Scientific Journal of Impact Factor(SJIF): 3.134

e-ISSN(O): 2348-4470
p-ISSN(P): 2348-6406

International Journal of Advance Engineering and Research Development

Volume 1,Issue 12, December -2014

POLYDADMAC TREATMENT ON COTTON FOR IMPROVING PRINTING WITH REACTIVE DYE

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Abstract: *Eco-friendly chemical processing of textile is now necessary for recent trends. Surface modification with polyelectrolytes on cotton might bring to a new approach. Reactive printing of cotton requires salt, and also hygroscopic agent in large quantity, which increase pollution load. To overcome from this problem, polydiallyldimethylammonium chloride (POLYDADMAC) is use for surface modification of cotton, which increase colour value of reactive dye in printing. Printing is carried out with four different methods. The colour strength and fastness properties of printed sample were assessed and reported in this paper.*

Keywords *Polyelectrolyte, POLYDADMAC, Printing, Reactive dye*

1. INTRODUCTION

Textile Industries for chemical processing are making maximum profit in printing process, which give maximum benefit to company. Cotton processing is centrally focused area in India. In market, printed cotton covers huge area compare to dyed cotton. Cotton is generally printed with reactive dye in textile industries in huge quantity. To increase the colour value, Mercerisation and NH_3 treatment are given to cotton for surface modification of cotton. These methods increase the pollution load and also material handling is difficult. These two techniques can be replaced by electrostatic self-assembly process, which is responsible for creating material with multilayers having desired properties [1]. Surface modification of cotton can also possible with electrolyte which charged the cotton positively. The surface functionality can be directly and flexibly change by choosing appropriate polyelectrolytes [2]. Layer by Layer technique suggests that substrate is alternately dipped into different polyelectrolyte's solutions [3]. This self-assembly technique on cotton has been reported by Hyde et al. [4]. POLYDADMAC deposition by multilayers on nylon fibres, also coating of silk with LBL technique using PSS/POLYDADMAC polyelectrolytes improve colour depth, brightness, fastness to washing [5,6,7]. Self-assembled PDDA/Clay films is also studied on lignocellulosic fibres [8,9]. POLYDADMAC (polydiallyldimethylammonium chloride) is chosen as polyelectrolyte in this experimental work for surface modification of cotton. POLYDADMAC is an quaternary ammonium compound which modifies the cotton surface by grafting with cellulose molecule. Four different printing methods are used to print reactive dye on cotton, which are widely used in small scale to large scale textile industries according to their industrial setup. Also Layer by Layer technique studied for dyeing cotton with reactive dye, which enhances the colour value in both exhaust and continuous dyeing method [10].

Hot brand reactive dye was used to print cotton for the experimental work, where treatment of polyelectrolyte on cotton done at room temperature. In some printing method, alkali was not used, but study has been done with usual textile auxiliaries. Different methods for printing have been selected for work to achieve maximum colour value and fastness.

II. MATERIALS AND METHODS

2.1 Materials

Cotton

Plain weave cotton fabric with 60 warp/inch & 80 weft/inch, (140g/m^2) was procured form local textile market, Ahmedabad, India.

Reactive Dye

C.I. Reactive Blue 28 dye was used for experiment supplied by Meghmani Dyes & Pigment, India.

Polyelectrolyte

POLYDADMAC (polydiallydimethylammonium chloride) was used as polyelectrolyte collected from BASF, India

Auxiliaries

Various auxiliaries used in experimental work were

Hygroscopic agent (Urea) from Yashdeep Chemicals, India ,

Reduction Inhibitor (Resist Salt) from Kolorjet Chemicals, Maharastra, India,
Na_2CO_3 (Alkali) collected from Koundinya Chemicals, Hyderabad, India,
Sodium Alginate (Thickener), sample was received from Vishnu Guam & Chemicals, Surat, India.
All chemicals used were of laboratory reagent grade.

2.2 Surface Modification and Printing of Cotton

Cotton was treated with two different concentrations of POLYDADMAC viz. 5 gpl and 10 gpl. using two bowl padding mangle by two dip two nip technique. Material was then dried at room temperature. Process map is reported figure – II.

After drying, materials were printed with reactive dyes by four different techniques (Table – I).

Method – I :- Without Alkali
Method – II :- Wet Development
Method – III :- Steaming
Method – IV :- Thermo fixation (Backing)

Method – I & II did not contain any alkali in its printing paste, while in Method – II printed material was treated in bath which contain alkali. Method – III & IV both had same paste but fixation conditions were different.

Printed materials were taken for fixation (Table – II).

All the printed goods were subject to washing with following steps

(1) Rinsing thoroughly with cold water
(2) Treatment with hot water
(3) Treatment with 2 gpl non-ionic detergent (Sunstar Industries, Chennai, India) at 60 – 70 °C
(4) Washing with hot water
(5) Washing with cold water

2.3 Fastness testing of printed fabric

For washing fastness, light fastness and rubbing fastness, AATCC Test Method 61 – 2006, AATCC Test Method 16 – 2004 and AATCC Test Method 8 – 2005 were used respectively [11].
Washing fastness was measured by using Launderometer, Asian Test Equipments, Gaziabad, India. Rubbing fastness was carried out by using Crockmeter, Taxcare Instruments, New Delhi, India. Light fastness was checked by using Light fastness tester, G.S. Instruments Co., New Delhi, India.

The rating for various fastness and its interference were taken as follows

1 = Poor
2 = Fairly Good
3 = Good
4 = Very Good
5 = Excellent

2.4 Colour value

The printed samples were evaluated for the depth of colour by reflectance methods using 10 degree observer using ultraviolet spectrophotometer (Premier Colorscan SS 5100, Navi Mumbai, India). Colour strength of printed fabric expressed as K/S Value was calculated using Kubelka – Munk equation. i.e.

$$K/S = (1 - R)^2/2R$$

Where, R is the reflectance at complete opacity; K is the absorption coefficient and S is the scattering coefficient.

III. RESULT AND DISCUSSION

In the case of absorption of dye on materials, it has been clearly seen that the cotton was absorbed less dye compare to positively charged (layer generated by POLYDADMAC), cotton in all the four printing techniques (Table – III). Due to this nano layer of positive charge on cotton, it attracts more reactive dye on the surface. This positive charge is due to treatment with POLYDADMAC. It has been also seen that the colour value, brightness as well as sharpness of the print is brilliant where thermofixation method (Method – IV) is used for printing the treated cotton material. Due to charge neutralisation the bond strength is also increases, which enhance the washing and light fastness greatly (Table – IV). Washing, rubbing & light fastness of samples collected form thermofixation method (Method – IV) are excellent, and even in POLYDADMAC treated materials show excellent fastness properties. Rubbing fastness is good to excellent for different printing sequences.

IV. CONCLUSION

- The utilization of suitable method for printing is a crucial factor for printing on POLYDADMAC treated cotton. Among for printing method used for the study, thermofixation (Method – IV) gave the best overall printing performance. The shades are quite brilliant very sharp printing is obtained.
- Also, when cotton is treated with POLYDADMAC, it increases the colour value drastically. POLYDADMAC is used in higher concentration gives excellent result.
- When POLYDADMAC is used as a polyelectrolyte for surface modification of cotton it gives excellent result in case of reactive dye printing of cotton.
- This method consumes less time and also less energy, because the treatment of cotton with polyelectrolytes is done at room temperature.
- Also, concentration of chemicals reduces in printing paste, which reduces pollution load of textile industries. Thus by properly selection of polyelectrolyte & printing method, successful printing can be achieved with various reactive dyes and pollution can also control, which leads us to eco-friendly processing.

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Table – I : Printing Paste for Four different printing techniques

Ingredients	**Method – I (g)**	**Method – II (g)**	**Method – III (g)**	**Method – IV (g)**
Reactive Dye	5	5	5	5
Hygroscopic agent (Urea)	20	20	20	20
Water	14	14	12	12
Resist salt	1	1	1	1
Na_2CO_3	---	---	2	2
Sodium Alginate (6%) paste	60	60	60	60
Total	100	100	100	100

Table – II : Fixation condition for Printed materials

Method – I	**Method - II**	**Method - III**	**Method – IV**
Printed materials were passed through Rapid Ager for 5 – 10 minutes	Printed materials were passed through following bath 6 g NaOH (66ºTw) 10 g Na_2CO_3 15 g NaCl 2 g Sodium Silicate 100 g with water At 90ºC for 20 seconds	Printed materials were passed through rapid ager for 5 – 10 minutes	Printed materials were backed at 150ºC for 5 minutes

Table – III : K/S and strength of cotton printed material (Treated with POLYDADMAC and non-treated)

Printing Technique	**Method – I**			**Method - II**			**Method - III**			**Method – IV**		
Concentration of POLY-DADMAC on	0 (gpl)	5 (gpl)	10 (gpl)	0 (gpl)	5 (gpl)	10 (gpl)	0 (gpl)	5 (gpl)	10 (gpl)	0 (gpl)	5 (gpl)	10 (gpl)

cotton fabric												
K/S	24.3	85.5	127.4	19.6	24.81	27.66	61.98	126.01	128.97	12.70	60.83	92.34
Strength (%)	100	350	522	100	126	140	100	203	208	100	478	726

Table – IV : Fastness rating of cotton printed with Reactive dye

Printing Technique		Method – I			Method - II			Method - III			Method – IV		
Concentration of POLYDADMAC on cotton fabric		0 (gpl)	5 (gpl)	10 (gpl)	0 (gpl)	5 (gpl)	10 (gpl)	0 (gpl)	5 (gpl)	10 (gpl)	0 (gpl)	5 (gpl)	10 (gpl)
Washing Fastness		4	4/5	4/5	3	3/4	3/4	4	4/5	4/5	4	5	5
Light Fastness		3/4	4	4	3	3/4	3/4	3/4	4	4/5	4	4/5	4/5
Rubbing Fastness	Wet	4	4	4/5	2/3	3	3	3/4	4	4	3/4	4/5	4/5
	Dry	4	4	4/5	3	4	4	4	4/5	4/5	4	5	5

Figure I : POLYDADMAC

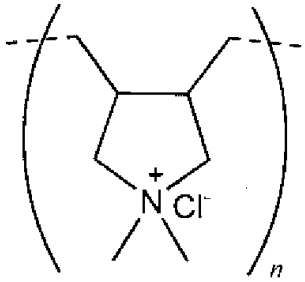


Figure II: Process map for application of POLYDADMAC on Cotton

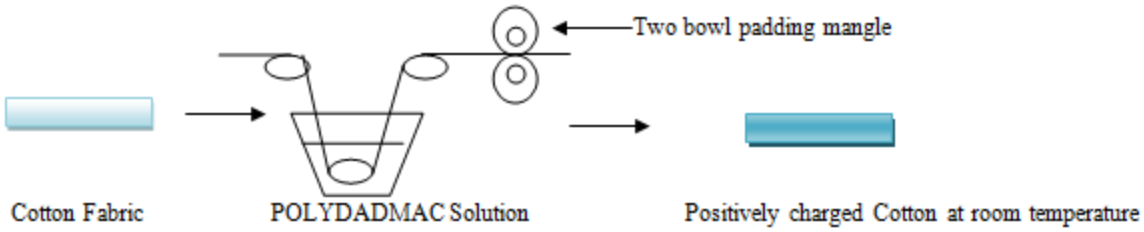
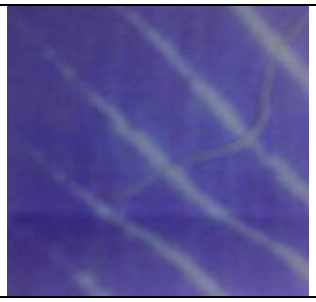
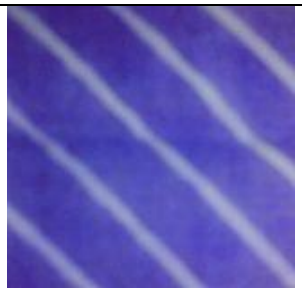
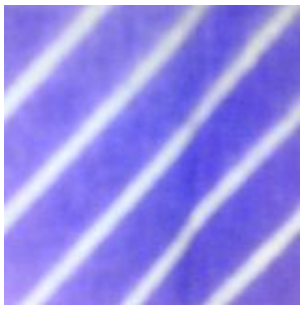


Figure III : Image of Printed Materials

Concentration of POLYDADMAC on cotton fabric	0 gpl	5 gpl	10 gpl
Method – I			
Method – II			

			
Method – III			
Method – IV