IOSR Journal of Polymer and Textile Engineering (IOSR-JPTE)
e-ISSN: 2348-019X, p-ISSN: 2348-0181, Volume 5, Issue 1 (Jan. - Feb. 2018), PP 05-10
www.iosrjournals.org

Effects of Printing with Different Thickeners on Cotton Fabric with Reactive Dyes

Md. Golam Kibria[1], Faisal Rahman[1], Dibakar Chowdhury[2], Md. Nasir Uddin[3]
[1,3] Department of Textile Engineering, Northern University Bangladesh, Bangladesh
[2]Department of Textile Engineering, World University of Bangladesh, Bangladesh

Abstract: *Printing is an integral part of textile coloration and thickener is just as essential a part of textile printing. The goal of this research was to investigate the effects of printing with different thickeners on the properties of cotton fabric with reactive dyes. The woven cotton fabrics were pretreated and mesh fabrics for printing were prepared. Printing was done on the fabrics with various thickeners, individually and in different ratios with flat screen printing method. The printed samples were then assessed for Strength, Crease recovery, Color fastness to wash and Color fastness to rubbing. Finally, after comparing the test results, it was found that the properties of the fabrics printed with thickeners in combination with sodium alginate were better than those printed with a single thickener.*

Keyword*: Printing, Thickener, Reactive dyes, Strength, Crease recovery, Fastness.*

Date of Submission: 03-01-2018 Date of acceptance: 29-1-2018

I. Introduction

Textile printing is the most versatile and important of the methods used for introducing color and design to textile fabrics. Considered analytically, it is a process of bringing together a design idea, one or more colorants, and a textile substrate (usually a fabric), using a technique for applying the colorants with some precision [1]. Cotton is a spongy, feathery staple fiber that is developed in a ball or shielded pill. The fiber is nearly clean cellulose. Cotton fiber is frequently twisted into yarn or thread and is used to build a soft, natural, flexible and breathable fabric material, then it is used for the main purpose of making garments [2].

In 1955, Rattee and Stephen, working for ICI in England, developed a procedure for dyeing cotton with fiber-reactive dyes containing dichlorotriazine groups. They established that dyeing cotton with these dyes under mild alkaline conditions resulted in a reactive chlorine atom on the triazine ring being substituted by an oxygen atom from a cellulose hydroxyl group [3].

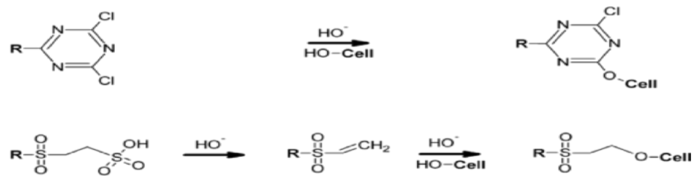


Figure01: Interaction of reactive dyes with cellulose (see [4]).

Thickeners are viscous pastes used for textile printing usually consist of either solutions of high molecular weight polymers or emulsions of immiscible liquids. The chemicals used belong to various chemical classes. Unbranched polymers give viscous solutions at low concentrations but the viscosity falls with increasing shear. Branched chain polymers require higher concentrations to give the required viscosity but are less sensitive to shear [3].

Color fastness to wash, color fastness to rubbing, strength of the finished fabric and its crease recovery properties are of paramount importance. This research was aimed towards finding the impact that different thickeners execute on these properties of the printed fabrics. The thickeners used were Sodium alginate, Printofix thickener DRA, Poly Print thickener CT-170, Thickening agent FS-80, Fine gum and Guar gum. The fabrics were printed with pastes containing these synthetic and natural thickeners and in combinations with sodium alginate in different ratios. This work also intended to minimize the shortcomings of sodium alginate by combining it with other natural and synthetic thickeners.

II. Literature Review

Hans Mollet showed that printing pastes usually contain thickeners in concentration of 2-10% including starch product, vegetable gum, resin, hydroxyethyl and hydroxypropyl starch, alginate, carboxy methyl cellulose, xanthangum and synthetic thickeners [5].

Katia Lacasse stated that synthetic thickeners are long chain polymers bearing carboxylic groups partially cross-linked. The substances have the ability to swell considerably in water upon neutralization and form high viscosity gels. He showed that these thickeners are in liquid, or aqueous form, neutralized with ammonia, and with a solid content of approximately 25% or anhydrous partially neutralized product with a solid content of up to 60% [6].

A study [7] conducted by Carolyn Dahl showed that unlike starches and gums, sodium alginate thickeners do not chemically bond with the fabrics' structure nor react with the fiber reactive dye. Sodium alginate has many advantages like good permeability, uniform color, easy cleaning, not sticking to the cylinder and scraper, soft hand feel, good plasticity and clear printing figure. Seaweed hydrocolloid is stable when the pH value is 6-11 and it will produce the gel when pH value is above or below this scope [7]. Guar gum, a natural gum, is an edible thickening agent extracted from the Guar bean. Guar beans have a large endosperm which contains galactomannan gum which forms a gel in water. This is commonly known as Guar gum and is widely used for food and industrial applications [8].

In printing with reactive dyes, sodium alginate or synthetic thickeners are typically used as thickening agents to prevent unacceptable fabric handle. A new reactive printing process for reactive dyes on cellulosic textiles has been developed using natural thickening agents and environmental friendly additives. Printing trials with Guar gums have shown that the use of different additives can prevent fabric stiffness. These additives have no significant influence on rheology and color strength but contributed to soft fabric handle even when Guar gums were used as thickening agents. The use of additives and Guar gum provide good quality prints with reduced waste water pollution [9].

The highest K/S value obtained in case of paste is prepared using formulated thickeners, also fastness properties, ranging between excellent and good compared to samples which are printed using natural thickeners such as Guar gum and sodium alginate. The synthetic thickeners perform better than natural thickeners in reactive printing on cotton [10].

III. Materials & Methods

3.1 Materials

3.1.1Cotton woven fabric

Weave type: Plain weave

Construction: $\frac{68\times 68}{30\times 30}$

GSM: 102.86

3.1.2 Dyes

Reactive dye: Drimarine Navy PS-2R

3.1.3 Name of thickeners

a) Na-alginate
b) Printofix thickener DRA
c) Poly Print thickener CT-170
d) Thickening agent FS-180
e) Fine gum
f) Guar gum

3.1.4 Recipe for printing

Dye-20g/kg
Antimussol UDF-5g/kg
Ladiquest 1097-10g/kg
Urea-100g/kg
$NaHCO_3$-30g/kg
Thickener – P g/kg (Na-alginate-x g/kg and other thickener-y g/kg). So, P=x+y
Water – X g/kg
Total- 1kg

3.2 Methods

The standard temperature and atmosphere for conditioning and testing textiles have been used (as defined in ISO 139), i.e. a temperature (20 ± 2)℃ and a relative humidity (65 ± 2) %.
In addition to the test apparatus and auxiliary materials specified in ISO 12947-1, a balance, having an accuracy of 1mg is used.

3.2.1 Flat screen printing

Flat screen printing is of three types, such as hand screen, semi-automatic and fully automatic flat screen printing. The print paste was spread across the screen and squeezed by a squeegee for passing the paste through the screen.

3.2.2 Combinations of recipe

Table 01: Recipe combinations

Sample no.	1	2	3	4	5	6	7	8
Na-alginate: Other	1:19	1:4	2:3	1:1	3:2	4:1	19:1	100% other thickener

3.2.3 Strength test (ASTM D5035)

For the strip test to determine the strength, the fabric was clamped between two jaws $8''$ apart and extended by the constant rate of elongation principle. When the fabric tore, the strength value in PSI was noted from the machine.

3.2.4 Crease recovery test (IS 4681-1968)

A $2'' \times 1''$ fabric was creased in half and placed between two glass plates with a 2 kg weight for 1 min. After removal of the weight, the specimen was transferred to the fabric clamp on the instrument and allowed to keep the free edge of the specimen in line with the knife edge of the specimen which rotated to recover from crease. At the end of the time period allowed for recovery, the recovery angle in degree was read on the engraved scale.

3.2.5 Color fastness to wash (ISO 105 C04)

Table 02: Color fastness to wash (ISO 105 C04)

Test	Temperature, °C	Time, minutes	Steel balls	Reagents	Liquor ratio
ISO 105 C04	95	30	10	Soap (5g/L) Soda (2g/L)	50:1

3.2.6 Color fastness to rubbing (ISO 105 X12)

The printed samples were mounted on the crock meter and the finger of the crock meter was covered with the cotton rubbing cloth. The specimen was rubbed with the covered finger 10 times in 10 seconds. For wet rubbing, the cotton rubbing cloth was soaked with water to 100% pickup. The degree of staining on the undyed fabric was evaluated with grey scale.

IV. Experimental Data

Table 03: Strength test (ASTM D5035)

Sample no.	Fine gum	Guar gum	CT-170	FS-80	DRA
1	125	135	120	100	150
2	138	157	150	50	160
3	133	70	127	145	170
4	80	140	150	172	170
5	85	160	145	85	160
6	100	160	120	150	82
7	101	113	105	115	195
8	90	70	140	168	172

Table 04: Crease recovery test (IS 4681 – 1968)

Sample no.	DRA (warp/weft)	Guar gum (warp/weft)	CT-170 (warp/weft)	Fine gum (warp/weft)	FS-80 (warp/weft)
1	55/40	62/91	72/70	70/58	68/54
2	61/65	78/65	60/68	72/54	70/58
3	55/90	75/70	78/52	68/62	72/60
4	90/38	70/65	50/63	70/52	72/64

5	68/75	76/81	53/73	72/54	74/58
6	50/85	85/90	58/66	64/66	68/62
7	50/80	61/80	50/55	72/62	66/58
8	55/65	70/61	90/55	70/72	78/52

Table 05: Color fastness to wash (ISO 105 C04)

Sample no.	DRA (change/cotton staining)	Guar gum (change/cotton staining)	CT-170 (change/cotton staining)	Fine gum (change/cotton staining)	FS-80 (change/cotton staining)
1	4-5/4-5	4-5/5	5/5	5/5	5/4-5
2	3-4/5	5/5	5/4-5	4-5/5	4-5/4-5
3	5/4-5	5/5	5/4-5	5/5	4/4-5
4	4-5/4-5	4-5/5	5/4-5	5/5	4/4
5	5/5	4-5/5	4-5/4-5	4-5/5	4-5/5
6	4/4-5	5/5	4-5/4-5	5/5	5/4-5
7	5/5	4-5/5	5/4	5/5	5/5
8	4/5	5/5	5/4-5	5/5	5/5

Table 06: Color fastness to rubbing (ISO 105 X12)

Sample no.	DRA (change/wet/dry)	Guar gum (change/wet/dry)	CT-170 (change/wet/dry)	Fine gum (change/wet/dry)	FS-80 (change/wet/dry)
1	4/3-4/5	4-5/3-4/5	4/1-2/4-5	4-5/4/5	4-5/3/5
2	4/3/5	4-5/4/5	4/2/5	5/4/5	4-5/3/4-5
3	4-5/2-3/5	4-5/3-4/5	4-5/2-3/5	4-5/3-4/4-5	4-5/2-3/5
4	4-5/3-4/5	4/4/4-5	4/2-3/4-5	4-5/3-4/5	5/2-3/5
5	4/2-3/4-5	4/3/5	4-5/2-3/5	5/3-4/5	4-5/2-3/4-5
6	4-5/3-4/4	4-5/3/4	4/3/5	4-5/3-4/5	5/2/5
7	4/2-3/4-5	5/2-3/5	4-5/3/4-5	4-5/3/5	4-5/2/5
8	4-5/3/5	4-5/3-4/5	4-5/2/5	4-5/4/5	4-5/2-3/5

V. Result & Discussion

5.1 Strength test (ASTM D5035)

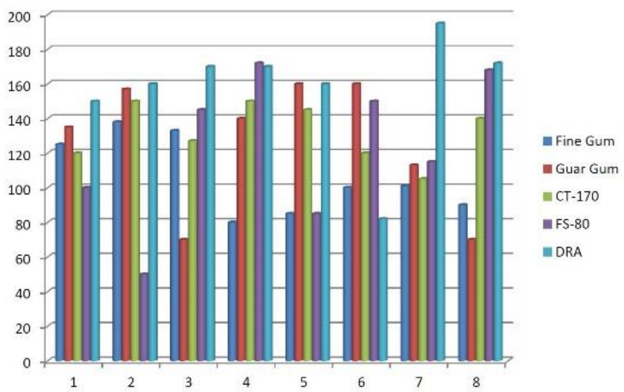
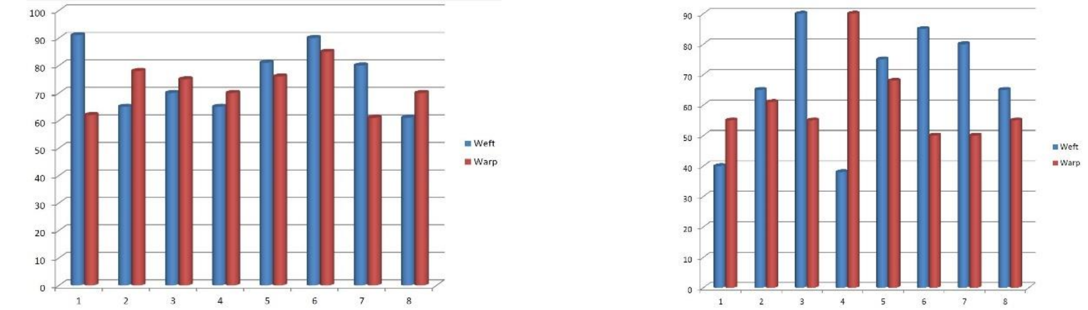


Figure 02: Result of strength test (ASTM D5035)

Among samples printed with 100% other thickener, the strength of Printofix DRA printed sample was the highest. For combination recipe, the strength of the sample printed with Na-alginate: DRA (19:1) was the highest.

5.2 Crease recovery test (IS 4681-1968)

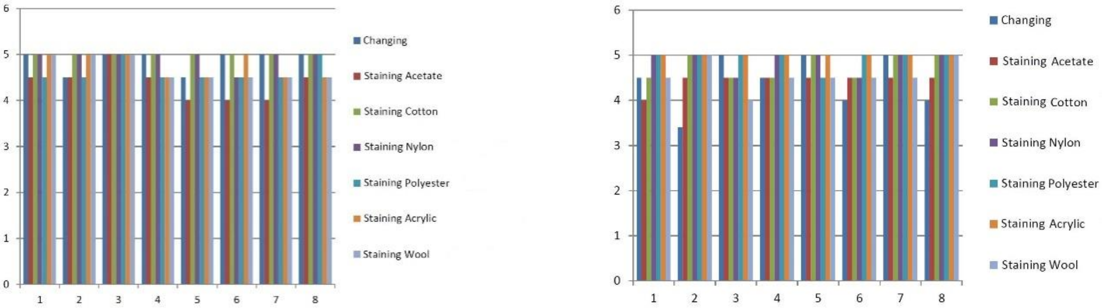


(a) (b)

Figure 03: Result of crease recovery test (IS 4681 – 1968); (a)usingGuar gum; (b) using DRA.

Crease recovery percentage of Na-alginate: Guar gum (4:1) printed sample was better for both warp and weft. Crease recovery percentage of Na-alginate: DRA (3:2) printed sample was better for both warp and weft. Compared to 100% recipe, crease recovery percentage of combination recipe was more.

5.3 Color fastness to wash (ISO 105 C04)

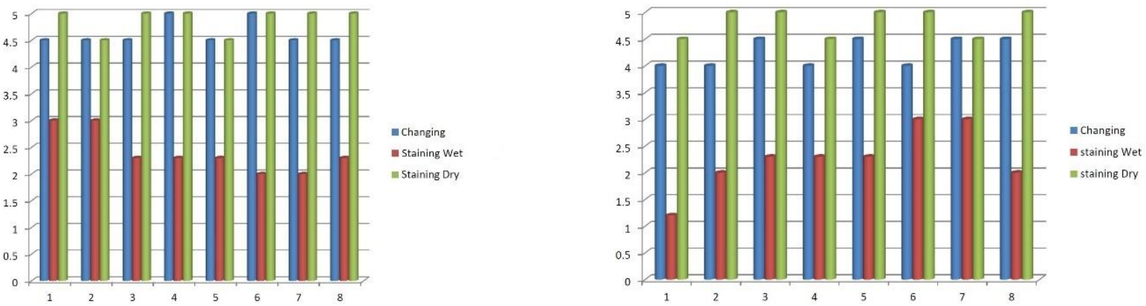


(a) (b)

Figure 04: Result of color fastness to wash test (ISO 105 C04); (a) using Fine gum; (b) using DRA.

Color fastness to wash of Na-alginate: Fine Gum (2:3) printed sample was better. Color fastness to wash of Na-alginate: DRA (19:1) printed sample was better. Compared to 100% recipe, color fastness to wash of combination recipe was more.

5.4 Color fastness to rubbing (ISO 105 X12)



(a) (b)

Figure 05: Result of color fastness to rubbing test (ISO 105 X12); (a) using FS-80; (b) using CT-170.

Color fastness to rubbing of Na-alginate: FS-80 (1:19) printed sample was better. Color fastness to rubbing of Na-alginate: CT-170 (4:1) printed sample was better. Compared to 100% recipe, color fastness to rubbing of combination recipe was more.

VI. Conclusion

The experiments exercised in the study will help the textile colorists in selecting appropriate thickeners considering their fastness properties and what combination of the thickeners might yield the best printed fabric. According to the study, it might be concluded that when sodium alginate is combined with other synthetic and natural thickeners, the properties of the printed fabrics improve considerably. So, the outcome of this study could be beneficial to the textile engineers in selecting suitable thickeners to produce printed fabrics with desired properties.

Acknowledgement

The authors would like to give special thanks to Rasheda Begum Dina, Assistant Professor, Bangladesh University of Textiles, Dhaka-1208, Bangladesh, whose insightful knowledge and suggestions about the necessary processes involved contributed to the successful completion of this research work.

References

[1]. Miles, C., & Leslie, W. C. (2010). *Textile Printing*: Revised Second Edition.
[2]. https://style2designer.com/apparel/fabrics/cotton-fiber-properties-and-chemical-composition/
[3]. Broadbent, A. D. (2001). *Basic principles of textile coloration*.
[4]. https://en.wikipedia.org/wiki/Reactive_dye#/media/File:Reactive_dyes.png
[5]. Molllet, H., & Grubenmann, A. (2001). *Formulation Technology Emulsions, Suspensions, Solid Forms*, diterjemahkan oleh Payne, HR, 59-62, 177, 259-262, Willey.
[6]. Bunke, D. (2005). *Textile Chemicals—Environmental Data and Facts* Autoren: Katia Lacasse, Werner Baumann. Umweltwissenschaften und Schadstoff-Forschung, *17(2)*, 127-127.[7]C. A. Dahl, (2004).*Transforming Fabric: Creative Ways to Print, Dye and Pattern Cloth*,Krause Publication, USA.
[7]. http://www.guargum.biz/guargum_faqs.html
[8]. Schneider, R., & Šostar-Turk, S. (2003). *Good quality printing with reactive dyes using guar gum and biodegradable additives. Dyes and pigments, 57(1), 7-14*.
[9]. Madhu, C. R., & Patel, M. C. (2016). *Reactive Dye Printing on Cotton with Natural and Synthetic Thickeners*. International Research Journal of Engineering and Technology, 3, 1418-1420.

Md. Golam Kibria "Effects of Printing with Different Thickeners on Cotton Fabric with Reactive Dyes." IOSR Journal of Polymer and Textile Engineering (IOSR-JPTE) , vol. 5, no. 1, 2018, pp. 05-10.