International Journal of Sciences: Basic and Applied Research (IJSBAR)

ISSN 2307-4531
(Print & Online)

http://gssrr.org/index.php?journal=JournalOfBasicAndApplied

Preparing Delicate Cellulose Fabric by Utilizing Polyacrylamide Softener to Enhance Surface Smoothness and Quality Properties

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Abstract

Series dilutions of polyacrylamide softeners were made, applied at surfaces of cotton fabrics and cotton/polyester fabrics respectively. Surface adsorption of polyacrylamide based softeners enhanced all smoothness/softness properties of end substrate. Various formulations and concentration of acrylamide functional based softeners were studied by post treatment on cotton/polyester fabrics. Polyacrylamide functional softener fixation onto cotton/polyester fabrics was due to acrylamide groups, to improve reactivity with cellulose substrate thereby increasing cross linking and group formation by providing quality softness. The experimental data stipulate better substantives and networking of acrylamide functional group that can reveal formation of hydrophobic film on surface of cotton fabrics and cotton/polyester fabrics. A tiny layer of applied polyacrylamide softeners also enhanced reduction of the surface roughness by increasing strength of polyacrylamide softener.

Keywords: Polyacrylamide; softener linkage with cellulose; Polyacrylamide application on fabrics; Fabric smoothness and softness properties.

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1. Introduction

Textile fabrics have a valuable market place since last century. Demand of easy care, economical and soft handles textile fabrics has increased in the market for costumers. At the end of the 19th century, the commercial center need indicated an unfaltering increment in the interest for easy-care and eco-friendly material fabrics. The capacity from claiming sturdy press fabrics on consolidating solace with not difficult mind gives a full range of benefit that a purchaser might conceivably anticipate [1]. Objective assessment of fabric properties needs to gain additional consideration not just will evaluate fabric properties yet on encourage advancement from claiming prominent fabrics to a few new requisitions [2].

Since those identification for formaldehyde as a possible human carcinogen, broad endeavors have been produced on find formaldehyde-free cross linking operators for cotton to displace those universal N-methylol reagents [3-4]. Recently, multifunctional carboxylic acids have brought been utilized similarly as non-formaldehyde sturdy press finishing operators to cotton [4–5, 6]. Need of extreme elasticity misfortune yellowing been the major obstacles for requisitions for polycarboxylic acids to form sturdy press finishing for cellulose fabrics. On the other side, cross linking about cotton cellulose for polycarboxylic acids alters both compound furthermore physical properties of the cotton. Such treatments alter extraordinarily limit the capacity of the cellulose fibers to absorb dyes from claiming different classes [4–7].

It may be accepted that little conditioner atoms infiltrate under the fiber furthermore provides for inside plasticization of the fiber shaping polymer toward lessening its glass move temperature Tg. Physical plan of conditioner atoms on the surface may be extremely critical. It fundamentally relies on the ionic method for the conditioner and the relative hydrophilicity of the surface. Cationic conditioners deal with themselves, with their emphatically charged mists to efficiently oppositely blamed fiber. This introduction to cationic softeners may be answerable for those most noteworthy delicateness furthermore lubricity got eventually cationic softeners [1].

Polyacrylamide is water-soluble engineered straight polymers made from claiming acrylamide alone or the blending for acrylamide with more acrylic compound. Polyacrylamide have the most noteworthy sub-atomic weight around the synthesized modern chemicals in the extend from claiming 10-20 millions. Poly (2-propenamide) poly (1-carbamoylethylene) is a polymer (-$CH_2CHCONH_2$-) organized by acrylamide functional groups that do expeditiously cross-connected [8].

Acrylamide is exceedingly water solvent compound whose sub-atomic weight is 71.08 a.m.u Polyacrylamide have been synthesized by rehashing the grouping of –CH_2–CH ($CONH_2$)– units for substitutions of amide gathering (–$CONH_2$) get together with another gathering which movements those ionic qualities and compound reactivity of the finish product. Pre-treatment about cotton with polyacrylamide enhances the likelihood about dyeing cotton at unbiased pH with different sensitive dyes. Such pre-treatment, concerning illustration connected through pad–dry–cure process, acquires over some concoction progressions in the approached fabric [9].

The essential work of a conditioner is to confer a specific handle on a material surface, with aggravate article of

clothing alternately fabric feel [1,10]. Polycarboxylic acid dark on dyed cotton, as wrinkle dyeing properties were analyzed that showed polycarboxylic acid immense fixation, useful softness properties also progressed wrinkle safety around cotton. Polycarboxylic acid darkness was totally utilized toward cycle dyeing because of the soundness of the color [11].

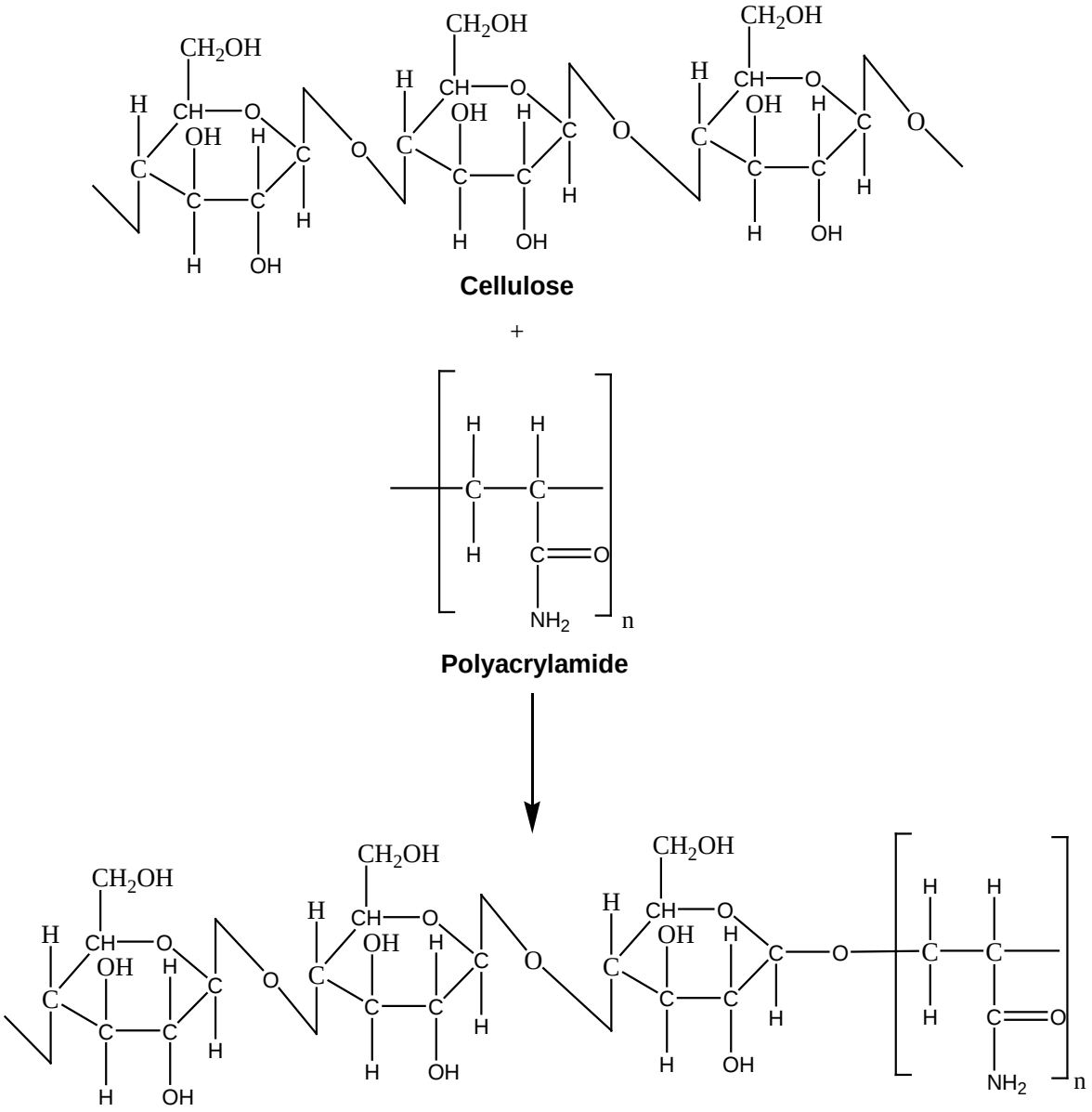

Figure 1: Polyacrylamide reaction with cellulose

In Figure 1: polyacrylamide made linkage with oxygen results in the formation of a strong covalent ether bond between cellulose and polyacrylamide.

The pre-treatment for claiming cotton fabric for polyacrylamide showed the acquaintance for utilitarian amino bunches which expanded the substantives reactivity of cotton. The cationic charged amino aggregations might a chance to be included in the adsorption about anionic chromophore about sensitive dyes. The color capability

might have been postulated because of those vicinity from claiming amide groups ($-CONH_2$) accessible starting with the polyacrylamide which likewise tented should enhance the reactivity about cellulose substrate. The connection of the dyed molecules onto the partially-modified cellulose substrate might have been finished toward covalent bonding since no dye strips out of the colored sample. This might have been additionally demonstrative through the fastness properties for the sample, as wash fastness. Therefore, as expected, the polymer dealt with colored tests which shown a change in the wrinkle recuperation. A large amount from claiming color depletion on the death with fabric could make attained in the nonattendance about salt and soluble base at temperature similarly as low as typically during 60-80°C that utilized within the routine dyeing process [12].

In this investigate polyacrylamide built aqueous softeners were ready toward changing sorts for focuses, furthermore connected onto those fabrics utilizing pad-dry-cure strategy. Impacts of the process parameters were efficiently investigated. These parameters incorporate progress tone, surface unpleasantness and smoothness, furthermore focus of the polyacrylamide connected onto those fabrics. The treatment with fabric swatches were monitored for surface unpleasantness furthermore yellowing impact.

2. Experimental

2.1. Materials

2.1.1. Cotton fabric

Five different types of desized, scoured, bleached, mercerized (white), dyed and printed fabrics were provided by Arzoo Textiles Mills Ltd., Khurrianwala, Faisalabad, Pakistan. Fabric specifications and characteristics, i.e. fabric quality, construction, count, and blend ratio were shown in (Table 1). These different types of fabric were treated by washing at 100 °C for 60 minutes using solution consist of sodium carbonate 2 g/L, sodium perborate 1 g/L and non ionic surfactant (BASF). All treated fabrics were washed various times with hot and cold water respectively. The applied fabrics were dried in oven at 150°C for 4 minutes.

Table 1: Fabrics specification with quality and processed applications

S. No	Quality	Construction/count	Blend ratio cotton/polyester	Processed/application
1	Dyed cotton	(76 × 68/30 × 30)	100% cotton	Combination of reactive dyes
2	Printed cotton	(76 × 68/30 × 30)	100% cotton	Combination of pigments
3	White bleached cotton	(100 × 80/40 × 40)	100% cotton	Optical brightener
4	White bleached polyester/cotton	(100 × 80/40 × 40)	50/50	Optical brightener
5	White bleached Denier	(76 × 46/35 × 150)	15/85	Optical brightener

2.1.2. Chemicals

Ammonium per sulphate was used of laboratory grade chemical. Acrylamide and Dietylene glycol (DEG) were

procured from Finger source corporation, Karachi, Pakistan. Acrylic acid was procured from Asiatic Chemicals, Karachi, Pakistan. Urea was purchased from Fatima Fertilizer Company Ltd., Lahore, Pakistan.

2.2. Preparation of polyacrylamide softener samples

For the purpose weighed amount of acrylamide was taken into a 500 ml beaker and 300 ml of reverse osmosis water were added into it. The arrangement was warmed in water shower at 40°C to guarantee totally disintegration of acrylamide into 300 ml water, a short time later ammonium persulfate (APS) was included as impetus. The mixture was stirred constantly for eight hours until the polymerization completed. After eight hours urea was added into it with constant stirring to maintain its pH. The pH was noted, i.e., 5. Hence polyacrylamide was prepared. By varying ingredients quantity, as shown in (Table 2), other polyacrylamide samples were prepared.

Table 2: Sample code designation and various formulation of polyacrylamide softener

S. No	Sample Code	Acrylamide	Distilled water	Ammonium Per sulphate	Urea	Diethylene Glycol	Acrylic acid
1	POLY-1	18g	300ml	0.4g	60g	6g	0.2g
2	POLY-2	18g	300ml	0.4g	62g	6g	0.2g
3	POLY-3	16g	300ml	0.4g	60g	6g	0.2g
4	POLY-4	20g	300ml	0.4g	60g	6g	0.2g
5	POLY-5	22g	300ml	0.4g	61g	6g	0.2g

2.3. Treatment of polyacrylamide built aqueous softener on Cotton, cotton/polyester fabric

Few dilutions of polyacrylamide built aqueous softener were made, i.e., 25 g/L, 30g/L and 35 g/L and applied at the surfaces of cotton, cotton/polyester fabrics. Pad-dry-cure technique was used for treatment of cotton and blends of cotton/polyester fabric with polyacrylamide softener. These fabric samples were managed with a watery arrangement of polyacrylamide conditioner (20%) with different dilutions (i.e., 25 g/L, 30 g/L and 35 g/L) at pH 5, dried at 130 °C for 4 minutes. The curing was done at 150 °C (only printed fabrics) and at 180 °C (all other samples) for 5 minutes.

2.4. Testing and investigation

The impact of applied conditioner onto the tint and perception of the colored, printed and white fabrics were assessed and reported. The impact of diverse utilized softener was additionally thought about and reported. Linkage of softener with cellulose results in increasing of delicate smoothness properties.

The delicate quality was assessed through hands feel technique. Be that as it may, the tone changes of colored and printed fabrics were seen by looking at the shades of treated and untreated fabrics after use of distinctive

dilutions of the conditioners taking after the routines reported in standard test methods [13–14]. Overall the study able to comply with the purpose by giving experimental results.

3. Results and discussion

Contact alternately handle is a paramount angle from claiming material assessment. Specialized foul textiles, clinched alongside particular, would subjected on a few transforming and completing operations which might aggravate those material merciless alternately fragile. Softening is, therefore, a critical last-step transform prerequisite over such provisions. Choice of a suitableness perfect softening treatment is critical; Overall the conditioner itself might disable the purpose of a specialized foul result. Those impacts from claiming conditioner provision on the physical properties, color, whiteness, handle also flammability of textiles material have been considered [15].

The treatment of textile materials with substances that adjust their surface properties has been normal practice from the most antiquated times. One of the least expensive and best softening operators is plain water. Textile fabrics and garments always become harsher by drying and softer by allows them to absorb a suitable amount of moisture. The glycerine, ethylene glycol and similar volatile substances are commonly used in place of water. The utilization of vegetable colors for shading, the starches to give firmness, the creature and vegetable fats, oil to grant flexibility, water repellence, and delicate quality were polished.

The textile material business has assumed a key part in expanding request on textile material scientific expert to give quality fabrics exceptional stylish properties. These properties were upgraded with textile conditioners. Polyacrylamide, polyvinyl liquor and silicones have been thought to be proficient to give a magnificent delicate silk gave to the fabric surface. By developing polyacrylamide and polyvinyl alcohol blends revealed a luxurious handle and smoothness.

3.1. Surface smoothness and softness of the treated fabrics

All the results of the dyed, printed and white fabrics have been presented in Table 3. To examine applied polyacrylamide softener strength on different processed textile fabrics (dyed, printed and white etc.), all results are presented in Table 3 based on grading letters; X, XY, Y, YZ, Z, and U. Surface of the applied samples clearly differentiable with smoothness and delicateness with novel solidness and handle. Sample no. 5 (POLY-5) has shown marvellous surface softness and smoothness comparative to all other samples. Sample no.4 (POLY-4) is just one step behind in smoothness and softness than sample no. 5 (POLY-5). Sample 1 to 3 (POLY-1-POLY-3) have demonstrated moderate surface softness and smoothness. Nevertheless, sample 1 (POLY-1) and sample 2 (POLY-2) shown lower grade results as compared to the sample no. 4 (POLY-4) and sample no.5 (POLY-5).

It has been reported [17] that conditioners gave incredible surface smoothness with delicate quality and strength. They are easily emulsifyable, stable on dilution and compatible with other finishing agents, non-yellowing and non-reactive. The non reactive fluids can be easily converted into emulsions using non-ionic emulsifiers. The variations in the surface smoothness observed are attributed to the nature of the emulsifier used. The nature and

amount of emulsifier directly control micelles size. Finer the micelles size better the penetration of polyacrylamide and its blends softener into the fabrics. Thus pronounced effect was observed in the studied samples.

Table 3: Grading Results of dyed, printed and white fabrics after application of polyacrylamide softener

S. No	Strength of solution	Type of fabric	POLY-1	POLY-2	POLY-3	POLY-4	POLY-5
1	25 g/L	Dyed	Y	Y	XY	XY	X
2	30 g/L	Dyed	Y	Y	XY	XY	X
3	35 g/L	Dyed	XY	XY	X	X	X
4	25 g/L	Printed	Y	Y	XY	XY	X
5	30 g/L	Printed	Y	Y	XY	XY	X
6	35 g/L	Printed	Y	XY	XY	X	X
7	25 g/L	PC	Z	Z	Z	Y	XY
8	30 g/L	PC	Z	YZ	YZ	Y	XY
9	35 g/L	PC	YZ	YZ	YZ	XY	X
10	25 g/L	Denier	Z	Z	Z	Y	XY
11	30 g/L	Denier	Z	Z	Z	Y	XY
12	35 g/L	Denier	Z	Z	Z	Y	XY

The pre-treatment of cotton fabric for polyacrylamide exhibited the presentation of functional amino aggregations which expanded the substantives also those reactivity about cotton. Those cationic charged amino aggregations might make included in the adsorption from claiming anionic chromophore from claiming sensitive dyes those progressed color capacity might have been postulated because of those vicinity about amino group short gatherings ($-CONH_2$) accessible starting with the polyacrylamide which additionally tented with enhance those reactivity from claiming cellulose substrate. The connection of the color atoms onto the incompletely changed cellulose substrate might have been carried by covalent bonding since no dyes strips out starting with those colored sample. This might have been likewise demonstrative through the fastness properties for sample, such that wash fastness. Therefore, similarly as expected, the polymer treated colored tests which shown a change in the wrinkle recuperation. A large amount about color depletion on the treated fabric might make attained in the nonattendance from claiming salt and soluble base In a temperature as low concerning illustration regularly toward 60-80°C that utilized within those customary dyeing methodology.

3.2. Effect of applied softener on the tone of the dyed and printed fabrics

Swatches of treated dyed and printed fabric with polyacrylamide are presented in Fig. 2 and Fig. 3 respectively. Prepared softeners were applied after dilution, 25g/L, 30 g/L, 35 g/L. Rich handle and smoothness can be observed on all treated fabrics having unique softness and stiffness as shown in Fig. 2 and Fig. 3.

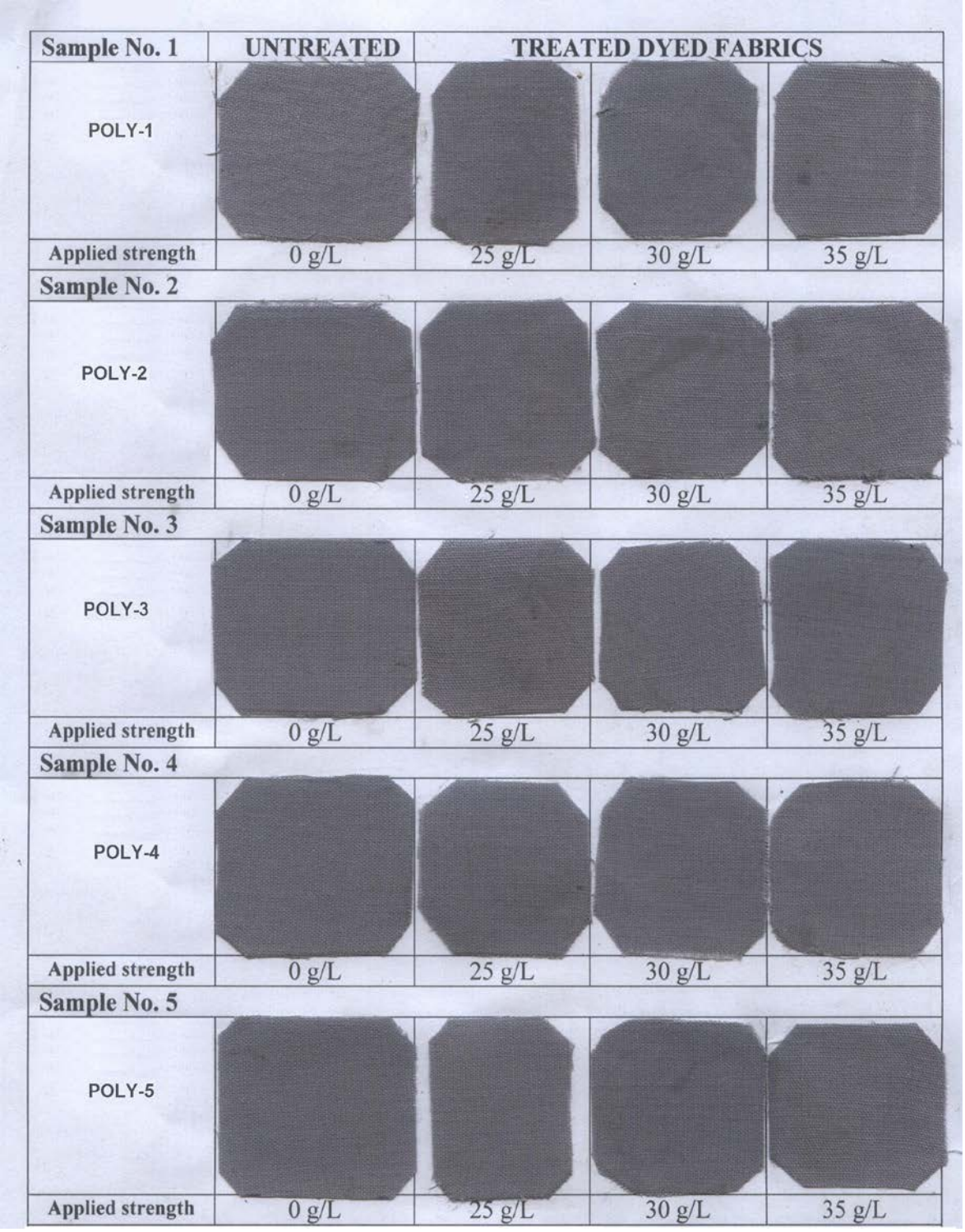

Figure 2: Surface smoothness and softness of polyacrylamide softener on the tone of dyed fabric

An untreated fabric swatch is also present with each set of fabric treated with softener. Shades of dyed, printed, treated, and untreated have no exclusive change in fabric tone. Different varieties of softeners are available in the market, but on treatment sometime cause color fadness. The consequence is that white light or medium color of dyed fabrics appears as yellow and off shady. Due to oxidation, course of action of azo and azoxy blends

happened which finally give yellowing and off shady to the fabric Azoxy yellow blends are molded as a result of oxidation of amino functional group.

The hued and printed treated fabric (Figs. 2 and 3). It can be watched that all the treated hued and printed fabric swatches (Figs. 2 and 3) have exhibited an outstanding sensitive smooth and constant handle which is credited to the partiality to amino group to fiber and furthermore its linkage to the silicones. But all the samples have shown rich handle sensitive quality, however the sample no. 5 (POLY-5) has demonstrated better result when diverged from each and every other sample. The relative results of the samples uncovered closeness of the conditioner used with that of open shaded/dyed fabric.

Figure 3: Surface smoothness and softness of polyacrylamide softener on the tone of printed fabric

4. Conclusion

Methodology to upgrading both the wrinkle spare and delicate quality properties from claiming cotton fabrics without adversely influencing their quality properties utilizing an eco-cordial finishing regimes have been investigated. Those acquired effects uncovered that post treatment with polyacrylamide built conditioner brings about an amazing change on fabric resiliency, and also for delicate quality degree, without influencing its properties with quality. Obsession from claiming polyacrylamide conditioner onto/or inside the modified cellulose structure will be went with by a arrangement of semi inter or intra-penetrated network, thereby upgrading both those degree of cross linking and additionally giving work to high delicateness. Every last one of outcomes infers should a chance to be consenting for smoothy and delicate quality from claiming all treated fabrics.

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