# Man Made Textiles in India

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## PRESENTS

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# Man Made Textiles in India

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## Contents





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# EDITOR'S PAGE

## Interim Budget Highlights

*While we discussed about the distressing conditions of our Armed Forces last month, one of the major changes the Finance Minister was proud to announce during the interim budget for 2019-2020 was the increase in the defense budget, which officially crossed Rupees 3,00,000 crore for the first time, the highest in any year. While it is good news the Indian armed forces have seen an increase in their budget, it is still a budget which does not satisfy the minimum requirements of a modern day military.*

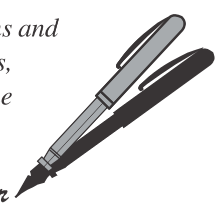
*The much-awaited Union Budget 2019 did not bring much cheer to the textile and garment industry. The outlay for textile sector has reduced from revised estimate of Rs. 6,943.26 crore to Rs. 5,831.48 crore. Out of this, the allocation to ATUFS and ROSL are Rs.700 Crore and Rs. 1,000 Crore respectively. The ROSL allocation of Rs. 1,000 crore is lower since the apparel exports per annum is hovering around Rs. 1,10,000 crore and with the existing ROSL rate at 1.7 per cent, the amount required would be Rs. 1,700 crore. Allocation for skill development and livelihood is reduced from Rs. 604 crores to Rs. 523 crores. There are some positives steps too in the budget. Industry association has welcomed the budget and expected that the Government will increase allocation in future.*

*On the other side, the announcement of 2 per cent interest subvention for MSMEs loans with a ticket size of Rs. 1 crore has given a big thrust to MSMEs to boost employment and economic growth. There is an increase in interest equalization scheme allocation from Rs. 2,600 crore to Rs. 3,000 crore. Procurement of cotton by CCI under price support scheme has increased from Rs. 924 crore to Rs. 2,018 crore. Allocation for Central Silk Board has also been increased from Rs. 501 crore to Rs. 730 crore. Announcement of pension scheme for the workers in the unorganized sector enabling such workers to receive Rs. 3000 per month as pension after attaining the age of 60 years has also affected the textile industry which is predominantly an unorganized sector. The scheme is expected to largely benefit the weavers of handlooms and powerlooms and also the workers of several other small, micro units from other segments of the industry.*

*The launch of the pension scheme for the nearly 10 crore informal sector workers will provide old age income security to those without it. Announced for rickshaw-pullers, ragpickers, agricultural workers, construction workers, beedi workers and others in similar occupations will be one of the largest pension programmes in the world in terms of beneficiaries. Officials said the government was laying the foundation of a much-needed edifice, which will boost flow of pension to workers and expand the ambit of the Employees Provident Fund (EPF) to cover new units.*

*The announcements, as we all know, are only part of the Interim Budget and the task of framing the full Budget are left to the incoming government.*

*Alas, no matter how prepared our Forces are in respect of arms and ammunitions and no matter how much budget is allocated to them for safety and tackling the enemies, they are vulnerable to the dastardly act of the perpetrators. My heart goes out to the families of those who lost their loved ones and prayers for recovery of those brave hearts in hospital*



*Dr.Manisha Mathur*

# Analysis of the operation of traverse mechanisms with scattering devices with the use of ASN

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**Abstract**

The winding process is one of the main processes of the textile industry. Therefore, in the present paper the analysis of quality of the winding of the formed bobbin was carried out by a) analysis of the winding structure on a PC-100M3 machine with a mechanism for additional axial offset of the spreader; b) analysis of the winding structure on a PC-100M3 machine with a periodic reduction in the swing of the yarn thread guide. A recommendation on rational modes of operation and modernization of the PC-100M3 machine to eliminate defects in the winding structure has been established.

**Key words:** Layout mechanisms, Decompaction, Rope structure, Chord, Package

## Introduction

Improving the quality and competitiveness of the finished products of textile enterprises directly depends on the systematic and effective quality control of semi-finished products and raw materials at all stages of textile production. One of the significant stages of textile production is the formation of cross wound bobbin, which is obtained either on spindle less spinning machines or by rewinding bobbins obtained on flyer frames.

The winding process is one of the main processes of the textile industry. The quality of packages formed largely determines the quality of the final products of the textile industry, as well as the productivity of labor and equipment. Therefore, attention to the analysis of the packages formation, the creation of new promising methods and the design of winding mechanisms does not weaken for many decades.

A device was developed that allows analyzing the quality of winding of a formed bobbin to analyze the quality of winding. The design of the device and the principle of its operation are protected by the author's USSR certificate [1]. A more detailed description of the device is presented in by Nuriyev and Rudovsky [2]. The principle of its work is that, with the package side illumination, light and shadow appear on its surface due to the uneven surface of the package. Its relief is closely related to the structure of the layer that is currently on the surface. In the case of installation of the photodetector above the side surface of package and uniform rotation of the package, areas of different brightness levels having different durations alternating in the field of view of the photodetector. The photodetector converts the brightness changes into a sequence of electrical pulses. Their transformation according to the order makes it possible to determine the character of the outer layer structure of the package and its defects in the presence of such. If the thread is continuously unwound from the package, you can get a complete picture of the distribution of structure defects in the package.

Due to this, the research aimed at controlling the winding structure of packages and analyzing the operation of the layout mechanisms with scattering devices seems to be relevant.

## Theoretical review

One of the main tasks of the winding mechanism is to obtain bobbins of cylindricality [3]. However, due to the fact that when the coils are turned at the sockets the angle of the layout passes through a zero value, a thickening is formed at the turns of the coils, which distorts the shape of the generatrix [4 - 6]. In places of thickening, there is an increased density of winding [7, 8]. As a result of the distortion of the shape of the generatrix, the main part of the load that presses the bobbin to the winding drum is carried by the sockets of the generatrix. Moreover, if we take into account that the middle part of the bobbin is formed practically without a clamp and therefore has a lower density, the deformation of the ends under the action of the clamping force leads to a distortion of the bobbin's shape [1, 2, 9 – 12]. This effect is especially noticeable on a PC-100 machine, where the width of the bobbin is much smaller than its diameter, as a result, a fairly large lobing of the package is observed. In order to eliminate this drawback, the profile curve of the spreader cam was changed so that in the middle of the generatrix the speed of the pin hole somewhat decreased. However, this did not eliminate the existing shortcomings, but led to the formation in the middle of the generatrix of one thickening [5, 6].

The aim of the paper is to analyze the quality of winding of a formed bobbin. To achieve the goal, the following tasks were set:

- to analyze the winding structure on the PC-100M3 machine with the mechanism of additional axial displacement of the spreader, recommendations for rational operating modes were developed;
- to analyze the winding structure on the PC-100M3 machine with a periodic reduction in the swing of the yarn thread guide, recommendations on rational operating modes were developed;
- to develop a recommendation for the modernization of the PC-100M3 machine, aimed at eliminating defects in the winding structure.

## Results and Discussion

formed which, in the process of further work itself can fulfill the role of the spreader. Since the formed rope leads the thread with one side, a number of turns are thrown off the package's socket, forming sluffs that accompany the diameters of cords.

To eliminate the described defect in the winding on a PC-100 M3 machine, mechanisms were tested that provided an additional shift of the yarn thread guide rod. According to the principle of operation, they are similar to the mechanisms used in machines for processing chemical fibers 13 . The mechanisms were made in two variants with a wiper providing a shift of ± 1.5 mm and ± 4 mm (Figure 1) and with a differential traverse guide rod that provided a complex law for the movement of the yarn thread guide.

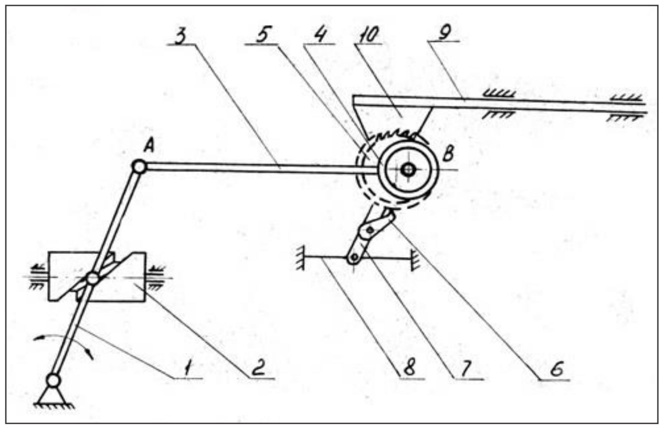


**Figure 1: Schematic of yarn thread guide shift with wiper**

The mechanism of laying the thread with a wiper consists of a winding lever 1, which receives a rocking motion from the spreader cam 2. The connecting rod 3 through the wiper 4 transmits the movement to the rod of the spreader. On the same axis as the wiper 4, a ratchet pinion 5 is mounted, which is driven by a pawl 6 fixed to a rocker shaft 8, the body of which, by means of a flexible connection 7, is fixed to the frame of the machine. The axis of the ratchet and wiper is fixed in the ear 10 of the spreader rod. For each stroke of the winding lever 1, pawl rotates the ratchet to a certain number of reeds, the ratchet in turn rotates the wiper, and the distance from point A to point B changes, that is, the yarn thread guide shifts.

As indicated above, the wiper mechanism provided the formation of packages with a yarn thread guide shift of ± 1.5 mm and ± 4 mm. By varying the length of the flexible connection 7, it was possible to adjust the number of ratchet reeds that are triggered per stroke of the yarn thread guide, i.e., the frequency of operation of the mechanism, expressed in the strokes of the spreader rod. The frequency of 10 and 15 passes of the yarn thread guide was set during the experiment process.

Thus, the shift of the yarn thread guide and the frequency of operation of the yarn thread guide shift mechanism can be considered as factors of the full factorial experiment of FFE-22 [13, 14]. After the formation of packages, their structure was analyzed with the aid of the ASN device. The matrix of the experiment is shown in Table 1.

**Table 1: Experiment matrix**

| No. | Number of reeds of the ratchet pinion | Turn of the ratchet pinion for 1 stroke of the yarn thread guide | Number of yarn thread guide strokes | | | No. of the diagram |
|---|---|---|---|---|---|---|
| | | | Max. sweep | Min. sweep | Heave | |
| 1 | 41 | 1 reed | 21 | 13 | 8 | 5.8 |
| 2 | 41 | 1 reed | 23 | 11 | 7 | 5.9 |
| 3 | 41 | 1 reed | 26 | 8 | 7 | 5.10 |
| 4 | 41 | 4 reeds | 4,5 | 4 | 1,5 | 5.11 |
| 5 | 41 | 4 reeds | 5,5 | 3 | 1,5 | 5.12 |
| 6 | 41 | 4 reeds | 6,5 | 2 | 1,5 | 5.13 |

Processing by the method of FFE-22 allows to obtain the following regression equation:

$$H = 11 - 3{,}5x1 \quad (1)$$

Indeed, the displacement of the thread in one or the other direction by ± 4 mm during the rope formation cannot significantly affect the number of threads laid in the rope, it affects only their location inside the formed defect. On the experimental bobbin, this tape is divided into parts by the yarn thread guide shift. Such shifts cannot have a significant influence on the winding structure. However, if we take into account the fact that during the formation of packages that are not subjected to liquid treatment, the main harmful effect of the rope winding is the coiling of the turns at the sockets accompanying it, an additional shift of the yarn thread guide can have a positive effect.

Indeed, when forming the rope winding, the previously laid coils play the role of a yarn thread guide, but they still tend to dump subsequent coils beyond the edge of the package, which leads to the formation of chords at the sockets. An additional shift of the yarn thread guide does not allow laying the turns in close proximity to one another, while the loose rope cannot play the role of a spreader, and the conditions for the formation of chords are eliminated. Although the yarn thread guide shift of ± 4 mm is clearly insufficient to dissipate the rope winding, all coils are stacked in practically the same narrow area.

In the course of the experiment, packages were also formed with a complex motion of the yarn thread guide, provided by the let-off-conrod traverse guide rod (Figure 2).

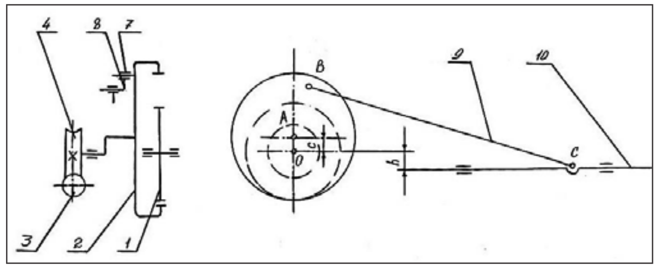


**Figure 2: Scheme of the yarn thread guide mechanism shift with differential traverse guide rod**

The two or single-thread worm 3 drives the worm wheel 4. The hub of the latter rotates in the housing of the stationary wheel 1. The hub has an eccentrically located hole into which the wheel axis 2 comes out, on the same wheel there is a pin 7 to which the bar 9 is attached, the bar of the adjuster which transmits the movement.

The swing of the rod depends on the eccentricity of the wheels 1 and 2, as well as on the variable distance between the pin 8 and the axis of the worm wheel, the rod moves pistonwise with a variable swing, changing its direction of movement several times during one cycle. Analysis of packages on the ASN device showed that the motion of the yarn thread guide does not affect the scattering effect.

In the present work, as an example, an analysis of some variants of the designs of scattering mechanisms for spinning and twisting machineries of the type PK-100 was carried out. The choice of the machine is explained by the breadth of its application in the textile industry.

When creating winding mechanisms for rewinding of chemical threads, a similar phenomenon has already been encountered, and a special mechanism has been developed to eliminate it, periodically reducing the swing stroke of the yarn thread guide by a certain amount [15]. It was establishes that the size of the thickening formed near the sockets is significantly influenced by the ratio of the full and short strokes of the yarn thread guide during the period of operation of the mechanism.

To clarify this relationship on a PC-100 M3 machine, a special design was developed and manufactured that allowed to change the percentage of short and full moves of the spreader within a wide range. The scheme of the mechanism is shown in Figure 3.

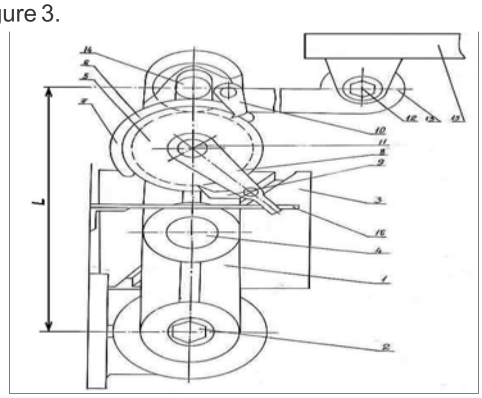

**Figure 3: Mechanism for reducing the sweep of the spreader**

The described mechanism for reducing the stroke of the yarn thread guide introduces perturbations into the work of the layout mechanism, so we can expect the appearance of the effect of dispersion of the rope structures, which will manifest simultaneously with the effect of decompaction of the sockets.

In the course of the experiment, six bobbins were wound at different percentages of the shortened strokes of the yarn thread guide and with different rotational speeds of the cams of the mechanism for reducing the span of the yarn thread guide.

The conditions under which the experimental packages were formed described in Table 2.

**Table 2: Conditions for obtaining experimental packages**

| No. | X1-yarn thread guideshift value frequency | | X2- yarn thread guide shift | | Diagram height at 95 diameter |
|---|---|---|---|---|---|
| | Natural meaning, mm | Conversion meaning | Natural stroke of the yarn thread guide | Conversion meaning | H, mm |
| 1 | ±1,5 | - | 10 | - | 15 |
| 2 | ±4 | + | 10 | - | 6 |
| 3 | ±1,5 | - | 15 | + | 14 |
| 4 | ±4 | + | 15 | + | 9 |

During the experiment, two parameters were recorded: the degree of decompaction of the sockets and the efficiency of dissection of the rope structures.

To assess the effectiveness of decompaction of the sockets of the package, the worked bobbins were cut along the generatrix into 7 parts. The dimensions of the obtained rings were preliminarily measured, then their volume was calculated.

According to the volume and weight of each ring obtained in this way, the density of the winding in it was determined. The distribution of the density along the generatrix of the bobbin is represented graphically in Figure 4.

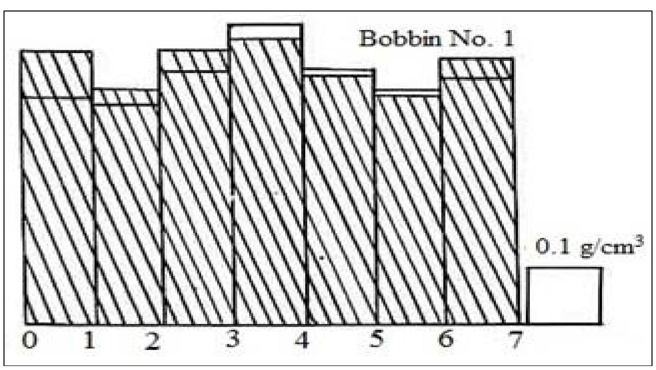


**Figure 4: The distribution of the winding density along the forming bobbin No. 1 on the PC-100 M3 machine (the shaded area corresponds to the control bobbin)**

In the middle part of the package there is a thickening caused by the slowdown of the yarn thread guide, provided by the cam profile of the spreader.

Since the mechanism for reducing the swing of the yarn thread guide does not affect the law of motion in the middle part, its application cannot cause changes in the density distribution in the middle part of the package, this is observed in all diagrams. Here, the highest density is observed in all cases.

Some deviations from the values obtained on the control bobbin are associated with a change in the pressing effect of the winding shaft due to the sockets decompaction.

When the density decreases at the sockets, the load on the the middle part of the bobbin, as well as its density, increases. This is most clearly manifested in the bobbin No. 3. The indicator of the decompaction effectiveness of the sockets can be the change in density during the transition from the socket to the adjacent section. Bobbin No. 3 is the best from this point of view.

For this bobbin, the ratio of the number of shortened strokes to the number of complete is close to 3, the same relation was also used for the winding of the bobbin No. 6. In this case, there is also an insignificant decrease in the density at the transition from the socket to the neighboring section.

The effectiveness of the rope structures dispersion was evaluated using an ASN device. The diagrams obtained from the unwinding of the bobbins are shown in Figures 5 – 9. As can be seen from the diagrams shown, the shortening of the yarn thread guide does have some dissipative effect on the package structure.

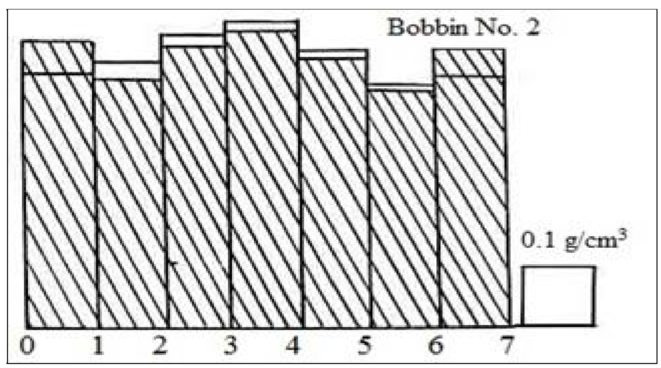


**Figure 5: The distribution of the winding density along the forming bobbin No. 2 on the PC-100 M3 machine (the shaded area corresponds to the control bobbin)**

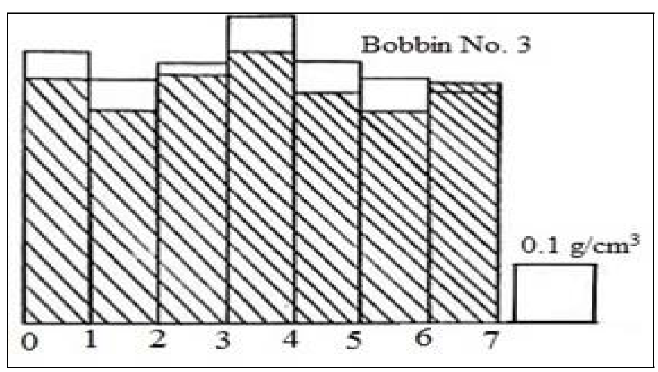


**Figure 6: The distribution of the winding density along the forming bobbin No. 3 on the PC-100 M3 machine (the shaded area corresponds to the control bobbin)**

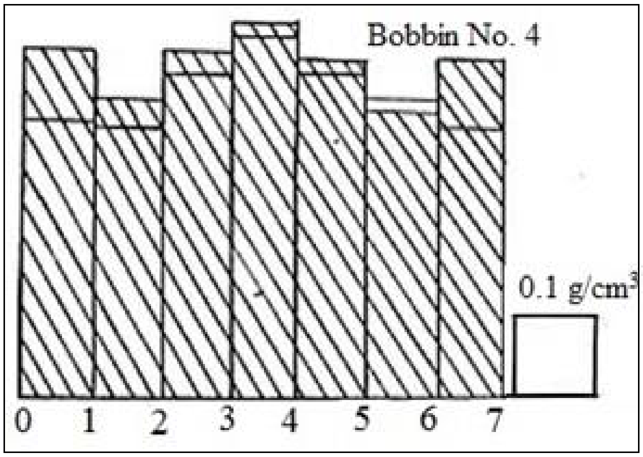


**Figure 7: The distribution of the winding density along the forming bobbin No. 4 on the PC-100 M3 machine (the shaded area corresponds to the control bobbin)**

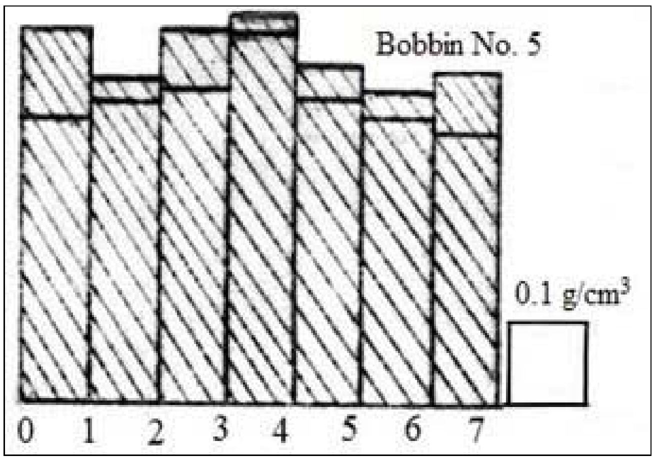


**Figure 8: The distribution of the winding density along the forming bobbin No. 5 on the PC-100 M3 machine (the shaded area corresponds to the control bobbin)**

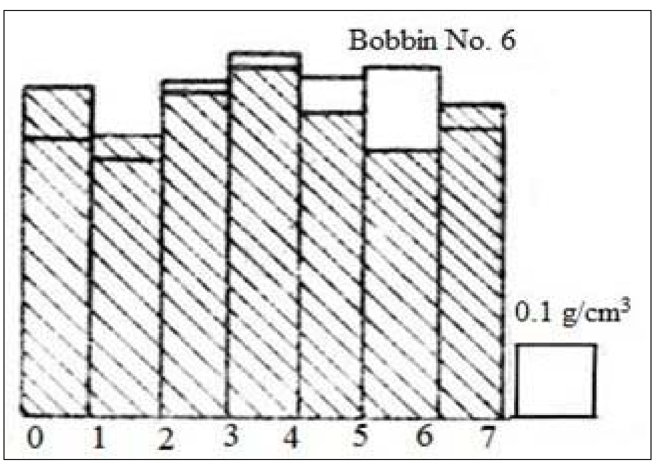


**Figure 9: The distribution of the winding density along the forming bobbin No. 6 on the PC-100 M3 machine (the shaded area corresponds to the control bobbin)**

At the cycle of the mechanism operation equal to the 41 course of the yarn thread guide, the influence of the ratio of the shortened and full strokes of the yarn thread guide is invisible Figures 5 – 7. This is explained by the fact that in the 41st course of the yarn thread guide, a rope or ribbon winding structure can be formed, and therefore the influence of the yarn thread guide on its formation is practically absent.

For the shortest time cycle of the mechanism, which made 9 moves of the yarn thread guide in the experiment, a somewhat different picture is observed. At the ratio of the shortened moves to the full close to 1 (more precisely 4/4.5), Figure 6, there is a significant decrease in the height of the columns in the diagram. In our opinion this is explained by the fact that when the yarn thread guide's stroke is shortened, the thread is stacked with some displacement in comparison with the full stroke of the yarn thread guide. This leads to the ropes dispersion. After the mechanism returns to its original position, the formation of the defect is resumed. Therefore, for the bobbin No. 6, where the number of shortened strokes is only 1/3 of the full ones, only 1/3 of the coils stacked in the rope are dispersed during normal winding, which, of course, reduces the efficiency of the mechanism as the rope structures disperser.

Thus, the requirements for loosening sockets and dispersion of the rope structures with a reduction in the stroke of the yarn thread guide are controversial, and should, depending on which requirements are priority for this package according to the conditions of the technological process. It should be noted that the absence of the scattering effect for the package with the ratio of the shortened and full strokes of the yarn thread guide equal to 1/3 does not mean that such an impact on the spreader does not lead to a thread smash, which eliminates the uncontrolled layout of the previously laid coils. This effect manifests itself in full measure and can be successfully used to eliminate chords at the sockets of the package.

## Conclusions

The studies lead to the recommendations for the modernization with following conclusions

- The analysis of the winding structure on a PC-100M3 machine with the mechanism of additional axial displacement of the spreader was carried out, recommendations on rational modes of its operation were developed
- The analysis of the winding structure on a PC-100M3 machine with a periodic reduction in the swing of the yarn thread guide were carried out, recommendations on rational modes of its operation were developed
- The PC-100M3 machine aimed at eliminating defects in the winding structure were developed.

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# Colouration and UV protection properties of cotton khadi fabric dyed with galls of *quercus infectoria* dye extract

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**Abstract**

Ultraviolet (UV) radiations are carcinogenic, repeated UV exposure causes damage to skin cells and leads to develop skin cancer. Generally, commercially available clothing items provide a limited UPF (less than 15). Present research has been taken up to develop eco-friendly Khadi fabric having UV protective action along with good colorfastness properties by extracting the dyes using galls of Q. *infectoria* at various dyeing concentrations. Optimal results were achieved by dyeing at 90-100 °C for 90 minutes using the pre-mordanting method with different mordants i.e. *Punica granatum, Phyllanthus emblica, Terminalia bellirica, Acacia catechu* and Ferrous sulfate.The developed fabric samples were evaluated for ultraviolet radiation in terms of UPF and the colour fastness towards washing, rubbing, and sunlight and colour strength (K/S) value. The results of colour fastness to washing and rubbing showed good to very good, whereas the colour fastness to light showed good to moderate fading. It showed very good colour strength (K/S) and provided beautiful shades in dyed samples. The data obtained showed that the mordanted samples have high dye uptake with excellent UPF values. These results are very important for industrial application with the production of natural dyes having an excellent UPF value with an inexpensive source from the galls of Q. *infectoria* on Khadi fabric.

**Key words:** UV, Khadi, Protection, Colour, Fastness, Dye, Extract, Fastness

## Introduction

Daily 10-15 minutes exposure of sunlight to human body is very essential for the production of vitamin D, which plays a crucial role in skeletal development, immune function, and blood cell formation [1]. Sunlight is a form of electromagnetic radiation in the form of ultraviolet (UV), visible, and infrared radiation [2]. Ultraviolet radiations are just about 7 % of total solar emission with spectrum extends from 290 nm to 400 nm but it has a huge dangerous effect on human skin. Chronic overexposure can lead to connective-tissue damage, premalignant lesions and malignancies (basal or squamous cell cancer, and perhaps melanoma skin cancer) [3]. Textiles offer the safest protection from harmful UV radiations using umbrellas and various accessories such as hats, sunglasses, hand gloves and summer coats etc. [4, 5]. The protectiveness of these materials depends on fabric construction (porosity, weight and thickness) fabric composition, (natural, artificial or synthetic fibers), and the nature of the treatment to the fabric like dyeing that may be natural or synthetic [6, 7]. Most of the researches have been focused on the UV-protection properties of natural fibers [8, 9]. Khadi is an Indian handspun and hand-woven cloth, was proposed in 1920 by Mahatma Gandhi during the freedom struggle [10]. It prevents skin rashes and imparts a very elegant and sober look. Khadi, has specific physical and chemical properties such as high-water absorption, high comfort, and good dyeability, and is the symbol of Indian's identity [11].The use of natural dyes rapidly declined after the discovery of synthetic dyes in 1856. Widely and commercially used synthetic dyes provide stable colours but cause carcinogenicity [12 -14]. Natural colourants and dyes are believed to be safe, non-toxic, non-carcinogenic and biodegradable nature because it derived from flora and fauna [15 – 17].

*Quercus infectoria* is a small tree, native of Greece, Asia Minor and Iran, belongs to the Fagaceae family, locally known as Manjakani in Malaysia and Majuphal in India. It is widely used in Indian traditional medicines and in the treatment of a toothache and gingivitis [18]. Galls of *Q. infectoria* have also been pharmacologically documented to hold antiviral, astringent, antifungal, antibacterial and UV protective activities. Its main constituent is tannin i.e., 50 – 70 % and a small amount of free gallic acid and ellagic acid [18, 19].

**Figure 1: Galls and powder of *Quercus infectoria* Galls**

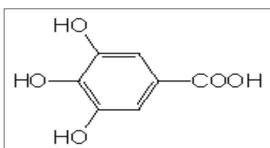

**Figure 2a: Gallic acid**

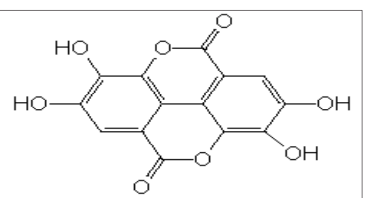

**Figure 2b: Ellagic acid**

Cotton Khadi fabric was chosen as a substrate as it is the preferred material in sunny outdoor location but has a low UPF value to start with. Present research was done with the objective to extract dye from the galls of Q. infectoria with selected mordants and investigate the UV protection and colourfastness properties.

## Material and Methods

## Fabric

Commercially available cotton Khadi fabric (with 0.47 mm thickness, 1.55 $g/m_2$ weight, and 54 × 38 fabric count per inch with plain weave) was used. The scouring was done using a standard method followed by pre-treatment with Myrobalan extract with 2 % concentration at room temperature.

## Dyes and mordants

Dye and all mordants were purchased from the local market of Udaipur (Rajasthan), India. Galls of *Q. infectoria* as a dye and Punica granatum, *Phyllanthus emblica*, *Acacia Catechu*, *Terminalia bellirica* and Ferrous sulfate as mordants were used.

The galls of *Q. infectoria* were cleaned and dried at room temperature and grounded in uniform particles. 100 gm of powdered raw material was taken into 1000 ml distilled water and soaked overnight. The obtained coloured solution was subjected to heating at 90 – 94 °C with continuous stirring for 5 hours. To remove suspended impurities, the extracted solution was filtered. The resulting solution was concentrated by keeping in the oven at 45 °C for 12 hrs. This solution was obtained through aqueous extraction and gave very good light yellow colour.

## Mordanting and dyeing

Pre-treated cotton Khadi fabric samples with Myrobalan were mordanted with selected mordants at three concentrations i.e., 5, 10 and 15 %, keeping 1:40 MLR at 90 °C for 45 minutes using pre-mordanting method. After mordanting the dye baths were prepared using three selected dyeing concentrations i.e., 10, 20 and 30 % with 1:50 M:L ratio at 90 – 100 °C for 90 minutes at pH 8. Both processes, dyeing and mordanting were carried out using the YORCO water bath shaker (YSI-412).

## Evaluation of colour fastness properties

The dyed samples were assessed for colour fastness in respect to washing, rubbing and light. The wash fastness of the dyed samples was evaluated as per the ISO 105-C06:1994 (2010) using Launder-o-meter. The rubbing fastness properties were tested with Crock-o-meter as per Indian standard IS 766:1988 (Reaffirmed 2004) which is based on ISO 105-X12:2001 test method. Light fastness was conducted on digital light having water-cooled Mercury Blended Tungsten lamp, according to ISO 105-B02:1994 (Amd.2:2000) and samples were exposed to xenon lamp for 24 hours at standard testing conditions.

## Colour values by reflectance method

The dyed samples were tested to assess the effect of dyes and mordants on colour strength (K/s) and colour values (L a* b* values) using Macbeth- colour Eye 5100A UV spectrophotometer. K/s value denotes the fabric colour strength. K/S can be calculated by the following formula:

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

In which R is the reflectance of light at a wavelength $\lambda$, K is the absorption coefficient and S is the scattering coefficient.

## Evaluation of Ultraviolet Protection Factor (UPF)

The transmittance of the fabric was measured according to UVA and UVB transmission while the UPF value was calculated using AATCC 183:2004 Test method [20]. The UPF of the test fabric was calculated according to the following equation:

$$UPF = \frac{\sum_{\lambda=290}^{\lambda=400} E_{\lambda} S_{\lambda} \Delta_{\lambda}}{\sum_{\lambda=290}^{\lambda=400} S_{\lambda} T_{\lambda} \Delta_{\lambda}}$$

where:

E = erythemal spectral effectiveness

S = solar spectral irradiance in Wm-2nm-1

T= spectral transmittance of fabric

$\Delta_{\lambda}$= the bandwidth in nm

λ= the wavelength in nm.

**Table 1: UPF Rating and Protection Categories***

| UPF Rating | Protection Category | % UV Radiation Blocked |
|---|---|---|
| 14-24 | Good | 93.3-95.9 |
| 25-39 | Very Good | 96.0-97.4 |
| 40 and over | Excellent | 97.5 or more |

*American Association of Textile Chemists and Colourists (AATCC) Test Method 183 specifies the protocol for conducting a UV transmittance test [20].

In Table 1, fabric with a UV Protection category in the range of 14 to 24, 25 to 39 and 40 or over is defined as providing "good, very good and excellent Ultraviolet protection respectively [21 – 24].

## Results and Discussions

## Colour strength of dyed samples

The CIE L a* b* colour values of control and the dyed fabric samples using different concentrations of the dye and the mordants are summarized in Table 2 and Figures 2 and 3.

The shades of control samples were observed very light. Colour strength properties of dyed samples increased with increase in concentration of mordants as clearly depicted in the table. At 10 % dye concentration, control sample showed 10.52 K/S value (colour strength), and at 20 % dye concentration it showed 13.06 K/S value while at 30 % dye concentration 15.83 colour strength value was obtained.

**Table 2: CIE Lab colour co-ordinates of dyed cotton Khadi fabric with Galls of *Q. infectoria using different mordants***

| Mordants and their concentrations (%) | | Dye % | L* | a* | b* | C | Colour strength (K/s) |
|---|---|---|---|---|---|---|---|
| | | Control | | | | | |
| | | 10 % | 65.69 | 2.01 | 22.36 | 23.18 | 10.52 |
| | | 20 % | 63.84 | 2.89 | 23.72 | 23.94 | 13.06 |
| | | 30 % | 62.23 | 3.73 | 23.91 | 24.14 | 15.83 |
| *Phyllanthus emblica* (PE) | 5 | 10 % | 60.34 | 3.01 | 23.10 | 24.10 | 21.24 |
| | 10 | | 60.53 | 3.65 | 23.34 | 24.34 | 24.10 |
| | 15 | | 58.62 | 3.83 | 24.64 | 24.64 | 25.96 |
| | 5 | 20 % | 58.97 | 3.01 | 24.24 | 25.24 | 26.89 |
| | 10 | | 57.02 | 3.75 | 25.98 | 25.71 | 27.64 |
| | 15 | | 57.94 | 4.57 | 26.99 | 26.39 | 29.98 |
| | 5 | 30 % | 59.64 | 3.01 | 25.75 | 25.95 | 31.89 |
| | 10 | | 56.46 | 3.65 | 26.29 | 26.77 | 33.64 |
| | 15 | | 56.89 | 4.97 | 26.92 | 27.13 | 35.59 |
| *Acacia Catechu* (AC) | 5 | 10 % | 62.34 | 3.01 | 21.17 | 21.10 | 9.01 |
| | 10 | | 60.53 | 3.65 | 21.73 | 21.34 | 12.65 |
| | 15 | | 58.62 | 4.57 | 22.64 | 22.64 | 15.57 |
| | 5 | 20 % | 58.85 | 3.01 | 22.24 | 22.59 | 13.02 |
| | 10 | | 59.20 | 4.65 | 23.37 | 23.98 | 17.24 |
| | 15 | | 56.46 | 5.57 | 26.79 | 26.99 | 18.07 |
| | 5 | 30 % | 57.38 | 4.01 | 23.75 | 23.75 | 16.54 |
| | 10 | | 56.92 | 4.65 | 25.17 | 25.97 | 19.60 |
| | 15 | | 53.23 | 5.57 | 27.59 | 26.92 | 22.60 |
| *Punica granatum* (PG) | 5 | 10 % | 66.27 | 3.01 | 23.10 | 23.19 | 24.27 |
| | 10 | | 62.76 | 3.65 | 24.34 | 23.77 | 28.85 |
| | 15 | | 55.37 | 4.57 | 26.64 | 24.24 | 31.11 |
| | 5 | 20 % | 60.10 | 3.01 | 23.98 | 23.98 | 34.40 |
| | 10 | | 59.54 | 3.65 | 24.24 | 25.64 | 41.52 |
| | 15 | | 50.59 | 3.57 | 29.99 | 28.59 | 57.47 |
| | 5 | 30 % | 57.95 | 3.01 | 26.75 | 26.75 | 53.26 |
| | 10 | | 55.08 | 3.65 | 28.17 | 28.17 | 55.98 |
| | 15 | | 48.75 | 3.97 | 29.92 | 30.92 | 59.72 |
| Terminalia bellirica (TB) | 5 | 10 % | 59.64 | 3.01 | 22.10 | 22.10 | 38.24 |
| | 10 | | 58.46 | 3.65 | 21.34 | 21.34 | 34.10 |
| | 15 | | 56.89 | 4.57 | 22.64 | 22.64 | 35.96 |
| | 5 | 20 % | 58.97 | 3.01 | 22.24 | 22.24 | 30.89 |
| | 10 | | 57.02 | 3.65 | 23.98 | 24.98 | 38.64 |
| | 15 | | 57.94 | 3.57 | 26.99 | 26.99 | 40.98 |
| | 5 | 30 % | 53.46 | 3.01 | 23.75 | 23.75 | 38.89 |
| | 10 | | 53.89 | 3.65 | 25.17 | 26.17 | 39.64 |
| | 15 | | 54.76 | 3.57 | 27.92 | 27.92 | 42.59 |
| *Ferrous sulfate* (FS) | 5 | 10 % | 45.88 | 1.01 | 14.82 | 14.82 | 68.24 |
| | 10 | | 44.92 | 2.65 | 13.94 | 12.94 | 74.10 |
| | 15 | | 24.10 | 4.57 | 11.26 | 9.26 | 312.59 |
| | 5 | 20 % | 43.23 | 3.01 | 10.51 | 14.82 | 110.89 |
| | 10 | | 31.29 | 4.65 | 10.15 | 13.94 | 128.64 |
| | 15 | | 33.83 | 3.57 | 9.34 | 10.26 | 280.98 |
| | 5 | 30 % | 35.86 | 1.01 | 11.10 | 11.82 | 198.89 |
| | 10 | | 27.86 | 1.65 | 10.26 | 11.94 | 210.64 |
| | 15 | | 28.06 | 3.57 | 10.69 | 11.26 | 385.96 |

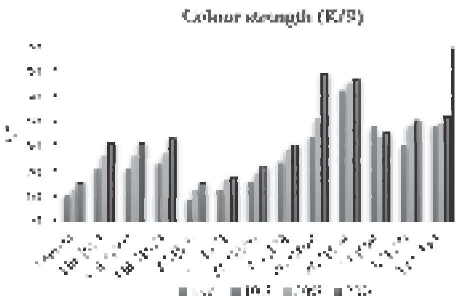


**Figure 2: Colour strength (K/s) of cotton Khadi fabric dyed with *Galls of Q. infectoria* dye and mordanted with different mordants i.e. AC *(Acacia Catechu)*, Ph E *(Phyllanthus emblica)*, TB *(Terminalia bellirica)*, PG *(Punica granatum)***

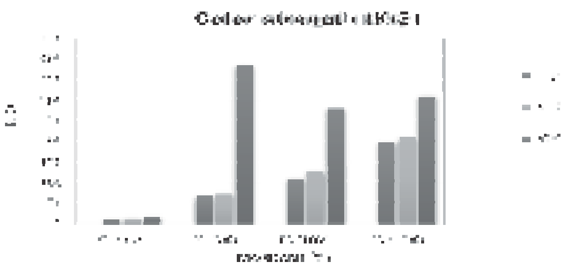

**Figure 3: Colour strength (K/s) of cotton Khadi fabric, dyed (with Galls of *Q. infectoria* dye) and printed (with FS= Ferrous sulfate)**

However, the colour strength (K/s) of the pre-mordanted Khadi fabric samples with different mordants i.e., *Punica granatum, Phyllanthus emblica, Acacia catechu, Terminalia bellirica* and Ferrous sulfate; showed deeper and fast shades. *Terminalia bellirica* and *Punica granatum* mordants obtained 42.59 and 59.72 K/s value at 30 % dye and 15 % mordant concentration followed by *Phyllanthus emblica* and *Acacia catechu* mordantsrespectively. Whereas, ferrous sulfate showed highest colour strength even at very low dye and mordant concentrations. Rajendran *et al*. also found that the dyed cotton fabric with *Punica granatum* dye showed good colour strength [25]. The colour intensity of the samples mordanted with *Punica granatum, Phyllanthus emblica, Acacia catechu* and *Terminalia bellirica* was obtained good, whereas Ferrous sulfate mordanted samples got better intensity as compared to other mordanted samples. The L* values were determined darker using *Punica granatum* at lower concentration and moved towards darker shades, while a* plot was found redder with all the mordanted samples and b* plots were found yellower with the increasing concentrations of dye and all mordants. Hence Ferrous sulfate was showing little towards a greener and bluer colorant.

All the mordanted samples were showing significantly higher color strength (K/s) values than control samples whereas samples mordanted with Ferrous sulfate showed excellent colour strength. All the samples dyed with *Q. infectoria* extract with different concentrations, were found in the red-yellow zone. Findings are supported by Mahangade et al., study that natural fibers such as cotton, have a very low affinity towards most of the natural dyes [26].

## Colour fastness of dyed samples

Natural dyes have a very low affinity in respect to natural fibers. Just because of the presence of tannins compound in galls of *Q. infectoria*, it showed different colour hues with a very good affinity for cotton Khadi fabric in the presence of different natural mordants. Table 3 depicts colourfastness properties of mordanted and dyed samples. Control samples of Khadi fabric obtained 2/3-4 wash fastness ratings and 3-4 rubbing fastness ratings which comes under fair to very good at five-point rating scale.

**Table 3: Colour fastness properties of Galls of *Q. infectoria* dyed samples**

| Mordants | Dye % | Rubbing fastness* | | | | | | | | Wash fastness* | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Dry | | | | Wet | | | | CC | | | | CS | | | |
| | | Control | 5 % | 10 % | 15 % | Control | 5 % | 10 % | 15 % | Control | 5 % | 10 % | 15 % | Control | 5 % | 10 % | 15 % |
| PE | 10 | 3 | 2 | 3 | 3/5 | 3 | 3 | 3 | 4/5 | 2/3 | 2 | 2/3 | 3 | 3 | 3 | 4 | 4 |
| | 20 | 4 | 2/3 | 4/5 | 4/5 | 3 | 3 | 4 | 5 | 3 | 3 | 3/5 | 4 | 3 | 3/4 | 4 | 4 |
| | 30 | 4 | 4 | 5 | 5 | 3/4 | 4 | 4 | 5 | 3 | 4 | 4 | 4/5 | 3/4 | 4 | 4/5 | 5 |
| AC | 10 | 3 | 3 | 3 | 4 | 3 | 3 | 2/3 | 4 | 2/3 | 2 | 3 | 4 | 3 | 2 | 3 | 4 |
| | 20 | 4 | 3 | 4 | 4/5 | 3 | 3 | 3/4 | 4/5 | 3 | 3 | 3 | 3/4 | 3 | 3 | 4 | 4/5 |
| | 30 | 4 | 4 | 5 | 5 | 3/4 | 3/4 | 4/5 | 5 | 3 | 3/4 | 4 | 4 | 4 | 3 | 3/4 | 5 |
| PG | 10 | 3 | 2 | 3 | 4 | 3 | 3 | 3 | 3/4 | 2/3 | 3 | 3 | 3/4 | 3 | 3 | 4 | 4 |
| | 20 | 3 | 3 | 4/5 | 4/5 | 3 | 3/4 | 3/4 | 4/5 | 3 | 3 | 4 | 4/5 | 3 | 4 | 4/5 | 4/5 |
| | 30 | 4 | 4 | 5 | 5 | 3/4 | 3/4 | 5 | 5 | 3 | 4 | 5 | 5 | 4 | 3/4 | 5 | 5 |
| TB | 10 | 3 | 2 | 3 | 4 | 3 | 3 | 3 | 4 | 2/3 | 3 | 3 | 4 | 3 | 3 | 3/4 | 3 |
| | 20 | 4 | 3/4 | 4/5 | 4/5 | 3 | 2/3 | 3/4 | 4/5 | 3 | 3 | 3/4 | 4 | 3 | 4 | 4 | 4/5 |
| | 30 | 4 | 4 | 4/5 | 5 | 3/4 | 3/4 | 4/5 | 5 | 3 | 3/4 | 4 | 4/5 | 4 | 3/4 | 4/5 | 5 |
| FS | 10 | 3 | 3 | 4 | 4 | 3 | 3 | 4 | 4 | 2/3 | 3 | 4 | 4 | 3 | 4 | 4 | 4 |
| | 20 | 4 | 4 | 4/5 | 5 | 3 | 4 | 5 | 5 | 3 | 4 | 4/5 | 5 | 3 | 4 | 4/5 | 4/5 |
| | 30 | 4 | 5 | 4/5 | 5 | 3/4 | 4/5 | 4/5 | 5 | 3 | 4 | 4/5 | 5 | 4 | 4/5 | 5 | 5 |

PE= *Phyllanthus emblica*, AC= *Acacia Catechu*, PG= *Punica granatum*, TB= *Terminallia bellirica*, FS= Ferrous sulfate, CC=Colour change, CS=Colour staining,

Rating* 1-5 where 1-poor, 2-fair, 3- good, 4-very good and 5-excellent

In the context of rubbing fastness, the highest dry rub fastness ratings explicated 5 with 15 % mordant and 30 % dye concentration with all dyes and mordants. Mordanted samples with *Terminalia bellerica* showing 4-5 with 5 – 15 % mordant and 10 – 30 % dye concentration even Ferrous sulfate showing 5 rating at 5 % mordant and 30 % dye concentration in terms of dry rubbing fastness. It can be observed that all the printed samples showed very good to excellent wash fastness grade in terms of colour change and indicating negligible or no staining at 15 % mordant and 30 %dye concentrations. Whereas rubbing fastness showed very good fastness grade at 10 %, 15 % mordant and 30 % dye concentration. Results are supported by the findings of Grifoni et al. that high fastness grade in the dyed samples is due to the presence of tannin and a small amount of free gallic acid and ellagic acid, present in galls of *Q. infectoria* [27].

**Table 4: Light Fastness Properties of Dyed Cotton Khadi Fabric samples**

| Mordants | D 10 % | | | | D 20 % | | | | D 30 % | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Control | Mordants | | | Control | Mordants | | | Control | Mordants | | |
| | | 5 % | 10 % | 15 % | | 5 % | 10 % | 15 % | | 5 % | 10 % | 15 % |
| PE | 2 | 3 | 3 | 4 | 3 | 4 | 4 | 5 | 3 | 4 | 5 | 6 |
| AC | 2 | 3 | 4 | 4 | 4 | 4 | 4 | 5 | 4 | 5 | 6 | 6 |
| PG | 3 | 4 | 4 | 5 | 4 | 3 | 5 | 6 | 5 | 5 | 6 | 7 |
| TB | 3 | 4 | 4 | 5 | 4 | 4 | 5 | 5 | 5 | 5 | 6 | 7 |
| FS | 3 | 4 | 5 | 5 | 4 | 5 | 5 | 6 | 5 | 5 | 6 | 8 |

PE= *Phyllanthus emblica*, AC= *Acacia Catechu*, PG= *Punica granatum*, TB= *Terminalia bellirica*, FS= Ferrous sulfate

Raring 1-8 where 1-poor, 2-fair, 3-moderate, 4-good, 5-better, 6-very good, 7-very slight and 8- excellent

As it can be noticed in Table 4 that the light fastness of control samples with 10 %, 20 % and 30 % concentrations of *Q. infectoria* dye showed fair to good ratings against blue wool standards of 1-8 rating scale. The light fastness properties of Galls of *Q. infectoria* dye produced moderate (3) to very good fastness (5-6) with *Phyllanthus emblica* and *Acacia Catechu* mordants respectively at 15 % mordant and 30 % dye concentration. Application of ferrous sulfate registered moderate to no fading (5-8) against at 5 %, 10 % and 15 % mordant concentrations using dye at 10 %, 20 %, and 30 % dye concentrations respectively. Based on the above results, *P. granatum, T. bellirica* and F. sulfate gave very good results of colour fastness tests on cotton Khadi fabric with all the dyes. The results are confirmed by the findings of Arora et al., that the light fastness properties were increased by using different mordants on the cotton fabric [28].

## UPF of cotton khadi fabric dyed with Galls of *Q. infectoria* using different mordants

It is noted that the UPF is strongly depended on the chemical structure of the fiber. A high correlation exists between the fabric porosity and the UPF but it is also influenced by the type of the fibers. Based on the above results, the researcher has selected 6 best samples for further UPF testing in which, one was control sample and another five were mordanted with different mordants at 30 % dye and 15 % mordant concentrations. The percentage of UV transmission of un-mordanted and mordanted cotton Khadi fabric showed in Figure 4. Ultra violet protection factor and UV blocking is shown in Table 5. Control sample obtained a mean UPF of 66.8. For a fabric to be labeled as sun safety, it should have a minimum UPF of 15 and maximum UPF of more than 50. Meanwhile, the tested samples have a UPF value more than 50 hence provide an excellent protection. UPF values obtained with ferrous sulfate mordanted samples, was found highest because ferrous provided the dark shades to the samples as compared to other mordanted samples.

UPF of *Terminalia bellirica* mordanted samples with *Quercous infectoria* dye came out to be 81.1 and able to block 98.3 % and transmit 1.70% of UV-A radiations at the same time able to block 98.73 % and transmitting 1.27 % of UV-B radiations whereas *Phyllanthus emblica* and *Punica granatum* mordants obtained 73.5 and 73.2 UPF rating by blocking 98.47 and 98.48 UV-A radiations and 98.60 and 98.59 UV-B radiations respectively. UPF of *Acacia Catechu* mordanted samples found 67.6 while Ferrous sulfate obtained 76.9 ultraviolet protection factor.

**Table 5: UPF Parameters of dyed cotton Khadi fabric samples**

| Test parameters | Test method | UPF | Blocking (UV-A) % | Blocking (UV-B) % | P.C.* |
|---|---|---|---|---|---|
| Control | As per AATCC 183 | 66.8 | 98.17 | 98.37 | Excellent |
| T. bellirica | | 81.1 | 98.3 | 98.73 | Excellent |
| P. granatum | | 73.2 | 98.48 | 98.59 | Excellent |
| A. catachu | | 67.6 | 98.26 | 98.39 | Excellent |
| Ph. emblica | | 73.5 | 98.47 | 98.60 | Excellent |
| F. Sulfate | | 76.9 | 98.48 | 98.65 | Excellent |

The term PC* represents Protection Category according to the Australian Capital Territory *(ACT)* cancer council recommended http://www.actcancer.org/

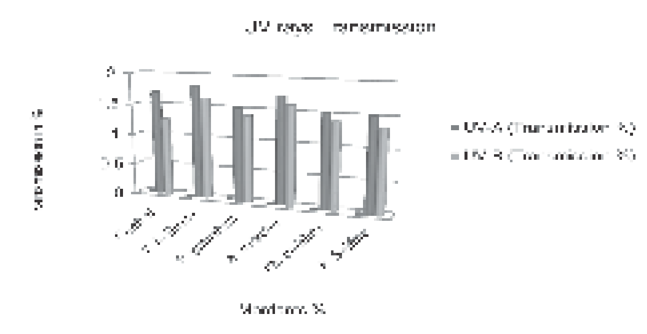

**Figure 4: Ultraviolet rays (UV-A and UV-B) transmission**

The UV Transmission at 30 % concentration of aqueous extract of *Quercus. infectoria* dye clearly revealed that it has well distinguished indicative the transmission value of T. bellirica showed highest, whereas unmordanted samples showed lowest with UV-A and UV- B region of the spectrum as compared to other dyed and mordanted samples. Meanwhile, it can be seen in the Figure 4 and Table 5 that as the UV transmission becomes less, the fabric became a very good UV rays' blocker and able to provide more protection from sun rays. Though, it can be evaluated using AATCC 183 test method, as the UPF category value became higher, the UVR transmission became lesser and provide excellent protection [20].

Therefore, it is clearly perceived with the findings of Feng et al., that the values of spectral transmittance decreased with different mordants such as AlK $FeSO_4$, $SnCl_2$, $(SO_4)_2$ and $CuSO_4$ [9], having different effects on the dyed fabric's spectral transmittance, besides it, the colour and colour depth of the fabric can be related to Ultraviolet transmittance [29], where the light colours transmit more ultraviolet radiation than dark ones [30]. The results confirmed that galls of *Q. infectoria* dye extract had potential applications for fabric dyeing and produced environment friendly cotton Khadi fabric having excellent UV protection properties. As the percentage of UVA and UVB transmission value is decreased, the UPF is increased and it can be attributed to shrinkage, which reduces fabric porosity [31]. In the findings of Driscoll, the dyed fabric protects more than un-dyed ones [32]

## Conclusion

It can be concluded that the cotton Khadi fabric showed very good colour strength value (K/s) with the increasing dyeing and mordanting concentrations and produced many colour shades. Colour strength and colour fastness properties was improved with the use of mordants. Khadi fabric samples exhibited excellent UV Protection and blocking to UVA and UVB rays from reaching to the skin. Even In some cases, Dark shades of dyed samples also evinced very good UV Protection. All the dyed and mordanted samples provided very good protection to the human skin from sun rays and manifested high protection against UV light with cotton Khadi fabric.

## Acknowledgement

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# Studies on thermal degradation behavior of nano silica loaded cotton and polyester fabrics

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**Abstract**

In this work cotton and polyester fabric were coated with silica nano particles using pad-dry-cure method. The prepared composite fabrics were analyzed in terms of change in their thermal degradation properties. The oxidative degradation characteristic of control and treated samples were studied using thermo gravimetric technique. The mass loss profile of untreated fabric compared with treated fabric. The results indicate that the thermal degradation rate was lower in treated sample as compare to control fabrics.

**Keywords:** Coating, Cotton, Silica nanoparticles, Polyester, Thermal property

## Introduction

Nanotechnology seeks to provide and apply knowledge of the behavior of objects in the nanometer (nm) size range to the assembly of complex structures for use in a variety of practical applications. The tiniest substances promise to transform industry and create a huge market. In chemicals, cosmetics, pharmaceuticals, technology and textiles, businesses are doing research and manufacturing products based on nanotechnology, which uses bits of matter measured in billionths of a meter [1 – 3].

Thermal properties are the properties of materials that changes with temperature. They are studied by thermal analysis techniques, which include DSC, TGA, DTA, dielectric thermal analysis, etc. Generally, the incorporation of nanometer-sized inorganic particles into the polymer matrix can enhance thermal stability by acting as a superior insulator and mass transport barrier to the volatile products generated during decomposition [3 – 7].

Nanoparticles can consist of various elements and compounds. The size of the molecules is the sole criterion for inclusion in the category of nanoparticles. Some of the inorganic nanosize particles currently available for use are $TiO_2$, ZnO, $Fe_2O_3$, Ag, Pt, $SiO_2$ etc. Among these nano particles $SiO_2$ nanoparticle are of most important [8 – 10]. As silica is most commonly found in nature as sand or quartz as well as in the cell walls of diatoms. Silica is manufactured in several forms including fused quartz, crystal, fumed silica, colloidal silica, silica gel, and aerogel. At present, there are several techniques reported in literatures for synthesizing nanoparticles [11, 12], however, wet-chemical technique is widely used in the field of material science and ceramic engineering [13, 14]. The coating of nano-particles on fabrics will not affect their breathability or feel. Therefore, the use of nanotechnology in textile is increasing day by day.

In this work attempt has been made to apply $SiO_2$ nano particles to cotton and polyester fabrics using pad-dry-cure technique. The in house synthesized $SiO_2$ nano particles have been elementally characterized EDX. The surface morphology of treated fabrics has been observed by SEM technique. Finally, the thermal degradation behavior of $SiO_2$ nano treated cotton and polyester fabric have been studied by Thermo Gravimetric technique.

## Materials and Methods

## Materials

### Fabric

Mill scoured and bleached cotton and fabrics with specification as given in Table 1 were procured from local market and used for the study. The procured fabric was further thoroughly washed, neutralized and air dried.

**Table 1: Specification of cotton and polyester fabric**

| Sample | Material Specification | | | | | | |
|---|---|---|---|---|---|---|---|
| | Count/Denier | | Ends | Pick | Weave | Wt.gm | Thickness |
| | Warp | Weft | /inch | /inch | | /sq.m. | (mm) |
| Cotton | 35s | 31s | 116 | 88 | Plain | 118.1 | 0.23 |
| Polyester | 128d | 146d | 90 | 72 | Plain | 109.7 | 0.21 |

### Chemicals

In-house synthesized nano $SiO_2$ nanoparticles [12] and poly acryl amide ($CH_2CHCO\ NH_2$, MW 71.08) of analytical grade purity was procured from SuLab reagents.

## Experimental methods

### Treatment of cotton and polyester with silica nano-particles

The coating solutions containing nano silica particle were prepared using 1 gpl, 2.5 gpl, and 5 gpl concentration, i.e., for 1 gpl solution, 0.1 gm nano particle was added with 5 gm Lissapol L surfactant and 10 gm polyacrylamide binder. The mixture was then stirred using magnetic stirrer at 250 rpm for 30 minutes at 60 °C temperature. Likewise all concentration solution was prepared.

The padding liquor was applied to the cotton and polyester fabric samples (size : 40 cm X 30 cm) by dipping them in the dispersion for 10 min and then padded on an automatic padding mangle machine, which was running at a speed of 15 rpm with a pressure of 1.75 Kg/$cm^2$ using 2-dip-2-nip padding sequence at 70 % expression. The padded substrates were air dried and finally cured for 3 min at 120 °C and 130 °C respectively for cotton and polyester fabric.

## Testing and Analysis

### Fabric characterization techniques

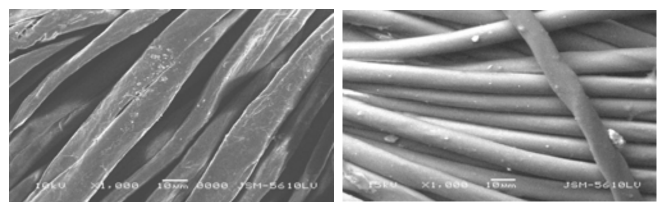
The surface morphology of the nano silica / cotton composite fabric was observed on scanning electron microscope (SEM) instrument (Model JSM5610LV, version 1.0, Jeol, Japan) and the presence of silica in composite fabric was confirmed on scanning electron microscope using Oxford-Inca software.

### Determination of thermal properties of fabrics

Thermogravimetry (TGA) was carried out for control and treated cotton and polyester samples by using a Shimadzu TGA-50 thermal analyzer. The samples were heated from ambient temperature to 500 °C with 10 °C/min rate in normal atmosphere. The thermograms associated with TGA for control and treated samples were obtained from the instrument output. The mass loss degradation at onset temperature were obtained from there thermograms for both the cotton and polyester treated as well as for untreated sample.

## Results and Discussions

Figure 1 shows the SEM micrographs of polyester and cotton fabrics loaded with silica nanoparticles distributed uniformly on fabric surface. The average diameter of in-house prepared nano particle as seen from the Figure 1 was ~180 nm. The elemental analysis of silica nano particle was performed on scanning electron microscope using Oxford-Inca software. The presence of silica was confirmed by the elemental analysis (Table 2); also the presence of oxygen indicates the silica is in the form of oxide or dioxide.



(a) (b)

**Figure 1: Nano silica loaded SEM images of (a) Cotton and (b) Polyester**

**Table 2: Elemental analysis of silica nano coated cotton and polyester fabric**

| Element | Weight % | Atomic % |
|---|---|---|
| O K | 51.03 | 61.90 |
| F K | 12.91 | 13.18 |
| Si K | 36.06 | 24.92 |
| Total | 100 | |

### Effect of nano silica on thermal behavior of fabric

Cotton and polyester fabric were treated with silica nano particle using pad-dry-cure technique. The oxidative degradation characteristic of control and treated samples were studied by using Thermo Gravimetric technique. The mass loss profile of control fabric compared with treated fabric. The cotton cellulose normally decomposes below 300 °C and under dehydration, depolymerization and oxidation, release of CO, $CO_2$ and carbonaceous residual char result. Tar and leaveglucosan are formed at around 300 °C. Polyester normally melts and flows under the influence of the temperature at above 260 °C. In case of polyester, the thermal decomposition is initiated by scission of an alkyl-oxygen bond and the material decomposes via the formation of cyclic or open chain oligomers with olefinic or carboxylic end group at above 510 °C. The thermal degradation is a combination of both physical and chemical process that involves decomposition and oxidation and depends upon the activation energy (E).

**Table 3: Thermal degradation behaviors of cotton and polyester fabric**

| Temp [oC] | % Reduction in wt. | | | |
|---|---|---|---|---|
| | Cotton | | Polyester | |
| | Untreated | Treated | Untreated | Treated |
| 25 | 0 | 0 | 0 | 0 |
| 50 | 1.75115 | 1.43095 | 0.226 | 0 |
| 75 | 2.30415 | 2.03095 | 0.225 | 0 |
| 100 | 1.19816 | 0.8704 | 0 | 0.112 |
| 125 | 0.46083 | 0.38685 | 0.225 | 0.111 |
| 150 | 0.27649 | 0.19342 | 0 | 0.112 |
| 175 | 0.09217 | 0.19343 | 0.233 | 0.111 |
| 200 | 0.09217 | 0.19342 | 0.008 | 0.111 |
| 225 | 0.18433 | 0.38685 | 0 | 0.112 |
| 250 | 0.36866 | 0.96711 | 0.226 | 0.111 |
| 275 | 1.19816 | 2.70794 | 0.225 | 0.111 |
| 300 | 3.5023 | 7.25338 | 0 | 0.112 |
| 325 | 56.84996 | 6.93277 | 0.45 | 0.111 |
| 350 | 6.19152 | 45.48503 | 0.676 | 0.446 |
| 375 | 2.39631 | 2.80464 | 2.027 | 1.893 |
| 400 | 2.48848 | 3.96518 | 5.856 | 9.02 |
| 425 | 9.67742 | 5.60929 | 20.495 | 23.162 |
| 450 | 0.46083 | 5.8027 | 40.09 | 38.196 |
| 475 | 2.85714 | 4.448746 | 16.667 | 9.02 |
| 500 | 4.239632 | 2.901354 | 1.126 | 1.114 |

The plots of thermal degradation of control and treated cotton and polyester fabrics are given in Figure 2. The % reduction in weight is observed during the thermal decomposition and the measured values from TGA curve are given in Table 3. The TGA curve in Figure 2 shows thermal degradation of control and treated cotton fabric. The TGA curve is analyzed in three steps to study the mass loss. In initial step, the mass loss of control sample is of 6 % and that of treated sample is 5.6 % observed at the temperature range of 25-150 °C. In second step, the mass loss of control and treated samples are 6 % and 11.7 % respectively, which is observed at the temperature range of 150-300 °C, and in final step, it was 84.6 % and 77.9 % of control and treated fabrics respectively observed at the temperature range of 300-500 °C. From the Table 3 the control sample loses 57 % of mass at the temperature range between 300-325 °C, which may be due to the de-hydration of cotton and oxidation thermal decomposition to CO, $CO_2$ and formation of carbonaceous char. The treated fabric gives maximum thermal decomposition at the temperature range of 325-350 °C. The results indicate that the thermal decomposition rate is higher in control sample as compare to treated fabric.

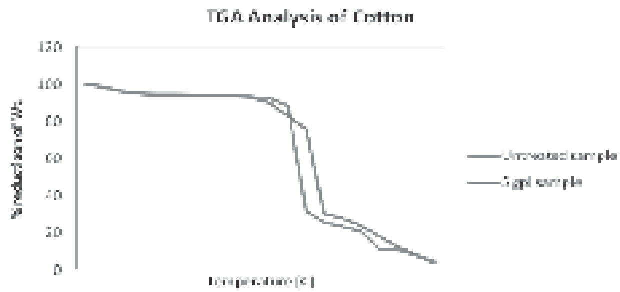



**Figure 2: Effect of temperature on weight reduction of cotton fabric**

In case of polyester the TGA curve in Figure 3 shows the thermal degradation of control and treated fabrics. In initial step the mass loss of control and treated fabrics are 0.6 % and 0.34 %, respectively. In second step it is 0.76 % and 0.67 % of control and treated fabrics respectively. In third step, the mass loss is 87.38 % and 82.95 % of control and treated fabrics respectively. The maximum thermal degradation of polyester treated and untreated fabrics observed at 425-450 °C temperature range. The results indicate that the thermal degradation rate is lower in treated sample as compare to control fabric.

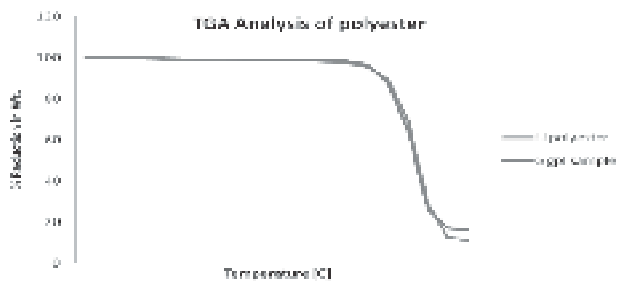



**Figure 3: Effect of temperature on weight reduction of polyester fabric**

## Conclusions

The in house synthesized nanosilica powder can be applied on cotton and polyester fabrics by pad-dry-cure technique. EDS results further confirm the existence of silica nano particles in their oxide form. The SEM image of treated cotton and polyester with silica indicates that the silica particles are uniformly distributed on individual fibre of fabric. The mass loss profile or thermal degradation rate with respect to temperature is lower in treated fabric compared to untreated fabric.

At last Nanotechnology holds an enormous, promising future for textile. The new concept exploited for the development of nano-finishes have opened up exciting opportunities for further research and development in this area.

## Acknowledgement

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# Weibull statistical analysis for the determination of relative reliability of cut pile carpet tuft bind strength - Methodology and case study

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**Abstract**

Weibull statistics were summarized and a step by step methodology on how to perform the calculations, as applied to tuft bind strength in cut pile carpets, was introduced. The analysis was investigated with a case study looking to find the Weibull modulus. This modulus is indicative of reliability of a material and can be used as a relative measurement. In this case, a latex poor and latex rich latex adhesive were investigated, knowing the latex rich adhesive should yield a higher Weibull modulus. Results showed the value was relatively higher, indicating Weibull statistics are a useful resource in looking at the relative reliability of cut pile carpets.

**Key Words:** Weibull analysis, Tuft bind, Cut pile carpet, Reliability testing

## Introduction

Weibull statistics and the Weibull distribution have been widely used for reliability measurements in engineering due to its seemingly accurate predictability of failure. Although this distribution has traditionally been used to represent single material specimens, i.e., steel, ceramics, nylon. In this paper, a new concept is explored. That is, the reliability of an adhesive latex to nylon carpet.

## Carpet essentials

In carpet manufacturing, there are two basic types of pile. A "cut pile" carpet is one in which the yarn has a free head. A "loop pile" carpet has no free head. Figure one depicts the difference between the two.

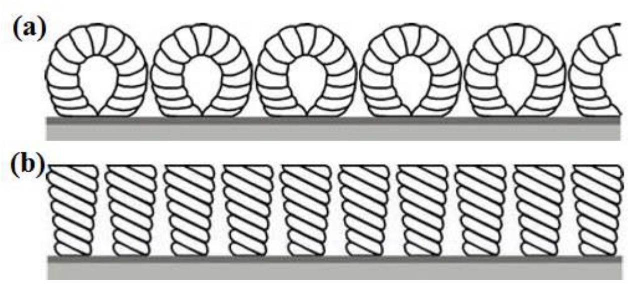


Figure 1: (a) loop carpet (b) cut pile

Typically, the pile is tufted into a polymer primary backing, a latex solutions is applied to the back of the primary backing which contains the stitching of the yarn, and then it is rolled onto a polymer secondary backing and dried.

The term “tuft bind strength” refers to the force required to pull one of the yarn pieces out of the carpet. The major cause for weak tuft bind strengths are poor quality latex, too little latex, or poor latex adhesion.

## Basic Weibull theory and Weibull modulus

Weibull analysis is a result of a probability theory that aims to find the probability of failure of the weakest link in a material [1]. In terms of specimen loading, this statistical distribution can be expressed mathematically as follows.

$$\ln\left(\frac{1}{P}\right) = \int \left[\frac{\sigma(x,y,z)}{\sigma_0}\right]^m \frac{dV}{V_0} \quad (1a)$$

Where P is defined as the probability of failure,

$$P = \frac{n}{N+1} \quad (1b)$$

And n is the number in which the term appears in the sequence of data when categorized from smallest to largest failure stress, σ. Which is defined as,

$$\sigma = \frac{F}{A_c} \quad (1c)$$

F is the tuft bind strength, in units of force. AC is the fiber cross sectional area. N is the total number of samples tested, V is the volume of the sample, and m is known as the Weibull modulus.

Tuft bind strength is taken at uniaxial loading. Considering this and simplifying equation 1a,

$$\ln\left(\frac{1}{P}\right) = \left[\frac{\sigma}{\sigma_0}\right]^m \frac{V}{V_0} \quad (2)$$

Taking the natural log and assuming no bending occurs in the specimen, the equation becomes,

$$\ln\left(\ln\left(\frac{1}{P}\right)\right) = m\ln(\sigma) + \ln(V) \quad (3)$$

Thus a plot of parameter A: $\ln(\ln(\frac{1}{P}))$ on the y-axis and parameter B: ln (σ) on the x-axis should yield a straight line with a slope of the Weibull modulus, m.

## Method to perform mathematical operations

Performing the calculation can be done in by hand or using desirable software, but a spreadsheet is the most convenient tool. After the tuft bind measurements are taken, the data should be lined up in order of increasing force. Typically, the carpet piles are of similar cross sectional area, so the stress can then be calculated or the force can simply replace the stress when graphing. The lowest value is assigned the number 1 and the largest value is assigned the value N. P is then calculated, followed by parameter A and B. The plot of A vs. B should be a straight line with a positive slope, m.

It is important to note, the Weibull modulus in this case serves as a relative value. Although quantitative, there are no standards for what “good” or “bad” Weibull modulus are. However, a high Weibull modulus means the specimen performs more reliably than a specimen with lower Weibull modulus. For example, epoxies and adhesives typically have a Weibull modulus on the order of 2.0-4.5 [2].

The number of tests performed should be significant. A minimum of twenty samples should be adequate, but more samples will only benefit the analysis [3].

## Case study

In order to determine if this approach is of value to analyzing tuft bind strength of cut pile carpets, the analysis was performed on using two different latex adhesives.

## Materials and Methods

Cut pile carpets were manufactured by Shaw Industries Plant WG in Santa Fe Springs, CA, USA. The base case samples contained a latex adhesive which was currently being used at the time, denoted in the paper as “latex poor”. The second set of samples had a latex rich adhesive, denoted “latex rich”. In was known that the latex poor samples would perform worse than the latex rich samples based. Samples were randomly cut from the center of carpet rolls from several shop orders and tested for tuft bind strength according to the American Society for Testing and Materials (ASTM) test number D1335: Standard Test Method for Tuft bind of pile yarn floor coverings [4].

## Results and Discussions

Cut pile carpets were chosen for this analysis because they frequently have tuft bind strength issues. So, increase the tuft bind strength, and reliability, will have ultimately positive impacts on quality. To ensure statistically relevant results 30 latex poor samples and 40 latex rich samples were tested.

Considering it is know that the latex poor sample will be less reliable than the latex rich sample, the Weibull modulus, slope of the graph, is expected to be smaller for the latex poor samples. This is exactly the trend seen. Figure 2 shows the Weibull plot of the latex poor samples. Although a couple apparent outliers, the trend is moderately fitted by a straight line with an R2 value of 0.8371.

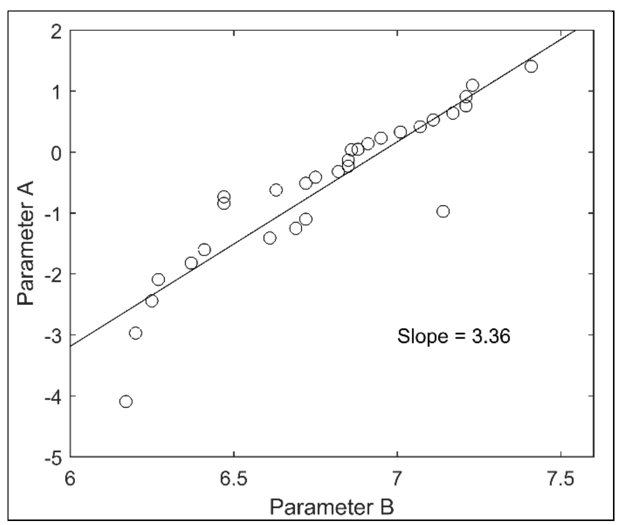


**Figure 2: Weibull plot of latex poor samples**

The latex rich samples shown in Figure 3 are better fitted by a straight line with an R2 value of 0.9061. The main parameter, however is the Weibull modulus. A difference of about 2 between the latex poor and rich samples is significant.

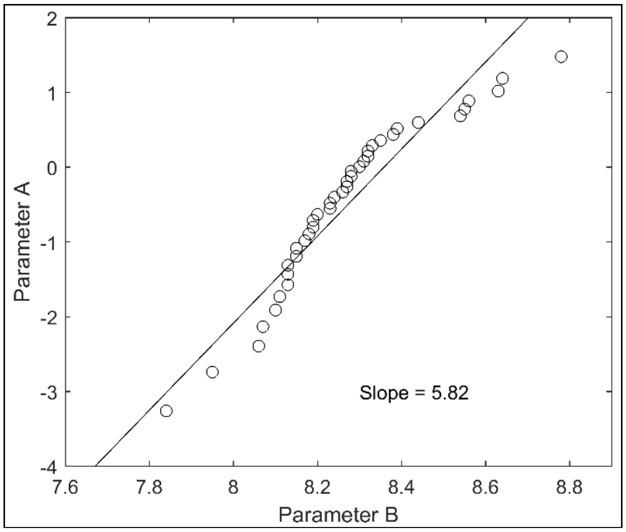


**Figure 3: Weibull plot of latex rich samples**

These results were expected. The Weibull modulus quantified the reliability of the latex fiber matrix to the polymer backing. Relatively speaking, the latex rich samples performed better than the latex poor samples.

## Conclusion

In this paper, an introduction of Weibull analysis was given along with a methodology on how to perform the computations. Although the Weibull modulus meaning has been debated [5, 6], a case study was used to exemplify that the analysis can be applied to tuft bind strength reliability. Although the case presented here was trivial and the outcome expected, the analysis can be applied to other process changes. The changes presented here were a latex rich latex versus a latex poor latex. However, other process variables may also change the reliability of the tuft. For example, the degree of heating, line speed through the latex application, or even the type of backing used can all be quantified and compared for reliability. This tool enables the measurement of process outcomes without requiring a simple relationship between changed variable and measured variable.

## Acknowledgement

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# Textile News Kaleidoscope

## Indian Textiles Minister launches 'India Size' project

Indian Textiles Minister has launched the 'India Size' project that aims to arrive at a standard Indian size for the ready-to-wear apparel industry, similar to the standards available in many Western countries. The project is being undertaken by her ministry in collaboration with the Clothing Manufacturers Association of India (CMAI).

CMAI represents 45,000 apparel manufacturers and retailers in India. The first-ever anthropometric study in the country covering 25,000 respondents will lead to a size chart that will primarily benefit consumers, she stated.

The minister also launched a study of apparel consumption in India, to be undertaken by CMAI over three to six months, to arrive at an accurate assessment of the total apparel consumption in the country. That will help in more accurate business projections, better marketing strategies and investment into the industry, an official press release stated.

The study aims will try to come up with region-wise and product category-wise consumption patterns in the country, a reliable database, which could then become the foundation to study growth patterns in nest year. The report would be ready for release by July 2019. The minister also presented the 'Transforming India through Retail Awards' to 18 retailers.

## Ind-Ra has maintained a stable outlook for the country's textile sector for 2019-20.

India Ratings and Research (Ind-Ra) has maintained a stable outlook for the country's textile sector for 2019-20. Strong domestic demand, along with the waning impact of the disruptions due to the goods and services tax (GST) and demonetisation and the rising export of textiles aided by a weak Indian rupee, is likely to lead to volume growth and make firms profitable.

Ind-Ra expects textile industry players to register improved cash flow from operations for fiscal 2019-20, as their working capital would stabilise as challenges related to demonetisation and GST subside, according to a press release from the agency. The liquidity of the majority of players in the sector is likely to remain adequate, along with a considerable improvement in operational cash generation, backed by steady raw material costs and strong demand from end user segments. Ind-Ra expects the domestic and global stock-to-use ratios to remain under pressure during cotton year 2018-19. The agency expects global cotton production to decline in cotton year 2018-19 owing to a low acreage and adverse weather conditions in key cotton-growing nations. Domestic cotton price moderated to an average rate of Rs.128/kg during the third quarter of 2018-19 from the average level of Rs.134/kg during the second quarter. While expectations of a high acreage during cotton year 2019-20 narrowing global production gap could keep cotton prices range-bound, an upward risk to cotton prices prevail, Ind-Ra stated.

China's cotton production continues to be significantly lower than its consumption. Its cotton deficit was increasingly met through imports, apart from a drawdown of its reserves, over the last three years. With its cotton reserves dwindling, the sensitivity of international cotton prices to China's cotton policies have increased in the past few quarters. China increased the cotton import quota by 0.8 million tonnes, amid concerns of declining inventory levels after the imposition of a 25.0 per cent import duty on US cotton. Any decision by China to further increase imports could lead to a rise in global cotton prices, the agency stated.

Domestic textile exporters are likely to continue to benefit from improved cost competitiveness due to a weak Indian rupee, which would drive volume growth. India's apparel exports showed signs of recovery in the third quarter of 2018-19 and are likely to rise in the next fiscal after remaining weak for three years. However, the continuance of export incentives remains critical as they meaningfully contribute to the operating profits of textile exporters, particularly those in the downstream segment of apparels and home textiles, Ind-Ra added.

## CAI reduces 2018-19 cotton estimate to 330 lakh bales

Cotton Association of India (CAI) has

further reduced its cotton crop estimate to 330 lakh bales of 170 kg each for the 2018-19 cotton season that began on October 1, 2018. The latest crop estimate is lower by 5 lakh bales than last month's estimate of 335 lakh bales. Crop estimate has been lowered for Telangana, Karnataka and Andhra Pradesh. "The main reason for lower crop is that in the Southern Zone farmers have uprooted their cotton plants due to moisture deficiency as a result of which there is no scope for 3rd and 4th pickings," CAI president stated in a press release.

In its January 2019 estimate, CAI has reduced the crop estimate for Telangana by 2.50 lakh bales, Andhra Pradesh by 50,000 bales and Karnataka by 2 lakh bales. The total cotton supply projected by the CAI during the months of October 2018 to January 2019 is 198.80 lakh bales, which consists of the arrival of 170.32 lakh bales up to January 31, 2019, imports of 5.48 lakh bales up to January 31, 2019 and the opening stock at the beginning of the season estimated at 23 lakh bales. Further, the CAI has estimated cotton consumption during the months of October 2018 to January 2019 at 105.34 lakh bales, while the export shipment of cotton up to January 31, 2019 has been estimated at 24 lakh bales.

Stock at the end of January 2019 is estimated by the CAI at 69.46 lakh bales including 39 lakh bales with textile mills and the remaining 30.46 lakh bales with CCI and others (MNCs, traders, ginners, etc). The CAI has also projected yearly Balance Sheet for the cotton season 2018-19 wherein total cotton supply till end of the cotton season i.e. up to September 30, 2019 has been estimated at 380 lakh bales of 170 kg each consisting of the opening stock of 23 lakh bales at the beginning of the season, cotton crop for the season estimated at 330 lakh bales and imports estimated by the CAI at 27 lakh bales, which are higher by 12 lakh bales compared to the previous year's import estimated at 15 lakh bales. The CAI has estimated domestic consumption of 316 lakh bales, which is lower by 4 lakh bales compared to the consumption figure estimated during the last month. The estimated exports for the season 2018-19 are 50 lakh bales, which are lower by 19 lakh bales compared to the export of 69 lakh bales estimated during the last year. The carry-over stock at the end of the 2018-19 season is estimated by the CAI at 14 lakh bales.

## Arvind fashion's True Blue to promote Indian handlooms

In line with its vision to transform the way the world sees India, True Blue, a joint venture between Arvind Fashions Limited and Sachin Tendulkar, has signed a memorandum of understanding (MoU) with the Ministry of Textiles. The association is aimed at creating a new platform for Indian Handlooms by giving them a modern contemporary expression. In accordance to the MoU, True Blue will source handloom products directly from local artisans and weavers, with support from the government. The collection crafted using these products will be retailed as True Blue Handcrafted. These will be specialised products which cannot be replicated by the power looms. The True Blue Handcrafted merchandise will be available across all True Blue stores starting March 2019.

True Blue Handcrafted collection will be developed by True Blue designers working closely with artisans practicing traditional Indian crafts across the country. This will bring contemporary renditions of traditional Indian crafts into a modern line of garments that the youth of today will desire. True Blue Handcrafted will be available widely through the brand's extensive distribution network and will open new markets and avenues for Indian craftsmen by imparting a new aspirational value to traditional Indian craft. The effort is expected to protect and revive several Indian crafts from across the country, including those from far flung areas, give them a modern contemporary meaning and make them relevant for the current and future generations. At the same time, the artisan will benefit economically by elimination of middlemen.

"Authentic handloom products have a special place in the heart of many Indian and global consumers who wear it with pride. Our partnership with True Blue will allow weavers across India to satiate this demand and make their creations available to the masses. We are happy to share that True Blue will help the weaver's community earn the much-deserved recognition and economic value for their offerings through a direct procurement channel. The ministry of textiles will do its due diligence with the weavers in quality management of the fabrics and adherence to SOPs," Union Minister for Textiles stated.

Arvind Fashions will identify and empanel quality artisans, liaise with them for samples and production, perform quality checks and manage post-production availability of the retailmerchandise at outlets. In parallel, the ministry will ascertain protocols, standards and processes to be adhered by the weavers to ensure timely delivery. "There are over 43 lakh handloom weavers in India and more than 23 lakh handlooms. The Ministry of Textiles is taking efforts for skilling weavers, providing design inputs, best in class raw materials and tools amongst other things. This empowers them so they continue to remain engaged in this craft. We at Arvind believe that our retail strength and understanding of consumer behavior can make a difference in bringing wide recognition and value to these gifted artisans and craftsmen. True Blue will continue to take all forms of Indian-ness to the world," Executive director, Arvind Limited stated.

The collaboration will enable True Blue to partner with the adept weaver clusters of Kanchivaram from Tamil Nadu, Baluchari and Jamdani from West Bengal, Paithani from Maharashtra, Chanderi and Maheswari from Madhya Pradesh, Muga from Assam, Patola from Gujarat, Kani from Kashmir, Tie & Dye Vichitrapuri and Bomkai from Orissa, Brocades from Varanasi, Balrampuram from Kerala, Pochampally from Andhra Pradesh, etc.

## Cotton and tariffs

Continued trade tension between the United States and China is impacting the global cotton and textile sectors. "Back and forth on tariff discussions is problematic and it results in the slowdown of global cotton demand," stated President and CEO of Memphis-based National Cotton Council, USA, in a Lubbock-based plains cotton growers' meeting. He also highlighted the impact of trade tensions between the world's largest cotton user, China and the largest cotton exporter, the United States of America. China's 25 % tariff on U.S. cotton affects the whole supply chain. China was expected to import about 3 million bales this marketing season, from the United States. The continued trade tensions have affected the cotton trade. Because of this situation, China may import less than one million bales from the United States. Tariffs affect the general economy and it certainly impacts cotton and textile consumption stated cotton Economist at Texas A & M University. Cotton's demand slows down during recessions and in uncertain trade scenarios, unlike food grains.

In the light of the current trade tensions between China and the United States, Executive Vice President of Plains Cotton Growers, Inc., stated, "Trade tensions certainly are casting some uncertainty as to the exact planting mix for farmers on the High Plains of Texas. There continues to be great interest in cotton production and some increase of plantings in our northern panhandle area, especially given the very successful growing season of 2018. Currently we expect some increase in cotton plantings for 2019, but relative prices for crops at planting time will ultimately dictate how much that increase might be." Certainly, cotton growers are hoping that a forthcoming visit by the Chinese delegation to the United States may find a favorable solution to the ongoing trade tensions between the two countries. There are no winners with retaliatory tariffs as they affect consumers' interest in textile goods.

## Cotton research on a high gear

Dryland cotton will be the future in the high plains of Texas-the largest cotton growing patch in the United States of America. Ginning byproducts, cotton seed developments, clean cotton initiatives, developing functional cotton and quality aspects were deliberated in the meeting organized in Lubbock by the Memphis-based The Cotton Board, attended by cotton farmers and researchers to discuss about the present and the future of cotton research and development. Opening the meeting, Southern Plains Regional Communication Manager of The Cotton Board traced the history of the cotton research and promotion program that started in 1966 which is continuously supported by the cotton growers. Stating that the research and promotion budget managed by Cotton Incorporated for this year is US$ 82 million, and that the research program has been a role model for other commodity industries. With competition from other fibers and the need to increase the market share of cotton, particularly in burgeoning economies, researchers working of innovative projects met with area cotton producers to seek their input. The strength of the United States' cotton sector has been the active involvement of producers in taking the industry to the next level in research and policy matters.

It was clear that the cotton sector was interested in promoting cotton seed as a nutritious meal. As its share in the seed crushers is nearly saturated, efforts are underway to take it beyond cattle feed and dairy industry. Recently, the United States' Department of Agriculture has deregulated gossypol free cotton seed, which opens-up new opportunities for the seed. "We are waiting on the FDA approval of the gossypol free seed, which will lead to commercial use for feeding aquaculture, poultry, swine and even humans," stated Vice President of Agriculture and Environmental Research at Cary-based Cotton Incorporated.

Manager Product Development at Cotton Incorporated showcased several new fabrics that utilize new technologies such as dyeing cotton using sulfur dyes from cotton byproducts. A project funded by Cotton Incorporated in the Nonwovens and Advanced Materials Laboratory at Texas Tech University is focused on finding industrial applications for low micronaire cotton such as toxic and crude oil absorbent mats.

## Egypt's garment exports cross $1.5 bn-mark in 2018

Garment exports from Egypt earned $1.598 billion last year, registering an increase of 9.5 per cent over $1.459 billion fetched in the previous year, according to the data released by the Readymade Garments Export Council (RMGEC), an organization set up jointly by the Ministry of trade and industry and the country's prominent readymade garments exporters. Nearly 50 per cent or $797 million of the Egyptian apparel exports were destined to the US, according to the data. Spain and Turkey were the next important destinations with exports worth $143 million and $134 million respectively. The UK accounted for $108 million of Egyptian clothing during the year, while Germany, Italy and France imported garments valued at $93 million, $74 million and $53 million respectively.

## Jordan's garment exports to rise despite domestic dive

Jordan's garment exports are rising and will continue to grow despite declining domestic sales last year, according to a recent study by the European Bank for Reconstruction and Development (EBRD). Domestic garment sales declined sharply by nearly 60 per cent in 2018, according to President of the Textile and Readymade Clothes Syndicate. The garment export sector in Jordan is a $1.8-billion industry and is expected to grow by at least 8 per cent this year, a top Jordanian newspaper reported. The United States is Jordan's top export market.

Eight five per cent of the $1.2 billion worth of commodities exported to the United States annually are garments, Secretary general of the Jordan Investment Committee stated.

The country's garment exports to the European Union too are expected to increase due to a 2016 agreement on simplified rules of origin, Hartoka said, adding it will create more jobs and boost the sector's revenues. The agreement is valid till 2026.

Challenges for the sector include absence of trained and qualified local labour, high borrowing costs and the lack of experience among leaders of the sector's small and medium enterprises (SME) sub-segment. The percentage of foreign labour in the sector is the most pressing issue and needs urgent attention, stated Principal Manager for EBRD's SME finance and development group in Jordan. Seventy five per cent of workers in the sector are foreign nationals.

Degree-holding Jordanians avoiding working in garment factories is also another challenge.

## SGS helping textile companies reduce harmful chemicals

SGS a multinational company headquartered in Geneva, Switzerland which provides inspection, verification, testing and certification services is helping textile manufacturers reduce their reliance on hazardous chemicals through services like hazardous substances control workshops which empower companies with the right knowledge to achieve compliance with regulations, maintaining competitive advantage and better reputations. SGS also helps stakeholders gain technical expertise in production. Textile production uses around 9.3 million metric tons of chemicals a year and the harmful effects of this are now being fully recognized. In addition, the sector is now being recognised as the "second biggest polluter in the world", a quote attributed to high-end clothing retailer Eileen Fisher. Pollution from the clothing industry is now so bad in some places, for example the Citarum River in Indonesia and the city of Xintang in China, that the natural environment is no longer safe for humans. In both cases, rivers have become too polluted to swim in or drink.

The French Agency for Food, Environmental and Occupational Health and Safety (ANSES) has recently published "Footwear and textile clothing: consumers need better protection from the risks of skin allergies and irritation". It notes that most irritations are caused by chemicals. The ANSES report included recommendations for how authorities can improve the industry. This included, among other suggestions, the recommendation that retailers should only stock clothing or footwear that their suppliers can prove do not include carcinogenic, mutagenic, reprotoxic (CMR) substances, and/or skin sensitising and irritating substances. This will require a better knowledge of chemical usage in the whole supply chain.

Part of the problem stems from rapid growth in the sector over the last few decades. It has led to long supply chains, meaning retailers aren't always sure of the full extent of the number of economic operators in them. At the same time, stakeholders are often too willing to rely on the advice of chemical suppliers, rather than gaining the necessary technical understanding to control the flow of chemicals themselves. The impact of remaining ignorant unaware of the full extent of chemical usage may be great. Consumers are already looking for products that are sustainably sourced and better for the environment. Knowledge of the chemical flow in the supply chain has therefore become very important; it is the key to the effective control of hazardous substances.

This knowledge also has several benefits for businesses such as reduced risk of non-compliance with market regulations, improved reputations from reduced pollution and better living conditions for workers, and better protection of consumers from skin allergies and irritations.

To better understand production and improve systems, SGS is advising stakeholders to gain technical expertise in the areas such as production, chemical knowledge, and water management.

This understanding will create better, more efficient productions systems while reducing waste. In addition, stakeholders can also reduce the use of hazardous chemicals and restricted substances by directly managing chemical sourcing. This will ensure that only chemicals that do not contain restricted substances are used, chemicals are used properly avoiding waste due to improper formulations, correct storage of chemicals, and that chemicals are discarded properly.

Deeper understanding of the processes involved in production will also reduce the water usage. For example, a simple tee shirt will use over thousand liters of water in its manufacture. Reducing this amount will also be good for the environment. With the damaging effects of chemical usage in the clothing industry become apparent, customers, authorities and retailers are looking to manufacturers to improve and reduce their use of chemicals. The key to better chemical usage is knowledge of the processes and chemicals involved in the production of footwear and textiles. This will result in lower levels of waste, improved efficiencies, more cost-effective methods of production, and better profit margins.

## Source:

- www.fibre2fashion.com
- www.yarnsandfibers.com
- Texas Tech University, Lubbock, TX, USA

# Technical Textile News

## Karl Mayer launches COP 5 M-EL tricot machine

Karl Mayer has launched the new five-bar COP 5 M-EL tricot machine for the production of new shoe fabric patterns and more. The former COP 5 version has been combined with Karl Mayer's EL pattern drive in this model to create a tricot machine capable of producing an extensive range of patterns. The company is a textile machinery producer based in Germany.

A coarse machine gauge was developed at Karl Mayer to produce a multifaceted collection for this particular end-use. The articles in this collection are used in tough, hardwearing sports, and leisure shoes that feature stylish, graphic patterns with a contrasting, two-tone coloured effect. Polyester was used to produce all the types: a textured, spin-dyed black yarn was used in ground guide bars, GB 1, GB 2 and GB 3, and a smooth, semi-matt, raw-white version was used in GB 4 and GB 5. The pattern is based on a 1 in/1 out threading arrangement in GB 4 and GB 5. Openings of different sizes can be produced in the ground by varying the lapping. The wide variety of motifs is produced on the ground pattern during production and protrudes clearly from the ground as a result of the spin-dyed yarn. A fully threaded pillar stitch in GB 1 increases the stability of the fabric. At the same time, the underlaps of the other guide bars are protected in order to improve the abrasion resistance. The patterned fabrics weigh approximately 300 g/m². They are produced in a gauge of E 20 and can be worked at an exceptionally high operating speed. The COP 5 M-EL has a maximum speed of 1.200 min -1.

Along with shoes, the COP 5 M-EL in a gauge of E 28 can produce sports goods, apparel fabrics and other semi-technical textiles, such as upholstery fabrics, automotive textiles, and coating substrates. The electronic guide bar control, in combination with the five guide bars, gives this all-round machine maximum flexibility.

## Invista to launch EcoMade technology products

Invista is one of the largest integrated producers of chemical intermediates, polymers, and fibres. Invista has announced that new products featuring the company's EcoMade Technology viz. Coolmax EcoMade fibre and Thermolite EcoMade fibre and insulation made from certified amounts of recycled resources such as plastic bottles offers the active/outdoor apparel industry a more sustainable alternative to virgin fibres. EcoMade technology is a key part of the company's all-encompassing sustainability vision, in which product sustainability is a critical component.

EcoMade technology gives new life to recycled resources by transforming them into fibres through a controlled process. This means less waste is going into landfills, which appeals to millennials and environmentally-conscious consumers. EcoMade technology is available for Lycra T400 and Lycra Dual Comfort Technologies, as well as for Coolmax and Thermolite brand names, which enables Invista customers to capitalise on each brand's global awareness and reputation for high quality and performance to help drive sales downstream. New! Thermolite T-Down EcoMade insulation is a sustainable alternative to down feathers at a lower cost that is GRS certified, made with recycled fibres, and offers key benefits over feather insulation. With its 500+ fill power, this insulation delivers lightweight warmth to cold weather outerwear, sleeping bags, and accessories. New! Lycra Dual Comfort technology, that utilises Lycra T400 EcoMade fibre to create fabrics combining outstanding stretch and cooling characteristics, and ideally suited for performance tops, will also be a part of the show. Coolmax EcoMade technology that keeps the wearer cool, dry and comfortable by moving moisture away from the skin to the surface of the fabric where it evaporates. Thermolite EcoMade technology delivers lightweight warmth to keep the wearer comfortable longer.

## Karl Mayer launches Textile-circuit for making e-textiles

Germany's Karl Mayer, has launched a new project named 'Textile-circuit' that works on established warp knitting technology to produce highly innovative e-textiles. Textiles can be used for heating, cooling, and lighting. They can measure the heart rate, and can be launched into space for use as space reflectors, as long as they are electrically conductive.

The electrical conductivity of warp-knitted textiles is the subject of extensive development work at Karl Mayer. In this project, multibar raschel machines are used with and without a jacquard facility to incorporate conductive yarns directly into the textile during manufacture. The first results are now available and show what can be achieved, including the use of textiles for remote control, according to Karl Mayer. Electrically conductive structures with a virtually unlimited range of designs can be produced on multibar raschel machines. This is possible, thanks to multibar patterning using Karl Mayer's innovative string bar system, with which the yarns can be positioned individually and as required onto a ground – following the principles of tailored fibre placement. The ground can be produced with a wide variety of different designs, and jacquard patterns can also be worked, depending on the type of machine. Along with extensive design freedom, warp knitting also delivers maximum efficiency when producing electrically conductive textiles. Furthermore, the typical performance features of textiles, such as softness, flexibility, elasticity and breathability, are fully retained. At the functional heart of these innovative e-warp-knitted textiles are filaments containing metal, such as Elitex. According to textile product developer at Karl Mayer, silver-plated polyamide can be processed very easily on multibar raschel machines. Aim in the next few stages is to optimise the sequences on the machine to suit mass production.

## HeiQ launches new additions to fresh product family

HeiQ, a leader in high performance textile technologies, has upgraded its family of odour control technologies with new products and the new name of HeiQ Fresh. The products offer both silver-free and less-silver odour control options. HeiQ offers the new odour control solutions for those brands looking to reduce or remove silver usage from their products.

All products in the HeiQ Fresh family are bluesign approved or in the approval process, according to a media statement by HeiQ. HeiQ Fresh FFL is a bio-based amino sugar polymer that is silver-free and not an antimicrobial. There are five precursors that need to form on textiles to cause sweat odour bacteria, warmth, fat, and protein from sweat, moisture, and the textile surface. By removing one of these items, the sweat odour is eliminated. HeiQ Fresh FFL removes the fat and protein from sweat, thereby eliminating the ability of the bacteria to grow. This amino sugar polymer also binds to the fibre, which allows odour to be easily washed off at low temperature and prevents permastink. With HeiQ Fresh FFL, brands get a silver-free odour control that is not a biocide but still preserves the fabrics freshness.

HeiQ Pure SPQR is a 90 per cent bio-based option for odour control that works with a minimal amount of recycled silver. Similar to HeiQ Fresh FFL, HeiQ Pure SPQR removes two of the five precursors needed to cause sweat odour – fat and protein from sweat as well as bacteria. HeiQ Pure SPQR still passes the traditional antimicrobial tests. With HeiQ Pure SPQR, brands get more freshness with less silver. “Humans are among the most social of animals and wish to be close to each other. Body odour on our clothes or home fabrics prevents us from close gathering. We are excited to offer less-silver and silver-free options to our HeiQ Fresh family. These options are more sustainable and work just as well to control odour as the traditional silver salt options currently on the market,” Chief sales officer at HeiQ stated. HeiQ also offers various odour control test methods for each of its HeiQ Fresh products, from proof of concept tests to proof of application tests.

## Teijin launches new ‘sensing wear’ range

Teijin Frontier, the Teijin Group's fibres and products converting company, has launched a new line of sportswear and other clothing incorporating “wearable solutions”. Teijin Frontier has developed new products integrating highly functional fibres and sensing techniques. Test sales will start with two types of new product, which will leverage continuing advances in IoT technology to provide new solutions to evolving social needs. The anti-slip Nanofront ultrafine fibre wear deploys an algorithm which visualises the difference between the actual motion of the wearer and their ideal motion at a particular time. It is expected this technology will be applied in various scenarios, including the improvement of sports techniques, the transfer of technology know-how and more effective support for those undergoing physical rehabilitation. This clothing facilitates sustainable and highly accurate sensing of the heart's electrical activity, heart rates and activity levels, minimizing the noise generated by contact of the body with sportswear during exercise. It combines the ultrafine fibre Nanofront with vital-sign sensing technology, and by simultaneously sensing heart rates and activity levels it can be used in various scenarios including sports team management and the prediction of heatstroke risk. Nanofront's high level of grip prevents vibration and displacement of sensors, allowing highly accurate measurement. In the future, Teijin Frontier plans to deploy comfortable and functional materials such as the outdoor sports textile Deltapeak and the stretchable and soft textile Solotex.

## Innovative technology for ultimate support

Sensitive Fabrics by Eurojersey with innovative Lycra Sport PCE certification usher in the new sports bra era. Unprecedented support and comfort combined with a certain appearance and quality are the key assets of a revolution which has taken sportswear by storm, from active wear to lifestyle trends, everything from training apparel to garments designed for the most extreme sports.

Ever the unquestioned protagonists of sports apparel, Sensitive Fabrics satisfy multiple requirements in terms of fit, protection and climate comfort. Performance fabrics which have now become even more sophisticated. Lightweight and breathable, Sensitive Fabrics certified Lycra Sport PCE enable the creation of bras which sculpt the body, create ergonomic shapes and offer an optimal mix of comfort and support, the essential plus factors ensuring full motion control in any type of sports training.

The Lycra Sport PCE Index Technology platform combines the elasticity of Lycra fibre with three key indexes: Power(P), Comfort (C) and Energy (E) in other words PCE, used for the performance evaluation tests of each individual fabric. This is an avant-garde, simple yet extremely efficacious method to accurately define fabric performance for each index on a scale of 1 to 10.

## Rock West composites expands filament winding capability

Rock West Composites (RWC) has expanded its filament winding operation with the acquisition of new winders, the addition of a long-length oven, and expansion into a third manufacturing bay in its building. The new equipment allows for the production of extra-long part lengths and large diameter tubes, plus additional manufacturing capacity. RWC's third manufacturing facility has added 20,000 square feet of space for staff and the new equipment, according to a media release by RWC. The company recently deployed the Titan-1-4-8M-Flex filament winder, which is complemented by 60 new mandrels. This machine adds the capability to wind tubes up to 30 inch in diameter, as well as lengths of over 22 feet, and is setup for tow-preg winding, further diversifying the company's manufacturing methodology. Also, RWC has scheduled the installation of a new six-spindle winder, similar to the one currently operating at the facility, expanding the company's high-volume manufacturing capacity. An oven with the volume to accommodate the new large format tubing is now onsite—as is a high-power, long-stroke, mandrel extractor—and set to be production ready shortly. In tandem, RWC has recently expanded its stock products to include a wider selection of large diameter filament wound tubing. Offerings include 52 diameter and material combinations, providing more cost effective, off-the-shelf options for many customers.

## Brands Partner with noble biomaterials for smart fabrics

As the consumer trend of demanding premium-quality apparel for multi-use is on the rise, more brands are partnering with Noble Biomaterials, a global leader in odour elimination and smart fabric solutions, to develop products with Noble's platform of inherent fibre technologies allowing them to stay current in the ever-evolving apparel industry. Hill City by GAP, Inc, a new men's active-apparel line of versatile, high-performance pieces, uses Noble's XT2 anti-odour technology. The technology helps people wear the same shirt for a workout and then go meet up with friends without offending anyone in the room. Lunya, a modern-luxury sleepwear brand, has adopted XT2 into its collection to help women sleep better at night. BN3TH features XT2 no stink technology in its Pro XT2 Base Layer, a full-length tight that keeps one feeling fresh all day long. XT2 uses the properties of silver ions to kill odour before it starts. Unlike topical finishes or treatments, the silver is inherent in the fibre providing a permanent anti-odour solution, said a media release by the company. Metallic silver is not released so it will not wash out or wear off – lasting the life of the product.

Noble has also partnered with Responsive Surface Technology, maker of the award-winning ReST Bed, the world's first smart bed that senses one's position and makes automatic real-time adjustments. The ReST Bed utilises bodirak pressure mapping sensors which use Noble's circuitex conductive technology, providing detection, transmission, and protection of electronic signals in a soft, flexible and fully-customisable format.

## Sanitized Odoractiv 10 technology gets bluesign label

The Sanitized Odoractive 10 odour management technology has been granted the Bluesign sustainability label, the skin-friendly certification from the Hohenstein Institute, and the Eco Passport by Oeko-Tex label. Sanitized, headquartered in Switzerland, is the leading producer of antimicrobial hygiene function and material protection for textiles and plastics. Polyester sport and functional textiles treated with Sanitized Odoractiv 10 are protected against permastink - an unwelcome odour which can quickly develop in polyester sport and functional clothing, even if freshly washed. Permastink is a challenge to the textile industry as it reduces the attractiveness and market opportunities of sport and functional clothing made from polyester.

The patented, non-biocidal Sanitized Odoractiv 10 technology provides specific solutions and sales arguments for the end products. It works in two ways: The odour-causing bacteria can't stick to the textile surface and are washed out completely in a normal wash cycle. This is due to the anti-adhesive coating applied in the padding process. This effect has been proven in a test procedure developed in cooperation with EMPA (Swiss Federal Laboratories for Material Science and Technology). Secondly, the treatment has an adsorbing effect. The odours are trapped and repeatedly expelled during a normal wash cycle, the company said in a press release.

The treatment with Sanitized Odoractiv 10 doesn't apply an additional binder system. As with all of its products, Sanitized uses no nano technology. The safety and tolerability have been confirmed by the skin friendly certification from the Hohenstein Institute and Eco Passport by Oeko-Tex label. These have now been joined by the Bluesign accreditation.

## Source:

- www.fibre2fashion.com
- www.technicaltextile.net
- www.innovationintextiles.com

# EVENTS CALENDAR

## National

### March 2019

1-4 KNITTECH 2019
Hi-Tech Tirupur Exhibition Centre, Tirupur

2-4 The 6th APSERI 2019
Hotel Southern Star, Vinoba Road,
Devaraja Mohalla, CFTRI Campus,
Kajjihundi, Mysore, Karnataka

### April 2019

10-12 CBME India – 2019
Bombay Convention & Exhibition Centre,
Mumbai

### June 2019

15-17 Garment Show of India 2019
Pragati Maidan, New Delhi

### July 2018

2-4 HGH India 2019
Bombay Convention & Exhibition Centre,
Mumbai

12-14 Mat N Fur India 2019
Pragati Maidan, New Delhi

15-17 India International Yarn Exhibition – Yarnex 2019
Mathura Road, Railway Colony, Pragati Maidan,
New Delhi, Delhi

### August 2019

10-12 Gartex 2019
Mathura Road, Railway Colony,
Pragati Maidan, New Delhi

### September 2019

7 International Conference on Apparel and Home Textiles 2019
India Habitat Centre, Lodhi Road
Lodi Colony New Delhi Delhi

10-13 Maquintex 2019
Ceara Events Center
Fortaleza - State of Ceará, Brazil

12-14 Yarnex 2019
India Knit Fair Association No-3,
Indira Nagar, Tirupur, Tamil Nadu

12-14 TexIndia 2019
Avinashilingampalayam,
Avinashi, Tamil Nadu

20-22 UMEX - Used Machinery Expo 2019
Bombay Convention & Exhibition Centre
Mumbai

### November 2019

20-22 Techtextil India 2019
Bombay Convention & Exhibition Centre
Mumbai

### December 2019

5-8 ITMACH INDIA 2019
The Exhibition Centre, Sector 17,
Gandhinagar, Gujarat,

## International

### March 2019

1-4 East China Fair 2019
Shanghai New International Expo Centre,
Century Park, Pudong, China

5-8 Shanghai APPPEXPO 2019
National Convention & Exhibition Center,
Laigang Road, Qingpu, Shanghai, China

25-28 IDEA 19
Miami Beach Convention Center, FL United States

26-28 Expo Produccion 2019
World Trade Center, Mexico

28-30 INDO INTERTEX 2019
Jakarta International Expo, Jakarta, Indonesia

### April 2019

2-6 Atlanta Apparel - April 2019
Americas Mart Atlanta, Peachtree Street
Northwest,
Atlanta, GA, USA

4-6 Intertex Machinery Tunisia 2019
Foire Internationale de Sousse, Sousse,

# International

Tunisia, North Africa

17-19 CIDPEX 2019
Wuhan International Expo Center, Yingwu Avenue, Hanyang, Wuhan, Hubei, China

23-25 Composite Expo 2019
Crocus Expo International Exhibition Center, Moscow, Russia

## May 2019

7-9 Outlook Latin America 2019
Sheraton Sao Paulo WTC Hotel, Sao Paulo, Brazil

14-17 Techtextil Germany 2019
Frankfurt am Main, Frankfurt, Germany

14-17 Texprocess - 2019
Messe Frankfurt, Frankfurt, Germany

## June 2019

5-8 Dallas Apparel and Accessories Market - 2019
Dallas Market Center, Dallas, United States of America

12-14 ATF 2019
Cape Town International Convention Centre, Cape Town, South Africa

12-15 Atlanta Apparel - June 2019
Atlanta Convention Center at AmericasMart, Peachtree Street, Atlanta, GA, USA

20-26 ITMA 2019
Fira de Barcelona, Gran Via, Barcelona, Spain

## July 2019

3-6 Garment Manufacturers Sourcing Expo 2019
Bangkok International Trade & Exhibition Centre Bangkok, Thailand

4-6 Intertextile Pavilion Shenzhen 2019
Shenzhen International Convention & Exhibition Center, Futian Shenzhen China, Shenzhen, China

## August 2019

6-10 Atlanta Apparel - August 2019
Atlanta Convention Center at AmericasMart, Peachtree Street, Atlanta, GA, USA

## September 2019

3-5 MUNICH APPAREL SOURCE 2019
Munchen Munich, Germany

5-7 Kyiv Textiles - 2019
International Exhibition Centre
Kyiv, Ukraine

10-12 Indigo Brussels 2019
Avenue du Port 86C, Brussels, Belgium

## October 2019

22-24 FILTECH - The Filtration Event 2019
KoelnMesse, Cologne, Germany

22-24 Automotive Interiors Expo 2019
Suburban Collection Showplace, Novi, United Kingdom

## November 2019

7-9 TEXTAILOR EXPO 2019
International Fair Plovdiv, Plovdiv, Bulgaria

25-28 ShanghaiTex 2019
Shanghai New International Expo Centre (SNIEC) Longyang Rd, Shanghai, China

## December 2019

8-11 ITA Showtime - 2019
Radisson Hotel, High Point, United States of America

# Analytical Testing Facility

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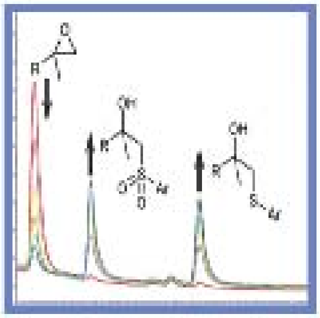

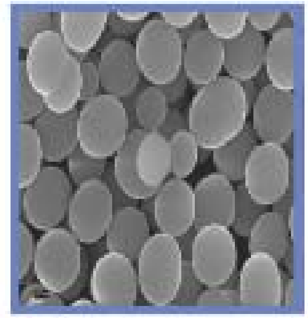

| Sr. No. | Instrument / Test |
|---|---|
| 1 | SEM (Scanning Electron Microscope) Analysis |
| 2 | Separation & Identification of Chemicals (HPTLC)<br>Qualitative Analysis<br>Quantitative Analysis |
| 3 | Banned Amines, Formaldehyde, Pesticides etc. (HPTLC) |
| 4 | Nano Particle Size Analysis (DLS ) |
| 5 | DSC (Differential Scanning Calorimetry) |
| 6 | Ultrasonication Treatment |
| 7 | TGA (Thermo gravimetric Analysis) |
| 8 | Porometer (Porosity Measurement) |
| 9 | Lyophilization of Bacterial Culture |
| 10 | Atomic Adsorption Spectroscopy |
| 11 | FTIR Analysis |
| 12 | CHNS Analyzer |

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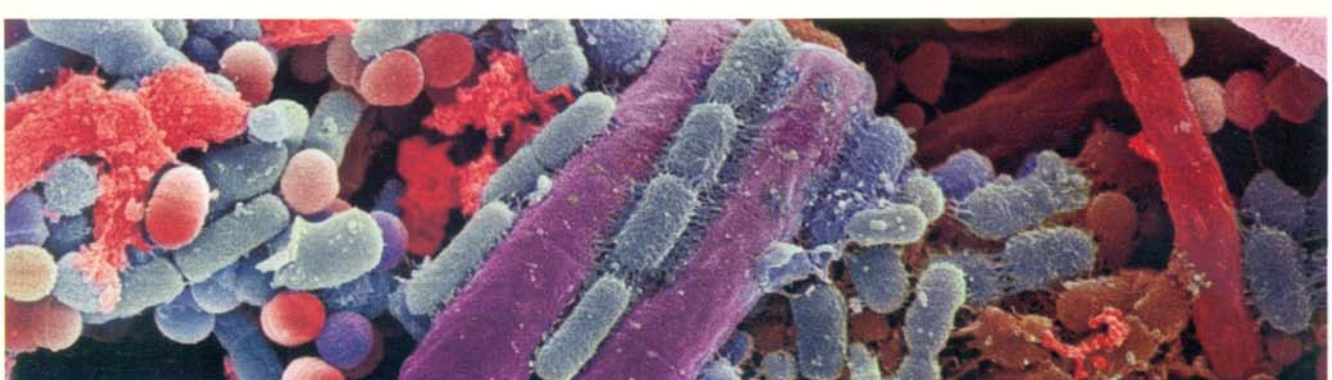

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