International Journal of Scientific Engineering and Technology
Volume No.4 Issue No5, pp: 306-309
ISSN : 2277-1581
01 May. 2015

Performance Evaluation of 100% Viscose Rayon Fabric Pre-treated with Different Alkalis

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Abstract: This study attempted to focus on the performance evaluation of 100% viscose rayon fabric in terms of strength, whiteness and hydrophilicity or absorbency after scouring and bleaching with two different alkalis such as NaOH and Na_2CO_3. This work was carried out with 100% viscose rayon knitted fabrics. A single stage scouring and bleaching process of the fabric was adopted using NaOH and Na_2CO_3 with varying concentrations and at the same processing conditions. The result obtained in this study indicated a great loss in strength with NaOH as compared to that with Na_2CO_3. Both the alkalis were found to be more or less equally efficient in terms of improved absorbency and whiteness.

Keywords— viscose rayon, scouring, bleaching, NaOH, Na_2CO3, bursting strength, whiteness index, hydrophilicity

I. Introduction

Viscose rayon is the oldest commercial man made fibre [1]. Viscose rayon's properties are more similar to those of natural fibers made of cellulose, such as cotton or linen, than those of petroleum-based synthetic fibers such as nylon or polyester [2,3].

Viscose is a solution of cellulose xanthate made by treating a cellulose compound with sodium hydroxide and carbon disulfide. Byproducts include sodium thiocarbonate, sodium carbonate, and sodium sulfide.[4] The viscose solution is used to spin the fibre viscose rayon, or rayon, a soft man-made fibre.

Viscose rayon is a fiber made from regenerated wood cellulose. Viscose rayon is structurally similar to cotton, which is almost pure cellulose. Cellulose is a linear polymer of β-D-glucose units with the empirical formula of $(C_6H_{10}O_5)_n$ [5]. To prepare viscose, the cellulose is treated with sodium hydroxide to form "alkali cellulose," which has the approximate formula $[C_6H_9O_4\text{-}ONa]_n$. The alkali cellulose is then treated with carbon disulfide to form a solution of sodium cellulose xanthate, which is called viscose.[6]

$$[C_6H_9O_4\text{-}ONa]_n + nCS_2 \rightarrow [C_6H_9O_4\text{-}OCS_2Na]_n$$

The rate of depolymerization (ripening or maturing) depends on temperature and is affected by the presence of various inorganic and organic additives, such as metal oxides and hydroxides. Air also affects the ripening process since oxygen causes depolymerization.[7]

Rayon fiber is produced from the ripened solutions by treatment with a mineral acid, such as sulfuric acid. In this step, the xanthate groups are hydrolyzed to regenerate cellulose and release dithiocarbonic acid that later decomposes to carbon disulfide and water.

$$[C_6H_9O_4\text{-}OCS_2Na]_{2n} + nH_2SO_4 \rightarrow [C_6H_9O_4\text{-}OH]_{2n} + 2nCS_2 + nNa_2SO_4$$

$$H_2COS_2 \rightarrow H_2O + CS_2$$

The thread made from the regenerated cellulose is washed to remove residual acid. The sulfur is then removed by the addition of sodium sulfide solution and impurities are oxidized by bleaching with sodium hypochlorite solution [8]. The final chemical structure of viscose rayon is shown below [figure 1].

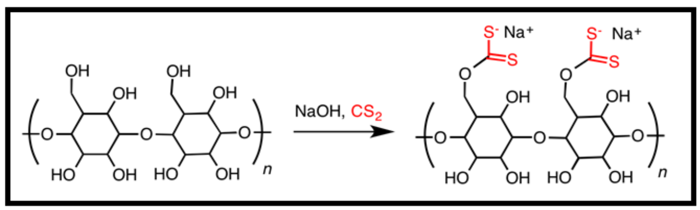

Figure 1: Cellulose is treated with alkali and carbon disulfide to yield Viscose Rayon [Wikipedia, 2015].

Viscose has lower tenacity in both wet and conditioned state than cotton – more care is necessary to prevent fabric breakages and tears in wet processing.

Moncrieff mentioned that Scouring is a purifying treatment of textiles. The objective of scouring is to reduce the amount of impurities sufficiently to obtain level and reproducible results in dyeing and finishing operations [9]. The appropriate type of scouring agent generally depends on the kind of fibres; fabric type i.e. woven or knitted, thick or thin; textures or non-textures and the extent of impurities present in the fibre. The selection of alkali is most important as free alkali can have a deleterious effect on certain fibres.

The action of alkaline scouring agent is to saponify any residual oils, to neutralise carboxylic acids, to solubilise any sizing materials and to cause dispersion of naturally occurring impurities in natural fibres [10].

This study mainly focuses on the investigation of properties affected by different alkali (scouring agent) NaOH and Na_2CO_3 pretreatments at various concentrations of viscose fabric and to construct a comparison of at the same time.

II. Material and Methodology

2.1. Substrate:

International Journal of Scientific Engineering and Technology ISSN : 2277-1581
Volume No.4 Issue No5, pp: 306-309 01 May. 2015

In the experiments, single jersey knitted 100% viscose rayon fabric, grey GSM160, yarn count 30 Ne was used.

2.2. Scouring/bleaching:

Scouring and Bleaching were adopted in single stage where samples were treated with different concentrations of alkalis: NaOH and Na_2CO_3 from separate bath set-ups following the recipe mentioned in Table 1.

Table 1: Scouring and bleaching recipe

Chemicals	Bath-1	Bath-2	Bath-3	Bath-4
Scouring chemical (Alkali)	**1.0 g/l**	**2 g/l**	**3.0 g/l**	**4 g/l**
Sequestering agent, (Tex-D-900)*	0.5 g/l	0.5 g/l	0.5 g/l	0.5 g/l
Antifoaming agent, (FFC)*	0.5 g/l	0.5 g/l	0.5 g/l	0.5 g/l
Bleaching agent, H_2O_2	4g/l	4g/l	4g/l	4g/l
Stabilizer (Centableach SOF)*	0.5g/l	0.5g/l	0.5g/l	0.5g/l
Temperature	95c	95c	95c	95c
Time	45 min	45 min	45 min	45 min
M:L	1:8	1:8	1:8	1:8
After-treatments:				
Per oxide killer (Crocks)*	0.5g/l	0.5g/l	0.5g/l	0.5g/l
Acetic Acid	0.5g/l	0.5g/l	0.5g/l	0.5g/l

* Commercial names of chemicals

2.3 Procedure of scouring/bleaching in a single stage

All the scouring and bleaching experiments were carried out in Fong's machine.

(i) Wetting agent, sequestering agent and antifoaming agent in calculated amount were put in the bath with fabric at room temperature
(ii)Then peroxide and stabilizer were added in the bath at 40° C.
(iii)Then alkali as NaOH was added in the bath and the temperature was raised to 95°C from room temp at a temperature gradient 2.5°C/min.
(iv) The bath was run for 35 minutes at 95°C.
(v) Then bath temperature was lowered down to 70-80°C from 95° C.
(vi)Then rinsing was done in hot water twice (around 70°C) and washing was done in cold water. Then temperature was raised to 80° C and at that temperature crocks was applied for removing residual H_2O_2.
(vii)At last acetic acid was applied for neutralizing the bath.
(viii) Different concentrations were applied seperately with different fabric samples. Finally allthe samples are then dried in air at a temperature less than 60^{o}C.
(ix)Same procedure (i to viii) was repeated using alkali Na_2CO_3 in similar concentrations seperately.

2.4 Testing for Evaluation

Conditioning:

The samples were brought from the prevailing atmosphere to moisture equilibrium for testing in the standard atmosphere for textile testing

2.4.1. Bursting strength

Strength was measured according to standard method ASTM D 3786 – 01[11]. Both alkali treated samples were tested at each concentration and strength loss percentage was evaluated as compared to the non-treated sample of fabric.

2.4.2. Whiteness Index

Degree of Whiteness (Berger) of the scoured/bleached fabrics was determined with the reflectance value evaluated using Datacolor spectrophotometer and the standard illuminant D65 (LAV/Spec. Incl., d/8, D65/10°).Whiteness values were measured in four different places making four folded in the samples and their average was taken for the analysis of result.

2.4.3. Fabric hydrophilicity or water absorbency

Water absorbency of the scoured/bleached samples were evaluated according to wicking test method. Each sample of 2.5 cm width were hung vertically immersing 1 cm length into 0.1% direct dye solution for 1 min. Height of liquid (in cm) absorbed by the sample was taken as a measure of absorbency.

III. Results and Tables

Table-2: Evaluation of strength loss

conc. (gpl)	strength at different conc. (kpa)		initial fabric strength (kpa)	strength loss %	
	NaOH	Na_2CO3		NaOH	Na_2CO3
1	410.2	486.7	503	18.45	3.24
2	377.3	479.5		24.99	4.67
3	347.6	471.1		30.89	6.34
4	302.1	465.4		39.94	7.48

From the data of strength, gradual loss of strength of fabric was found for equal concentrations of both alkali treatments. A great loss in strength was found in case of NaOH which reached about 40% for 4.0 gpl. whereas Na_2CO_3 showed only about 7.5% strength loss of fabric. It may be due to the breakage of more of the oxygen linkages of the cellulosic polymer of viscose by strong alkali NaOH. The values of strength at different concentrations of both alkali treated samples and the percentage loss of strength are shown in Table 2.

Table-3: Whiteness measurement

conc. (gpl)	Berger Whiteness Index	
	NaOH	Na_2CO3
1	74.4	74.3
2	74.6	74.4
3	75.3	75.1
4	75.4	75.3

Table-4: Absorbency test (column test)

conc. (gpl)	Height or length of liquid in cm	
	NaOH	Na_2CO3
1	4.6	4.3
2	4.8	4.6
3	5.2	5.1
4	5.8	5.5

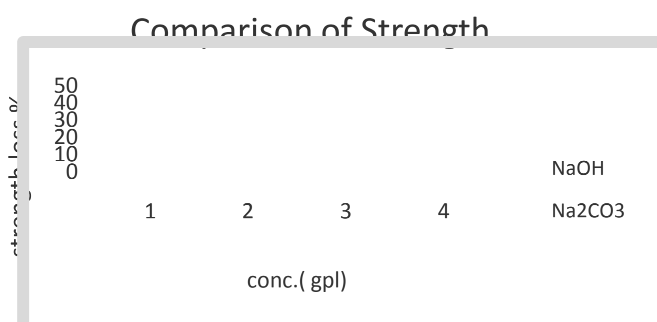

Fig.2 Bar diagram of strength loss percentage of different alkali treated samples at various conc.

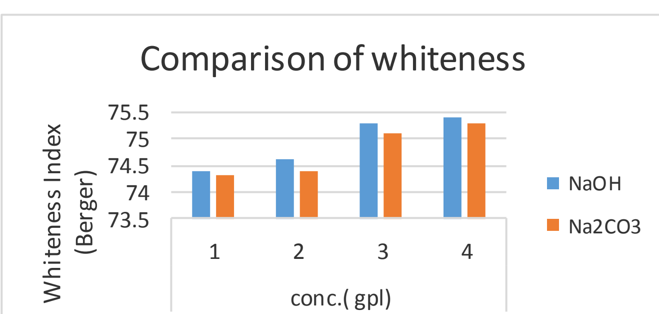

Fig.3 Bar diagram of Berger whiteness index of different alkali treated samples at various conc.

In case of whiteness value, results found almost similar for both alkali treatments which was above 75% for maximum concentration of alkali used. A slight gradual increase in whiteness value was found for both alkali applications in higher concentrations as the whiteness mainly depends on the bleaching agent used. Table 3 shows the results of whiteness of treated samples.

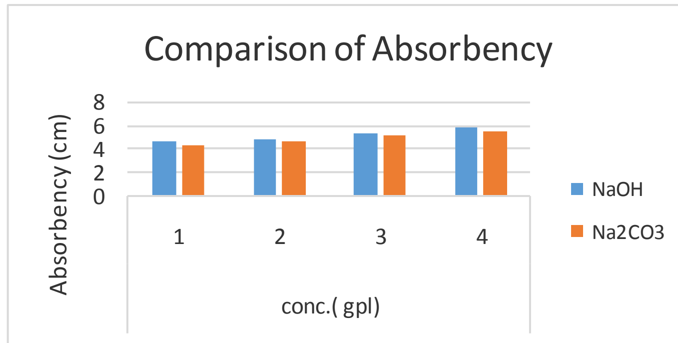

Fig.4 Bar diagram of absorbency of different alkali treated samples at various conc.

The absorbency values determined as height/length of liquid were also found to be increasing with the raising concentration of both alkalis. Being stronger than Na_2CO_3, NaOH showed more powerful scouring or cleaning effect on fabric and hence showed a slight greater amount of hydrophilicity than Na_2CO_3 with the same amount. Absorbency values are listed in Table 4.

IV. Conclusion

The scoured/bleached viscose fabric showed a gradual loss in strength with the increasing concentrations of NaOH whereas different concentrations of Na_2CO_3 affected a little on the strength. The sample treated with the highest concentration of NaOH severely lost its strength. Whiteness Index values showed increases in the treated samples as compared to untreated fabrics. Almost similar patterns of whiteness values were found for different concentrations of both alkalis. Absorbency values were found to be higher for raising concentrations of both chemicals. A little bit larger value of absorbency was noticed in case of NaOH treated fabrics. Summarizing the results, NaOH was suitable for scouring/bleaching of 100% viscose rayon only in very low concentrations whereas higher concentrations caused very adverse effects on fabric strength but in comparison, Na_2CO_3 was safer for viscose pretreatment.

Acknowledgement

The authors gratefully acknowledge the support from Far East Knitting & Dyeing Industries Ltd. Gazipur, Bangladesh.

References

i. *Sisson, W.A. (1946), "Cellulose and Cellulose Derivative", E.H.H, pp 32-40*

ii. *Ghezelayagh Ava, "A Comparison of the Chemical Structures and Production Methods of Silk and Artificial Silk", http://cosmos.ucdavis.edu/archives/2008/cluster8/ghezelayagh_ava.pdf*

iii. *Goswami, B.C., Martindale, J.G. & Scardino, F.L. (1977). "Textile yarnsTechnology, structure and applications", A Wiley-Interscience Publication.*

iv. *E.R Trotman (1975) "Dyeing and Chemical Technology Textile Fibres" 5th Edition, pp 540*

v. *J.E.Booth (1987), "Principle of Textile Testing'', pp 127*

vi. *F.W.Billmeyer Jr. and M. Saltzman(1981), " Principle of Color Technology'', 2nd Edition; pp 140*

vii. *T.L Vigo and E.J Blanchard (1987), Textile Chemists and Colorist, pp 19*

viii. *Edward Menezes and Mrinal Choudhari, " Pretreatment of Textile prior to Dyeing'' pp 65*

ix. *Moncrieff, R.N , "Man-made Fibres, London 1975", Newness Butterwarths, pp 1094*

x. *Prof. Peter J. Hauser (edited:2011), " Textile dyeing" , 2011, pp 68*

xi. *ASTM D 3786 – 01, (2005): (Hydraulic Bursting Strength of Textile Fabrics—Diaphragm Bursting Strength Tester Method)*