Hardness in Bleaching & Dyeing Liquors

How Much is Cotton to be Blamed?

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Summary:

Specimens of nineteen different varieties of cotton were boiled separately in specific amounts of distilled water. The calcium, magnesium and total hardness of the water was tested before and after boiling cotton specimens in water samples. Then the contribution of each variety of cotton towards water hardness was calculated.

Introduction

Cotton is one of the most important fibers in the world's textile trade. It has many desirable characteristics and countless end uses, which make it one of the most abundantly used textile fibres in the world [1-4]. It is a seed hair of plant of genus *Gossypium* [5], the purest form of cellulose found in nature. Although cotton may be as much as 96 % cellulose, there are always some other components present in it as impurities. The level of impurities in cotton is affected by geology of cultivation area, soil constitution, weather conditions during the maturing period, cultivation techniques, chemicals, pesticides and fertilizers, and harvesting techniques. Among the impurities present in cotton, the elements that pose the greatest threat in textile wet processing are alkaline earth and heavy metal contaminants such as iron, manganese, calcium and magnesium.

In scouring processes, water hardness (calcium and magnesium ions) causes the most problems. These ions precipitate soaps forming a sticky insoluble substance which deposits on the cotton fabric. These deposits impair the fabric handle, cause resist spots in dyeing, attract soil to the material and cause inconsistent absorbency in subsequent processes. Although most synthetic detergents used in scouring today do not precipitate in the presence of calcium and magnesium ions, the fatty acid

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hydrolysis products formed by the saponification of natural waxes, fats, and oils in the fibres will precipitate. The formation of complexes with alkaline and alkaline earth salts drastically reduces the solubility and the rate of dissolution of surfactants, thus impairing the wash removal ability of the surfactants [6].
Although magnesium produces beneficial effects when present in peroxide bleaching solutions, the presence of calcium may result in decreased stability of peroxide bath due to blockage of stabilisers, harsh handle of the fabric due to deposition of insoluble salts and decrease in fabric whiteness due to formation of insoluble products with optical brighteners [7-8].
In dyeing, the presence of calcium and magnesium ions may result in lowering of solubility of dyes, staining due to formation of insoluble products with dye, change in dyeing shades, and difficulties in the removal of hydrolysed reactive dye resulting in low washing fastness [9].
Due to so many problems associated with them, it is imperative that calcium and magnesium ions are not present during wet processing of cotton materials. It is usually suspected that the major source of these impurities may be the water used in textile processing. However, this may not always be the case, as these impurities may also come from the cotton itself [10]. This study was undertaken to compare hardness characteristics of various global varieties of cotton to see how much these different varieties may contribute to the hardness of water used in textile processing.

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Experimental

Samples of nineteen varieties of cotton fibres of different countries of origin were obtained from Nishat Textile Mill Faisalabad Pakistan, which imports various varieties of raw cotton from all over the world for spinning. Four of the tested cotton varieties were from the USA (SJV Pima, Elpaso, Memphis, Mote), three each from Egypt (Giza 70, Giza 86, Giza 88) and Brazil (Lot 992, Lot1017, Lot1832), two each from India (MCU 5, Shankar 6) and Commonwealth of Independent States (Elisa, Sultop), and one each was from Mali, Greece, Ivory Coast and Pakistan. As all the collected samples were in raw form, they contained varied contents of trash such as dust, seed-coat fragments, leaves, and stems etc. In order to eliminate the influence of these impurities on the test results the non-lint trash content of each sample of cotton was removed by passing the samples through a laboratory machine "Shirley Analyzer" as per standard method [11]. The machine operates on mechanical-pneumatic principles and segregates trash and cotton fibres in separate chambers. After the preliminary removal of trash, samples of each variety of cotton were conditioned as per standard method [12] and representative specimens of 10 grams of each cotton variety were boiled separately in 500 ml of distilled water. Initial hardness of the distilled water used was zero. After 10 minutes of boiling in distilled water, cotton fibres were then removed from water with tweezers and the excess liquid was allowed to drip back to the extracts. The extracts ware allowed to cool down at room temperature. Then the hardness of each extract was determined according to the method described elsewhere [13].

Results and Discussion

Table 1 gives the hardness characteristics of different varieties of cotton tested in this study.

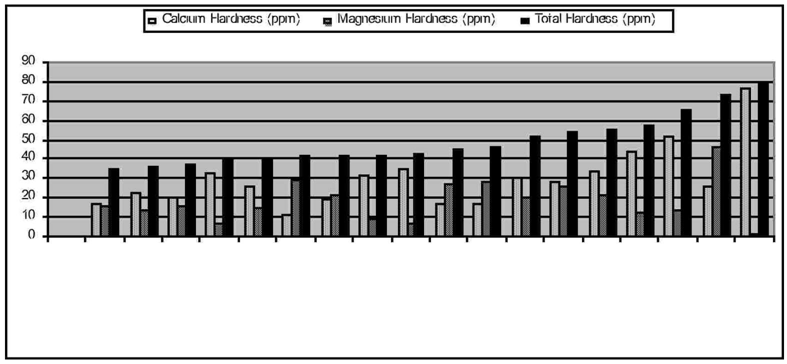
No.	Cotton Varieties	Calcium Hardness (ppm)	Magnesium Hardness (ppm)	Total Hardness (ppm)
1	Elisa	0	0	0
2	Shankar 6	18	17	35
3	Mote	23	14	37
4	MCU-5	21	17	38
5	Mali	33	7	40
6	Barkat	26	15	41
7	Giza-88	12	30	42
8	SJV Pima	20	22	42
9	Brazil Lot 1832	32	10	42
10	Ivory Coast	35	8	43
11	Giza-86	18	28	46
12	Sultop	18	29	47
13	Giza-70	31	21	52
14	Elpaso	29	26	55
15	Memphis	34	22	56
16	Brazil Lot 1017	45	13	58
17	Greece	52	14	66
18	Pak	27	47	74
19	Brazil Lot 992	77	2	79

Table 1: Hardness Characteristics of Different Varieties of Cotton

Figure 1 gives the graphical representation of the results obtained.

A can be seen, CIS Elisa cotton was found to be the best in terms of hardness characteristics, resulting in absolutely zero water hardness. The worst among the tested varieties, in terms of total hardness, was Brazil Lot 992, while Pakistani cotton was only the second worst. However, Pakistani cotton was found to contribute highest towards magnesium hardness of water rather than calcium hardness. Since presence of magnesium is beneficial in hydrogen peroxide bleaching, it means that Pakistani cotton behaves the best as far as bleaching process is concerned. However, along with calcium, magnesium may contribute to other problems in wet processing such as decreased efficiency of desizing and scouring, as well irregularities in dyeing.

The results indicate that most of the cotton varieties have significant amounts of salts of calcium and magnesium, which can contribute to hardness of the water used in wet processing. The ratio of the water



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and cotton used in this study was 50:1. In most of the textile wet processes, much lower L:R is employed. Hence, it is expected that at lower level of liquor ratio, the contribution of cotton to water hardness may be much higher. This means that water softening plants alone are not sufficient to guarantee that no problem associated with water hardness will occur during textile wet processing since water hardness-causing salts may also come from the cotton even when initially the water is absolutely free from the calcium and magnesium ions. Therefore, it is always advisable to subject cotton either to a demineralization process in order to remove the naturally occurring hardness-causing salts of calcium and magnesium or to make use of sequestering agents during textile wet processing to be on the safe side.

Conclusions

The level of impurities such as calcium and magnesium is different in different global varieties of cotton. Due to the presence of calcium and magnesium salts, different varieties of cotton contribute to water hardness to different degrees. In order to avoid the problems in textile wet processing associated with water hardness, appropriate measures must be taken such as demineralization of cotton or use of sequestering agents during wet processing even when soft water is used for processing.

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