)	20	30	40
Soda Ash (g/L)	8	12	16
Temperature x Time	60^0C x 60 mins	60^0C x 60 mins	60^0C x 60 mins
pH	11-12	11-12	11-12
M:L	1:40	1:40	1:40

Comparison on shade variation

The shade difference of the samples has been evaluated by verivide light box. The color shades of the dyed fabrics are evaluated by illuminant D_{65} standard observer.

Spectrophotometric evaluation

Strength of any colorant (dyestuff / pigment) is related to absorption property. Kubelka – Munk theory gives us the following relation between reflectance and absorbance: $K/S = [\{(1-R)^2/ 2R\}]$ Where R is the reflectance, K is absorbance and S is the scattering. By using the above equation color strength of different samples were measured. The spectrophotometric evaluation of the samples has been done by Data color 650 ™.

Color fastness to wash

Color fastness to wash was done by the ISO 105 C03 method. Sample size was 10cm × 4cm. 4 g/L European Color Fastness Establishment (ECE) reference detergent & 1 g/L sodium carbonate solution was used in open bath wash at 40°C.

Color fastness to rubbing

This test is designed to determine the degree of color which may be transferred from the surface of a coloured fabric to a specific test cloth for rubbing (dry and wet), Method: ISO 105 × 12 and Crock master has been used for rubbing test.

III. Results and Discussions

Comparison of shade

Table 2 shows the dyeing recipe and the shades of each samples dyed with rain water and normal water. The comparison was done under D_{65} light source in verivide light box. Bezaktiv Red S-3B dyes of cold brand was used for colouring. The amount of salt and soda were mentioned on the table.

Table 2: Dyeing recipe & comparative shade between the samples

Recipe	Normal Water dyed	Rain water dyed
Bezaktiv Red S-3B 0.5% Salt/Soda (g/L) 20/8		
Bezaktiv Red S-3B 1.0% Salt/Soda (g/L) 30/12		
Bezaktiv Red S-3B 2.0% Salt/Soda (g/L) 40/16		

Spectrophotometric Evaluation

The light sources D_{65} and TL_{85} were used for the spectrophotometric evaluation. The lightness (DL), saturation (Dc), Tone (DH), CIE lab value for references (Da and Db), total color deviations (DE) were evaluated between the samples of normal water and rain water dyed cotton samples. Normal water dyed samples were taken as standard. Table 3 shows that the samples of 0.5%, 1% and 2% shades of both water dyed samples have been passed by CMC (Colour matching committee) decision. The DE value for 0.5% shade was 0.02 in both light sources and metamerism index was 0.03. Similarly for 1% shade the DE values were 0.02 and 0.01 under D_{65} and TL_{85} light sources respectively and metamerism index was 0.03. The samples of 2%

shade% the DE values were 0.01 and 0.06 under same light sources where metamerism index was 0.08.

Table 3: Spectrophotometric evaluation of different shade of fabric samples

Shade %	ILL/Obs	DL	Da	Db	Dc	DH	CMC DE	CMC Decision	Metamerism Index
0.5	D_{65}	-0.01	-0.01	-0.03	-0.01	-0.03	0.02	Pass	0.03
	TL_{85}	-0.02	-0.04	-0.02	-0.04	-0.02	0.02	Pass	
1	D_{65}	0	-0.04	0.01	-0.04	0.01	0.02	Pass	0.03
	TL_{85}	-0.01	-0.02	-0.01	-0.02	-0.01	0.01	Pass	
2	D_{65}	-0.02	-0.02	0.02	-0.02	-0.02	0.01	Pass	0.08
	TL_{85}	-0.02	-0.02	0.1	-0.01	0.2	0.06	Pass	

Colour strength K/S value comparison

Table 4 shows the colour strength (K/S) evaluation of normal water and rain water dyed fabric samples of 1% and 2% shade. For 1% shade the maximum K/S value was 5.0 at 520-540 nm and the minimum K/S value was about 0.2 at 620 nm for both fabric samples which indicates that the results were almost same. Similarly for 2% shade the maximum K/S value was 8.5 and about 9.7 at 520-540 nm for normal water and rain water respectively. The minimum K/S value was at 640 nm. The maximum K/S value for rain water was found slightly higher.

Wash Fastness Test

The samples of 2% shade for both water dyed fabrics were evaluated for wash fastness test. Table 5 shows the result of change in colour due to wash of normal and rain water dyed fabric samples. The wash fastness ratings for both samples were found 4-5. This indicates that the wash fastness is same for both samples.

Table4: K/S value evaluation of different shade of fabric samples

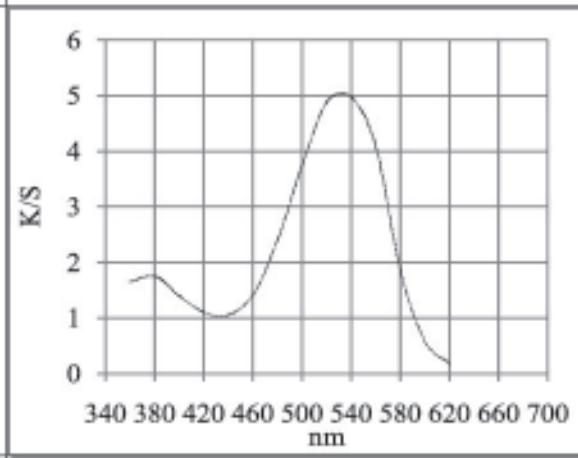
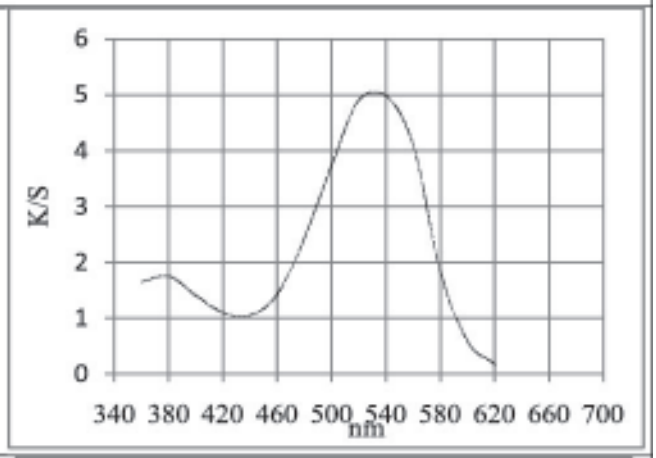
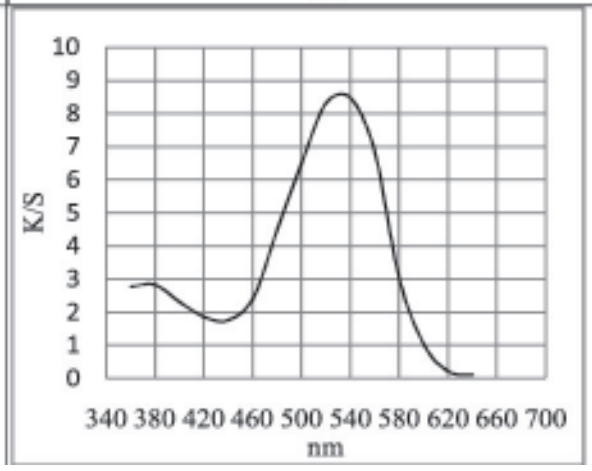
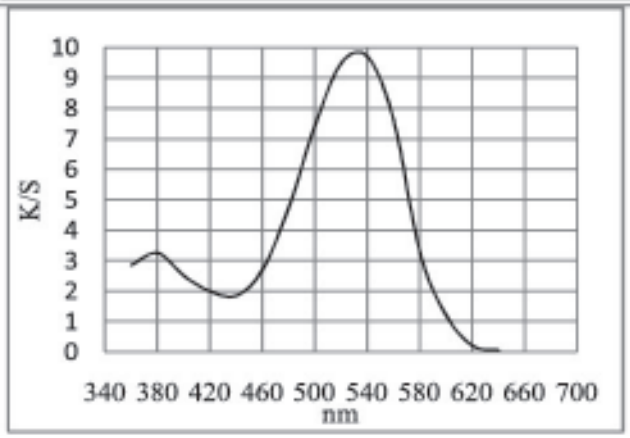
Shade	Normal water dyed sample	Rain water dyed sample
1%		
2%		

Table 5: Result of color fastness to Wash test (color change)

Water Type	Grade	Remarks
Normal Water	4-5	Very good
Rain Water	4-5	Very good

Color fastness to rubbing

The samples of 2% shade for both water dyed fabrics were evaluated for rubbing fastness test.

Table 6: Results of rubbing fastness test (Dry and Wet Condition)

Rubbing Type	Water Type	Grade	Remarks
Dry	Normal Water	4-5	Very good
	Rain Water	4-5	Very good
Wet	Normal Water	4	Good
	Rain Water	4	Good

Table 6 illustrates the rubbing fastness in dry and wet condition of normal and rain water dyed fabric samples. In dry rubbing, the scale is 4-5 which indicates very good result and in wet rubbing, the scale is 4 which is also a good result. Hence, it means that there was not any change in fastness with the change in water of different sources during dyeing.

IV. Conclusion

This work was investigated to see the influence of different types of water on cotton fabrics with different shade percentages. The results showed that normal water and rain water dyed cotton fabric with reactive dyes were almost similar for 0.5%, 1% and 2% shades. It was found that the wash fastness is very good for both fabric samples. In dry rubbing fastness, the result was also very good for both water dyed fabric samples. The wet rubbing fastness was also found good.

The K/S values of normal water and rain water dyed fabric samples were almost same.Research is required to assess the feasibility and cost effectiveness of rain water harvesting.

Acknowledgements

The authors would like togive thanks to Mr. ZunaiedMorshed, ShahadatShaharier, AbidHasanMurad and Muhammad Rafayat Amin for their help in experiments.

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