Effect of Desizing Modes on Dyed Cotton Fabrics for Colourfastness to Sunlight and Perspiration

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Summary: Desizing is applied to the yarn for ease in weaving process. In this study, three different desizing modes i.e., water, acid and enzymatic were used. The samples were bleached in Salomatic bleaching process. Finally samples were dyed with direct, sulphur and reactive dyes. Colourfastness to sunlight and perspiration were checked on grey scale. The sizing material was removed efficiently by the enzymatic desizing mode. However, the different dyes showed somewhat similar colourfastness to sunlight and perspiration.

Introduction

Desizing is a process of removal of sizing material. Different types of sizing materials are being used in the industries. The sizing material is of no use after the yarn being woven into a fabric. It is generally assumed that sizing material has to be removed completely in order to achieve satisfactory levelness of scoring/bleaching and dyeing operations. Degree of proper desizing can be determined by extremely sensitive iodine test. Improper desizing may result in faulty dyeing of fabrics like un-even dyeing, variation in shades, irregular printing and ultimately substandard finishes of the fabrics. Reactive dyes showed excellent dye affinity and fastness to light and perspiration [1]. In 1983 Othmer [2] reported that enzymatic desizing had better results regarding softness of cloth. Bahrini and Burkinshaw [3] studied the extent of fixation of six dichlorotriazinyl dyes on cotton and noted that the extent of dye fixation was enhanced by modifying the dying method.

The study in hand was carried out to determine the best mode of desizing of cotton fabrics in the dyeing industries.

Results and Discussion

The results of the study regarding colourfastness to sunlight and perspiration of cotton fabric desized with acid, water, enzyme and dyed with sulphur, direct, reactive dyes are given in Tables/ Bar-diagrams and discussed here as under:-

Colourfastness to sunlight

The desized samples showed scoring on grey scale with water treatment as 4,3, 4; with acidic treatment as 4, 4-5, 5; and with enzymatic treatment as 5, 4, 5 for sulphur, direct and reactive dyes coating respectively. It means that the desizing mode with enzymatic treatment for sulphur and reactive dyes showed excellent colourfastness to sunlight. The performance of acidic treatment for reactive dyes was also excellent.

Colourfastness to perspiration

The two type of perspiration solutions were used i.e., acidic and alkaline, therefore colourfastness of the samples were studied separately.

Acidic perspiration

Colourfastness to perspiration of water desized samples

The samples on grey scale showed "scoring of 3 for all dyed treatment *i.e.*, sulphur, direct and reactive dyes. It means "good" colourfastness to perspiration for all the samples. However, Peters [4] observed moderate fastness to perspiration of water desized samples.

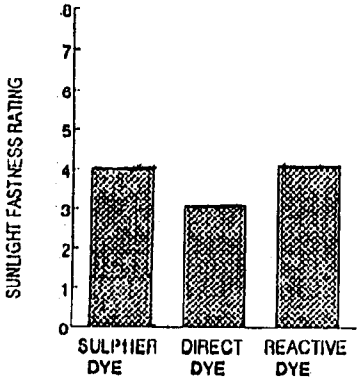
Colourfastness to perspiration of acid desized samples

The samples dyed with sulphur, direct and reactive dyes scored a rate of 4,5 and 5 respectively

TABLE/GRAPH 1

COLOURFASTNESS TO SUNLIGHT

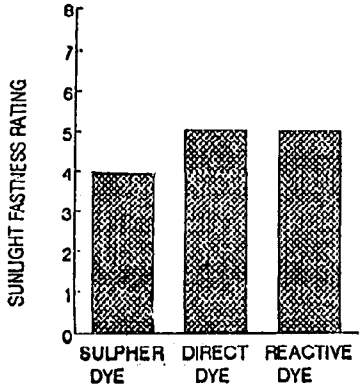
SUNLIGHT EXPOSURE PERFORMANCE OF WATER DESIZED SAMPLE



Water Desized Sample	Sunlight Fastness Scoring	Rating
Dyed with Sulpher Dye	4	Very Good
Dyed with Direct Dye	3	Good
Dyed with Reactive Dye	4	Very Good

TABLE/GRAPH 2

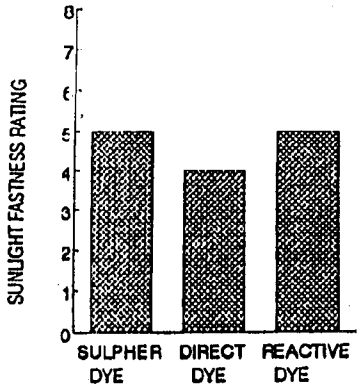
SUNLIGHT EXPOSURE PERFORMANCE OF ACID DESIZED SAMPLE



Acid Desized Fabric	Sunlight Fastness Scoring	Rating
Dyed with Sulpher Dye	4	Very Good
Dyed with Direct Dye	4-5	Very Good to Excellent
Dyed with Reactive Dye	5	Very Good

TABLE/GRAPH 3

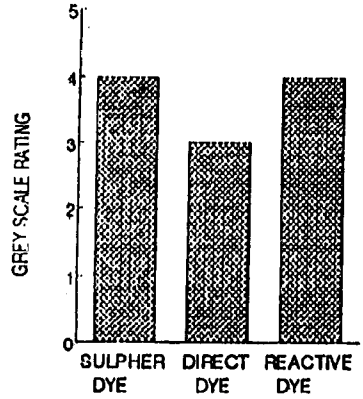
SUNLIGHT EXPOSURE PERFORMANCE OF ENZYME DESIZED SAMPLE



Enzyme Desized Sample	Sunlight Fastness Scoring	Rating
Dyed with Sulpher Dye	5	Excellent
Dyed with Direct Dye	4	Very Good
Dyed with Reactive Dye	5	Excellent

TABLE/GRAPH 4

PERFORMANCE OFWATER DESIZED SAMPLE TO ACIDIC PERSPIRATION SOL



Water Desized Sample	Grey Scale Scoring	Rating
Dyed with Sulpher Dye	3-4	Good to Very Good
Dyed with Direct Dye	3	Good
Dyed with Reactive Dye	3-5	Good to Very Good

on grey scale. The sulphur dyed samples exhibited "very good", and the direct and reactive dyes both showed "excellent" colourfastness to acidic desized samples.

Joko *et al.*, [8] reported better perspiration fastness for acidic desized fabrics, excellent dye affinity and fastness to light and perspiration of reactive dyes [1]. The results of the study confirmed their findings.

Colourfastness to perspiration of enzyme desized samples

The sulphur and reactive dyed samples exhibited "very good to excellent" showing a score of 4-5 on grey scale. The direct dyed samples showed "excellent" results with a score of 5. These results agree with (4) who showed excellent fastness to perspiration of enzyme desized samples.

Alkaline perspiration

Colourfastness to perspiration of water desized samples

The samples according to grey scale, showed a scoring of 3-4, 3 and 3 for sulphur, direct and reactive dyes respectively. The direct and reactive dyes exhibited "good" and sulphur dye produced "good to very good" results for colourfastness to alkaline perspiration of water desized samples.

Colourfastness to perspiration of acid desized samples

The acid desized samples when dyed with sulphur, direct and reactive dyes showed scoring on grey scale as 4-5, 4 and 4 respectively It means that colourfastness to alkaline perspiration was "very good to excellent", "very good" and "very good" for sulphur, direct and reactive dyes respectively.

Leonova [9] reported that high temperature fixation of dyes and their perspiration fastness were superior than other methods. In the present case temperature and methods were the same, the nature of desizing and dyeing were different.

Colourfastness to perspiration of enzyme desized samples

The samples of enzyme desized, observed a scoring of 5 each for all dyes i.e. sulphur, direct and reactive dyes, showing "excellent" results for colourfastness to alkaline perspiration. These results agree with [1] and [4] who reported excellent colourfastness to perspiration of enzyme desized fabrics.

Experimental

The study was carried out at Quality Control Laboratory of Processing Department, Crescent Textile Mills Limited, Faisalabad and in the Department of Fibre Technology, University of Agriculture, Faisalabad. The samples of same quality cotton cloth (21 x 21/60 x 60) were collected from the Mills and were desized acidic, water and enzymatic starches separately. These samples were bleached with same type of salomatic bleaching process. The samples were then dyed with direct, sulphur dyes by exhaust and reactive dyes by padsteam methods. The samples were tested for colourfastness to sunlight and perspiration and the best desizing method was chosen. The detail of the recipes and methods applied are given as under:

Desizing

Three different desizing modes were used and the methods were applied as [4] and [5].

Water desizing (steeping)

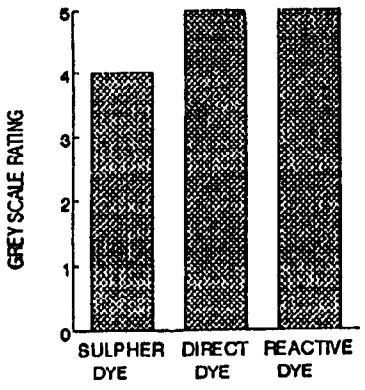
Recipe Water = 1 litre tap water, time = 24 hours, temperature = 25-40°C, sample weight = 15 grams.

Procedure The fabric samples were completely dipped in water individually and the container was sealed with polyethylene sheet in order to avoid addition of any foreign material. The temperature of water was maintained. The sample of sizing material was allowed to be attacked by bacteria present in the water. The microbes in water ferment the sizing material and degrade it to constitute components. These components were washed away by rinsing thoroughly.

Iodine Test Assessment of proper desizing was carried out by dipping a piece of cloth into iodine solution for one minute. The Recipe was KI = 10 g, Iodine = 0.5 g, Ethanol = 8 ml and water = 200 ml. The

TABLE/GRAPH 5

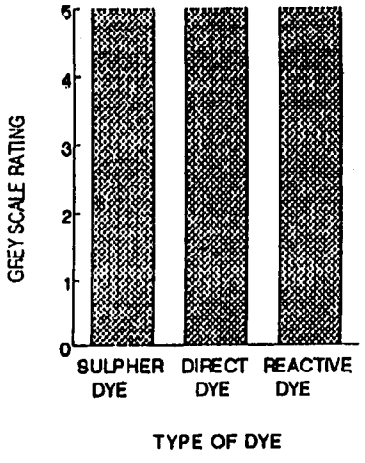
PERFORMANCE OF ACID DESIZED SAMPLE TO ACIDIC PERSPIRATION SOL



Acid Desized Sample	Grey Scale Scoring	Rating
Dyed with Sulpher Dye	4	Very Good
Dyed with Direct Dye	5	Excellent
Dyed with Reactive Dye	5	Excellent

TABLE/GRAPH 6

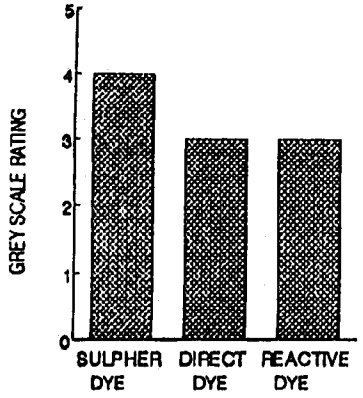
PERFORMANCE OF ENZYME DESIZED SAMPLE TO ACIDIC PERSPIRATION SOL



Enzyme Desized Sample	Grey Scale Scoring	Rating
Dyed with Sulpher Dye	4-5	Very Good to Excellent
Dyed with Direct Dye	5	Excellent
Dyed with Reactive Dye	4-5	Very Good to Excellent

TABLE/GRAPH 7

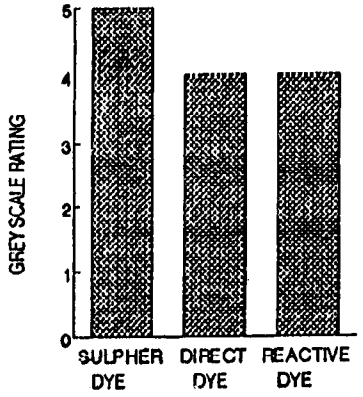
PERFORMANCE OF WATER DESIZED SAMPLE WITH ALKALINE PERSPIRATION



Water Desized Sample	Grey Scale Scoring	Rating
Dyed with Sulpher Dye	3-4	Good to V. Good
Dyed with Direct Dye	3	Good
Dyed with Reactive Dye	3	Good

TABLE/GRAPH 8

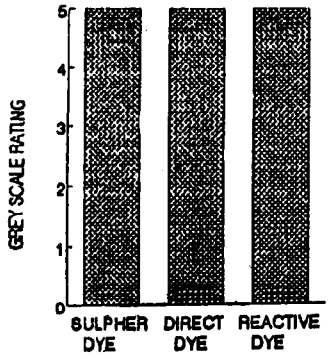
PERFORMANCE OF ACID DESIZED SAMPLE WITH ALKALINE PERSPIRATION



Acid Desized Fabric	Grey Scale Scoring	Rating
Dyed with Sulpher Dye	4-5	Very Good to Excellent
Dyed with Direct Dye	4	Very Good
Dyed with Reactive Dye	4	Very Good

TABLE/GRAPH 9

PERFORMANCE OF ENZYME DESIZED SAMPLE WITH ALKALINE PERSPIRATION



Enzyme Desized Sample	Grey Scale Scoring	Rating
Dyed with Sulpher Dye	5	Excellent
Dyed with Direct Dye	5	Excellent
Dyed with Reactive Dye	5	Excellent

piece was then rinsed in water and compared on violet scale immediately.

Acid desizing

Recipe: Acid HCl = 1%, Temperature = 100°C, Time = 15 minutes and sample weight = 15 g.

Procedure Acid desizing was carried out by boiling the fabric sample in acidified water for 15 minutes. The acid degrade the sizing materials present in the fabric to water soluble products. The sample was then washed thoroughly in hot water to remove the remaining acid present in the sample.

Iodine test The iodine test was repeated for acidic desizing sample. After washing with water compared on violet scale immediately.

Enzymatic desizing

Recipe: Enzyme (Nervanase 3 x) = 3 g/litre,
Sandopan (DTC) = 4 g/litre,
NaCl = 5 g/litre,
Temperature = 65 - 70°C,
pH = 6.5 - 7.0.
Acetic acid was used to keep the pH at neutral. The enzyme was activated at this temperature properly.

Procedure: The fabric sample was passed through the padder adjusted at settings: Pick up = 80-100 %, Speed = 2.4 rev./min. and Pressure = 2.5 kg/cm^2. After treating the sample with enzymatic solution, it was wrapped in a polyethylene sheet and kept for 16 hours to allow the enzyme to work properly. The sample was then thoroughly washed with water.

Iodine test: The sample from enzymatic desizing was dipped in iodine solution, rinsed with water and compared on violet scale immediately.

Salomatic bleaching

Recipe: Liquor = 1 litre, H_2O_2 = 40 ml, NaOH = 5 g, Soap (Sandopan), 7 g, Sodium silicate = 5 g, Temp = 100°C, Time = 10 minutes. Salomatic bleaching is a combined process including scouring

Table-10: Consclidated table for results of colourfastness characters

	Colourfastness to Sunlgith			Colourfastness to Perspiration					
				Acidic Perspiration			Alkaline Perspiration		
Treatment	Water	Acid	Enzyme	Water	Acid	Enzyme	Water	Acid	Enzyme
Sulpher Dye	4	4	5	3-4	4	4-5	3-4	4-5	5
Direct Dye	3	4-5	4	3	5	5	3	4	5
Reactive Dye	4	5	5	3-4	5	4-5	3	4	5

Grey Scale Standards	Colourfastness to Sunlight	
	Hours	Rating
5 - Excellent	6	1
4 - Very Good	12	2
3 - Good	25	3
2 - Moderate	50	4
1 - Poor	100	5

and bleaching. This is single step process, saving time and chemicals. During this process, pectins, proteins and various organic compounds were removed. At the same time, fabric was decoloured from grey state, its whiteness was improved and natural colouring extraneous substance were removed, according to the method [1] and [6].

The purpose of bleaching is also to facilitate ready absorption and even, uniform distribution of dye. The success of salomatic bleaching is determined in terms of absorbency and whiteness of the fabric.

Dyeing

Dyeing was done by exhaust method in case of direct and sulphur dyes and padsteam for reactive dyes [4] and [7].

Direct dyeing

Recipe:

Dye (Pyrazol orange RS)	= 1%,
NaCl	= 8 g/litre
Liquor ratio	= 1:50
Total time	= 50 minutes
Weight of sample	= 15 g.

Procedure: Electrolytes are usually used with direct dyes. Cellulose fibres usually assume a negative charge when immersed in water. Electrolytes reduce or extinguish the charge on the fibre. Dyeing of fabric with direct dye was carried out by exhaust method. Dye shade at 1% was prepared. The sample was dipped in cold dye solution for 10 minutes indivudually. The heating was started and 4 grams of salt was added to the solution. Dyeing was continued for not less than 40 minutes. After 40 minutes, the fabric sample was taken out and given cold rinsing. It was followed by soaping at 40-50°C. Soaping was carried out for 5 minutes and sample was dried afterward [7]. Dyeing of the samples desized with different modes was done separately.

Sulphur dyeing

Recipe:

water	= 500 ml
Dye shade (Sulphur blue)	= 1%
Soda ash	= 10 g
Sodium sulphide	= 0.4 g
NaCl	= 30 g.

Procedure: The sulphur dyes contain sulphur linkages within their molecules. These are usually insoluble in water but dissolve in a solution of sodium sulphide to which sodium carbonate may or may not be added. The sodium sulphide acts as a reducing agent. Water was boiled and sodium sulphide was added to it. After dissolving sodium sulphide in water, sulphur dye was added. It was kept boiling until complete solubility of sulphur dye was achieved. Then soda ash and common salt were added to it. The fabric sample was treated in the dye solution at boiling for one hour. The sample should remain dipped in solution otherwise that particular area exposed to air might become oxidized, causing non-uniformity in dyeing. After an hour of boiling, the sample was dipped in water for development of colour by oxidation. Afterwards, the samples obtained were washed with soap. After washing, the samples were dried. The process was carried out for each sample of each desizing modes.

Reactive dyeing (Pad steam method)

Recipe:

Dye shade (Drimarene golden yellow K2RL)	= 1%
Urea	= 60 g/lit.
Glauber salt	= 15 g/lit.
Sodium Bicarb	= 12 g.
Lyoprint RG	= 10 g.

Procedure: Reactive dyes directly react with the cellulose of cotton fibres. These dyes have very good fastness. The shades are generally bright. They have only moderate resistance to weathering and chlorine. Thorough mixing of chemicals must be assured.

Colour fastness

The dyed fabric samples were subjected to the colourfastness to sunlight and perspiration, according to the standard methods for determination of colourfastness of textiles [5] and [1].

Colourfastness to sunlight (1S0-105/BO-1)

The principle of this method is to expose the specimen to the sunlight under prevailing conditions including protection from rain. The strips of dyed samples were lined up in the sample stand. Tester was operated for 100 hours. The samples were checked after 6, 12, 25, 50 and 100 hours and change of colour of the samples was assessed. Change of colour was determined according to standards devised for sunlight tester. S.D.L. Sunlight fastness tester was used in this test.

Colourfastness to perspiration (1S0/50/EO4)

Apparatus and reagents

Perspirometer, undyed cloth pieces and specimens.

Perspiration Solution - Alkaline

Histidine monohydrochloride monohydrate	= 0.5 g/l
NaCl	= 5 g/l
Di-Sodium hydrogenorthophosphate	= 2.5 g/l
pH	= 8.0

Perspiration Solution - Acidic

L-Histidine monohydrochloride	=0.5 g/l
Monosidum hydrogen-orthophosphate	= 2.2 g/l
NaCl	= 5 g/l,
pH	= 5.5

The composite specimens were thoroughly wetted in alkaline and in acidic perspiration solutions separately. The samples contained pieces desized with acid, water, enzyme and dyed with direct, sulphur, reactive dyes and were kept in both the solutions for 30 minutes separately. Then the solutions were poured off and each wet specimen was placed on glass plate and another glass plate was put on it. A weight of 4.5 kg was applied on the specimen and this was placed at 37 ± 2°C temperature for 4 hours. Then the specimens and undyed cloths were separated and dried in air. Change of colour of specimens and stating of undyed cloth were assessed with standard grey scale.

Conclusion

The enzymatic desizing was the most efficient mode for the removal of starch/the sizing material (alpha glucoside), in this study. The enzymatic desizing did not effect fabric cellulose (beta glucoside). In comparison, the different dyes showed somewhat similar colourfastness to sunglith and perspiration.

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