Effect of Surface Active Agents on Cellulosic Fabric Properties

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Abstract: The effects of four different types of surfactants on Cellulosic Fabric Properties were studied. The non-ionic surfactant improve surface and mechanical properties by approximately 15% while in the presence of amphoteric, anionic and cationic surfactants decreased by13, 18, and 50%, respectively. The mechanical properties, such as tensile strength, thickness and crease recovery (angle) of the cellulosic fabrics were measured. In the presence of non-ionic surfactant, the tensile strength loss for cellulose treated fabric was increased by 17%. The loss of tensile strength did not change using cationic surfactant while in the presence of amphoteric and anionic surfactants, the strength loss decreased rather insignificantly. The results obtained from measuring the mechanical properties of the cellulosic fabric compared with using surfactants treatment.

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1. Introduction

The objective measurement of fabric hand can be dated to work by Pierce on fabric bending and compression in the 1930's**.** In the 1950's and 1960's work (**De** Boos, A.,**1994**) at the Swedish Institute for Textile Research (TEFO) in Sweden was focused toward objective measurement and analysis of fabric bending, buckling, tensile, shear and compression properties. More recently, instrumentation has been developed to measure mechanical properties that specifically contribute to fabric hand and quality. The two primarily used fabric objective measurement systems are the Kawabata Evaluation System for Fabrics (KES-F) and the Fabric Assurance by Simple Testing (FAST). The FAST system was designed for measuring properties of fabrics important to the intended performance and the appearance of tailored garments in-wear**.** This work reports changes in the mechanical and surface properties of a plain weave cotton/blend fabric subjected to different types of surfactants treatment.

Surfactants as the typical auxiliaries are extensively used in the textile industry **(Ueda, M.etal. 1994)** Target site of these compounds on the protein structure is hydrophobic domains and/or charged groups of the proteins. Formation of partially unfolded substructures including micelle-like regions is considered as the driving force for this type of denaturation process. Extensive works have been done on the subject of cellulose action on cellulose and it is known that the catalytic reaction rate of cellulose is affected by several factors such as pH, temperature, presence of the chemicals along with the substrate **(Bailey, J.etal. 1986).**

2. Experimental procedure

1 Materials

Cellulosic fabrics used as the substrate in this procedure had the specification illustrated in Table (1).

Surfactants of the various compounds have the following specifications:

- Anionic: dodecylbenzene sodium sulphonate.
- Non-ionic: nonylphenol ethoxylate.
- Cationic: cetyl trimethyl ammonium bromide (CTAB).
- Amphoteric: Albegal A(AMS) is alkylamine polyglycol ether. The surfactants were kindly supplied by Ciba Co.

Table (1): Constructional parameters of fabric samples

Fabric code	Fabric Blend, % Cotton/polyester	Warp Count, Nm	Weft Count, Nm	Ends/cm	Picks/cm	Weave	Fabric Weight, g/m²
1	55/45	30/1	25/1	33	27	Plain1/1	123

2 Methods

Cotton fabrics in the appropriate size were prepared (15 cm×15 cm) and 10 g of the fabrics was soaked in 200 mL buffer solution containing the appropriate concentration of the surfactants (0.1, 0.2, 0.5, 1 and 2 g per liter of the buffer solution). Buffer solution had the following specification: acetate buffer, 0.02 M, pH 4.5. Temperature and time of the surfactants treatments were 50 ^{o}C, 30 min, respectively. The experiment was carried out in Lintiest dyeing apparatus with 20:1 liquor per g of fabric, agitation in the bath was provided by 10 steel disks. Reducing measurements upon this treatment was measured at the end of the time interval.

3 Fabric Parameters

Some parameters of the fabrics measured in this study were: loss of strength, thickness, crease recovery (angle) and shearing. Loss of strength was measured on an Instron tester T.M.S.M model, England, speed: 5cm/min, gauge length: 20 cm. Variation in thickness was measured on Shirley equipment (O.S.K), 240 g/cm^2, England. Shearing rigidity was measured on FAST instruments.

3. Results

The results of the study on mechanical properties of cotton fabrics are shown in Table 2. Table 2 shows the average values of mechanical properties of cotton fabrics. Details of the mechanical properties and their respective limits are described.

Effects of different kinds of surfactants on the cellulose treatment of cellulosic fabrics were examined inTable2.The non-ionic surfactant improve surface and mechanical properties by approximately 15% in comparison to a content without surfactant (WOS) Ref. while in the presence of other surfactants namely amphoteric (AMS), anionic (ANS) and cationic surfactant(CAS) decreased by 13, 18, 50 percent, respectively.

4. Discussion

As it has been mentioned before **(Ueda, M.etal. 1994a)** the adsorption mechanism has a rather special meaning in the cellulose hydrolysis of cellulose. Surfactants, amphiphilic molecules, tend to adsorb onto surfaces and therefore, provide a means of surface alteration in the physical properties of cellulose. This improvement is reported to be more evident when NNS is used. Moreover, the data obtained by Mizutani **(Mizutani, C.etal.1999 i**n the recent work showed that the use of NNS on the cellulose treatment of cotton fabric enhanced the effect of cellulose. Based on the results and observation from scanning electron microscopy, those authors suggested that there could be a relationship between the enhancement effect obtained and the degree of crystallinity and order ness of the cellulosic fibers. Cellulose crystallinity showed to be relatively invariant over extended hydrolysis time **(Helle *et al.,* 1993)**, they suggested that crystallinity is considered perhaps, a less important factor than it is originally perceived to be. It is postulated that surfactant exerts its improving effects on cellulose action, perhaps by two mechanisms: (1) altering the cellulose's properties, and by the disturbing the structure of cellulose (reduction the degree of crystallinity), making the substrate more accessible to the enzyme, (2) preventing the adsorbed cellulose from becoming inactive(**George, G.etal.1992).** On the other hand, some studies on the cellulose treatment of cotton fabrics showed that ionic surfactants impose some inhibitory effects on the cellulose catalytic reaction.

In the present study, the results obtained from the tensile strength loss (%) of the cellulose treated cellulosic fabrics are in agreement with the pattern of the hydrolysis of the fibers by cellulose (Table 2). Loss of the tensile strength for the cellulose treated cotton fabrics is shown to be increased when NNS is used in the reaction mixture as compared to that of the control treatment (Table 2). Tensile strength loss is considered as one of the major factors in determining the physical properties of treated fabrics **(Leung, M.Y.etal .2004 Saied,F.F.etal.2011).**Results obtained from the thickness and crease recovery (angle) measurement of the treated fabrics showed decreasing in fabric thickness, fabric surface thickness and shear rigidity **(Ebrahim,F.2010)**with using surfactants treatment Table (2). The decrease of this results increased with used (NNS) compared to control treatment, while crease recovery angle have limited increase with (CAS), (AMS) and (ANS) surfactants. NNS has high effect increase recovery angle (Table2).

Table (2): Factors affecting on fabrics using different types of surfactants

Fabric property	Control Treatment	Anionic, ANS	Non-ionic, NNS	Cationic, CAS	Amphoteric, AMS	WOS
Tensile strength	41	38.95	34.03	37.72	38.13	37.72
Crease recovery Angle	124◦	125◦	127◦	126◦	126◦	126◦
Thickness (mm)	0.419	0.409	0.382	0.408	0.404	0.396
Shearing G(N/m)	49.9	47.41	41.42	45.91	46.41	45.80
Surface Thickness (mm)	0.179	0.175	0.163	0.174	0,173	0.171

The catalytic specificity of cellulose in the presence of CAS and AMS decreased significantly; however, this specificity reduction in the presence of ANS was less than that of the two above named surfactants. Possible formation of the attractive force(s) between cellulose with its negatively charged surfaces [8] and the cationic surfactant may be of more importance as compared to the existence of the repulsion force(s) between the cellulose substrate and anionic surfactant. Presence of the amphoteric surfactant in the reaction mixture may show again the importance of occurrence of the attractive force between the substrate and the positively charged portion of the AMS.

Conclusions

The effects of four different types of surfactants treatment of cellulosic fabrics were studied. The presence of nonionic surfactant increases fabric properties improvement which accompanied by decrease in the strength loss, while decreasing the improvement in presence of amphoteric, cationic and anionic may indicate that these surfactant possibly acting as an inhibitor on the action of cellulose. Therefore, lack of denaturing effect of NNS reported elsewhere [6], was confirmed in the present study. Although cationic, amphoteric and anionic surfactants may have some denaturing effects as mentioned by others.

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