

# Study of some properties of greige cotton fabrics after hot mercerizing.

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## Abstract

Mercerizing leads to an improvement in luster, tensile strength, dye absorption, chemical reactivity and dimensional stability of the cotton fabrics. The mercerizing process is treating yarn or fabric with soda solution which can be divided into two types: normal mercerizing and hot mercerizing. In this study the effect of hot mercerizing on some properties of greige cotton fabric has been investigated. Mercerizing was performed within temperature range of 15-90 C during 5 minutes in a constant concentration of caustic in slack state and under tension. After mercerizing the material was bleached with hydrogen peroxide and caustic soda and then dyed with reactive dyes. Some properties of cotton fabrics such as tensile strength, shrinkage and dye uptake were measured. The obtained results showed an increase in fabrics strength after mercerizing specially in the slack state and in weft direction. Increasing mercerizing temperature increase fabric strength, dye uptake and shrinkage to a maximum and then decrease to some extent.

*Keywords:* Hot mercerizing, Dyes uptake, Shrinkage, Tensile strength

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## Introduction

Mercerization is an important textile finishing process for imparting properties of cotton fibres alone or in blends with polyester fibres, mainly in the form of yarn or fabric. Mercerizing can be divided into two types. Normal mercerizing and hot mercerizing. Normal mercerization process is normally carried out by treating yarn or fabric with 20-25% caustic soda solution for 30-180 sec at a temperature between 15 and 20 °C after treatment, the material is washed, while still stretched, to remove excess caustic soda. The material, which is then in a relaxed state, is further washed and finally treated with dilute acid to remove the remaining alkali.

The mercerizing conditions, i.e. concentration, temperature, dwell time in alkali, etc., are varied in accordance with the particular effect required on the processed fabric.

Although normal mercerizing leads to an improvement in luster, tensile strength, absorption of dyes, coverage of dead cotton and dimensional stability. There are difficulties in carrying out normal mercerizing. Cotton is essentially hydrophobic, particularly in the loom state, and caustic soda solutions of mercerizing at low temperatures are highly viscous and of low surface activity and further penetration is almost impossible.[1]

New processes based on discoveries concerning mercerization were described by I.RUSZNAK and C.Duckworth[1].The basic principle of this process are described by the following sequence:

- 1) Saturation with caustic soda solution of mercerizing strength, preferably under relaxed conditions at the boiling point of the caustic solution.
- 2) Controlled hot stretching following saturation.
- 3) Controlled cooling of the hot stretched fabric.
- 4) Traditional, tension-controlled washing.
- 5) Traditional final washing.

In the hot mercerizing the penetration of caustic soda into the textile structure and fiber self is extremely rapid, thorough, and

uniform in effect. The fiber and textile structure become more pliable and less elastic than when saturated with cold concentrated caustic solution. Shrinkage of the fabric is much less than that occurring in the cold process[2].If necessary The fabric can be considerably overstretched to get improved luster, tensile strength and dimensional stability.

Hot mercerizing produces better luster, high tensile strength and improved dimensional stability than cold mercerization for two main reasons. Firstly owing to thorough penetration of the hot caustic soda into the fabric and fiber structure a far greater proportion of the cellulose is modified[2].

Secondly in the presence of concentrated caustic soda solution at an elevated temperature, the fabric becomes highly plastic and less elastic and so is capable of being readily stretched, leading to improvement in the properties of the fabric being considered[1-4]. Extent of the change in these properties depending on the degree of stretch. For example greater than normal stretch will lower the affinity for dyes, because this is affected by the degree of internal orientation of the molecular structure.

Short staple, thick coarse cotton with a high percentage of immature fibres have in the past produced unattractive effects when mercerized. Such coarse, low grade cottons respond much more favourably to hot mercerization and the desired final quality of the product can be obtained from a cheaper grade cotton.

Another advantage of the process is that no wetting agent is necessary even when mercerizing grey fabrics.

Further more, the desizing stage can be eliminated whether the sizing material is starch-based, a modified starch, carboxy methyl cellulose or a synthetic size such as polyvinyl alcohol[2].

The effect of mercerization temperature on dye uptake has been studied by others[4]. The results indicate that improvement in dye uptake during mercerization between 5 and 45°C is almost the same. Though significantly higher than that of the control. There was further increase in dye sorption on mercerizing at 55°C and when using cold water instead of water at 70°C for the first

wash. Cotton slack mercerized hot has greater affinity for dyes than cotton slack mercerized cold, but, on the other hand, cotton mercerized under high tension hot has less affinity for dyes than cotton mercerized cold under the same tension.

### Materials and method

Fabric: 100% cotton made from 20sNe open end yarns for warp and weft with weight 241 gr/m<sup>2</sup>  
 Caustic soda: laboratory grade caustic soda of 99/5% Purity was used.  
 Dye: Remazol Turquoise Blue G (C.I Reactive Blue21) was used.

#### Mercerization frame

A square frame of stainless with stenter stainless pins were fixed with screws on the frame strips. The greige cotton fabrics were lightly stretched and fixed on the pins so that there was no chance of slippage of cloth during alkali treatment. The fabric holding frame with another sample in slack state were immersed in to caustic soda solution (300 gr/lit).  
 Mercerizing was performed within temperature range of 15-90oc during 5 minutes. The mercerized fabrics were then washed with hot and cold water to remove excess caustic soda. Any remaining alkali was neutralized with dilute acetic acid solution, followed by washing with cold water.

#### Bleaching

The mercerized samples were bleached with Hydrogen peroxide and caustic soda by exhaustion method.

#### Dyeing

The bleached samples when were dyed with Remazol Turquoise Blue G (C.I Reactive Blue21) using Pad – batch method.

#### Dye uptake measurement

The reflectance of dyed samples were measured by Tex- flash reflection spectrophotometer in 16 different wave length.  
 The relevant K/S value of dyeing samples were measured by equation 1.

$$K/S = \frac{(1-R)^2}{2R} \quad (1)$$

#### Tensile strength measurement

The tensile strength samples were measured by Tensolab tester at 65% RH and 21co using 170 mm as the gauge length and 125 mm/Min as the rate of extension.

#### Measurement of weight loss (WL)

The equation 2 was used to calculate WL.

$$WL(\%) = \frac{W - W'}{W} \times 100 \quad (2)$$

Where W and W' are the weights of the fabric before and after mercerizing, respectively.

#### Measurement of size removal

The equation 3 was used to calculate size removal

$$\text{Size removal}(\%) = D - D' \quad (3)$$

Where D is starch percentage in the greige cotton fabric and D' is starch percentage in the mercerized cotton fabric.

#### Measurement of shrinkage

The equation 4 was used to calculate shrinkage amount :

$$\text{Shrinkage}(\%) = \frac{L - L'}{L} \times 100 \quad (4)$$

Where L and L' are the lengths of the fabric before and after slack mercerization, respectively.

### Results and discussion

#### Weight loss

The greige cotton fabrics were mercerized in a constant concentration of caustic soda solution in slack state and under tension within temperature range of 15-90Co during 5 minutes. In Figures 1 and 2, the weight loss and size removal of mercerized the greige cotton farics is plotted against mercerizing temperature.

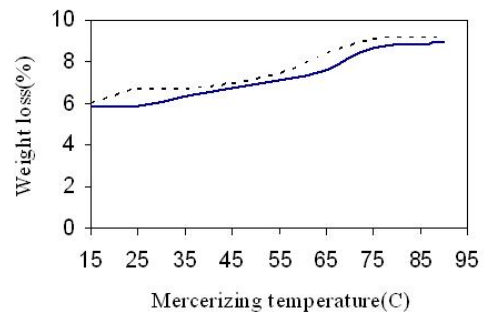


Fig. 1. The effect of mercerizing temperature on the fabric weight loss: mercerizing under tension(—), slack mercerizing(---)

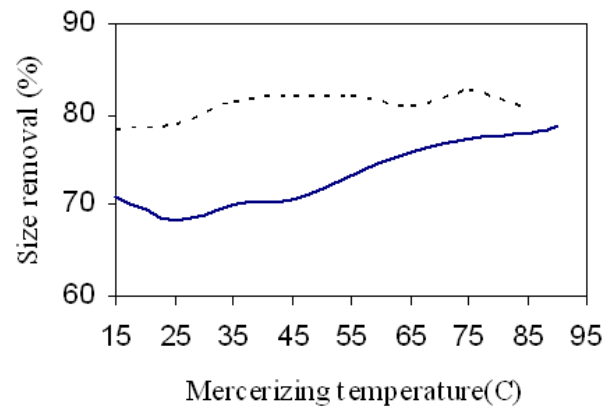


Fig. 2. The effect of mercerizing temperature on the fabric size removal: mercerizing under tension(—), slack mercerizing(---)

The weight loss may be due to starch and wax removed from fabric. There is a correlation between treatment temperature and weight loss, as well as between the fabric being under tension or slack state and weight loss (figure 1 and 2).

The results show that an increase in mercerizing temperature will increase the weight loss in the fabric. The samples mercerized in slack state have shown more weight loss than the mercerized samples under tension. An increase in mercerizing temperature will decrease the viscosity of caustic soda solution, so the penetration of caustic soda into the fabric and fibres becomes more rapid thus the more starch and wax can be

removed from fabric, therefore weight loss will increase. The greater weight loss in the slack mercerization fabrics than the mercerized samples under tension may relate to the easier penetration of caustic soda into the fabric and spaces between fibres, because warps and wefts are compacted in the mercerized samples under tension.

**Shrinkage**

The amount of fabric shrinkage in the warp and weft direction of the mercerizing samples in slack state is shown in Figure 3.

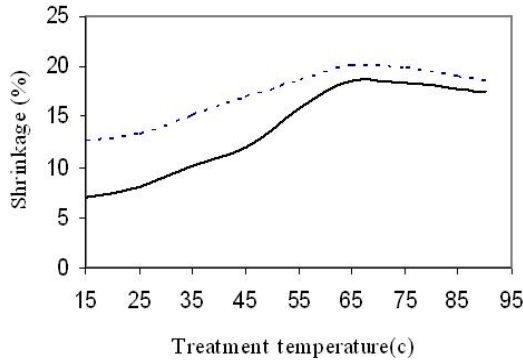


Fig.3.The effect of mercerizing temperature on the fabric shrinkage: weft direction ( — ),warp direction(-----)

Although previous works has shown that increasing in mercerizing temperature, decreases the amount of fabric shrinkage, we found that for open-end fabrics, an increase in mercerizing temperature increased shrinkage percentage in the warp and weft direction , that may be also to the greige cotton fabric which was used (Figure3 ). Shrinkage in the warp direction was greater than that of weft direction. Increasing in mercerizing temperature till 65oC the fabric shrinkage increases to a maximum amount and then decreases to some extent. Decrease in shrinkage was observed after 65oC.

**Tensile strength**

The fabrics tensile strength in warp and weft direction after mercerizing is shown in table 1 and Figures 4 and 5. Used fabric has had a tensile strength 29.5 kg in warp direction and 32.5 kg in weft direction.

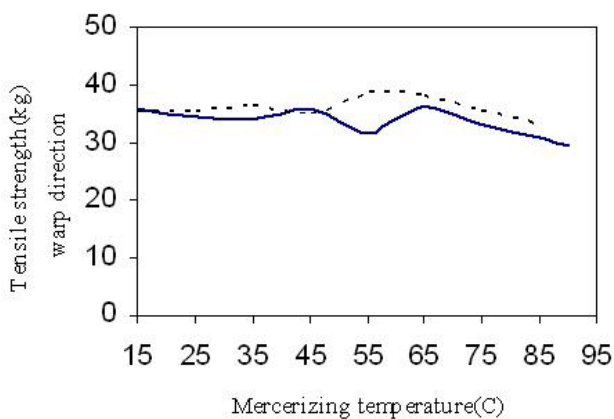


Fig. 4. The effect of mercerizing temperature on tensile strength: mercerizing under tension ( — ), slack mercerizing (-----)

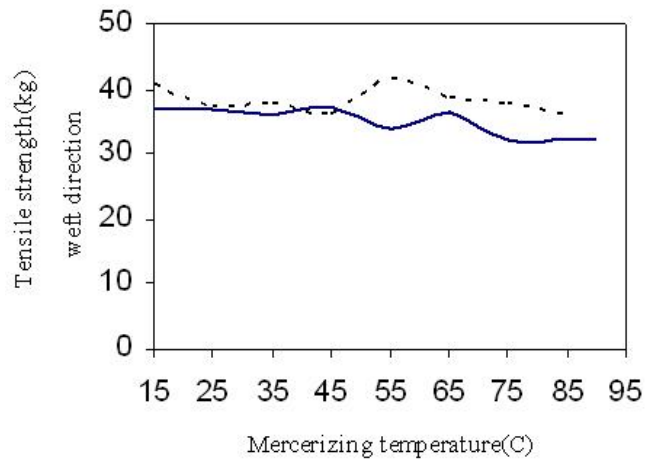


Fig. 5. The effect of mercerizing temperature on tensile strength: mercerizing under tension ( — ), slack mercerizing (-----)

The tensile strength on the fabric was increased after tension and slack mercerization . The major reasons for the increased strength might include an alleviation of internal stresses and the deconvoluting of the fibres in the fabric during swelling .

Table.1:The effect of mercerization temperature on tensile strength

Treatment(Co) Temperature	Tensile strength warp direction Tension mercerizing	Tensile strength weft direction Tension mercerizing	Tensile strength warp direction slack mercerizing	Tensile strength weft direction slack mercerizing
15	35.7	37	36.23	41
25	34.4	36.97	35.5	40.7
35	34.1	35.87	35.5	37.17
45	35.9	37.3	36.2	37.6
55	31.7	34	35	36
65	36.5	36.6	38.6	41.7
75	33	32.2	38	38.7
85	31	32	35.5	37.8
90	29.5	32	33	35.6

The mercerized samples in slack state showed the greater tensile strength than the mercerized samples under tension .

Increasing in mercerizing temperature will increase tensile strength to a maximum amount in 65oC and then decreases to some extent(table 1). Increase in tensile strength can relate to the easier penetration caustic soda into fibres .

**Dye uptake**

The greige cotton fabric was mercerized and then bleached by hydrogen peroxide and caustic soda and then dyed by reactive dye. Figure 6 demonstrates the dye uptake of the mercerized samples against increasing temperature. The samples were compared with bleached and nonmercerized cotton dyed fabrics. Dye uptake after mercerization has increased than nonmercerized fabrics.

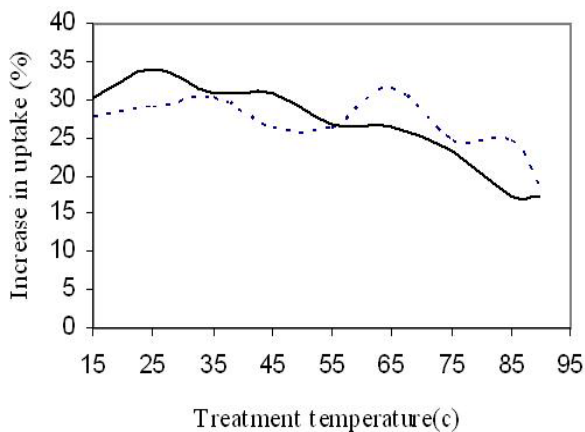


Fig. 6. The effect of mercerizing temperature on uptake:slack mercerizing ( ), mercerizing under tension (-----)

There was further increase in dye sorption on mercerized samples under tension at 35°C and 65°C and dye sorption above 65°C was decreased(Fig. 6).

There was further increase in dye sorption on slack mercerized samples at 25°C and then dye sorption decreased.

Figure 6 indicates that until 65°C the slack mercerized samples show higher dye sorption than the mercerized samples under tension and above 65°C, the mercerized samples under tension show higher dye sorption than the slack mercerized samples.

### Conclusion

The greige cotton fabrics were treated with caustic soda solutions at different temperatures, under tension and relaxed conditions. The samples mercerized in slack state showed greater weight loss and tensile strength than the mercerized samples under tension. By increasing mercerizing temperature rate of shrinkage in the warp and weft direction increases on the other hand shrinkage in the warp direction was higher than that of weft direction. The results show that the dye uptake on mercerized samples increased than nonmercerized fabrics and there was further increase in dye sorption on slack mercerized samples at 25°C and on mercerized samples under tension at 35°C and 65°C. The results indicate that till 65°C the slack mercerized fabrics show higher dye uptake than the mercerized samples under tension and above 65°C the mercerized fabrics under tension showed higher dye uptake than the slack mercerized samples.

### References

- [1] Duckworth and Rusznak, proc. Loth IFA TCC congress, Barcelona, May 1975.
- [2] Duckworth, and L.M.wrennall, J.S.D.C, November 1977, P:407-412.
- [3] Burkitt, succ symposium, Zurich, 1973.
- [4] Niaz Ahmed and K.D.Tahir, Textile Horizons, February 1985, P:20-21.