# Effect of Maturity on Reflectance Percentage of Bleached and Dyed (Reactive Dye) Cotton Fibre

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**Abstract**

*Maturities of five cotton fibre samples were measured in Hazi Hashem Spinning Mills Ltd, Narayongonj, Bangladesh on 21 July, 2011. Scouring, bleaching and dyeing of these cotton samples were performed in Delta Knit Composite Ltd., Gazipur, Bangladesh on 30 July, 2011. Reflectances of bleached and dyed samples were measured in Cotton Club (BD) Ltd, Gazipur, Bangladesh on 31 July 2011. It was found that with the increase of maturity, the reflectance percentage of both the bleached and dyed cotton fibres were increased up to a certain value then again decreased for comparatively high matured fibres. The increase of reflectance % are due to the increase of cellulose content in the primary and secondary cell wall whereas lowering of reflectance % after a certain maturity may be due to the formation of interior layer (consisted of mineral salts and proteins) adjacent to the lumen thus reducing the relative amount of cellulose content per unit mass of fibers.*

**Keywords:** *Maturity of cotton, Scouring, bleaching and dyeing, Shed variation, Reflectance Percentage, Cellulose content.*

## 1. Introduction

Cotton is a natural vegetable fibre produced in the cotton plant in many countries of the world. Among the different properties of cotton fibres, maturity is an important property which is related to the dye absorption ability of cotton.Cotton maturity denotes the degree of cell wall thickening of the fibres. Matured cotton has a well-developed primary and secondary cell wall, but immature fibre is thin walled with a wide lumen (central cannel) throughout the fibre ( J.E. Booth. Report-1696).The primary and secondary cell wall are composed of cellulosic material which constitutes the bulk of the fibre. Dyes and chemicals are absorbed in this cellulosic cell wall (http://www.scribd.com/doc/30439788/Structure-and-Properties-of-Cotton-Fiber-A-Literature-Review). With the increase of maturity of fibres, the cellulose content is also increased, so that more dyes and chemicals are absorbed in the fibre. As a result, shed variation is occurred with the change of maturity of cotton. This shed variation can be estimated by measuring the reflectance of fibres. Then there is a possibility to find a relationship fibres. For this reason, we performed a series of experiments to correlate the maturity of cotton between the maturity and reflectance of cotton fibres with the reflectance of bleached and dyed cotton samples measured by spectrophotometer.

## 2. Materials and Methods

Five varieties of raw cotton samples were collected from a cotton importer. The varieties were 1. Tajikistani cotton, 2. Pakistani cotton, 3. Australian cotton, 4. Guzrati (India) cotton, 5. Bunni Burma (India) cotton. The cottons were cleaned thoroughly in the laboratory by hand.

Maturity of cotton samples were measured by USTER HVI SPECRUM machine in Hazi Hashem Spinning mills Ltd., Narayongonj, Bangladesh. The found maturity indexes were as shown in Table 1.

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Table 1: The maturity indexes of different varities of cotton.

| Varities | Maturity Index |
|---|---|
| Tajikistani cotton | 0.89 |
| Pakistani cotton | 0.9 |
| Australian cotton | 0.91 |
| Guzrati (India) cotton | 0.94 |
| Bunni Burma (India) cotton | 0.95 |

Table 2: Scouring and bleaching recipe of 5 cotton samples.

| Name of chemicals | Amount |
|---|---|
| Sodium hydroxide | 2 gm/l |
| Hydrogen peroxide | 7 gm/l |
| Detergent (AWC) | 1 gm/l |
| Sequesteringagent Trilon, BASF) | 1 gm/l |
| Stabilizer(Tinuvin,BASF) | 0.5 gm/l |
| Time | 40 min |
| Temperature | 100°C |
| M:L | 1:10 |

Scouring, bleaching and dyeing of above mentioned cotton samples were performed in the laboratory of the Delta Knit Composite Ltd., Konabari, Gazipur. For scouring and bleaching 10 gm cotton samples of each variety were taken in the pot of Rapid Sample Dyeing machine. The scouring and bleaching of 5 cotton samples were performed by same recipe. The recipe was as shown in table 2.

The samples were then washed thoroughly and dried in a combined Laboratory Oven & Incubator. 5 gm of each bleached samples were kept separately for reflectance measurement. From rest of the bleached cotton samples,5 gm of each variety were taken for dyeing with reactive dye. Same recipe was used to dye the five cotton samples. The dyeing recipe was as shown in table 3. The dyeing process was as follows:

Required amount of water was taken in the pots of sample dyeing machine. Then required amount of sequestering agent, leveling agent and gluber salt were taken and stirred. 5 gm cotton samples of each variety for each pot were taken and immerged. 1.25 % stock solution of reactive dye was made

Table 3: Dyeing recipe of 5 cotton samples.

| Name of chemicals | Amount |
|---|---|
| Reactive dye | 1.25% |
| Glauber salt | 50 gm/l |
| Soda ash | 12 gm/l |
| Sequestering agent | 1 gm/l |
| Leveling agent | 1 gm/l |
| $p^H$ | 11 |
| M:L | 1:8 |

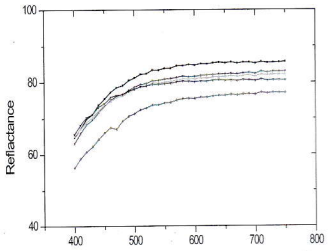

Figure 1:Wave length versus reflectance curve of five bleached cotton fibre samples.

separately. Then 5 ml of dye stock solution was taken in each pot. The samples were agitated in the sample dyeing machine at room temperature for 30 min. After then the required amount of soda ash was added to each pot and dyed again for 60 min at 60 C. After dyeing, the samples were washed and dried. The reflectance of five bleached and five dyed samples were measured by GretagMacbeth Color-Eye 7000 A Spectrophotometer. The spectral range was from 360 nm to 750 nm. Reflectance aperture was small area view (0.75 cm × 1 cm).

## 3. Results and Discussion

Figure 1 shows the wave length versus reflectance curves of five bleached cotton measured by spectrophotometer. The spectrophotometer

Measured the reflectance % from 400 nm to 750 nm wave length range. As the bleached samples are white, most of the lights of different colors were reflected from the samples.

From Figure 1, we can see that light from 500 nm to 750 nm range, the samples reflected 75 -85% light.

The reflectance % below 500 nm is, however, dropped steadily upto 60% at 400 nm. As the samples are white, rest of the light are refracted and transmitted through the sample. The refracted and transmitted light in the blue and violet regions are higher than from the green to red regions. We plotted the maturity index versus reflectance values % in the green to red region (500 to 750 nm) which is shown in Figure 2. (Points are taken at 50 nm interval from 500 to 750 nm).

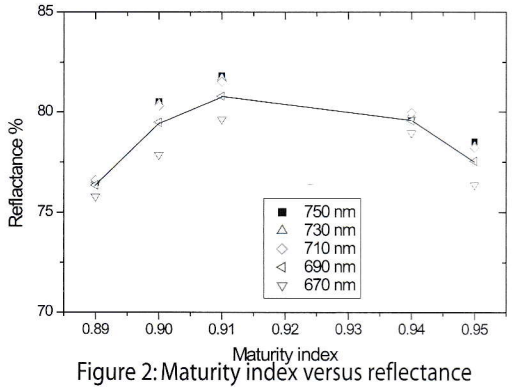


Figure 2: Maturity index versus reflectance % curves in the wave length range 540nm to 750 nm.

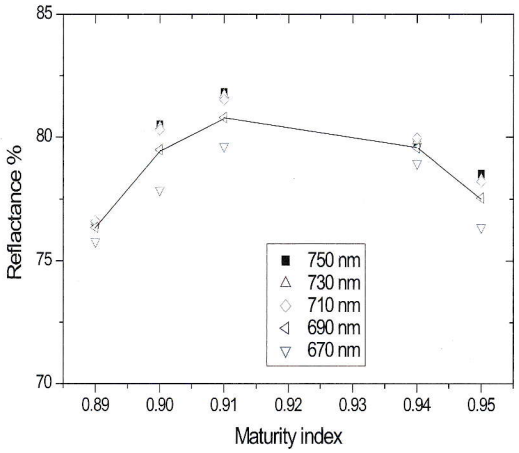


Figure 2 shows that with the increase of maturity index of different cotton samples, the reflectance values % are increased up to a certain value then again decreased for comparatively high matured fibres.

Figure 3, shows the wave length versus reflectance % of five dyed samples of cotton. The wave length range of spectrophotometer was from 400 nm to 750 nm. As the dyed cottons were red, the reflectance % of red light (635 nm to 750 nm) is very high (from 72% to 82%). The curves dropped rapidly below 635 nm and most of the rays from 400 - 635 nm are absorbed by the red samples. The maturity index versus reflectance values (%) taken from red region were plotted which is shown in Figure 4. These curves also show that the reflectance % values are increased with the increase of maturity index up to a certain values then again decreased for the comparatively high matured fibres.

According to Uster literature, the maturity index range from 0.75 to 0.85 are considered as immature, maturity index range from 0.86 to 1 are considered as mature and maturity index above 1.01 are considered as very mature fibres [3]. Thus the measured maturity indices of our cotton samples all lie in the mature fibre group. As the fibre maturity denotes the degree of cell wall thickening of cotton fibre, a more matured fibre sample will absorb more dyes and chemicals than the lower matured fibres. For this reason with the increase of maturity index, the white nesses of bleached samples are increased and also the depths of the shed of colored (Red) samples are increased. The lowering of reflectance values (%) after a certain maturity ( after 0.91 maturity index) may be due to formation of interior layer adjacent to the lining of the lumen which is consisted of mineral salts and proteins [4], thus reducing the relative amount of primary and secondary cell wall per unit mass of fibres. Again the crystallinity of relatively more matured fibres might be increased markedly so that the dyes and chemicals have less or not at all access into the crystalline regions of these cotton samples (W. E. Morton and J. W. S. Hearle "Physical properties of textile fibres" Woodhead Publishing Limited, Cambridge, England. Fourth edition 2008, p 7. )

## 4. Conclusion

Reflectance measurement of bleached and dyed cotton samples by spectrophotometer were showed that with the increase of maturity of cotton fibres, the reflectance percentage was also increased up to a certain value then again decreased for more matured fibres. The increase of reflectance % with maturity are due to the increase of cellulose content in the primary and secondary cell wall where as lowering of reflectance percentage after a certain maturity may be due to the formation of interior layer (composed of mineral salts and proteins)
adjacent to the lining of the lumen thus reducing the relative amount of cellulose content per unit mass of fibres.

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