Assessment of Degree of Mercerization in Foam-Mercerized Sample

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Mercerization is one of the important processes of treating cotton fabrics as it improves dyeability and strength apart from lustre. The most well-known effect of mercerization on the fine structure in cotton is the partial change of crystal lattice from cellulose I to II. During the mercerization of the cellulose materials with about 30% alkali (w/v), the alkali breaks the bonds between various hydroxyl groups of cellulose chains in cellulose I structure and on subsequent washing and drying the structure is partially converted into cellulose II. In conventional mercerization, alkali penetrates both sides of the fabric, since the fabric is in contact with alkali on both sides. Foam mercerization is the latest innovation which offers the possible advantages of saving caustic soda and dyes. Foam mercerization also permits preferential treatment of one side of fabric which is not possible by conventional processes.

The degree of mercerization in a conventional mercerized sample is estimated by barium activity number (IS: 1689-1973). Foam mercerization is a highly localized effect and hence the above method is not suitable for determining the degree of mercerization in a foam-mercerized fabric. In this paper, a novel method using X-ray diffraction and infrared spectroscopy has been described to assess the difference in the degree of mercerization between the two sides of foam-mercerized fabrics.

Materials and Methods

Foam-mercerized samples were prepared using the BTRA foam technique. Foam mercerization was carried out on both bleached poplin and drill fabrics.

Sodium hydroxide solutions of 10, 12, 14, 16, 18, 20 and 25% concentrations (w/v) were prepared. Small pieces of fabric samples were immersed in slack condition in alkali solutions of various concentrations for 10 min at room temperature and washed free of alkali by the usual method and dried. These samples were used to make a calibration graph (Fig. 1).

Foam-mercerized samples were dyed with reactive dyes such as Porcion Red H8B and Orange HIR in order to determine the differential dye uptake on both sides of the fabric.

X-ray analysis—X-ray analysis of the samples was carried out on a Philips 1720 unit fitted with a vertical goniometer using nickel-filtered Cu Kα radiation. For the diffractometer studies, the samples were finely cut, sieved through a 300 mesh screen and made into a circular pellet weighing exactly 50 mg with the aid of a special die. In the case of foam-mercerized samples, 50 mg of samples were scraped from the surface of each side of the fabric and X-ray scan was taken separately.

Infrared analysis—Infrared spectra of the treated fabrics were recorded on a Perkin-Elmer double-beam spectrophotometer (model 377) using a technique called attenuated total reflectance (ATR). The fabric was cut into the required size and kept on either side of a KRS-5 crystal capable of 10 multiple internal reflections.

Fig. 1—Calibration plot of LCR ratio from X-ray scan against IR ratio
Thick fabric (Drill)

<table>
<thead>
<tr>
<th>Mercerized side</th>
<th>IR ratio</th>
<th>LCR from X-ray scan</th>
<th>Colour difference</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.97</td>
<td>0.41</td>
<td>4.3</td>
<td>1429 cm⁻¹</td>
</tr>
<tr>
<td>1.55</td>
<td>0.29</td>
<td>1.50</td>
<td>1429 cm⁻¹</td>
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</tbody>
</table>

Thin fabric (Poplin)

<table>
<thead>
<tr>
<th>Mercerized side</th>
<th>IR ratio</th>
<th>LCR from X-ray scan</th>
<th>Colour difference</th>
</tr>
</thead>
<tbody>
<tr>
<td>2.60</td>
<td>0.51</td>
<td>4.6</td>
<td>1429 cm⁻¹</td>
</tr>
<tr>
<td>1.60</td>
<td>0.28</td>
<td>2.60</td>
<td>1429 cm⁻¹</td>
</tr>
</tbody>
</table>

Table 1 — Data on Foam-Mercerized Samples

Table 2 — Data on Foam-Mercerized Samples

ATR technique. The relative intensities of 895-1429 cm⁻¹ bands were calculated. From the calibration graph, the corresponding LCR values were noted; this gives an indication of the amount of mercerization. To countercheck the results, the top layers of the fabric samples were scraped out, made into a pellet and X-ray scanned. LCR values were calculated directly from the X-ray scan. The experiment was repeated with the reverse side of the fabric also. LCR values obtained from the calibration graph using IR method are in good agreement with those obtained by X-ray scan directly. The results are shown in Table 2.

To investigate whether differential mercerization has taken place on both sides of the fabric, the fabrics were dyed with reactive colours and the colour difference between mercerized and reverse side was calculated. The results (Table 2) show that there is a differential dye uptake between both sides of the fabric, which indicates a difference in mercerization on both sides of the fabric.

Conclusion

Foam mercerization is a highly localized effect, and hence conventional methods such as barium activity number and X-ray diffraction cannot be used for finding out the degree of mercerization. Using IR-ATR method, it is possible to assess the degree of mercerization of both the sides of the fabric individually.
Acknowledgement

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References