Effective and Economic Evaluation of Different Reducing Discharging agent for Printing on Cotton Fabric with Direct Dyes

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Abstract— Discharge printing is the most important and lucrative methods used for introducing design to textile fabric. It is used mainly for aesthetic attractiveness of the product. Discharge printing can be conducted by various dyes and chemicals, direct dyes is one of them. They are environmentally safe and having sensible overall fastness properties. The main objectives of this research is to find out the better color performance, less impact on fabric strength and cost effectiveness of different reducing discharging agents for printing on cotton fabric dyed with direct dyes.

Index Terms— Discharge printing, Direct dyes, Discharging agents, Color fastness, Fabric strength, Costing, Hydrose.

1 Introduction

Discharge style has been important since the earliest times of textile printing. The theory of discharge printing involves the degradation by chemical regents of the chromophore system of the dyestuffs applied to textile materials [1]. There are mainly two types of discharging agents, namely oxidizing agents, and reducing agents [2]. The most important discharging agents in textile printing today are reducing agents.Here we used three types of reducing agents, namely Dithionite, Stannous Chloride & Hydrose. Direct dyes are also quite important in cellulose fibers dyeing, 75 % of the total consumption of these colorants is used, in fact, to dye cotton or viscose substrates [3].

2. Materials & Methods

2.1 Dyeing of cotton fabric with direct dyes:

Here we used three color of fabrics which are dyed by direct dyes. Direct dyes are one of the most versatile classes of dyestuff applicable to cellulose, wool, silk and nylon fibers although this classes of dyes have deficiency in wet color fastness.

2.1.1 Substrate:

100% BCI cotton, Single jersey knit fabric, 160 GSM.

2.1.2 Typical Recipe:

Particulars	Sample-1	Sample-2	Sample-3
Sample Weight	90 gm.	90 gm.	105 gm.
Dye	Dysin-Orange: 4.5 gm.	Dysin-Yellow: 4.8 gm.	Dysin-Black: 5.25 gm.
Soda ash	6.75 gm.	7.2 gm.	10.5 gm.
Salt	27 gm.	28.8 gm.	42 gm.
Wetting agent	1.35 cc	1.44 cc	1.7 cc
Sequestering agent	1.35 cc	1.44 cc	1.7 cc
Levelling agent	1.35 cc	1.44 cc	1.7 cc
M:L	1:15	1:15	1:20
Temperature	90^0C	90^0C	90^0C
Time	90 min	90 min	90 min

Table 01: Dyeing recipe of Cotton fabric with direct dyes.

2.1.3 Dyeing procedure:

a) Setting the dye bath with substrate at room temperature.
b) Adding dye solution with other auxiliaries and raise the temperature to 90^0C.

c) Running the bath for 15-20 minutes and adding salt step by step according to dye bath concentration.
d) This is better to add this salt after reaching the temperature to boiling point.
e) Run the dye bath for 30- 60 minutes at 90-95^{0}C for complete the dyeing cycle.
f) Cooling down the bath temperature to 60-70^{0}C.
g) Dropping the bath and rise carry on the after treatment to improve wet fastness.

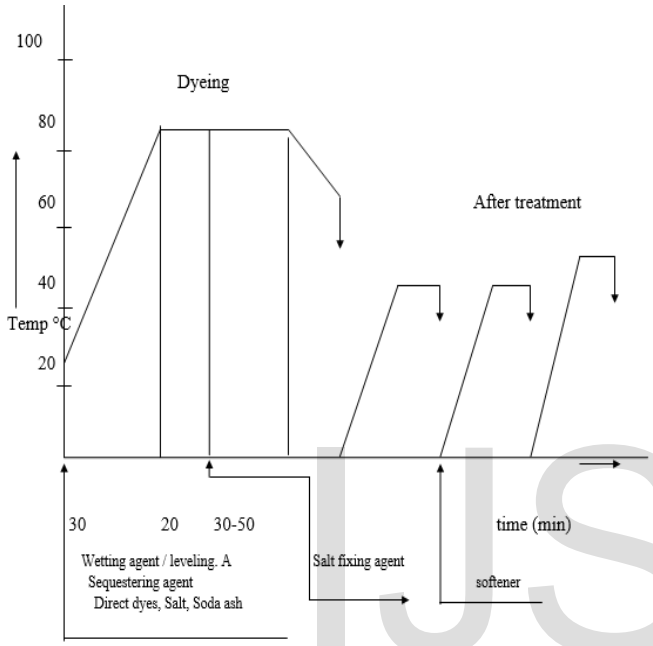

Fig 01: Dyeing of cotton with direct dyes [4].

2.1.4. AFTER TREATMENT PROCESS

In after treatment process, fixing agent is used for improving color fastness properties; usually this process is done at 30 – 400C. A cationic softener is added to the last rising bath for improving handle proving of fabric; this process is done at 40-50^{0}C for 15-20 minutes. Then washing with hot and cold water has been done and dried at last.

2.2. PRINTING

Printing is related to dyeing but in dyeing, the whole fabric is uniformly covered with one color, whereas in printing one or more colors are applied to it in certain parts only, and in sharply defined patterns [5].Printing is done as per described recipe and procedure.

Recipe 01		Recipe 02		Recipe 03	
Dithionite used as discharging agent		Stannous Chloride used as discharging agent		Hydrose used as discharging agent	
Dithionite ($Na_2S_2O_4$)	15 gm.	Stannous Chloride ($SnCl_2$)	15 gm.	Hydrose	15 gm.
TiO_2	10 gm.	TiO_2	10 gm.	TiO_2	10 gm.
Na-alginate	55 gm.	Na-alginate	55 gm.	Na-alginate	55 gm.
Egg's albumin	6 gm.	Egg's albumin	6 gm.	Egg's albumin	6 gm.

Table 02: Recipe for printing of cotton fabric dyed with direct dyes.

a. Thickener preparation

100 gm. water is added with 8 gm. starch / Na alginate print paste.

b. Print paste preparation

The above chemicals & auxiliaries are added together to make the print paste.

c. Printing procedure

Prepare the print paste accurately by different ingredient

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Making an impression of the print paste on the fabric by hand screen printing and by discharge style

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Now dry the fabric which is printed

↓

Steaming of the printed fabric

↓

After treatment (Neutralizing, soaping etc.)

3. Result and Discussion

3.1 Evaluation of color performance

In this research, we examined color fastness to perspiration, color fastness to wash and color fastness to rubbing to evaluate the better color performance.

Condition	Properties	$Na_2S_2O_4$	$SnCl_2$	Hydrose
Alkali	Change of shade	3	2	3-4
	Staining	3	3	3
Acid	Change of shade	3	2	4
	Staining	3	3	3

Table 3: Color Fastness to Perspiration of printed fabric with different reducing discharge agent.

Table 03 represents that Hydrose displays higher color fastness to perspiration than others.

Discharging agent	Fastness value (fading)
Dithionite	2-3
Stannous Chloride	2-3
Hydrose	3-4

Table 4: Color Fastness to wash (fading) of printed fabric with different reducing discharge agent.

It is intituively obvious from the above table that, Hydrose displays higher color fastness to wash (color fading) than the others.

Agents	Dry	Wet
Dithionite	3-4	2-3
Stannous Chloride	2-3	2-3
Hydrose	4	4

Table 5: Color Fastness to rubbing of printed fabric with different reducing discharge agent.

Table 5 indicates that Hydrose displays higher color fastness to rubbing than the others.

3.2 Impact on fabric strength

Hydrose				
Reading	Fabric strength (lbs) (x_i)	Average strength (lbs) $\bar{x}$ = Sum ofthe strength / Number of sample	SD $\sqrt{\frac{\sum_{i=1}^{n}(xi-\bar{x})^2}{n}}$	CV%= Standard deviatio / Average Strength 100%
1	62	60.2	1.6	2.66
2	58			
3	59			
4	62			
5	60			

Table 6: Tensile Strength of fabric printed with Hydrose reducing discharging agent.

Dithionite				
Reading	Fabric strength (lbs) (x_i)	strength (lbs)$\bar{x}$ = Sum ofthe strength / Number of sample	SD $\sqrt{\frac{\sum_{i=1}^{n}(xi-\bar{x})^2}{n}}$	CV%= Standard deviation / Average Strength $X100\%$
1	59	58.6	1.02	1.74
2	57			
3	59			
4	58			
5	60			

Table 7: Tensile Strength of fabric printed with Dithionite reducing discharging agent.

Stannous Chloride				
SN	Fabric strength (lbs) (x_i)	Average strength (lbs) $\bar{x}$ = Sum ofthe strength / Number of sample	SD= $\sqrt{\frac{\sum_{i=1}^{n}(xi-\bar{x})^2}{n}}$	CV%= Standard deviation / Average Strength $X100\%$
1	56	57.2	1.17	2.04
2	58			
3	59			
4	56			
5	57			

Table 8: Tensile Strength of fabric printed with Stannous Chloride reducing discharging agent.

Table 6, 7 and 8 represents that Hydrose is better than the other two reducing discharging agent in case of loss in tensile strength of fabric than the rest two reducing discharging agent.

3.3 COST ANALYSIS

For used material, as the dyeing process and pretreatment is same for all reducing agent, their cost will be same and so we are calculating here the print ingredients cost. As manpower utilization and energy consumption same for these three reducing discharging agent, so we are ignoring the manpower and energy cost too.

For Hydroze		
Chemical Name	Cons. (Kg) x Unit price (USD)	Total Price ($)
Thickener (Na-alginate)	=0.055x7.93	0.44
TiO_2	=0.01x7.32	0.073
Egg Albumin	=0.006x0.49	0.003
Hydroze	=0.015x2.44	0.04
Total/Kg		0.556
For Dithionite		
Chemical Name	Cons. (Kg) x Unit price (USD)	Total Price ($)
Thickener (Na-alginate)	=0.055*7.93	0.44
TiO_2	=0.01*7.32	0.073
Egg albumin	=0.006*0.49	0.003
Dithionite	=0.015*18.3	0.28
Total/Kg		0.8
For $SnCl_2$		
Chemical Name	Cons. (Kg) x Unit price (USD)	Total Price ($)
Thickener (starch)	=0.055*1.71	0.09
TiO_2	=0.01*7.32	0.073
Egg Albumin	=0.006*0.49	0.003
$SnCl_2$	=0.015*109	1.65
Total/Kg		1.816

Table 9: Cost calculation of printing with different discharging agent

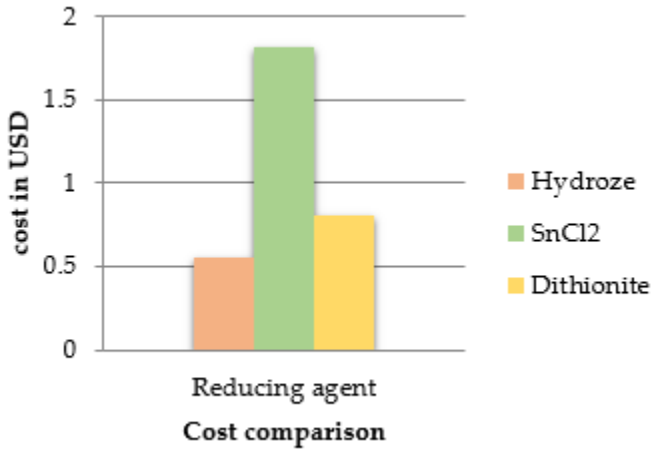

Fig 02: Cost analysis for different discharging agent

After analyzing the cost, we have reached in this decision that Hydrose costs the least whereas SnCl2 costs a significant amount of money to prepare one kg paste.

4. CONCLUSION

From this comparative study of different types of reducing discharging agents used in discharge printing we found that-

1. Hydrose displays higher color fastness to perspiration than the others.
2. Hydrose exhibits higher color fastness to rubbing than the others.
3. Hydrose shows higher color fastness to wash than the others.
4. Hydrose is better than the others in case of loss in tensile strength of fabric than the others.
5. In case of cost comparison Hydrose is less expensive than the others whereas SnCl2 is the most expensive.

After justifying the terms - cost, color fastness, washing fastness, perspiration fastness, rubbing fastness, fabric strength and quality of printing, we find that Hydrose shows better result in almost all aspects than other two agent. That's why Hydroze reducing discharging agent utilization would be suitable for obtaining better result.

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