Remedial Measure to Improve Tear Strength of Cellulosic Material

By Dr. Naresh M. Saraf, *F.T.I., F.S.D.C., F.A.I.C., F.R.S.C.* and Dr. Geeta N. Sheth, of Sarex Overseas, India of Sarex, India

The utility function that fabrics should fulfil depends first of all on their end use. Woven/knitted fabrics have a very wide range of applications. Such a wide range of application means that, during their lifetime, fabrics undergo actions from different forces and strains, depending on their end use. They can be stretched in one direction or many directions, torn or compressed.

An important feature of cellulosic fibres is chemical stability, enabling them to withstand degradation, with its consequential loss of strength, under normal conditions of processing. Even a slight deviation in processing may lead to unacceptable loss of strength and other undesirable effects. In general, different treatments that may lead to degradation are: exposure to acids, alkalis, oxidizing agents, resins, enzymes, heat and radiation. Under certain circumstances, cellulose can also be degraded mechanically.

The degradation of cellulose by aqueous acid results in hydrolysis of glycosidic linkages, which varies with acid concentration, temperature and time of treatment. The glycosidic linkages in cellulose can also be attacked during kier boiling, where a temperature as high as 140°C can cause a loss of tensile strength.

Peroxide bleaching is generally regarded as safe, but if proper conditions are not maintained, it can damage cellulose in the presence of Fe, Mn or Cu. Cellulose can be degraded by heat when immersed for a long time in an alkaline or acidic medium. Further, cellulose may degrade photochemically. The most important group of photosensitisers includes the yellow, orange and red vat dyes. Also, vat, sulphur and basic dyes, in the same colour range, with certain metallic oxides, can enhance photodegradation.

Relative Humidity, %	Time of Exposure, days	Loss in breaking strength, %
0	0	-
0	23	16
0	46	28
0	85	37
0	177	54
30	0	-
30	23	16
30	46	19
30	85	24
30	177	44
55	0	-
55	23	8
55	46	13
55	85	22
55	177	28

Table 1. Breaking strength loss on exposure to Fadeometer at varying humidity

Exposure of cotton in oxygen atmosphere at different relative humidities, in a Fadeometer, shows a loss in breaking strength, as studied by A.C.Mehta1. The loss in strength is shown in Tables 1 and 2.

The mechanical and certain other properties of cellulosic fibres are profoundly affected by crosslinking agents, and these effects are reflected in the tensile properties. The introduction of covalent crosslinks into a cellulosic fibre has two important effects. It reduces the ability of the chain molecules (a) to move laterally and (b) to extend longitudinally under stress. The second effect will reduce strength.

Varghese et al2 have shown that the desizing operation has no influence on tear strength, whereas on scouring there is some loss in tear strength, while in bleached fabric there is significant losses in strength of around 35%. Further, they have shown that bleached sheeting fabric, dyed with 0.5% Reactive Red 11 and washed with nonionic detergent shows a high order of decrease in tear strength.

Direction	Time of Exposure, days	Loss in breaking strength, %
Perpendicular	0	-
	7	17
	21	33
	42	50
South	0	-
	7	8
	21	24
	42	44
North	0	-
	7	4
	21	12
	42	22

Table 2. Effect of Sunlight on totally exposed cotton in different directions

S.M Doshi3 has shown the decrease in strength loss after treatment with DMDHEU resin with 1.5% mixed catalyst ($MgCl_2.6H_2O$: Citric acid (1:1) w/w) (Table 3).

Also, it is a well-known fact that cellulose, dyed with sulphur dyes, shows tendering due to formation of sulphuric acid during storage in high humidity and

Concentration of resin, %	%, Loss in Breaking strength	%, Loss in Tear strength
8	38	35
10	44	42

Table 3. Decrease in tear strength after treatment with DMDHEU resin

temperature. All the above factors reduce the strength of fabric.

We, at Sarex, have developed a cure to minimise the strength loss that might occur in spite of preventive measures. We have developed a new generation of products to improve tear strength, and capable of improving tear strength by 60-100%, both individually and in combination, depending on the type of the cellulosic material. The products are:

Tear strength H
Tear strength D
Tear strength X

Tear strength D and X improve tear strength along with softness and are useful for high-value cotton shirting and cotton bed sheets. Tear strength H can be added in certain qualities of fabrics. It does not affect whiteness and brightness of finished fabrics.

The above products are compatible with normal finishing ingredients like softeners and resins. Guideline recipe for Tear strength is as follows:

Tear strength H – 30-40g/l
Tear strength D – 10-15g/l
Tear strength X –15g/l

Optional to add: Sarapeach AM – 10-15g/l, or Sarapeach MR – 20-30g/l. Addition of Sarapeach AM or Sarapeach MR will further improve tear strength.

Finishing Agent	% increase in Tear strength
10g/l Tear strength D	78
20g/l Tear strength D	83
30g/l Tear strength H	67
15g/l Tear strength X	84
30g/l Sarapeach AM	44
40g/l Tear strengthH + 30g/l Sarapeach AM	117
40g/l Tearstrength H +15g/l Tearstrength D +30g/l Sarapeach AM	100

Table 4. Tear strength after treatment with various finishing agents

Since Tear Strength D/H/X also impart softness, conventional softeners from the recipe can be eliminated, to optimise the recipe. Products can be applied in the normal finishing/softening recipe or along with resin finishes by padding. Products do not improve tear strength of a fabric already finished with a conventional recipe.

The performance of these products in the finishing of cotton bottom weight is given in Table 4.

References:

- Thesis entitled "Photochemical degradation of cotton and chemically modified cotton", by A.C. Mehta Sep. (1964).
- Project report entitled "Influence of scouring and dyeing on strength-abrasion of durable–press cotton", by VJ Verghese (1982-1983) btra.
- Thesis entitled "Studies in resin finishing of cotton textiles including the use of high temperature steam", by S.M. Doshi, Oct. (1975)