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Forthcoming Events
Yet again India got to see a tsunami, spreading the orange, massive victory of BJP in Uttar Pradesh. In the 5 state elections that took place from February to April 2017, BJP won clear majority in 3 states. This assembly election in the five states was considered the first big assessment for the Bhartiya Janta party after the demonetization drive. The efforts made by the ruling parties to form a stable government and bring in development is moderately praised by the people. As said and believed, every coin has two sides, there's one side of the population who believe that the elected government is striving hard for the development of the country whereas the other side of the coin has population who is trying to undo the efforts made by them. It seems party under NAMO is certainly making inroads in states where it had little hold in the past and will walk away with 2019 which will be a rare feat for the party to replicate success of 2014.

Talking about the developments of the country with respect to the textile industry, ministry of textiles is organizing a three-day mega exhibition, “Textiles India 2017” starting from 30th June 2017 to 2nd July 2017. This event not only will showcase the Indian textile value chain but comprises of an international conference which will see participation of global and national leaders of textile industry, technical leaders and senior policy makers from the Union and state government, as mentioned by the ministry of textiles. This event should also prove to be an excellent platform for B2B interactions for exploring investment opportunities and technological tie-ups across various segments in the textile value chain.

With the increasing competitiveness across the globe, every opportunity seems to be of immense importance taken at appropriate time to success. No stone is kept unturned to advance in research for new fibres, their modifications, applications and so on. Rising star on the horizon of material science is a unique substance is Graphene. Graphene is one of the most widely researched material now-a-days, taking the world of textiles to a completely new dimension. Graphene is 200 times stronger than steel and is incredibly flexible. It is also, the thinnest material on the earth possible.

Graphene may be the most remarkable substance ever discovered. Graphene-like structures were already known since 1960's, but there were experimental difficulties in isolating single
layers in a way that electrical measurements could be performed on them, and there were doubts that this was practically possible.

It is interesting to consider that everyone who has used an ordinary pencil has probably produced graphene-like structures without knowing it. A pencil contains graphite, and when it is moved on a piece of paper, the graphite is cleaved into thin layers that end up on the paper and make up the text or drawing that we are trying to produce. A small fraction of these thin layers will contain only a few layers or even a single layer of graphite, i.e., graphene.

Curious to know more about Graphene and its processing??

Well, we are starting from this issue a series of chapters dedicated to Graphene for all those readers out there interested in knowing more about it. This issue will introduce you to "Graphene - A wonder material" and so on the chapters shall continue in the upcoming issues. Hope you all enjoy and benefit from this series of articles.

Prof. (Dr.) R. V. Adivarekar,
JTA, Editor
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Bio-Processing of Organic Cotton Weft Knitted Fabric

Mr. D. Sureshkumar*1, Dr. M. Krishnakumar2

1Department of Fashion Technology, National Institute of Fashion Technology,
2Associate Professor, Department of Fashion Management Studies,

Abstract
In the recent years, the requirement for eco-friendly products in textiles has also got momentum. The cotton fibres, which are grown by using synthetic fertilizers and harmful pesticides and have a significant impact on the characteristics of the garments and the causes health hazards to the users of the garments. The synthetic chemicals, which are used in the wet processing of cotton, are not biodegradable and required more water for washing. Natural products like enzyme may substitute some synthetic chemicals. An effort has been made in this study to develop fabric samples, which are eco-friendly in nature and a comparative study of properties has been done with fabric samples, which are produced by conventional synthetic methods. The similarities and differences between the properties of both the fabric samples are discussed in the comparative study. This study also helped to study the advantages and disadvantages of bio-processing and further experiments could be made by using natural dyes.

Keywords
Bioprocessing, eco-friendly, enzyme, fabric properties knitted fabric, organic cotton,

1. Introduction
In the recent years, there is an increase in awareness towards eco-friendliness. This is due to the environmental pollution and global warming [1]. In Textile field also, the requirement has increased for eco-friendly products. These products are less harmful for the consumers and the environment [2]. Conventionally the cotton fibres are grown by using synthetic fertilizers and harmful pesticides, which will have an impact on the characteristics of the garments made out of these cotton fibres. Generally, the fabric is processed by using synthetic chemicals, which would cause skin allergies and even skin cancer [3]. Moreover, the effluents produced in the synthetic processing are not biodegradable and required more water for washing [4]. Organic cotton farming is done without using pesticides, herbicides, insecticides, chemical fertilizers or any other chemicals. Organic farming involves using natural resources like compost. Compost is derived by mixing the waste of plants & animal refuse [5]. Bioprocessing can simply be defined as the application of living organisms and their components to industrial products and processes [6]. Bioprocessing is the application of biological organisms, systems or processes to manufacturing industries [7]. Today enzymes have become an integral part of the textile processing. With the increase in awareness and regulation about environment concerns, enzymes are the obvious choice because enzymes are biodegradable and they work under mild conditions saving the precious energy [8]. Conventional chemical processes are generally severe and fibre damages may occur. However, enzymes are characterized by their ability to operate under mild conditions. As a result processes may take place without additional harm to the fibre. Enzymes are also readily biodegradable and therefore potentially harmless and environmentally friendly [9]. The comparative study gives the similarities and differences between the properties of both the fabric samples. The main objectives of this study are i) to study the properties of the single jersey weft knitted grey fabric produced from organic cotton., ii) to study and compare the properties of fabric samples produced using conventional chemicals and other with enzyme in the preparatory processes, iii) to study and compare the properties of both dyed samples prepared form conventional and enzymatic preparatory processes, iv) to analyze the advantages and disadvantages of both the preparatory processes.

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2. Literature review

2.1 Organic Cotton

As per the National Organic Standards Board, USA, Organic agriculture is defined as an 'ecological production management system that promotes and enhances biodiversity, biological cycles and soil biological activity. It is based on minimal use of off-farm inputs and on management practices that restore, maintain and enhance ecological harmony' [10].

Organic cotton farming is done without using pesticides, herbicides, insecticides, chemical fertilizers or any other chemicals. Conventional cotton uses up to 10% of all agricultural chemicals, 25% of all insecticides consumed in the planet while using only 3% of the farming land. In general, organic cotton is grown using methods and materials that have low impact on the environment with the organic production systems replenishing and maintaining soil fertility reducing of the use of synthetic pesticides, fertilizers and building a biologically diverse agricultural system [11]. Certification of organic cotton production adds credibility to the final product assures the buyer of the organic status of the product and encourages payment of premium prices to farmers who engage in organic practices. Organic agriculture protects the health of people and the planet by reducing the overall exposure to toxic chemicals from synthetic pesticides that can end up in the ground, air, water and food supply, and that are associated with health consequences, from asthma to cancer [12].

2.2 Bioprocessing

Bioprocessing can simply be defined as the application of living organisms and their components to industrial products and processes. Bioprocessing is the application of biological organisms, systems or processes to manufacturing industries [13]. In Textile Processing, the Enzymatic removal of starch sizes from woven fabrics has been in use for most of this century and the fermentation vat is probably the oldest known dyeing process. Bioprocessing also offers the potential for new industrial processes that require less energy and are based on renewable raw materials [14].

2.2.1 Enzymes in bioprocessing

Today enzymes have become an integral part of the textile processing. Though enzyme in desizing application was established decades ago, only in recent years the application has widened with new products introduced. With the increase in awareness and regulation about environment concerns, enzymes are the obvious choice because enzymes are biodegradable and they work under mild conditions saving the precious energy [15]. Enzymes being biocatalysts and very specific are used in small amounts and have a direct consequence of lesser packing material used, the transportation impact is lower. In an overall consideration enzymes are the wonder products [16].

<table>
<thead>
<tr>
<th>S.No</th>
<th>Type of enzyme</th>
<th>Application</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Amylases</td>
<td>To decompose starches in sizing preparations</td>
</tr>
<tr>
<td>2</td>
<td>Catalases</td>
<td>Act on Hydrogen Peroxide to decompose it into water and oxygen</td>
</tr>
<tr>
<td>3</td>
<td>Protease, lipases &amp; pectinase</td>
<td>When combined, act on Proteins, Pectins and natural waxes to effect scouring</td>
</tr>
<tr>
<td>4</td>
<td>Laccases</td>
<td>Decompose indigo molecules for wash-down effect on denim</td>
</tr>
<tr>
<td>5</td>
<td>Cellulases</td>
<td>Break down Cellulosic chains to remove protruding fibres by degradation &amp; create wash-down effect by surface etching on Denims</td>
</tr>
</tbody>
</table>

2.3 Enzymes

Enzymes are biological catalysts. A catalyst is any substance which makes a chemical reaction go faster, without itself being changed [17]. A catalyst can be used over and over again in a chemical reaction: it does not get used up. Enzymes are very much the same except that they can be easily denatured by some means. Enzymes must have the correct shape to do their job. Enzymes change their shape if the temperature or pH changes, so they have to have the right conditions [18]. Conventional chemical processes are generally severe and fibre damage may occur. However, enzymes are characterized by their ability to operate under mild conditions. As a result processes may take place without additional harm to the fibre. Enzymes are also readily biodegradable and therefore potentially harmless and environmentally friendly [19].
2.3.1 Properties of the enzymes

i) Enzymes accelerate reaction (High reaction rates)
Enzymes accelerate a particular chemical reaction by lowering the activation energy for the reaction. They achieve this by forming an intermediate enzyme-substrate complex, which alters the energy of the substrate such that it can be more readily converted in to the product. The enzyme itself is released unaltered at the end of the reaction, thus acting as a catalyst.

ii) Enzymes are specific in their action
Enzymes are specific in their activity, which describes the enzymatic strength towards a particular substance. Enzyme activity is a measure of substrate molecules converted into product in a unit of time, per molecules of enzyme when the enzyme is fully saturated with the substrate. This is a key value for determining an enzyme's selling price, its dosage and thus, its cost in actual use.

iii) Enzyme activators and inhibitors
Some of the bivalent metallic cations activate certain enzymes as for example Ca++, Sr++, Mg++, Zn++, Co++ etc sensitize the substrate towards enzymatic attack. Some of the chemicals like alkalis, antiseptics, acid liberating agents tend to inhibit the enzymes activity. Enzyme activity is inhibited by blocking certain useful groups. The inhibitors possess certain affinity to the enzymes and thus there occurs a competition between the substrate and the inhibitor to combine with the enzyme which retards the reaction.

iv) Enzymes can replace hazardous chemicals
Quite a number of chemicals used in textile chemical processing are known to pose various environmental problems and hazardous to the persons working with, if not rigidly controlled. The use of an enzyme can often replace a number of such chemicals which are toxic and are better avoided where possible. The use of an enzyme catalyzed reaction may permit much shorter times for a certain process to occur and milder conditions to be employed, thus being both safer and more cost effective.

v) Enzymes are biodegradable
After completion of an enzymatic reaction the enzymes when released in drain water get decomposed to amino acids by various proteolytic enzymes secreted by micro organisms present in sewerage plants which are then available to re-enter the food chain [20].

vi) Chemical reactions at mild conditions
Requirement above means in particular that there will be enzymes functioning under mild conditions of temperature, pH, etc., as well as enzymes adapted to harsh conditions such as extreme cold (in arctic or high-altitude organisms), extreme heat (e.g., in organisms living in hot springs), or extreme pH values (e.g., in organisms in soda lakes).

2.3.2 Mechanism of enzyme action - Lock & Key theory
Enzymes act like tiny molecular machines to ensure that molecules come into contact with each other and react. Like a key fitting into a lock, chemical molecules fit into pocket-like structures located on an enzyme. These pockets hold the molecules in a position that will allow them to react with each other, ensuring that they are close enough together and aligned properly for a reaction to occur. In this way, enzymes speed up reactions [21]. The enzymes are not changed themselves by the reaction. When the reaction is complete, enzymes release the product(s) and are ready to bring together more molecules and catalyse more reactions. Enzymes have active centers, which are the points where substrate molecule can join. Just as a particular key fits into a lock, a particular substrate molecule fits into the active site of the enzyme. The substrate forms a complex with the enzyme. Later the substrate molecule is converted into the product and the enzyme itself is regenerated (Fig.2.1).

Fig. 2.1 - Lock & Key model of enzyme specificity

The process continues until the enzyme is poisoned by a chemical bogie (Fig.2) or inactivated by extremes of temperature, pH or by other negative conditions in the processing environment.

Fig. 2.2 - Poisoning of enzyme
2.3.3 Sources
Commercial sources of enzymes are obtained from three primary sources, i.e., animal tissue, plants and microbes. These naturally occurring enzymes are quite often not readily available in sufficient quantities for food applications or industrial use [22].

2.4 Different applications in bio-processing
2.4.1 BIO-catalysis (Organic synthesis)
Biocatalysis is the general term for the transformation of non-natural compounds by enzymes. The accelerated reaction rates, together with the unique stereo-, regio-, and chemoselectivity (highly specific action), and mild reaction conditions offered by enzymes, makes them highly attractive as catalysts for organic synthesis.

2.4.2 Bio-singeing
This mode of finishing has been specifically developed to achieve clearer pile on terry towel goods. When treated with an enzyme, which is a powerful cellulase composition, gives clearer look to the pile, improves absorbency and softness.

2.4.3 Bio-desizing
Conventionally, desizing was done treatment with caustic soda at high temperature. The chemical treatment was not totally effective in removing the starch (which leads to imperfections in dyeing) and also results in a degradation of the cotton fibre resulting in destruction of the natural, soft feel, or hand, of the cotton. The use of enzyme to replace starch-based sizing agents result in complete removal of starch-containing size without fibre damage is best obtained by using enzymatic desizing agents [23].

2.4.4 Bio-scouring
Cotton could be treated with bio-scouring enzyme although the techno-economical parameters were not conductive. But, it had a bright future due to rigorous effluent treatment since disposal of both caustic soda and soda ash was causing environmental concern. Advantages of bioscouring were lower BOD, COD, TDS, and the alkaline media of water, extent of cotton weight loss, which was a boon to the knitting industry, lower alteration of cotton morphology i.e. less damage since it was specific to pectin and waxes and not cellulose besides increased softness [24].

2.4.5 Bio-bleaching
Earlier denim was bleached with chlorine to get lighter denim or wash down effect. Bio-bleaching had been adapted for denim where Indigo specific lipases were used to bleach indigo. The advantages were environment friendly application, non-AOX generation and cellulose was not affected. A bio-bleaching or lipase treatment on denim gave an authentic wash resulting in an excellent look, which was better than a neutral wash and a grey cast, which was used in bleaching.

2.4.6 Peroxide killers
Enzymes acts as peroxide neutralisers after bleaching and it ensured shade quality particularly with reactive dyes, reduced the complexity of treatment after peroxide bleaching and conserved water. They did not affect reactive dyes and only react with the peroxide [25].

2.4.7 Bio-polishing
Bio-polishing or cellulase enzyme treatment of lyocell type of regenerated cellulose could produce peach like effect. Bio-polishing give cleaner appearance to the garment besides wash down effect.

2.4.8 Bio-carbonizing
Polyester / cellulose blends after dyeing and/ or printing are occasionally treated with strong solution of sulphuric acid to dissolve cellulose component. The resultant goods are soft and have a peculiar fluffy feel. This process is risky due to highly corrosive acid that is also difficult to treat in an ET plant. The process developed at UNO, has none of the above drawbacks. It offers a safe and eco-friendly to the obnoxious practice of using sulphuric acid. The goods are treated with cellulose enzyme based formulation to achieve dissolution of cellulosic fibres.

2.4.9 Degumming of silk
Silk is made up of two types of proteins like fibrin and ceresin. In the case of enzymatic treatment, a ceresin specific protein was used to degum the silk without causing damage, impart softness and increase dye uptake of about 30%. If silk was degummed by alkaline treatment, there was damage to fibrin and heavy weight loss.

2.4.10 Textile auxiliaries
Textile auxiliaries such as dyes could be produced by fermentation or from plants in the future (before invention of synthetic dyes in the nineteenth century many of the colours used to dye textiles came from plants e.g. woad, indigi and madder). Many microorganisms produce pigments during their growth, which are substantive as indicated by the permanent staining that is often associated with mildew growth on textiles and plastics.
2.4.11 Enzymatic decolourization
Enzymes can be used in effluent treatment of dyeing water to remove the colour. It is known that 90% of reactive dyes entering activated sludge sewage treatment plants will through unchanged and be discharged into rivers. Biological treatments have been used to reduce the COD of textile effluents. Instead of using the chemical treatments, various biological methods can be used to treat the water from the textile industry [26].

2.4.12 Finishing of cotton knits
Cellulase enzyme treatments increasingly find applications in cotton hosiery sector to enhance aesthetic feel as well as surface clarity. Ultrazyme Super is an enzyme-based formulation, well suited for use in winches or high turbulence soft flow machines [27].

2.4.13 Bio-Denim Washing
Another use of cellulase enzyme is in the fading of denims. Earlier the effect was obtained by washing denim with pumice stones. The major problem with stone washing is that lot of sludge gets deposited in the effluent tank due to wearing of pumice. The sludge has to be separated from effluent water and disposed off. The use of stones was, therefore, replaced by cellulase enzymes [28].

3. Materials and Methods
3.1 Materials used
The grey fabric used for processing is single jersey weft knitted fabric made from organic cotton. The specifications of the grey fabric is given in table 3.1

Sodium hydroxide and Hydrogen peroxide were used for conventional combined scouring and bleaching. An enzymatic scouring and bleaching agent, Bactosal CO IP was used for combined enzymatic scouring and bleaching process. The dyeing was carried out by using three Remazol (Reactive hot brand) dyes in identical conditions. The details of the dyes used are given below:
(1) Drimarene Red CL5B
(2) Drimarene Yellow CL2R
(3) Drimarene Blue HFRL

3.2 Methods
3.2.1 Conventional preparatory process
Conventional combined scouring and bleaching process was carried out by using sodium hydroxide and hydrogen peroxide. The recipe is given below in table 3.2:

<table>
<thead>
<tr>
<th>S.No</th>
<th>Name of the chemical</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Imerol NLF - Wetting Agent</td>
<td>0.5%</td>
</tr>
<tr>
<td>2</td>
<td>Imacol Cg - Lubricant</td>
<td>0.5%</td>
</tr>
<tr>
<td>3</td>
<td>2UDI - Demineraliser</td>
<td>0.5%</td>
</tr>
<tr>
<td>4</td>
<td>Soda ash</td>
<td>0.3%</td>
</tr>
<tr>
<td>5</td>
<td>Sodium hydroxide</td>
<td>0.5%</td>
</tr>
<tr>
<td>6</td>
<td>Hydrogen peroxide</td>
<td>2.0%</td>
</tr>
<tr>
<td>7</td>
<td>Acetic acid</td>
<td>0.5%</td>
</tr>
</tbody>
</table>

The combined scouring and bleaching bath was prepared by adding the wetting agent, lubricant, acetic acid and soda ash to the bath. The grey fabric was introduced into the bath. The pH should be maintained in the range of 9-9.5 throughout the process. After 10 minutes, Sodium hydroxide was introduced into the bath, at room temperature. After 10 minutes, Hydrogen peroxide was added to the bath. Then the tempera-
ture was raised to 80°C. After 15 minutes, demineraliser is added. Then the temperature of the bath is raised to 98°C. The process is continued for further 45 minutes. Then the temperature is reduced to 80°C. After that, draining is done and hot wash was given at 80°C for 15 minutes. Then neutralization is done [29].

3.2.2 Enzymatic preparatory process
Enzymatic combined scouring and bleaching process is carried out by using Bactosal CO IP, an enzymatic scouring and bleaching agent. The recipe is given below in the table 3.3:

<table>
<thead>
<tr>
<th>S.No.</th>
<th>Name of the chemical</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Imerol NLF - Wetting Agent</td>
<td>0.5%</td>
</tr>
<tr>
<td>2</td>
<td>Imacol CG - Lubricant</td>
<td>0.5%</td>
</tr>
<tr>
<td>3</td>
<td>2UDI - Demineraliser</td>
<td>0.5%</td>
</tr>
<tr>
<td>4</td>
<td>Bactosal CO IP - Enzymatic scouring and Bleaching agent</td>
<td>0.12%</td>
</tr>
<tr>
<td>5</td>
<td>Soda ash</td>
<td>0.3%</td>
</tr>
<tr>
<td>6</td>
<td>Acetic acid</td>
<td>0.5%</td>
</tr>
<tr>
<td>7</td>
<td>Bactosal Apm - Enzyme killer</td>
<td>0.6%</td>
</tr>
</tbody>
</table>

The combined scouring and bleaching bath was prepared by adding the wetting agent, lubricant, acetic acid and soda ash to the bath. The grey fabric was introduced into the bath. The pH should be maintained in the range of 9-9.5 throughout the process. After 10 minutes, enzymatic scouring and bleaching agent was introduced into the bath. Then the temperature was raised to 80°C. After 15 minutes, demineraliser was added. The temperature was raised to 98°C and continued for further 45 minutes. Then the temperature is reduced to 80°C and draining is done. After that hot wash is given at 80°C for 15 minutes. Then neutralization is done. After that enzyme killer is added to terminate the action of enzyme [30].

3.2.3 Dyeing process
For dyeing, Remazol (Reactive hot brand) dyes are used. Three basic colours are used in self and combinations. The details of the dyes are:
(1) Drimarene Red CL5B - D1
(2) Drimarene Yellow CL2R - D2
(3) Drimarene Blue HFRL - D3

The dyes are used in self and combinations in three different shades such as 0.5%, 2.0% and 3.5%. The different combinations used are D1, D2, D3, D1+D2, D2+D3, D1+D3, D1+D2+D3. The procedure used for dyeing is common for all the combinations and shades. The recipe used for the dyeing process is given below in the table 3.4:

<table>
<thead>
<tr>
<th>S.No.</th>
<th>Shade %</th>
<th>0.5%</th>
<th>2.0%</th>
<th>3.5%</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Dye</td>
<td>owm</td>
<td>owm</td>
<td>owm</td>
</tr>
<tr>
<td>2</td>
<td>M:L ratio</td>
<td>1:15</td>
<td>1:15</td>
<td>1:15</td>
</tr>
<tr>
<td>3</td>
<td>Common salt (g/l)</td>
<td>30</td>
<td>60</td>
<td>70</td>
</tr>
<tr>
<td>4</td>
<td>Soda ash (g/l)</td>
<td>10</td>
<td>15</td>
<td>20</td>
</tr>
</tbody>
</table>

Note: owm - own weight of the material.

The dye powder was sprinkled slowly with stirring, in required quantity of water for dissolution at 60-70°C. The amount of water depends on the solubility of the dyestuff. Addition of urea improves the solubility of the dyestuff. The required amount of urea was mixed with dyestuff powder and pasted with cold water. Then the required amount of water was added at 60-70°C to carry out dissolution.

The dye bath is set with soft water at 50°C. The scoured and bleached fabric was entered and run for 5 to 10 minutes. Then the dyestuff is added slowly and run for 15 minutes. 1/3 quantity of dissolved common salt was added and run for 10 minutes. Simultaneously the temperature was raised at a rate of 1°C/min. Again 1/3 quantity of dissolved common salt was added and run for 10 minutes. Then the remaining 1/3 quantity of dissolved common salt was added and the temperature was raised to 80-85°C. Dyeing is carried out at this temperature for further 15 minutes. Then the required quantity of soda ash (dissolved in soft water) and the dyeing is continued at 80-85°C for another 60-75 minutes. Then the fabric is drained and rinsed with hot and cold water.

After treatment is given by using 1g/l soap, 1-2g/l Sandopur and 0.5-1.0g/l soda ash, at a pH of 9-9.8 and at a temperature of 85-90°C, for 30-60 minutes.

Fixation is carried out with 1-2% Sandofix WEI and soda ash, at 35-40°C and pH 9.0, for 30 minutes.

3.3 Testing
Various properties of the fabric samples were tested after the preparatory process and after the dyeing pro-
cess. The methodology used for testing various parameters is discussed in this section.

3.3.1 Bursting strength
This test method describes the measurement of the resistance of knitted fabric to bursting using a hydraulic or pneumatic diaphragm bursting tester. Ten circular specimens having 125 mm (5 inch) diameter are prepared. No two specimens from knitted fabric should contain the same wale or course yarns. The bursting strength is expressed in kg/sq.cm.

3.3.2 Washing shrinkage
This test method is intended for the determination of dimensional changes of fabrics when subjected to home laundering procedures used by consumers. Test specimens are conditioned in the standard testing atmosphere. Samples are laid on a flat surface. Using a template for the selected test size, mark specimens parallel to the selvage or fabric length direction. Specimens should be taken from areas with different lengthwise and widthwise yarns. Length direction of the specimen should be identified before cutting them out of the sample. Mark each 380 x 380 mm (15 x15 inch) test specimen with three 250 mm (10 inch) pairs of benchmarks parallel to the test specimen length and three 250 mm pairs of benchmarks parallel to the test specimen width. Each benchmark must be at least 50 mm (2 inch) from all test specimen edges. Pairs of bench marks in the same direction must be spaced approximately 120 mm (5 inch) apart.

Then washing, rinsing and drying of the samples are done as per the required number of cycles. The specimens are conditioned for at least 4 hours. Each test specimen is laid without tension on a flat, smooth, horizontal surface. Measure and record the distance between each pair of benchmarks to the nearest millimeter. The length and width averages are separately calculated using the formula:

\[
\text{Average}\% \text{ DC} = 100 \left( \frac{B - A}{A} \right)
\]

where,

A = Average original dimension
B = Average dimension after laundering

Both the average original and average final dimensions are the averages of the measurements in each direction made on all test specimens. When the final measurement is smaller than the original measurement, it results in a negative dimensional change, which is shrinkage. When the final measurement is larger than the original measurement, it results in a positive dimensional change, which is growth.

3.3.3 Scouring loss
The extent of scouring process is most simply assessed by measuring the weight loss of the cotton material. This method gives the information of impurities removed during the scouring process. The scouring loss percentage is calculated by the formula:

\[
\text{Scouring loss}\% = \left( \frac{A - B}{A} \right) \times 100
\]

where,

A = Sample weight before scouring
B = Sample weight after scouring

4.3.4 Absorbency
Absorbency is one of the several facts that indigence textile processing such as fabric preparation, dyeing and the application of finish and often interchanged with the term wettability. The absorbency characteristics of a fabric can indigence the uniformity and completeness of bleaching and dyeing by the ability to take in water into the fibre, yarn or fabric construction. The suitability of a fabric for a particular use is also dependent upon a fabric's ability and propensity to take up water. To assess the efficiency of cotton scouring process, absorbency tests are more useful. Two methods of absorbency tests are carried out:

1. Drop test
2. Wicking height test

\textbf{Drop test:}
In this method, a drop of water is allowed to spread on the test specimen. A lamp is suitably placed so that the image of the lamp is seen on the drop. The time taken for the image of the lamp to just disappear at the edge of the drop is noted by using a stop watch. The time is the measure of the absorbency of the sample.

\textbf{Wicking height test:}
In this method, a fabric specimen is cut to the size of 12 inches. The lower end of the fabric strip is made to touch the water in such a way that half an inch height of the fabric is kept immersed inside the water level. To keep the fabric strip in straight configuration, a load of 10 grams is applied on the bottom of fabric strip. The beaker is filled with distilled water. The fabric is allowed to touch the water in the beaker. The stop watch is started. The rise of the water level in the fabric in 10 minutes is observed. After 10 minutes, the wicking height in cm is measured.
3.3.5 Whiteness index

The simplest objective method of evaluating the degree of whiteness colorimetrically is to measure the amount of white light reflected by the white object and correlate the reflectance with the whiteness. While, colour has three dimensions and can be expressed in terms of lightness, saturation and hue or in terms of the coordinates L, a, b. these specifications are not sensitive enough to define whiteness. Ideal whiteness should have L = 100 and since it has to be perfectly achromatic, a and b should also be zero. In practice, L may vary from 40 to 200, while a and b are very small, having a value of ±5 for white textiles. The value of L varies considerably depending upon the spectrophotometer used. Thus the whiteness index will also vary depending upon the spectrophotometer used even if the formula used for calculating this index is the same. Whiteness is a subjective quality where preferences vary. Hence, there is some disagreement as to what is preferred white although there are several whiteness scales, indices and formulae. In textile materials, whiteness is inversely proportional to the degree of yellowness. Since the all yellow objects absorb strongly in the blue region, the simplest and the most widely used formula for computing the whiteness index W was:

\[ W = \frac{R_b}{R} \]

where,

\[ R_b \] is the reflectance in the blue region of the visible spectrum.

Whenever reflectometers are available, the nominal wavelength used was 456nm. If a spectrophotometer is used, this wavelength is 460nm.

While none of the formulae totally meet these requirements, the CIE formula meets many of them. Hence this formula is recommended for regular use. However, it should be used for textile samples which are white and not creamy or brownish like wool. The CIE has limited the use of the formula to whiteness above 40. The tint of the sample should be mentioned. White samples having a dominant wavelength of 466nm are considered neutral. If the value of the tint \( T \) is within ±0.5, the sample is neutral. If the value is negative, the sample has a reddish tint. If the value is positive, the sample has a greenish tint. For a good white material, the tint value should be within ±5.5.

3.3.6 Colour differences

Colour strength (\( K/S \) value) of the dyed sample was measured on Data Spectra Flash 5100 Spectrophotometer. These values are computer calculated from reflectance data according to Kubelka-Munk equation:

\[ K/S = (1-R)^2/2R \]

where,

\( K = \) light absorption co-efficient
\( S = \) light scattering co-efficient
\( R = \) reflectance of the dyed samples

Whenever it is desirable to minimize the variations in reflectance values obtained from different spectrometers, the specular component shall be included. The reflectance values shall be converted into X, Y, Z tristimulus values using the colour matching functions (spectral tristimulus values) in the CIE (International Commission on Illumination), 1964 supplementary standard colorimetric system(100 observer data) for illuminant D65. Whenever a master reference is established, the tristimulus values shall be converted into the x, y chromaticity co-ordinates and recorded together with the Y tristimulus value.

The X, Y, Z tristimulus values of a specimen representing the reference and of a specimen representing a sample shall be determined by using either a spectrophotometer or a tristimulus colorimeter. These values shall then be converted into \( L^*, a^*, b^* \) values using the equations given in the CIE publication. If any one of the ratios \( X/X_n, Y/Y_n \) or \( Z/Z_n \) is equal to or less than 0.008856, the equations given in note 1 of sub-clause of CIE publication shall be used. The \( L, a, b \) values of the reference and the sample shall then be used to calculate the colour difference in CIELAB units using the equations given in CIE publication.

(a) A lightness component
(b) A chroma component
(c) A hue component

Whenever the colorimetric data \( x, y, Y \) of a master reference are established, the tolerances for working references shall be given in CIELAB units.

Colorimeter measures the amount of visual red, green and blue components reflected from a particular colour sample. The tristimulus values, \( X, Y, \) and \( Z \) reveal metamerism. Spectrophotometer gives non-metameric colour matches spectral reflectance. Color eye is a combination of a colorimeter and a spectrophotometer. Reflectance value for each fabric was measured at 30 different places using spectrophotometer. While measuring reflectance value, three parameters namely \( L, a \) and \( b \) are obtained:
L = lightness of the colour
A = redness or greenness of the colour
B = blueness or yellowness of the colour

The colour non-uniformity (\(\Delta E\)) is achieved by:
\[
\Delta E = (\Delta L^2 + \Delta a^2 + \Delta b^2)^{1/2}
\]

3.3.7 Washing fastness
A specimen of the textile in contact with one or two specified adjacent fabrics is mechanically agitated under specified conditions of time and temperature in a soap solution, then rinsed and dried. The change in colour of the specimen and the specimen and the staining of the adjacent fabrics are assessed with the grey scales. The apparatus used is Launderometer and non-corrodible stainless steel balls approximately 0 cm in diameter. The adjacent fabrics used are acetate rayon, cotton, nylon, polyester, acrylic and wool. The chemicals used are standard soap ECE detergent (4gpl-without optical brightener) and sodium perborate.

Attach a specimen measuring 4x10 cm to a piece of the multifibre adjacent fabric, also measuring 4x10 cm, by sewing along one of the shorter sides, with the multifibre fabric next to the face of the specimen. Place the composite specimen in the container and add the necessary amount of soap solution, previously heated to 40±20°C, to give a liquor ratio of 50:1. Treat the composite specimen at 40±20°C, for 30 minutes. Remove the composite specimen, rinse it twice in cold grade 3 water and then in cold running tap water for 10 minutes and squeeze it. Open out the composite specimen (by breaking the stitching except on one of the shorter sides, if necessary) and dry it by hanging it in air at a temperature not exceeding 60°C, with the two or three parts in contact only at the line of stitching. Assess the change in colour of the specimen and the staining of the adjacent fabrics with the grey scales. Report the numerical for change in the colour of the specimen and for staining of adjacent fabrics.

3.3.8 Rubbing fastness
A specimen of the textile is rubbed with a dry rubbing cloth and with a wet rubbing cloth. Two alternative sizes of rubbing finger are specified, one for pile fabrics and one for other textiles. The staining of the rubbing cloths is assessed with the grey scale. The apparatus required are crock meter, adjacent fabric and 5x5 CMS 100% cotton over fabric.

For dry rubbing, with the dry rubbing cloth flat in place over the end of the finger of the testing device, rub to and fro in a straight line along a track 10 cm long on the dry specimen, 10 times to and fro in 10 seconds, with a downward force of 22N or 9N.

For wet rubbing, repeat the test described as in dry rubbing with a fresh dry specimen and with a rubbing cloth that has been wetted with water by placing it on the grating and dropping evenly on to its own mass of water, or use any method to ensure a take up about 100%. After rubbing, dry the cloth at room temperature. Remove the cloth and evaluate the degree of stain with the help of grey scale and assign the ratings.

<table>
<thead>
<tr>
<th>Grade</th>
<th>Rating of change in colour</th>
<th>Rating of staining</th>
</tr>
</thead>
<tbody>
<tr>
<td>5</td>
<td>Excellent</td>
<td>Negligible stain</td>
</tr>
<tr>
<td>4</td>
<td>Good</td>
<td>Slight stain</td>
</tr>
<tr>
<td>3</td>
<td>Fair</td>
<td>Unsociable stain</td>
</tr>
<tr>
<td>2</td>
<td>Poor</td>
<td>Considerable stain</td>
</tr>
<tr>
<td>1</td>
<td>Very poor</td>
<td>Severe stain</td>
</tr>
</tbody>
</table>

4. Results and Discussion
4.1 Comparison after preparatory
The grey single jersey weft knitted fabric was prepared for dyeing in two types of preparatory processes. One is conventional combined scouring and bleaching done by using sodium hydroxide and hydrogen peroxide. The other one is the combined scouring and bleaching done by using enzyme. The properties of the fabric samples prepared in both the processes were studied and the comparison of the properties is given in table 4.1.

From the above results, it was found that there is no significant variations between the two samples in terms of course density, wale density, areal density, loop length, tubular width and absorbency. Bursting strength is more in enzymatically processed fabric. Spirality is less in the enzymatically processed fabric. With respect to washing shrinkage, shrinkage is in lengthwise direction and elongation is in widthwise direction in both the fabrics. Lengthwise shrinkage is slightly less and the widthwise elongation is slightly more in case of enzymatically processed fabric. Scouring loss is comparatively less in the enzymatically processed fabric. Whiteness is more in case of the conventionally
processed fabric than the enzymatically processed fabric.

4.2 Eco testing
The testing was done to check the presence of organo chlorine pesticides (GC-MSD) in all the dyed samples. The results show that none of the pesticides were detected up to 0.5 ppm. From the results, it is understood that the dyed samples, prepared from both the preparatory processes, are free from pesticides.

<table>
<thead>
<tr>
<th>S.No.</th>
<th>Organo Chlorine Pesticides (GC-MSD)</th>
<th>Status</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>2,4,5-T</td>
<td>ND</td>
</tr>
<tr>
<td>2</td>
<td>2,4-D</td>
<td>ND</td>
</tr>
<tr>
<td>3</td>
<td>Azinophosmethyl</td>
<td>ND</td>
</tr>
<tr>
<td>4</td>
<td>Azinophosethyl</td>
<td>ND</td>
</tr>
<tr>
<td>5</td>
<td>Aldrine</td>
<td>ND</td>
</tr>
<tr>
<td>6</td>
<td>Bormiphose-ethyl</td>
<td>ND</td>
</tr>
<tr>
<td>7</td>
<td>Capatafol</td>
<td>ND</td>
</tr>
<tr>
<td>8</td>
<td>Carbaryl</td>
<td>ND</td>
</tr>
<tr>
<td>9</td>
<td>Chlordane</td>
<td>ND</td>
</tr>
<tr>
<td>10</td>
<td>Chlordimeform</td>
<td>ND</td>
</tr>
<tr>
<td>11</td>
<td>Chlorfenvinphos</td>
<td>ND</td>
</tr>
<tr>
<td>12</td>
<td>Coumaphos</td>
<td>ND</td>
</tr>
<tr>
<td>13</td>
<td>Cyfluthrin</td>
<td>ND</td>
</tr>
<tr>
<td>14</td>
<td>Cyhalothrin</td>
<td>ND</td>
</tr>
<tr>
<td>15</td>
<td>Cypermethrin</td>
<td>ND</td>
</tr>
<tr>
<td>16</td>
<td>DEF</td>
<td>ND</td>
</tr>
<tr>
<td>17</td>
<td>Deltamethrin</td>
<td>ND</td>
</tr>
<tr>
<td>18</td>
<td>DDD</td>
<td>ND</td>
</tr>
<tr>
<td>19</td>
<td>DDE</td>
<td>ND</td>
</tr>
<tr>
<td>20</td>
<td>DDT</td>
<td>ND</td>
</tr>
<tr>
<td>21</td>
<td>Diazinon</td>
<td>ND</td>
</tr>
<tr>
<td>22</td>
<td>Dichlorprop</td>
<td>ND</td>
</tr>
<tr>
<td>23</td>
<td>Dicrotophos</td>
<td>ND</td>
</tr>
<tr>
<td>24</td>
<td>Dieldrin</td>
<td>ND</td>
</tr>
<tr>
<td>25</td>
<td>Dimethate</td>
<td>ND</td>
</tr>
<tr>
<td>26</td>
<td>Dinoseb and salts</td>
<td>ND</td>
</tr>
<tr>
<td>27</td>
<td>Endosulfan, α</td>
<td>ND</td>
</tr>
<tr>
<td>28</td>
<td>Endosulfan, β</td>
<td>ND</td>
</tr>
<tr>
<td>29</td>
<td>Endrine</td>
<td>ND</td>
</tr>
<tr>
<td>30</td>
<td>Esfenvalerate</td>
<td>ND</td>
</tr>
<tr>
<td>31</td>
<td>Fenvalerate</td>
<td>ND</td>
</tr>
<tr>
<td>32</td>
<td>Heptachlor</td>
<td>ND</td>
</tr>
<tr>
<td>33</td>
<td>Heptachloroepoxide</td>
<td>ND</td>
</tr>
<tr>
<td>34</td>
<td>Hexachlorobenzene</td>
<td>ND</td>
</tr>
<tr>
<td>35</td>
<td>Hexachlorobenzene, α</td>
<td>ND</td>
</tr>
<tr>
<td>36</td>
<td>Hexachlorobenzene, β</td>
<td>ND</td>
</tr>
<tr>
<td>37</td>
<td>Hexachlorobenzene, δ</td>
<td>ND</td>
</tr>
<tr>
<td>38</td>
<td>Lindane</td>
<td>ND</td>
</tr>
<tr>
<td>39</td>
<td>Malathion</td>
<td>ND</td>
</tr>
<tr>
<td>40</td>
<td>MCPA</td>
<td>ND</td>
</tr>
<tr>
<td>41</td>
<td>MCPB</td>
<td>ND</td>
</tr>
</tbody>
</table>

Table 4.2 Eco Test Results

Table 4.1 Comparison of samples after preparatory processes

<table>
<thead>
<tr>
<th>S.No.</th>
<th>Test Parameters</th>
<th>Combined Scouring and Bleaching (Conventional)</th>
<th>Combined Scouring and Bleaching (Enzymatic)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Courses / inch</td>
<td>48</td>
<td>50</td>
</tr>
<tr>
<td>2</td>
<td>Wales / inch</td>
<td>40</td>
<td>42</td>
</tr>
<tr>
<td>3</td>
<td>Areal Density (GSM)</td>
<td>150.39</td>
<td>154.25</td>
</tr>
<tr>
<td>4</td>
<td>Loop Length (cm)</td>
<td>0.272</td>
<td>0.272</td>
</tr>
<tr>
<td>5</td>
<td>Tubular Width (inch)</td>
<td>20.67</td>
<td>21.25</td>
</tr>
<tr>
<td>6</td>
<td>Bursting Strength (kg/sq.cm)</td>
<td>4.75</td>
<td>7.3</td>
</tr>
<tr>
<td>7</td>
<td>Spirality (%)</td>
<td>13.6</td>
<td>11.2</td>
</tr>
<tr>
<td>8</td>
<td>Washing Shrinkage, % Length</td>
<td>7.44</td>
<td>6.96</td>
</tr>
<tr>
<td>9</td>
<td>Washing Shrinkage, % Width</td>
<td>+2.52 (+Elongation)</td>
<td>+3.40 (+Elongation)</td>
</tr>
<tr>
<td>10</td>
<td>Scouring loss (%)</td>
<td>6.2</td>
<td>3.74</td>
</tr>
<tr>
<td>11</td>
<td>Absorbency (seconds)</td>
<td>Below 1</td>
<td>Below 1</td>
</tr>
<tr>
<td>12</td>
<td>Whitenss Index CIE (Using Macbeth 7000A Spectrophotometer)</td>
<td>77.57 (-0.50 Reddish)</td>
<td>58.85 (-2.01 Reddish)</td>
</tr>
</tbody>
</table>
4.3 Colour coordinates

The colour non-uniformity value (ΔEab*) is very low in all cases except in medium and dark shades of the combination D1+D2. It is because of the difference in the hue values of the conventionally processed fabric sample and the enzymatically processed fabric sample. The colour non-uniformity is not significant in other cases. The reasons for this non-uniformity may be problems in the fabric which affect the absorbency, lack of affinity of the fabric towards the particular dye combination, etc.

In case of light shade (0.5%), the colour strength values of conventionally processed fabric samples were slightly more than enzymatically processed fabric samples.

In case of medium shade (2%), the colour strength values are more for conventionally processed fabric sample than enzymatically processed fabric sample, except in the combinations D2 and D1+D2.

<table>
<thead>
<tr>
<th>Dyes</th>
<th>Shade %</th>
<th>L*</th>
<th>C*</th>
<th>h*</th>
<th>ΔEab*</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>C</td>
<td>E</td>
<td>C</td>
<td>E</td>
</tr>
<tr>
<td>D1</td>
<td>0.5%</td>
<td>64.28</td>
<td>60.48</td>
<td>45.98</td>
<td>49.10</td>
</tr>
<tr>
<td></td>
<td>2.0%</td>
<td>47.46</td>
<td>46.44</td>
<td>60.58</td>
<td>60.22</td>
</tr>
<tr>
<td></td>
<td>3.5%</td>
<td>42.27</td>
<td>41.35</td>
<td>60.90</td>
<td>60.57</td>
</tr>
<tr>
<td>D2</td>
<td>0.5%</td>
<td>82.64</td>
<td>81.39</td>
<td>57.63</td>
<td>58.55</td>
</tr>
<tr>
<td></td>
<td>2.0%</td>
<td>77.10</td>
<td>78.06</td>
<td>72.15</td>
<td>72.40</td>
</tr>
<tr>
<td></td>
<td>3.5%</td>
<td>69.46</td>
<td>68.36</td>
<td>88.16</td>
<td>88.40</td>
</tr>
<tr>
<td>D3</td>
<td>0.5%</td>
<td>56.20</td>
<td>55.67</td>
<td>25.95</td>
<td>25.53</td>
</tr>
<tr>
<td></td>
<td>2.0%</td>
<td>38.06</td>
<td>36.79</td>
<td>31.04</td>
<td>30.83</td>
</tr>
<tr>
<td></td>
<td>3.5%</td>
<td>31.04</td>
<td>30.63</td>
<td>31.34</td>
<td>31.26</td>
</tr>
<tr>
<td>D1+D2</td>
<td>0.5%</td>
<td>65.42</td>
<td>63.83</td>
<td>43.34</td>
<td>43.95</td>
</tr>
<tr>
<td></td>
<td>2.0%</td>
<td>51.48</td>
<td>51.86</td>
<td>68.35</td>
<td>61.37</td>
</tr>
<tr>
<td></td>
<td>3.5%</td>
<td>46.27</td>
<td>46.58</td>
<td>65.52</td>
<td>59.81</td>
</tr>
<tr>
<td>D2+D3</td>
<td>0.5%</td>
<td>66.98</td>
<td>66.04</td>
<td>13.43</td>
<td>14.10</td>
</tr>
<tr>
<td></td>
<td>2.0%</td>
<td>42.12</td>
<td>41.79</td>
<td>17.79</td>
<td>17.96</td>
</tr>
<tr>
<td></td>
<td>3.5%</td>
<td>35.21</td>
<td>34.50</td>
<td>17.47</td>
<td>17.32</td>
</tr>
<tr>
<td>D1+D3</td>
<td>0.5%</td>
<td>57.45</td>
<td>55.76</td>
<td>25.73</td>
<td>25.77</td>
</tr>
<tr>
<td></td>
<td>2.0%</td>
<td>34.57</td>
<td>34.17</td>
<td>34.05</td>
<td>33.78</td>
</tr>
<tr>
<td></td>
<td>3.5%</td>
<td>26.40</td>
<td>28.01</td>
<td>33.38</td>
<td>34.00</td>
</tr>
<tr>
<td>D1+D2+D3</td>
<td>0.5%</td>
<td>59.72</td>
<td>58.63</td>
<td>5.61</td>
<td>6.09</td>
</tr>
<tr>
<td></td>
<td>2.0%</td>
<td>39.95</td>
<td>36.09</td>
<td>8.01</td>
<td>8.34</td>
</tr>
<tr>
<td></td>
<td>3.5%</td>
<td>31.85</td>
<td>29.34</td>
<td>8.23</td>
<td>7.96</td>
</tr>
</tbody>
</table>
In case of dark shade (3.5%), the colour strength values are more for conventionally processed fabric sample than enzymatically processed fabric sample, except in the combinations D1+D2 and D1+D3.

4.4 Washing and rubbing fastness

In general, the washing and rubbing fastness results show fair to excellent grades both in conventional and enzymatically processed fabric samples. Washing fastness included change in colour and staining on materials like wool, acrylic, polyester, nylon, cotton and acetate. Rubbing fastness included dry and wet rubbing. In most of the cases, the fastness properties of both the fabric samples were more or less, the same. In the combination D1+D2+D3, the change in colour was slightly less in case of conventional sample than enzymatic sample. In the case of staining with cotton, the conventional sample showed slightly better result. In dry rubbing, the combination D1+D3 showed better fastness properties in the enzymatic sample than the conventional sample.

5. Conclusion

From the results and discussions, it is concluded that the enzymatic processing treatment have many advantages and few disadvantages when compared with the conventional processing treatment.

- Scouring loss is reduced in enzymatically processed fabric because the impurities alone are removed, without damaging the fabric.
- Bursting strength is more and spirality is reduced in the enzymatically processed fabric.
- No significant variations in dimensional properties of both the fabrics.
- No traces of pesticides were found in both the fabrics.
- Variation in colour absorption occurred in only one combination (D1+D2) - medium and dark shades.
- No significant variations in washing and rubbing fastness properties.
- The only disadvantage of the enzymatic process was low whiteness index than the conventional process.

References

[29]. Shenai V.A, "Technology of bleaching and mercerizing", Sevak publication.
1. Introduction

The demand for natural dyes has been increasing in the context of environmental safety throughout the globe. In many of the world’s developing countries, natural dyes can offer not only a rich and varied source of dyestuff but also the possibility of an income through sustainable harvest and sale of these dye plants. Natural dyes have a far superior aesthetic quality which is much more pleasing to the eye. Wearing a naturally dyed textile gives a feeling of being with nature which the consumers are able to enjoy today. The advancements in natural dye processing are able to address a few limitations of natural dyes today. Even though natural dyes are in forefront due to the ban on the use of certain synthetic dyes having the potential to release banned amines on reduction, a lot of repetitive research has been indicating an advanced level of research in the gaps identified.

The colouration of cotton textiles being cellulosic is a mature and highly efficient industrial technology. A number of distinct cotton dyeing processes and classes of cotton dye have been developed and are particularly suited to certain product types. The most commonly used dyes for cotton are reactive, direct, vat and sulphur dyes. The levels of wash-fastness achieved using direct dyes is generally not good, hence manufacturers generally recommend an after treatment to improve it with the compounds which are cationic in nature. Reactive dyes form a covalent bond with cotton fibres, so provide moderate to good fastness properties. Vat and Sulphur Dyes being insoluble in nature are applied by a two-step process in which water-soluble forms of the dye are absorbed by cotton and subsequently after treated to yield insoluble dyes in the fibre to give good to excellent fastness properties. Acid dyes and cationic dyes lack affinity for the cotton fabric and only surface deposition occurs due to the ionic attraction. These dyes can be fixed on cotton with the help of natural or metallic mordant. Similarly, natural colourants which lack affinity for cotton are applied onto the fabric with the assistance of mordants, which help to bind of the dyes to the fabric by forming a chemical bridge from dye to fibre and hence, improves dye-pickup and its fastness properties.

Home furnishings and apparels are exposed to a wide variety of conditions which may affect the fastness of a colour, such as light, perspiration, laundering, dry cleaning, gas fumes and crocking [1]. When a coloured textile is subjected to particular conditions, e.g. during washing one or more of several things may happen. There may be an alteration in hue, colour, value or intensity. In certain cases, there may be an alteration in all three. Further, under certain conditions, e.g. during

---

**Abstract**

As per increasing stringent norms of environment and demand of marigold, it is a necessity to conserve the colorants as well as mordant like alum during colouration of textile. Dyeing of cotton with the marigold flower is achieved by standing bath technique for dyeing as well as mordanting. UV-visible spectrophotometer showed non-relationship between absorbance value and concentration of multiple heated dye bath. The required amount of colourants and mordants were determined by using theoretical calculation as well as experimental outcomes. Thermal property of marigold was studied by FTIR which showed loss of some groups on heating of dye solution. The present study indicates that the results obtained have good potential in saving 80% water and a significant amount of dye, thus causing less effluents and reducing the cost of production.

**Keywords**

Standing bath technique, marigold, cotton, mordant, dyeing.
washing coloured material may acquire new colour and adjacent white material may become coloured due to the transfer of dye from the originally dyed material, which is generally known as staining [2]. The reactions with substituents also lead to colour modification by affecting auxochromes groups [3]. The UV light is an important cause in the weakening of fibres and fabrics, and in the fading of practically all dyes, and in the photo-degradation of many other substances [4]. The type of mordant is also found to be important in determining the light fastness of natural coloured textiles. Some natural colourants undergo marked changes in hue on washing due to the presence of even small amount of alkali in washing mixture, highlighting the necessity to know the pH of alkaline solution used for the cleaning of textiles dyed with natural colourants [5].

However, due to dwindling supply and increasing demand of water in the textile industries, a better alternative is to attempt to further elevate the water quality of wastewater effluent from a secondary wastewater treatment plant to a higher standard for reuse. Thus, far very little attention has been paid to this aspect [6]. The investment in the search for methodologies to more effective treatment of these effluents can be much smaller than that spent in tertiary treatment to remove these products in low level of concentrations and in the presence of much other interference. This requires action that the cost / benefit are reviewed and the development of new techniques for wastewater treatment capable of effective removal of these dyes is intensified and made economically viable [6-7]. An alternative to minimize the problems related to the treatment of textile effluents would be the development of more effective dye that can be fixed on to the fiber with higher efficiency, decreasing losses on tailings waters and reducing the amount of dye required in the dyeing process, reducing certainly cost and quality of the effluent.

In accordance with the sustainability parameters, natural products have been used by many researchers in natural dyeing techniques. A lot of plant sources like tamarind seed coat, flower waste from the temple and Emblicaofficinalis G. fruit (amla), sterculia fruit shell extract etc has been utilized for natural dyeing [8-12]. African marigold (Tagetes erecta L.), a major source of carotenoids and lutein, is grown as a cut flower and a garden flower, in addition to being grown for its medicinal values. Marigold flowers (Tagetes), which are yellow to orange-red in colour, are a rich source of lutein, a carotenoid pigment. Tagetes species belonging to family Asteraceae, are most common in the plant kingdom, which is used in different areas like cosmetic preparation, medicines as well most widely used in textile dyeing. It is found in different colours and different fragrances. The yellow colour is most common. In eastern countries cut flowers are used loose or in garlands for social and religious purposes. Marigold is indigenous to central, eastern and southern parts of Europe. The marigold plant has been grown in European gardens from the 12th century and is used in the popular culture dates back to those times, but it is widely distributed in the world now. Due to the short period needed for its cultivation, it is conveniently grown as part of a monocrop system, rotated with other agricultural or horticultural crops.

The present work deals with a need of sustainable textile processing technology for natural dye application on cotton fabric. The main objective of this study is to explore the potential of using standing bath technique so that amount of dye and mordant used would be optimized which if found successful in effect will cause cost saving as well as saving in water and lowering in effluent load. Thus, it is aimed that after first dyeing is over, the same dye bath would be made use of repeatedly. The addition of some quantity of fresh dye at every stage of new dyeing cycle will be done. In this study, the typical relationship is expected to be found out to replenishment of the used dye baths.

2. Materials and Methods

2.1 Materials
Cotton (100%) was purchased from Arvind Ltd Ahmadabad and chemicals were collected from laboratory grade of S.D Fine Chemicals Ltd Mumbai. Natural waste colorants were collected from Siddhivinayak temple, Mumbai.

2.2 Preparation of mordants solution
A 5% (w/v) stock solution of potassium aluminium sulphate was prepared by dissolving 5 gm of potassium aluminium sulphate in water and final volume of 100 mL was made. Complete dissolution was achieved by proper stirring for a homogeneous solution.

2.3 Extraction of natural colourants
A stock solution of the dye (5%) was prepared by boiling 5 gm dry pulverized marigold flower in 100 mL of water for 1 hour. The extract was filtered and made to original volume and used for dyeing. Reflux method was used for extraction of colourant to achieve the maximum colour yield.
2.4 Mordanting and dyeing process
Mordanting of silk fabrics with 20% (owf) was done in Rota Dyeing Machine with material to liquor ratio 1:30. The fabrics were introduced at a room temperature, then the temperature was slightly increased to 60°C and run for 30 minutes with continuous rotating. After mordanting, fabrics were removed and squeezed and then dyeing was carried with a 50% (5 gm dried flower for dyeing of 10 gm of cotton fabric) shade. The fabrics were introduced at a room temperature and the temperature was raised to 60°C and run for 60 minutes with continuous rotating.

2.5 Absorbance values of dried flower
A spectrophotometer is employed to measure the amount of light that a sample absorbs. The instrument operates by passing a beam of light through a sample and measuring the intensity of light reaching a detector. The intensity of light (Io) passing through a blank was measured. The intensity of light (I) passing through the sample solution was also measured. Experimental data was used to calculate two quantities: the transmittance (T) and the absorbance (A).

\[
T = \frac{I}{I_0}; \quad A = \log_{10}\frac{I}{I_0}
\]

The transmittance is simply the fraction of light in the original beam that passes through the sample and reaches the detector. The remainder of the light, 1 - T, is the fraction of the light absorbed by the sample. In most applications, one wishes to relate the amount of light absorbed to the concentration of the absorbing molecule. It turns out that the absorbance rather than the transmittance is most useful for this purpose. If no light is absorbed, the absorbance is zero (100% transmittance). Each unit in absorbance corresponds with an order of magnitude in the fraction of light transmitted. For A = 1, 10% of the light is transmitted (T = 0.10) and 90% is absorbed by the sample. For A = 2, 1% of the light is transmitted and 99% is absorbed.

2.6 Colour value by reflectance method
The dyed samples were evaluated for the depth of colour by reflectance method using 10-degree observer. The absorbance of the dyed samples was measured on Rayscan Spectra scan 5100+ equipped with reflectance accessories. The Kubelka Munk function or K/S values were determined using the following expression;

\[
K = \frac{(1-R)^2}{2R}
\]

where, R is the reflectance at complete opacity; K is the Absorption coefficient & S is the Scattering coefficient. Dyed fabrics were simultaneously evaluated in terms of CIELAB colour space (L*, a* and b*) values using the Spectra scan 5100+. In general, the higher the K/S value, the higher the depth of the colour on the fabric. L* corresponding to the brightness-darkness (100- white, 0- black), a* to the red-green coordinate (positive - red, negative - green) and b* to the yellow-blue coordinate (positive - yellow, negative - blue). As a whole, a combination of these entire coordinates enables one to understand the tonal variations.

2.7 ATR- FTIR analysis
Attenuated Total Reflection (ATR), Fourier Transform Infrared (FTIR) spectra of the untreated and treated silk fabrics, were recorded using Shimadzu FTIR-8400S machine with a scan rate of 32 scans per minute at a resolution of 1 cm-1 in between 700 - 4000 cm-1.

2.8 Evaluation of washing fastness
Evaluation of colour fastness to washing was carried out using ISO II method. A solution containing 5 g/L soap solution was used as the washing liquor. The samples were treated for 45 min at 50 0C using liquor to material ratio of 50:1 in rota machine. After rinsing and drying, the change in colour of the samples was evaluated on the respective standard scales (rating 1-5, where 1-poor, 2 -fair, 3-good, 4-very good and 5-excellent).

2.9 Evaluation of rubbing fastness
Dyed fabric was tested for colour fastness to light according to BS1006 UK/TN. The light fastness was determined using artificial illumination with Tungsten lamp as a source, at atmospheric pressure and temperature. The samples were compared with the standard scale of blue wool (ratings, 1-8, where 1 - poor, 2 - fair, 3 -moderate, 4 - satisfactory, 5 - good, 6 - better, 7 - very good and 8 - excellent).

2.10 Evaluation of light fastness
Dyed fabric was tested for colour fastness to light according to BS1006 UK/TN. The light fastness was determined using artificial illumination with Tungsten lamp as a source, at atmospheric pressure and temperature. The samples were compared with the standard scale of blue wool.
3. Results and Discussion

3.1 Standing dye bath technique on cotton fabric

In this work, an attempt is made to conserve natural dyes during their application on textiles such as silk by using UV-Spectrophotometer to estimate dye requirement for replenishment. In other words, after the first dyeing was done, the dye bath was replenished with fresh colour and readjusted for next set of dyeing. Marigold dye extract was obtained by refluxing and it was used for calibration dyeing. Optical density against concentration curve was plotted in order to establish the relation between the two. Subsequently, actual dyeing experiments were carried by the pre-mordanting method of dyeing. Alum was used as a mordant. In these cases, after the first dyeing was over, the bath was replenished with fresh dye in different proportion making use of calibration curve which indicated the extent to which the fresh dye solution was to be added. The relationship was attained with respect to the amount of fresh dye liquor required to be used in the next dyeing cycle and then dyeing was repeated. Five times dyeing was repeated before dye bath was finally drained out. The repeat dye bath was adjusted for the equivalent optical density of the liquor after replenishment. Finally, dyeing thus obtained were expected to give equivalent K/S values and thus it was anticipated that a lot of dye, other chemicals as well as water could be conserved with such standing bath technique (SBT) in the dyeing of natural colours like marigold.

The filtrate dye solution was evaporated in the oven for conversion into solid powder form. Then this dried dye powder was used for calibration curve using UV-Visible spectrophotometer by preparing 1% of stock dye solution from oven dried powder. Oven drying was carried out at 70°C for 12 hours. By drying, it was found that when 10 gm of marigold flowers were extracted in 100 ml of water by Reflux extraction at a boil for 1 hour, 3.1 gm of dye powder was obtained. Oven drying was carried out at 70°C for 12 hours. By drying, it was found that when 10 gm of marigold flowers were extracted in 100 ml of water by Reflux extraction at a boil for 1 hour, 3.1 gm of dye powder was obtained. Oven drying was carried out at 70°C for 12 hours. By drying, it was found that when 10 gm of marigold flowers were extracted in 100 ml of water by Reflux extraction at a boil for 1 hour, 3.1 gm of dye powder was obtained. Oven drying was carried out at 70°C for 12 hours. By drying, it was found that when 10 gm of marigold flowers were extracted in 100 ml of water by Reflux extraction at a boil for 1 hour, 3.1 gm of dye powder was obtained. Oven drying was carried out at 70°C for 12 hours. By drying, it was found that when 10 gm of marigold flowers were extracted in 100 ml of water by Reflux extraction at a boil for 1 hour, 3.1 gm of dye powder was obtained. Oven drying was carried out at 70°C for 12 hours. By drying, it was found that when 10 gm of marigold flowers were extracted in 100 ml of water by Reflux extraction at a boil for 1 hour, 3.1 gm of dye powder was obtained. Oven drying was carried out at 70°C for 12 hours. By drying, it was found that when 10 gm of marigold flowers were extracted in 100 ml of water by Reflux extraction at a boil for 1 hour, 3.1 gm of dye powder was obtained. Oven drying was carried out at 70°C for 12 hours. By drying, it was found that when 10 gm of marigold flowers were extracted in 100 ml of water by Reflux extraction at a boil for 1 hour, 3.1 gm of dye powder was obtained. Oven drying was carried out at 70°C for 12 hours. By drying, it was found that when 10 gm of marigold flowers were extracted in 100 ml of water by Reflux extraction at a boil for 1 hour, 3.1 gm of dye powder was obtained. Oven drying was carried out at 70°C for 12 hours. By drying, it was found that when 10 gm of marigold flowers were extracted in 100 ml of water by Reflux extraction at a boil for 1 hour, 3.1 gm of dye powder was obtained. Oven drying was carried out at 70°C for 12 hours. By drying, it was found that when 10 gm of marigold flowers were extracted in 100 ml of water by Reflux extraction at a boil for 1 hour, 3.1 gm of dye powder was obtained.

The truth will set you free, but first it will make you miserable
- James A. Garfield
ment with fresh dye does not give satisfactory values for the dyeings so obtained. An attempt was thus made to study the effect of heat. For this study, 5% dye was extracted and this stock solution was taken for further study.

Initially, dyeing was carried out using this extracted dye solution and it was considered as the first sample. Then only extracted dye solution was heated for 60°C for 60 minutes in rota dyer, same as dyeing condition without a sample. The second sample was dyed from this heated stock dye solution. Similarly, again same extracted dye solution was heated for 60°C for 120 minutes in rota dyer and dyed the third sample from this solution. A similar experiment was carried for 180, 240 minutes and samples were dyed. Finally, the fabric performance was assessed by K/S values of the dyeing and it became very clear that there was a reduction in K/S values of the dyed substrate due to the multiple times heating of dye solution in the same bath as shown in Figure 3.2 Results show that heating of same dye bath for multiple times in standing bath is responsible for giving non-linear relationship, because of loss in affinity of dye towards the fabric due to heating. Hence, we cannot simply use the exact amount of dye for replenishment of bath by using calibration curve and it needs some more fresh dye solution [13].

Furthermore, another study was considered for heating effect on the optical density of dye solution. For this 5, 10, 15, 20, 25 and 30 ml of dye solution was taken and its volume was made to 100 ml with water. These six different concentration solutions were heated individually for 60, 120,180, 240 minutes. Optical density values of there were assessed of these solutions at intervals of 60 minutes as shown in Figure 3.3 Results show that optical density was not affected by heating of natural marigold dye solution. In other words as observed earlier, optical density measurement and adjustment for preparing repeat baths, do not comply with final dyeing which is required to be of almost same K/S values for perfect colour matching in various batches of dyeing.

This further indicates that there should be further additional fresh dye needs to be added, over and above the amount required to adjust for getting same optical density (O.D). In other words with repeat bath, starting O.D. of the bath will go on increasing as we go for a higher number of baths for repeat dyeing.

3.4 Replenishment of dye bath by trial and error method for cotton

The prediction was made to replenish the dye bath by using trial and error method. In the pre-mordanting method, first mordanting was carried out and followed by dyeing. The fresh mordanting bath was used for mordanting for each sample with the application of 20% (owf). Dyeing was performed for 50% of shade at 60°C for 60 minutes in rota dyer. The results in Table 1 show the trend of concentration variation of replenishment of dye bath. When 75% fresh dye solution was used for replenishment there was an increase in K/S values than that of the K/S obtained for the initial bath sample. For every additional 2% dye solution, the
K/S values further increased. For 75% + 6% fresh dye addition maximum increase in K/S was as high as 31.19% as compared to the initial bath sample.

**Table 3.1: Trend of depth in trial and error method (1st trial)**

<table>
<thead>
<tr>
<th>Bath No.</th>
<th>(% Addition)</th>
<th>K/S (75%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Bath 1 = Initial bath</td>
<td>14.91 (% change)</td>
</tr>
<tr>
<td>2</td>
<td>Bath 2 = Bath 1 + 75% of fresh dye solution</td>
<td>15.28 (+2.48)</td>
</tr>
<tr>
<td>3</td>
<td>Bath 3 = Bath 2 + 77% of fresh dye solution</td>
<td>17.10 (+14.69)</td>
</tr>
<tr>
<td>4</td>
<td>Bath 4 = Bath 3 + 79% of fresh dye solution</td>
<td>17.92 (+20.19)</td>
</tr>
<tr>
<td>5</td>
<td>Bath 5 = Bath 4 + 81% of fresh dye solution</td>
<td>19.56 (+31.19)</td>
</tr>
</tbody>
</table>

The results in Table 3.2 show the trend of concentration variation of replenishment of dye bath and K/S values. When 70% + 2% increase on every stage was used for replenishment, there was a gradual increase in K/S values than that of the K/S obtained from initial bath sample. For 76% (70% + 6%) fresh dye addition, maximum increase in K/S was as high as 14.45% as compared to initial bath sample.

**Table 3.2: Trend of depth in trial and error method (2nd trial)**

<table>
<thead>
<tr>
<th>Bath No.</th>
<th>(% Addition)</th>
<th>K/S (70%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Bath 1 = Initial bath</td>
<td>14.95 (% change)</td>
</tr>
<tr>
<td>2</td>
<td>Bath 2 = Bath 1 + 70% of fresh dye solution</td>
<td>15.41 (+3.07)</td>
</tr>
<tr>
<td>3</td>
<td>Bath 3 = Bath 2 + 72% of fresh dye solution</td>
<td>16.08 (+7.59)</td>
</tr>
<tr>
<td>4</td>
<td>Bath 4 = Bath 3 + 74% of fresh dye solution</td>
<td>16.84 (+12.64)</td>
</tr>
<tr>
<td>5</td>
<td>Bath 5 = Bath 4 + 76% of fresh dye solution</td>
<td>17.11 (+14.45)</td>
</tr>
</tbody>
</table>

When 65% was used for replenishment there was K/S near about the same than that of the obtained from initial bath sample and that of maximum variation of 2.27% (Refer Table 3.1). Finally, this 65% addition was optimised by trial and error method and was used further. Hence, we used this concentration as an optimised concentration. The results of this optimised experiment using 65% + 2% increase in every next bath for the addition of fresh dye in standing bath are given in Table 3.3

**Table 3.3: Trend of depth in trial and error method (3rd trial)**

<table>
<thead>
<tr>
<th>Bath No.</th>
<th>(% Addition)</th>
<th>K/S (65%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Bath 1 = Initial bath</td>
<td>14.98 (% change)</td>
</tr>
<tr>
<td>2</td>
<td>Bath 2 = Bath 1 + 65% of fresh dye solution</td>
<td>15.32 (+2.27)</td>
</tr>
<tr>
<td>3</td>
<td>Bath 3 = Bath 2 + 67% of fresh dye solution</td>
<td>15.31 (+2.21)</td>
</tr>
<tr>
<td>4</td>
<td>Bath 4 = Bath 3 + 69% of fresh dye solution</td>
<td>15.08 (+0.67)</td>
</tr>
<tr>
<td>5</td>
<td>Bath 5 = Bath 4 + 71% of fresh dye solution</td>
<td>15.12 (+0.93)</td>
</tr>
</tbody>
</table>

Then 65% of dye addition for next dye bath was optimised from initial stock dye solution and then every time 2% increasing addition was made in next dyeing baths and these details are shown in Table 3.4 By 65% addition with 2% increase, which was optimised on the basis of achieving near about same K/S values for the final dyeing obtained by replenishment up to five baths. Also, it was found that the deviation in K/S values of the dyed sample up to five baths was maximum up to 2.27%, which is quite acceptable. Looking at a* and b* values, there was not much difference in tonal variation.

**Table 3.4: Effect of standing bath technique on dyeing of cotton**

<table>
<thead>
<tr>
<th>Bath No.</th>
<th>Quantity of dye solution addition (ml)</th>
<th>K/S Values</th>
<th>L*</th>
<th>a*</th>
<th>b*</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Bath 1 = Initial bath</td>
<td>14.98 (% change)</td>
<td>64.68</td>
<td>0.82</td>
<td>53.22</td>
</tr>
<tr>
<td>2</td>
<td>Bath 2 = Bath 1 + 65% of fresh dye solution</td>
<td>15.32 (+2.27)</td>
<td>66.79</td>
<td>2.25</td>
<td>58.38</td>
</tr>
<tr>
<td>3</td>
<td>Bath 3 = Bath 2 + 67% of fresh dye solution</td>
<td>15.31 (+2.21)</td>
<td>67.38</td>
<td>2.61</td>
<td>59.75</td>
</tr>
<tr>
<td>4</td>
<td>Bath 4 = Bath 3 + 69% of fresh dye solution</td>
<td>15.08 (+0.67)</td>
<td>67.04</td>
<td>2.23</td>
<td>58.54</td>
</tr>
<tr>
<td>5</td>
<td>Bath 5 = Bath 4 + 71% of fresh dye solution</td>
<td>15.12 (+0.93)</td>
<td>66.98</td>
<td>2.11</td>
<td>58.55</td>
</tr>
</tbody>
</table>

**3.5 Fastness properties of standing bath dyed samples**

Performance properties such as wash fastness, light fastness, and rubbing fastness were measured. Wash fastness assessed by using ISO II methods and ratings are shown in Table 5 which indicate that it was between 4-5 (very good to excellent). Light fastness values were constant of rating 6 (good). Dry rubbing fastness properties were 4 to 5 i.e. very good to excellent and wet rubbing fastness was in between 3 to 4(fairly good to good). All five bath samples showed good fastness properties, which are all acceptable. In
the post-mordanting method, dyeing was performed for 50% of shade at 600°C for 60 minutes in rota dyer followed by mordanting. The fresh mordanting solution was used for mordanting of each sample at a concentration of 20% (owf).

Table 3.5: Effect on fastness properties of standing bath dyed samples

<table>
<thead>
<tr>
<th>Bath number</th>
<th>Wash Fastness</th>
<th>Light Fastness</th>
<th>Rubbing Fastness</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Fastness</td>
<td>Dry</td>
<td>Wet</td>
</tr>
<tr>
<td>1</td>
<td>4-5</td>
<td>6</td>
<td>4-5</td>
</tr>
<tr>
<td>2</td>
<td>4-5</td>
<td>6</td>
<td>4-5</td>
</tr>
<tr>
<td>3</td>
<td>4-5</td>
<td>6</td>
<td>4-5</td>
</tr>
<tr>
<td>4</td>
<td>4</td>
<td>6</td>
<td>4-5</td>
</tr>
<tr>
<td>5</td>
<td>4</td>
<td>6</td>
<td>4-5</td>
</tr>
</tbody>
</table>

3.6 Effect of standing dye bath on K/S values on dyed cotton for post-mordanting dyeing technique

Here, 80% (trial and error) of dye added for next dye bath were optimized from initial dye solution and then goes on increasing with addition by 2% in next dyeing baths as per the details are shown in Table 3.6 By 80% addition with increment of 2%, which was optimized on the basis of achieving same K/S values by replenishment up to five baths. Also, the deviation in K/S values of the dyed fabric of up to five baths was limited to a maximum of 2.07%. By this post-mordanting method depth achieved was higher than pre-mordanting method, also it gave slightly redder tone.

Table 3.6: Effect of standing dye bath on K/S values of dyed cotton

<table>
<thead>
<tr>
<th>Bath No.</th>
<th>Quantity of dye solution addition (ml)</th>
<th>K/S Values</th>
<th>L*</th>
<th>a*</th>
<th>b*</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Bath 1 = Initial bath</td>
<td>18.39</td>
<td>62.86</td>
<td>8.753</td>
<td>61.42</td>
</tr>
<tr>
<td>2</td>
<td>Bath 2 = Bath 1 + 80% of fresh dye solution</td>
<td>18.01</td>
<td>65.37</td>
<td>8.256</td>
<td>65.26</td>
</tr>
<tr>
<td>3</td>
<td>Bath 3 = Bath 2 + 82% of fresh dye solution</td>
<td>18.69</td>
<td>64.53</td>
<td>8.154</td>
<td>63.55</td>
</tr>
<tr>
<td>4</td>
<td>Bath 4 = Bath 3 + 84% of fresh dye solution</td>
<td>18.60</td>
<td>64.37</td>
<td>8.453</td>
<td>64.01</td>
</tr>
<tr>
<td>5</td>
<td>Bath 5 = Bath 4 + 86% of fresh dye solution</td>
<td>18.13</td>
<td>64.88</td>
<td>9.002</td>
<td>65.48</td>
</tr>
</tbody>
</table>

3.7 Assessment of fastness properties on dyed cotton fabric for post-mordanting dyeing technique

Fastness properties assessed such as wash fastness, light fastness, and rubbing fastness were measured for all the dyed samples. The results of wash fastness were assessed by ISO II method and ratings are shown in Table 7, which lye in between 3-4 (i.e. good to very good). The light fastness values are constant of rating 6 (good). Dry rubbing fastness properties were lying between 4/5 i.e. very good to excellent and wet rubbing fastness 4 (very good). All five bath samples showed near about satisfactory fastness properties. In the meta-mordanting method, dyeing and mordanting were performed at the same time in the same bath. Dyeing was performed for 50% shade from 5% stock solution and 20% (owf) of mordant at 600°C for 60 minutes in rota dyer.

Table 3.7: Effect of standing bath technique on fastness properties of dyed fabric

<table>
<thead>
<tr>
<th>Bath number</th>
<th>Wash Fastness</th>
<th>Light Fastness</th>
<th>Rubbing Fastness</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Fastness</td>
<td>Dry</td>
<td>Wet</td>
</tr>
<tr>
<td>1</td>
<td>1</td>
<td>3-4</td>
<td>6</td>
</tr>
<tr>
<td>2</td>
<td>2</td>
<td>3-4</td>
<td>6</td>
</tr>
<tr>
<td>3</td>
<td>3</td>
<td>4</td>
<td>6</td>
</tr>
<tr>
<td>4</td>
<td>4</td>
<td>3-4</td>
<td>6</td>
</tr>
<tr>
<td>5</td>
<td>5</td>
<td>3-4</td>
<td>6</td>
</tr>
</tbody>
</table>

3.8 Effect of standing bath on K/S values on dyed cotton by meta-mordanting dyeing technique

Here, 70% of dye addition and 10% of mordant addition were optimized from initial dye solution and then it went on increasing by the addition of 2% for next dyeing baths for dye as per the details shown in Table 3.8 By 70% addition, with 2% increment was optimized on the basis of achieving same K/S values by dyed fabric up to five baths. In the case of mordant concentration, it was kept at 10% constant without progressive increment in mordant. Also, the deviation of K/S values up to five baths was maximum of 2.21% for consecutive samples.

"In rivers, the water that you touch is the last of what has passed and the first of that which comes; so with present time."

- Leonardo da Vinci
Table 3.8: Effect of standing bath on K/S values of dyed cotton

<table>
<thead>
<tr>
<th>Bath No.</th>
<th>Quantity of dye solution addition (ml)</th>
<th>K/S Values</th>
<th>L*</th>
<th>a*</th>
<th>b*</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Bath 1 = [50% (owf)dye + 20% (owf) mordant]</td>
<td>16.30 (68.04)</td>
<td>6.62</td>
<td>69.33</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>Bath 2 = Bath 1 + 70% of fresh dye solution + 10% mordant</td>
<td>15.94 (-2.21)</td>
<td>67.39</td>
<td>6.002</td>
<td>67.13</td>
</tr>
<tr>
<td>3</td>
<td>Bath 3 = Bath 2 + 72% of fresh dye solution + 10% mordant</td>
<td>16.14 (-0.98)</td>
<td>69.20</td>
<td>5.39</td>
<td>68.71</td>
</tr>
<tr>
<td>4</td>
<td>Bath 4 = Bath 3 + 74% of fresh dye solution + 10% mordant</td>
<td>16.06 (-1.47)</td>
<td>69.63</td>
<td>4.88</td>
<td>68.12</td>
</tr>
<tr>
<td>5</td>
<td>Bath 5 = Bath 4 + 76% of fresh dye solution + 10% mordant</td>
<td>15.98 (-1.96)</td>
<td>69.88</td>
<td>4.69</td>
<td>68.06</td>
</tr>
</tbody>
</table>

3.9 Fastness properties of standing bath of dyed cotton by meta-mordanting dyeing technique

Performance properties such as wash fastness, light fastness, and rubbing fastness were measured. Wash fastness were assessed by using ISO II methods and ratings are shown in Table 3.9 which indicate that it was between 4-5 (very good to excellent). Light fastness values were constant of rating 6 (good). Dry rubbing fastness properties were 4 to 5 i.e. very good to excellent and wet rubbing fastness was in between 3 to 4 (good to very good). All five bath samples showed acceptable or satisfactory fastness properties.

Table 3.9: Effect on fastness properties of cotton fabric

<table>
<thead>
<tr>
<th>Bath number</th>
<th>Wash Fastness</th>
<th>Light Fastness</th>
<th>Rubbing Fastness Dry</th>
<th>Rubbing Fastness Wet</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>1</td>
<td>4</td>
<td>6</td>
<td>4-53-4</td>
</tr>
<tr>
<td>2</td>
<td>2</td>
<td>3-4</td>
<td>6</td>
<td>4-54</td>
</tr>
<tr>
<td>3</td>
<td>3</td>
<td>4</td>
<td>6</td>
<td>4-53-4</td>
</tr>
<tr>
<td>4</td>
<td>4</td>
<td>4</td>
<td>6</td>
<td>4-53-4</td>
</tr>
<tr>
<td>5</td>
<td>5</td>
<td>4</td>
<td>6</td>
<td>5 3-4</td>
</tr>
</tbody>
</table>

3.10. Effect of different mordanting methods on depth of cotton fabric

Figure 4 clearly shows that there was the difference in depth of shade with respect to mordanting methods. Out of three methods, post-mordanted samples gave more depth than meta-mordanted samples which were followed by pre-mordanted samples. It is to note that the mechanism with which mordant works in the dyeing of natural dye is that of complex formation. Hence, in the pre-mordanting method where the fabric is first impregnated in mordant, it is within the fibres and subsequent top dyeing makes the metal mordant has to attract the dye within the interior of the fabric. Whereas in a post-mordanting method, the metal is on the top of the dye applied and will attract the dye upwards. Hence, the relatively higher amount of dye will be on the surface as compared to the reverse case of pre-mordanting, where the dye-metal complex will be relatively in the interior. Thus post-mordanting gives higher K/S values as compared to pre-mordanting. However, the fastness properties of post-mordanting dyed samples such as wash fastness are inferior to those obtained for pre-mordanting, supporting the mechanism proposed.

Figure 3.4: Relationship between different mordanting methods and K/S values

4. Conclusions

Replenishment of dye bath for cotton dyeing by pre-mordanting method was achieved at 65% of initial dye concentration with progressive increase in 2% in addition to the next dye bath. In the case of the post-mordanting method, it was achieved at 80% of fresh dye addition, as initial dye concentration with progressive increment in 2% for next dye bath. For the post-mordanting method, 70% of dye along with 2% increase in every single step of dyeing was used in addition to 10% of the original fresh mordant used bath was sufficient. Also, all these replenished bath samples showed good fastness properties. The light fastness was 6 (good), wash fastness was in the range 3-4 (very good to very good). Dry rubbing fastness was 4 to 5 (very good to excellent) and a wet rubbing fastness was in the range 3 to 4 i.e. good to very good. Also, this method saved almost about 80% of water which was required in every bath for dyeing and hence, this method generates only 20% effluent with the same shade reproducibility on fabric depth and also saves...
on dye. This standing bath technique of natural dyeing is having thus great potential saving of dye, water and thus cost of production.

References
Performance Enhancing Sportswear - A Review

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Abstract
The essential requirements of a regular sportswear apparel is thermal comfort and freedom of movement, other properties such as dimensional stability, odour reduction, light weight etc. are also desirable. As the competition among sportspersons is increasing now-a-days, the sports technology has improved a lot and performance enhancing sportswear is one of the key factor in high speed sports. The two major aspects of performance enhancement is - firstly, compression wear, which involves application of graded pressure on to specific parts and secondly, the study of aerodynamic behavior to reduce fluid drag in high speed sports. The present paper reviews the work in the field of performance enhancing sportswear - the approaches and evaluation techniques followed by various researchers.

Keywords
Aerodynamic drag, compression garments, recovery, sportswear, stretch, thermal comfort.

1. Introduction
The performance of engineered sports apparel is largely determined by complex relations between various factors - material surface structure, mechanical properties, thermal and moisture characteristics and the size and shape of the athlete’s body. Sports apparel with advanced performance characteristics has had a major impact in high speed sports such as ski jumping, downhill skiing, cycling, speed skating, swimming and sprint running [1]. The main requirements of sports fabrics can be classified into two main categories - Essential requirements and Performance enhancement needs. Thermo-physiological comfort and freedom of movement are the fundamental necessities apart from dimensional stability, light weight, odour reduction etc. The other aspect of sportswear is performance enhancement of the sportsperson. Two principles primarily govern the design and engineering of Performance Enhancing Sportswear i.e. application of compression on specific muscles to increase blood flow and application of principles of aerodynamics to reduce wind or air drag in high speed sports like skiing [2]. Lots of research and review articles concerned with various aspects of thermal comfort and elastic behavior of knitted fabrics have been reported. [3-7,28-31] However there is a lack of comprehensive coverage of various research work in the field of Performance Enhancing Sportswear. Therefore in present paper an attempt has been made to consolidate the work in this area. The impact of nanotechnology in various areas has also been discussed.

2. Essential Functional Requirements
2.1 Thermo-Physiological Comfort
The important textile properties for thermo physiological comfort are - Thermal conductivity, Moisture vapour permeability, Water absorption, Wettability, Wicking, Rate of drying and Air permeability. [4] Waterproof breathable fabrics that convey water vapour [body perspiration] out through the material while remaining impervious to external liquids are widely used in sportswear.

The influence of two production parameters which are tension and elastane composition were investigated on the comfort characteristics of the compression garments. Specifically, the absorption and wicking characteristics were found to be closely related with the porosity of the fabrics whereas the vertical wicking characteristics were influenced from the changes in pathways and disturbances of the pores of the fabric. Drying on the other hand, was found to be closely related with the thickness and initial water content of the fabric [8].

It was reported that fabrics knitted at longer loop length has more permeability to air and moisture vapour with better absorption and overall moisture management capacity but lower in-plane wicking as compared to fabric knitted at shorter loop length [9].

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Email : dhirendra.mlvti@gmail.com
The concept of layered clothing has been popular in sportswear design. In layered clothing, the functions of various layers can be optimized according to specific end use and climatic conditions and seasons. Usually, three layers are identified - inner layer provides comfort by keeping skin dry, mid layer provides thermal insulation and outer layer protects from wind and/or water. In layered fabric, the inner layer made of hydrophobic filaments and outer layer made of hydrophilic fibre is preferred [3].

Tetra channel and hexa channel fibre cross-sections offer more surface area for liquid to transport and gives better wicking ability and faster drying [3]. High tech synthetic fabrics are light weight, capable of transporting moisture efficiently, and dry relatively quickly. Gore-tex, an innovative water proof breathable material, comprises of extended layer of microporous PTFE sandwiched between two layers of nylon. The size of the smallest drop of water is greater than 100 µm and the size of water vapour molecule is in the range of 0.0004 µm. The pores of Gore-tex are less than one micrometer in diameter, a single water drop is about 20,000 times bigger than the holes in microporous GORE-TEX, and a water molecule is about 700 times smaller than the pores. Thus it selectively transfers water vapour only and prevents liquid water transport [10].

2.2 Freedom of Movement
The sportswear fabric needs stretch and recovery properties to be a close fit to the body and also complete recovery after stretching. There are two quantities that are generally measured: one is the extension at a given load, which is a measure of how easily the fabric stretches; the other is how well the fabric recovers from stretching to this load, usually measured as growth or residual extension.

The typical values of stretch that are encountered during the actions of sitting, bending, or flexing of knees and elbows are Back flex 13-16%, elbow flex lengthwise 35-40%, circumferentially 15-22%, seat flex 25-30%, across 6% and knee flex lengthwise 35-45%, circumferentially 12-14%.

Knitted fabrics are preferred for sportswear, as these fabrics have greater elasticity and stretchability as compared to woven fabrics. [35] Knitted fabrics allow better extensibility, recovery, shape retention and vapour transmission than woven fabrics. [36] Technical knitted fabrics that are moisture wicking tend to be more open in structure on the back than on the face. [5]

Lycra [Elastane] is widely used in sportswear for its superior stretch and recovery properties. Dynamic Elastic recovery [DER] can assess the instantaneous garment response due to body movement; the bare elastane plaited fabric is found to have higher DER than fabric knitted from spandex core-spun [3].

3. Performance Enhancement Needs
3.1 Compression Athletic Wear
The application of compression on specific muscles to increase blood flow is used to enhance the performance of a sportsperson. The degree of pressure produced by a compression garment is determined by a complex interrelation between the following principal factors: the construction and fit of the garment, structure and physical properties of its materials, the size and shape of the part of the body to which it is applied and the nature of the sporting activity undertaken. It has been proposed that the ratio of tensile force T to circumference C represents a quantitative measure that may provide an approximation of many fabric properties that are relevant in design of compression and general sports garments.[33]

The pressure threshold of discomfort was found to be around 70g/cm² which is close to the average capillary blood pressure of 80g/cm² near the skin surface [6]. Biomechanical considerations form the basis of design of specialized clothing classes e.g. sportswear, where compression may be applied on selected muscles to enhance performance and reduce fatigue [11]. Compression garments are reported to cause reduction in metabolic energy consumed for running at specific speed. It additionally enhances lactate removal and improves oxygen supply. It has been reported that compression shorts resist fatigue due to reduced muscle oscillation during landing in sports like sprints or jump events [3].

The effects of compression apparel on the damping of soft tissue vibration and muscle activity during treadmill running have been investigated. The results showed that the compression apparel increased the damping and decreased the muscle activity. Compression apparel has a positive effect on soft tissue vibration damping and muscle activity in running [12].

Fabrics knitted with lower loop length, coarser elastane
and modified cross-section of polyester filament show higher interface pressure with lower rate of pressure drop and good elastic recovery [9].

The tight fit and elastic nature of the garment may have a performance enhancement and injury reduction role by assisting the muscles [13].

The implications for the use of compression garments as a means for improving recovery after exercise have been studied. The lowered systolic venous pressure after exercise suggested that external pressure applied to the lower limbs could make the superficial veins less compliant, reducing venous pooling and possibly improving muscle oxygenation [14].

The impact of different laid-in stitches knitting designs on structural characteristics, tension behavior, and interfacial pressure performances induced by circular knitted fabrics through knitting constructional design have been investigated. The elastic hoses with corporations of laid-in and more tuck loops generated the lower values in elastic hysteresis and tensile energy in both course and wale directions in stretch, while the hoses with more inlay threads floated behind technical face increased the elongation property but reduced tensile resilience properties [15].

An attempt has also been made to study the effect of inlay yarn pre-tension at the time of manufacturing of stretch fabrics on the pressure generated by the garments. [32]

Recent developments in fibres, fabrics, and finishing technologies enabled researchers to develop compression sportswear that is based on a graded application of pressure to the extremities of the body in order to pump the blood back to the heart faster.

The reported benefits of compression wear are - reduce muscle soreness and swelling, reducing muscle oscillation during a vertical jump or fall, increase VO₂ max [a physiological index of sports performance], reduce collection of blood lactate levels in the tissue, reduce muscle injury or cramps [16]. VO₂ is a measure of cardiovascular fitness. It is maximum rate of oxygen measured during incremental exercise.

Warp knitted fabrics are used with multiple fine quality yarns. These fabrics do not have any natural stretch. The spandex mix imparts desired amount of elasticity and perfectly controlled compression. Circular knit fabrics, which have natural stretch make it difficult to maintain the appropriate level of compression, moreover, it is less durable and likely to run if snagged[17].

The high density caused by shrinkage in the course-wise due to yarn floating rather than overlapping influenced the weight and thickness of knitted fabrics. Yarn floating reduced course-wise elasticity and increased wale-wise elasticity in the fabric stretch test; however, yarn overlapping reduced elasticity in both directions.

3.2 Aerodynamic Drag

In high speed sports a major part of the athlete’s force is used to overcome wind resistance, for example in outdoor cycling it is typically 90%, and in high speed ice skating, it is more than 75%. Therefore it is fair to assume that even a small improvement in the aerodynamic properties can cause a considerable enhancement of performance [19]. The drag force has two components - one is friction drag-acting on the surface in the boundary layer and other is the pressure drag-which is due to pressure difference between the windward and leeward side of the body. With high pressure in the front, and low pressure behind, the cyclist feels the pull backwards, resulting in reduction in his speed. The surface structure [roughness, seam and fibre direction] of sports garments has significant effect on aero/hydrodynamic drag. [1]

The instrument used to measure aerodynamic drag is a wind tunnel, which consists of a tubular passage with the object under test mounted in the middle. Air is made to move past the object by a powerful fan system or other means. The test object is instrumented with suitable sensors to measure aerodynamic forces, pressure distribution, or other aerodynamic-related characteristics. Instead of the air standing still and an object moving at speed through it, the same effect
would be obtained if the object stood still and the air moved at speed past it. In that way a stationary observer could study the moving object in action, and could measure the aerodynamic forces being imposed on it. [20]

![Figure 3.2: Experimental arrangement to measure lift and aerodynamic drag [21]](image)

The double layer concept of knitted fabrics is suitable for performance sportswear, where each layer is separate from the other. Aerodynamic properties of this assembly, where the base layer is made of 100% wool and an external layer made of 100% filament polyester were determined. Fabric samples were placed over a single diameter cylinder to imitate the human leg. The aerodynamic resistance was acquired at different speeds relevant to high speed winter sports. In general, it is established that the surface roughness has an important effect on the drag coefficient. Garment surface roughness depends on combination of factors such as fibre choice and fabric construction; porosity [openness/tightness] and thickness of fabric assembly. All of these factors, in turn, depend on fabric's cover factor [CF]. Cover factor is the most important factor for the determination of fabric's physical properties. [22]


The standard cylindrical arrangements in wind tunnel environments that can provide precise data on aerodynamic drag and lift and can be correlated to fabric surface textures and material properties has been examined. Due to complex surface structure, the aerodynamic behavior of a fabric is significantly different compared to a smooth surface [21].

The aerodynamic drag of three commercially available nylon/spandex running apparel at four velocities has been measured. Under all conditions, the high sheen and tight fit allowed air drag reduction of between 17.5% to 7.4% at running speeds. A hood over hair was responsible for 6 of 7.4% reduction in air drag. [23]

The fundamental difference between knitted and woven fabric structures makes the former favourable in body fitting apparel such as aerodynamic sports apparel. The aerodynamic properties of the fabrics depend on the air permeability and on the roughness of its resultant surface. [19]

It has been recommended to use filament yarn rather than spun yarn in high performance suits. [24] Textiles with high permeability had higher drag than textiles with low permeability at super critical speeds. The effect of stretching on aerodynamic drag of alpine ski competition suits has been reported. Results indicated that roughest fabrics experienced flow transition at somewhat higher speed when stretched to 100% indicating that surface becomes smoother. [25]

The aerodynamic behaviour of 80/20 PET/spandex knitted fabrics under a range of angles of attack [0 to 90 degrees] has been investigated and all the three forces [drag, lift and side forces] and three moments [yaw, pitch and roll] at a time has been reported. The maximum and minimum value of lift to drag ratio was obtained at 45 and 75 degree respectively. [26]

In a number of sport disciplines characterized by high speed, aerodynamic performance of sports apparel is a major concern. The goal is to reduce the aerodynamic drag force and thereby increase speed. One fabric property which has been considered an influencing parameter on aerodynamic performance is the air permeability. A weak dependence of flow transition on air-permeability could be found, but this could be considered to have a limited effect on the aerodynamic performance of sports garments. [27].

### 3.3 Nanotechnology

Has gained much momentum in recent years due to its wide application of principles and products. One of the biggest problems in sports is that of smelly gym clothes and sports equipment. Silver has been used traditionally due to its natural antibacterial and antifungal properties. This is where nanotechnology comes...
Nano silver particles that typically measure around 25 nm gives particles a small volume, but a very large surface area at the same time. The large surface area enables the particles to interact with more bacteria and fungi, which greatly improves its effectiveness in killing them.[34]

Developments in nanofibres, nano-finishes, nano-membranes and nano-composites can be used to impart antimicrobial, anti UV, moisture control, thermo regulation properties etc. at the molecular level without affecting the inherent flexibility and comfort of the fabric [11]. Nanotechnology is allowing scientists to create new, ultra-light weight swimwear that allows the swimmer to practically glide through the water. The water absorbed by the new fabrics is 2% of the fabric weight compared to the 50% absorption of the previous materials, resulting in low drag swimwear. [34]

4. Summary

◆ Sports apparel requirements can be classified into two categories - essential ones - Thermo-physiological comfort and freedom of movement and performance enhancement - compression wear and aerodynamic aspects.

◆ The concept of layered clothing, with the inner layer made of hydrophobic filaments and outer layer made of hydrophilic fibre and tetra channel and hexa channel cross-sectional fibres having more surface area for liquid to transport are widely popular for their better wicking ability and faster drying. Gore-tex, a water-proof breathable material is also being widely used in sports apparel.

◆ Lycra, for its superior stretch and recovery properties, in combination with filament yarns having warp knitted structures is used for highly elastic sports apparel.

◆ Compression garment, by creating an external pressure gradient, thereby reducing the space available for swelling, is widely used in sports garments. The compression garments provide the wearer with the enhanced blood flow, better muscle oxygenation, reduced fatigue, faster recovery, reduced muscle oscillation and reduced muscle injury.

◆ In a number of sport disciplines characterized by high speed, aerodynamic properties of sports apparel is a concern. The goal is often to reduce the aerodynamic drag force and thereby increase speed. The various factors affecting aerodynamic drag are- textile type, garment fitting, garment stretching, air permeability, seam positioning etc.

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Creation of Innovative Value Added New Generation Fabrics by Application of Specialty Synthetic Yarns

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Abstract
The focus of this article is to use specialty synthetic yarns for producing specialty fashion, comfort and utility fabrics. In the developed and developing countries specialty fabrics of today are being produced by application of specialty yarns. However in less developed countries, conventional commodity yarns are being used in making of fabrics. In the developed and developing countries regular exhibitions are being held on such specialty man made yarn and fibres like Nylon, Polyester, Rayon, Acrylic, etc. Leading fabric manufacturers like Tactel/Dupont, Nylstar, Li-Peng, etc. take active participation to create awareness on the changing trends in the textiles.

Saree and dress material manufacturers in India like Surat, always look for new yarns for creating value added distinct apparels on continuous basis as competition is quite severe. In fact, countries like Japan and China are using such specialty synthetic yarns to make apparels for India. Through this article, I am making an attempt to encourage use of specialty man made yarns for making fashion fabrics, silk like fabrics for enhanced lustre, comfort fabrics and safety fabrics like flame retardant fabrics.

Keywords
Hollow light weight, more yield, Shaped yarns, Cool effect, Air Permeability, Unique Dye effects

1. Introduction
In the present competitive environment, fabrics producers, who are open to change and diversification, have opportunities to survive and grow. In the textile world, innovation in yarn & fibres is continuously growing, having definite bearing on potential to develop new product range of textile apparels & fashion fabrics. The focus of the article is to create awareness on the availability of such specialty/next generation yarn and fibres to create new woven and knitted fabrics, just by their applications.

Product life cycle have its own age and goes on changing with the changing needs of the customers. Hence we need to diversify from commodity products and mould ourselves to the changing product life cycle.

Product life cycle:- Kindly Visualise, as above, the product life cycle. Products are developed and introduced in the market (Introduction phase). If the products are accepted by the end users, then growth of the product (Growth phase) starts. Producers earn profits as long as there is pull for the product by the customers. After some time each product becomes commodity product and hence demands and value addition starts coming down. This is called as maturity phase. At this juncture the manufacturers need to take position to survive and grow because decline phase affects the business adversely. The consumers always look for new and innovative ways to continuously add value and demand for their products.

Figure 1.1: Product life cycle

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2. Present Textile Scenario

Natural yarns like Cotton and silk yarns were developed and remained as king for making textile apparels for a long time. Cotton availability declined due to requirement of land for other purpose like growing grains and vegetables. Real estate development also came in picture which reduced availability to grow cotton. With increased labour and processing cost, the cost of cotton yarn went on increasing. Similarly pure silk has declined due to cost of growing and labour cost. At this point, substitution of natural yarns started coming. Polyester yarn started replacing cotton in a big way due to low cost and better properties. Nylon yarn started replacing silk. Hence Polyester and Nylon dress material and Saree with new versatile designs became fact of life in the textile apparels.

Commodity polyester yarns came in huge volumes. Similarly nylon commodity also saturated the dress material, Sarees and other woven and knitted goods market. Now trend started modernising and so decline of commodity Polyester & Nylon yarns started for use in textiles. Now product life cycle has shifted to new Specialty products in Nylon, Polyester and also in Rayon.

In this article, new next generation man made yarns shall be projected for fulfilling changing needs of the customers and end users.

◆ Specialty Synthetic Yarns to Produce Next Generation/Specialty Woven and Knitted Fabrics:-
Recent developments in the Man Made Specialty Yarn and Fibres are revolutionary. Some of them are:

A) Special Shaped Nylon and Polyester High Performance Yarns:-
Normally, synthetic yarns are produced with round or trilobal/triangular cross sections. Recent developments of shaped yarn has given rise to specialty cross sections for changing yarn reflectance pattern. Some important shapes are quadralobal (four lobes), Pentagonal (five lobes), Hexagonal, Octagonal. Such shapes create scattered reflectance of light and exhibits special effects.

High performance /Shaped Yarns
Quadralobal (four lobes) Cross Section Nylon/ Polyester

Figure 2.1 : Mechanism of Creation of Cool Effect and Silk like reflectance in Synthetic Yarns

The modified cross section Yarns like four lobed (quadrilobal) actually have more gaps between two such yarns in the woven and/or knitted fabrics as compared to normal circular or trilobal cross section yarns. Shaped yarns have higher surface cover area compared to the normal and hence it soaks more perspiration from the human skin, speeds up the conduction and removes from the gaps (pores) between the yarns. So perspiration out easily and faster. The air permeability in such fabrics is also much more and so results in cool effect.

Such yarns also give silky appearance due to yarn cross section shapes. For example, quadrilobal have four legs compared to circular and/or triangle cross section. Four curved portions reflect the light in concentrated focus star shape. This creates silk like reflectance in the fabric. Due to special cross section, fabrics dry quickly and dyed fabrics appear darker compared to normal synthetic yarn cross sections. Feel also becomes soft.

Shaped Yarn Special Characteristics:
*Cool effect,*Sophisticated glittering,*more Like silk effect.*Deeper dye compared to round/trilobal cross section.*Crisp effect.*Higher fabric surface cover & fabric yield.* Quick drying.

End use applications:-
*Ladies Salwar suit/Dress material for cool effect and air permeability,*Cool effect Sarees -blouse, Salwar - suit in the warm climate,*Gents shirtings, T shirts & apparel.*Hosiery, under garments for vicking action.

B) Hollow Synthetic Yarns:--
Specialty:- 20-25% Hollow hole in the yarn without adversely affecting external surface and yarn characteristics compared to normal solid yarns. Light in weight of the fabrics, due to hole in centre, is equivalent to the hollow portion. The hole in the centre also retards heat/cold conductivity compared to the solid yarns.

![Cross section of hollow yarn](image)

End use applications (USP):--
*Light weight fabrics knitted and/or weaved apparels.
*Airtex light-weight fabrics.*Light weight Jeans.*T Shirts.*Medical use like Crepe bandages.

Advantages of Hollow Nylon yarns (USP):--
*Suitable for woven and knitted fabrics.*Customers happy to get 15-20% more fabric Length vs Normal and so more fabric yield/unit weight. *Feather touches light weight fabrics*Comfort, heat insulation and light weight feather touch fabrics.*Good for use in fabrics, All types of Knitting, Bolting cloth, Medical.

C) Versatile dye effect yarns for lively &fancy effect fabrics:--
*Cationic Dyeable Synthetic Yarns:--
Both, nylon and polyester are extensively used in India to make woven and knitted textile apparels. They are used in a big way in dress material for ladies like salwar suit, skirts, blouse and mainly in sarees. Gents clothing is also mainly with Nylon and polyester yarns.

Normal Polyester filament yarn is dyeable with disperse dyes. Disperse dyeing is done at high temperature and pressure but Dyed products do not exhibit lively deep dyeing. However, Normal Nylon filament yarns are dyed with acid dyes, resulting deep and lively dyeing effects.

Cationic dyeable Nylon and Polyester are specialty products. Polyester and/or Nylon are anionically modified in polymer stage so that the yarns can be dyed by cationic dyes. Cationic dyeable Polyester / Nylon yarns do not require high pressure and temperature dyeing like in polyester but it is dyed at low temperatures to give deep and lively dyeing effect.

Cationic dyeable Polyester is available in India since a long and being used for specialty effects in the fabrics but cationic dyeable Nylon was not available in India. Recently cationic Dyeable Nylon has been produced in India. Cationic dyeable nylon is used for high class fabrics to give versatile specialty effects and gaining momentum in the woven and knitting segments for rich silk like fabrics.

End Use applications and advantages of Cationic Dyeable Synthetic Yarns:--
*a) Differential Dye/ Multicolour Effects:-- If the fabric made of normal nylon and cationic Nylon with any design and dyed in acid dye bath or cationic dye bath, there shall be differential dye effect because cationic component shall not dye with acid dyes and vice versa. If such combination of Nylon and cationic dyeable nylon is dyed in the same bath containing acid dye and anionic dyes, the both the components shall dye as we desire depending on the recipe.

Similarly fabrics made of Polyester and Cationic dyeable Polyester and dyed with anionic dyes then normal polyester shall not be dyed, giving very good multicolour design effect.

b)Ease of dyeing: In polyester, the cationic dyeable polyester dyes at low temperatures without high pressure and hence saving in energy. The shades obtained are also deep and lively for making beautiful fabrics.

*UltraDeep and Very Light Dyeing Nyons: Ultra deep and light dyeability yarns are created in Nylon by modifying the polymer at Polymerisation stage. It dyes
extremely deep to produce deep dyed apparels like Sarees and dress material. Similarly very light shade dyeability yarns are pre produced by chemical modification during Nylon Polymerisation. Such a variation in dyeing with acid dyes can produce high differential dye effect and also designs, as we desire by using normal dyeable, ultra deep dyeable and/or light dyeable nylons. Beautiful fabrics are possible with different permutation and combinations.

*Modified polyester for deep dye effect when dyed with disperses dyes: Normal polyester yarn has a rigid backbone; this combined with significant crystallinity, makes it difficult to dye. The dyeability can be increased by using a copolymer during Polycondensation process of making polymer. The modified polyester dye easily and comparatively darker due to reduced crystallinity and presence of copolymer.

*Spun Dyed Synthetic yarns for dyed/designing fabrics:-

a) Various methods for dyeing nylon and polyester yarns for use in fabrics:-

b) Specialty of spun dyeing:-
   - Dyed during yarn spinning by dosing master batch dyed chips through weigh feeder.

c) Advantages of master batch spun dyed POY & FDY yarns:-
   - *Low dying cost, compared to the above methods.*Easy change over from one colour to other.*Small dyed lots possible.*Less mix up chances.*Less cost to the customers.*Very good light and wet fastness as compared to conventional dyeing.

End use applications (As drawn, textured, air textured yarns):- All applications, where dyed yarns are needed.*Textile Apparels through weaving and/or knitting routes.*Tapes/ low width.*Sox and hosiery products like track suits. Host of other end use applications.

*D)Bi-Shrinkage/ Differential Shrinkage Polyester/ Nylon yarns:-

Introduction and technical back ground of Bi-shrinkage yarns:-

Bi-shrinkage yarns are combination of two yarns of different shrinkages combined to create one composite yarn. The yarns are characterised by the special "Shrink bulk effect", i.e. when fabrics knitted or woven manufactured from such a yarn and subjected to hot wet processing/finishing, theyarn differentially shrinks. The shrinkage differs from filament to filament. Thus low shrink components loop out from the core, unlike the high shrink components (as shown in the diagram below). This provides the bi-shrinkage product with a very nice textured effect, peach effect, brushed effect or terry loop effect, depending on the fabric construction, and the component yarn characteristics used.

*Synthetic Yarns with Bi-shrinkage effect:-

Polyester filament yarns are widely used for making Bi-shrinkage by adopting different methods. Now Nylon Bi-shrinkage yarns are also available, which are made by unique technique for effective bi-shrinkage effects.

*End use application to create Bi-Shrinkage Yarns (BSY) :-

Differential or Bi-shrinkage effect can be produced by various ways, e.g. ATY process, combining on doubler or draw winder or Draw texturizing. One Normal Polyester/Nylon yarn and the other Bi-shrinkage yarn. These days Air Texturing process (ATY) is very popular to produce excellent textured BSY with lower cost compared to draw texturizing process.

The process has the potential to create yarns that can also replace textured yarns in certain applications. In principle, BSY (bi-shrinkage) yarns result in a soft-touch fabric with a very different feel. Japanese researchers claimed that "it provides a brushed feel without the brushing".

* Specialty of BSY yarns in knitted and Woven fabrics:-

1) Peach skin effect. 2) Textured effect. 3) Brushed effect. 4) Terry loop effect. 5) Shingosen fabrics (Japanese) with aesthetic touch.

E) Bi-Component Yarns:- The man-made fibres/yarns of two strongly bonded (but separable) polymers od
different chemical and/or physical construction.

Due to the different shrinkage behaviour of the two polymers, when treated, crimping takes place, which can also be described as chemical-thermal texturising. The most important end use applications are in knitted fabrics, woven fabrics, textile floor covering, non wovens, etc.

F) Flame retardant Yarns:- Fire accidents generally result in considerable loss of life and property. Mainly fire accidents occur due to burning of textile yarns/fibres. The blend yarns like polyester and cotton are highly flammable. Nylon and Polyester flame retardant yarns resist such types of burning. Such yarns are used to make fire protection fabrics, Ladies kitchen apron and also apparels prone to fire hazard. Fire retardant fabrics are used in hotels for furnishing and linen. In aircraft also fire retardant fabrics are used.

G) Antibacterial/deodorant Yarns:- Now people are very health conscious and so need to make biodegradable, antibacterial, deodorant textile apparel. Moreover bacterial growth in fabrics cause skin irritation, offensive odour, visual spoilage and disfiguring stains making the fabrics unusable. Hence creation of such yarns/fibres/fabrics is essential and is being done now.

H) Hygroscopic Yarns:- Yarns and fibres with less moisture absorption and regain cause multiple problems like Static development, skin allergy. Although polyester yarn has all the advantages in apparel but moisture regain is a problem. Now process has been developed to increase moisture absorption to create comfort and avoid skin diseases. Nylon and Polyester hygroscopic yarns are available for comfort and feel like natural yarns.

I) Optically whitened Yarns:- Lustre and whiteness of Nylon and/or polyester yarns and fibres can be altered by additives and/or surface structure of the yarns. Knitted/woven fabrics made from such yarns exhibit special enhanced whiteness on permanent basis. Normally such yarns are used in knitting, specially netting fabrics, bolting cloth and other apparels.

J) Micro fibres/Yarns:- Very fine individual denier per filament yarns in Synthetic yarns are called Micro fibres/Yarns. Low denier with high number of filaments in yarn exhibits a soft feel, soft gloss and high fabric density. Such micro silk type yarns are becoming high value added for textile fabrics of modern age.

Following is broad classification of yarns on the basis of denier per individual filament:-

<table>
<thead>
<tr>
<th>Yarn/ Fibre type</th>
<th>Denier per filament (dtex)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Coarse</td>
<td>Over 7</td>
</tr>
<tr>
<td>2. Medium -</td>
<td>fine 2.4 to 7</td>
</tr>
<tr>
<td>3. Fine</td>
<td>2.4 to 1.0</td>
</tr>
<tr>
<td>4. Micro</td>
<td>1.0 to 0.3</td>
</tr>
<tr>
<td>5. Super-micro</td>
<td>below 0.3</td>
</tr>
</tbody>
</table>

There is high growing demand for high grade apparel. Fabrics, using low denier textured microfilament yarns create high quality fabrics with excellent touch, drape and gorgeous appearance. End uses of microfiber also include water and wind proofing properties suitable for fabrics like wind cheaters and similar applications. Finding increased use in fashion clothing, sports-wear. Micro-fibres are most suitable for filter media in technical textiles.

K. Airtexured Yarns:- Airtexured yarns have become very popular as specialised yarn to create special effects for apparel as well as furnishing/industrial use. Special airtex machines are used to make normal textured yarns and also creating in big special effects like differential shrinkage, differential dye effect, thick & thin yarn, slub effect, interlaced yarns and many others.

Airtexured yarns can offer an entirely different look and hand to any fabric. Airtexured yarns can be used in broad range of fabrics from simple light weight shrim all the way to very heavy duty soft luggage fabrics, from light weight swim wear to heavy weight parkas. End use products are becoming very popular, like sewing thread, sports-wear, Leiser wear, Men’s and Ladies apparel, Rain wear, automotive fabrics, coating, decorating fabrics. The airtex yarn can substitute nicely expensive natural fibres like silk, wool and cotton and still feel spun like, can replace very expensive fine count spun yarns for dress weight and blouse weight fabric. ATY yarns can replace coarse countryarns or heavy denier false twist yarns.

Compared to draw textured yarns, ATY is a yarn with zillions of small loops, which give it a distinct feeling and look, whereas DTY is ayarn with preferably no, loops at all. The loops in ATY contribute to the bulk and loft of a fabric, where as in DTY the even crimp in every filament creates the bulk and volume of the fabric.
ATY yarn has advantages of high yarn stability, high bulk, reduced boiling shrinkage, low and uniform package take off tension, high pilling resistance, uniform appearance, sizing of warp beams may not be necessary for slower running looms.

The ATY process can be used to create varying effects by using specialty fibres as indicated in this chapter. Combining two or more yarns in this process is called commingling, which helps in making fancy specialty yarns.

ATY Yarns are available for weaving and knitting segment manufacturers.

3. Conclusion
Customer needs are never static but dynamic, changing with the time. Textile fashion world has changed tremendously. It is necessary to cope up with the changing fashion in apparels, comfort, lustre, feel, designs, furnishings, safety fabrics, unique drape, handle, dye advantages, easy care. Strength, suppleness, weather proofing and breathable etc, synthetic yarns are contributing significantly through versatile effects, shapes, enhanced air permeability and cool effect, feather touch hollow, increased moisture absorbance, flame retardancy (knitted and woven segments). Creating awareness on such changes is the main objective of this article.

Now the fabric manufactures (Weaving & knitting segments) can take initiative to create tomorrow’s fabric today. The change shall be comparatively economical with higher value addition through unique range of apparels with added advantages to the customers. For example, hollow yarns shall give more woven/knitted fabric yardage per unit weight, associated with light weight apparels for comfort, without losing on its characteristics. Using shaped yarns, airtex yarns, wide range of sports-wear, wind cheaters, T shirts, high performance fabrics for ladies wear are possible. The skill to orient differently, various yarns in 100% and/or combinations can create wide range of apparels with unique get up.

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Study to Determine Factors affecting long-term Buyer-Vendor Relationship in Domestic Apparel Industry

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Abstract
Growing Indian apparel industry with fast changing business practices and fashion is putting organizations under tremendous pressure to constantly improve product quality, delivery, performance, and responsiveness along with reducing costs. Even though both buyer and supplier want to sustain their relationship so that they can concentrate on only these above mentioned points but due to conflicts and issues they stop working with each other and look for other resources which again require a lot of time to understand the requirements of both vendor and buyer. There are so many of issues which occurs while buyer and supplier work together to achieve their business goals but not all the issues play major role for friction and further in discontinuation of buyer and vendor relationship. Hence a little empirical research has been conducted to find out the factors which are often the reason for friction between the buyer and vendor. Findings show the factors that are very often and often the reason for friction between a buyer and supplier and affect their long-term relationship. If worked upon further, these findings will help industry to look after these issues to have a healthy and long-term business relationship.

Keywords
Buyer, Vendor, Relationship, Apparel Industry, Suppliers, Business etc.

1. Introduction
Globalization and fast changing business practices putting organizations under tremendous pressure to constantly improve product quality, delivery index, performance, and responsiveness along with reducing costs. Organizations also increasingly exploring ways to leverage their supply chains and giving more focus on the role of suppliers in their chain. In other words firms are now more trying to utilize their resources and increasing the value of the supply chain and in return they are experiencing more flexibility and responsive to the demands and customers. Outsourcing allows firms to utilize the capabilities, expertise, technologies, and efficiencies of their suppliers. Increased outsourcing, however, implies greater reliance on suppliers and commensurate need to manage the supplier base. Development and maintenance of long-term relationships between buyers and sellers is the key to industrial buying success. Existing supplier relationships are a powerful competitive advantage for company. Relational exchanges can contribute to product differentiation and create barriers to switching for suppliers and buyers.

Today, large and small companies are making partnerships with suppliers a foundation of their supply strategies. At an operational level, the benefit to a buyer of developing close relationships with key suppliers comes in the form of improved quality or delivery service, reduced cost, or some combination thereof. At a strategic level, it should lead to sustainable improvements in product quality and innovation, enhanced competitiveness, and increased market share.

The Indian Apparel Industry has an overwhelming presence in the economic life of the country. It is one of the earliest industries to come into existence in the country. The sector has a unique position as a self-reliant industry, from the production of raw materials to the delivery of end products, with considerable value-addition at every stage of processing apart from providing one of the basic necessities of life, the apparel industry also plays a pivotal role through its contribution to industrial output, employment generation and the export earnings of the country.

The Indian apparel market has demonstrated resilience
and growth in an environment characterized by slow economic growth. The domestic apparel market, which was worth INR 207,400 Cr as of 2012, is expected to grow at a compound average growth rate (CAGR) of 10% over the next decade. Further, the recent omission of excise duty on branded apparel has provided an impetus to retailers in terms of the overall market sentiment. Indian apparel market is segmented in three different ways: segmentation by user category, segmentation by use and segmentation by price.

1.1: Buyer and Vendor Relationship

Buyer is the person or organization that purchases products from suppliers. A buyer could be a manufacturer purchasing raw materials or a customer buying finished product from a manufacturer. The relationship between the buyer and seller can be either short or long term, involving regular purchases based on established agreements. Both short term and long term buyer and seller relationships have advantages and disadvantages. Short term relations can be useful when a degree of flexibility is required. For example, short term agreements give the buyer the option to switch suppliers for their next purchase. They can also be beneficial in markets where the prices of materials are volatile and long term commitments are not appropriate. The high level of competition to win short term contracts can also provide opportunities for price discounting and special deals to be done. However, short term arrangements also have their disadvantages. They generally provide little scope for payment and order flexibility. For example, a new supplier on a short term agreement will want a definite order and prompt payment. There is no trust built up over time between parties, so the opportunity to share market information is also reduced.

There are many advantages that come as a result of having strong buyer and seller relations over a period of time. There is a greater commitment from both groups which means that you will be better able to rely on them when it comes to orders and payments. There may also be more scope for discounts after the relationship is established and there may be more flexibility in the timing of payments. Trust between the buyer and seller is developed over time and this may allow for the sharing of information, forecasts, knowledge and customers between the buyer and seller.

1.2: Necessity of having Buyer -Supplier Relationship in Industry

Buyer-supplier relationship in the supply chain is one of the most important elements of supply chain integration. Establishing and managing effective relationships at every link in the supply chain is becoming the prerequisite of business success. High volatility in the retail industry reflects rapid fluctuations in customer demand and unpredictable market trends. In addition, environmental diversity reveals uncertainty in the global business environment. Facing market volatility and diversity, retailers are encouraged to develop a long term relationship with their partners to deal with unexpected market demands.

Business relationship stands on understandings of mutual business needs, benefits and sincere wish to continue relationship for the common shared objective. The most important element of the supply chain is buyer-supplier relationships. A sustainable and effective relationship is the prerequisite of organizational success. The priorities like resource maximization, investments, time and regulatory compliance may force the relationship into stressed zone. The role of organizations is to make a balance of mutual expectations and to address the issues well within time frame so that healthy relationship between buying organization and selling organization can prevail.

1.3: Dimensions of Buyer-Supplier Relationship

There are five prominent dimensions of the buyer-supplier relationship:

1.3.1: Trust

Trust is a crucial factor in sustaining the complex business network and contributing to the success of a firm in business communities. Trust indicates "a person's reputation for trustworthiness on both a professional and personal level as well as credibility in a business situation". The reputation of the supplier's fairness has a significant effect on its credibility in the business, and consequently satisfactory credibility will create higher level of trust.

1.3.2: Communication

Effective communication in channel relationships can enhance levels of channel member coordination, satisfaction, commitment levels and performance. In fashion apparel industry, frequent communication between buyers and suppliers can expedite quick and accurate response to volatile market and reduce the costs and impact of inaccurate forecasts. With the presence of trust and support, channel members are more willing to pass information upward and promote bidirectional communication. Consequently, it will help better match
supply with demand and increase profitability for channel members. Effective communication is crucial to maintain a long-term buyer-relationship and achieve high performance.

1.3.3: Interpersonal Relationship
Interpersonal relationships play a significant role in Indian domestic industry hence if maintained it will help to manage the long term business relationship.

1.3.4: Cooperation
Cooperation between the exchange parties reflects the expectations of working together to achieve mutual and individual goals jointly. The cooperative inter-business relationship is primarily based upon personal trust between business parties. Most businessmen say that the most reliable sources of information come from close relationships within and among business organizations. Without close relationship, the suppliers or buyers are not willing to share information and have less intention to cooperate.

1.3.5: Power-Dependence
The issue of power is closely associated with the nature of dependency in business relationships. Power plays a significant role in the supply chain, and the different sources of power have differing impact on inter-firm relationships and the performance of the entire supply chain.

1.4: Purchasing Process
The relationship between a buyer and supplier starts with the negotiation process which actually involves the mutual discussion and agreement between the buyer and supplier as to the terms of various business transactions. It is the bargaining activity that occurs between buyer and supplier over certain goods and services to avoid any conflicts later on. This process provides an opportunity for both the parties to understand each other requirement so that accordingly they can set their goals. A variety of activities involved in the process help them to meet their objective. Chief among the negotiating activities are:

1.4.1: Buying Authority
When buyer is employed by the brand/company, he or she is given the authority to act on behalf of that firm as a duly authorized agent and will represent the firm in dealing with merchandise resources. Generally in industry buyers are specialized in their categories and they only deal for their category.

1.4.2: Securing Discounts and Allowances
A second activity involved in the negotiation process is securing discounts and allowances. A discount or allowances may be defined as any reduction in the list or quoted cost to buyer by vendor. There are three kinds of discounts available for the buyer by supplier these are Quantity Discount, Seasonal Discount and Cash Discount.

1.4.3: Arranging Transportation and Distribution
Arranging transportation and distribution is a third important negotiating activity. When considering transportation arrangements, the buyer should ask himself or herself two important questions: Who is to pay for the cost of transportation? And who is to own the merchandise and be responsible for it while it is en route? Transportation terms offered by the vendor may be either prepaid or to be paid by brands when it reaches to their warehouse. Time and cost are two important elements the buyer must consider when determining methods of transportation and storage.

1.4.4: Seeking Price Guarantees
Seeking price guarantee is a necessary activity in the negotiation process. The retail buyer may seek a guarantee from the vendor to protect him or her against possible future price fluctuations. For example a buyer may ask for the seasonal discount along with the price guarantee. The vendor may be willing to make concession to obtain early orders from buyers. The price guarantee is fairly common for seasonal merchandise because the vendor is eager to encourage the buyer to place early orders, or the vendor may use price guarantee along with the quantity discount to encourage buyer's of staple goods to place especially large orders.

1.5: Causes of Friction between Vendors and Buyers
There are some important causes of friction which occurs between vendors and buyer while they work together.

1.5.1: Shipping Problems
Early, late and split shipments can cause friction between vendors and buyers. For example, if the buyer
has limited storage space then it may be impossible for him to accept merchandise before the given delivery date in purchase order. Also early shipment requires early payment which can affect buyer financial planning for the season. So if a buyer doesn’t want an early shipment of goods, this should be clearly written in the order form.

Late shipments also cause problems for the buyers. They may find themselves with an inadequate assortment of merchandise, which may cause their customer to shop elsewhere. The buyer may be stuck with out of season goods. Prior information from the vendor would help buyer to plan more effectively and eliminate heavy markdowns.

Split shipments often are an unusual hardship for the vendors as well as the buyer. A manufacturer/vendor who is not able to ship the entire order in one go may make a partial shipment on the confirmed delivery date with a notation that remainder will be shipped at a later date. However when the balance portion is ready, the buyer may refuse to accept the goods/merchandise, even though he or she has not previously notified the vendor of intention to reject the goods.

1.5.2: Product Quality Issues
Poor product quality shipped by the vendor may also be the cause of friction. For example if the product is not up to the quality which was specified by the buyer may lead to dispute between buyer and supplier. Quality issues can be fabric defect, trims and accessories defects and print/embroidery quality not up to the mark or different from what was approved earlier. Quality issues in garmenting and fitting.

1.5.3: Return and Adjustments of Goods
Some brand return the goods after the season is over or merchandise is not selling properly in store to the supplier, when they have no legal right to do so. For example if the merchandise is having very poor response from the customer in store they will return goods to vendor saying quality issues or some other issues.

Vendor may agree to take back merchandise, particularly if the brand is a good customer of them. On the other hand, some vendors may refuse to accept legitimate returns or to make adjustments when they themselves are responsible for the fault. Such practices will cause friction and lead to poor vendor buyer relations. If objectionable practices become excessive, the buyer may seek another vendor or the vendor may drop the buyer account.

1.5.4: Cancellation
A cancellation policy should be agreed on between buyers and vendors. The following list is the representative of conditions under which orders may be cancelled:

- When merchandise is not shipped by the final due date specified on the "Purchase order".
- Major Quality concerns.
- When the vendor or manufacturer receives a cancellation notice from the buyer.
- Buyer and vendor mutually agreed upon the cancellation.

1.5.5: Special Orders and Minimum Orders
Special orders enable buyers to provide for special needs of customers or to target some specific group of customer for expansion. On the other hand, special orders are costly for manufacture to handle and therefore they avoid working on them. To discourage special orders, a manufacture may charge an extra handling fee, which buyer object rather strongly.

1.5.6: Selling Competitors and Exclusives
Vendor selling same product line to competitor’s buyers also causes friction between both the parties as some time it leads to copying of styles. Exclusive agreements may be arranged between vendors and buyers. The purpose of exclusive agreement is primarily to protect the buyers from having the same goods offered for sale to his her Competitors.

1.5.7: Fashion Piracy
Fashion piracy is matter of concern among vendors themselves. However, occasionally a buyer will copy a vendor’s sample or hold out a sample and seek another supplier to reproduce the article. Buyers and vendors must establish policies prohibiting such practices.

1.5.8: Substitutions
Often a vendor will have to send the buyer substitutes for the original merchandise offered. Sometimes when reorder is placed by the buyer it’s not possible for vendor to get the same fabric again, so they buy similar fabric to produce the order and meet the demand. In such cases supplier should notify the buyer of the substitution and get the permission to ship the goods. Sending goods without the prior notification and ap-
proval can leads to a friction between buyer and supplier.

1.5.9: Failure to follow Instruction & Improper communication

Finally, friction between vendors and buyers is caused by failure to follow instruction like not following the proper method of shipping the goods as advised by the buyer can lead to more expenses, similarly in production also if buyer instructions are not being followed can lead to poor quality product.

Improper communication too is an important factor of causing friction between both the parties. Hence both the parties should communicate properly so that transparency between business and relationship can be maintained.

4 Methods & Materials

4.1 Research Design

Planning of the process to collect and analyze the needed information. After doing the literature survey and studying the buyer vendor relationship and its importance and based out of the working experience of the author, objective of this research paper was to find out the major factors which affect the buyers and suppliers relationship. A quantitative research needed to be done using empirical research method to collect the accurate data and result. Therefore following steps have been followed to conduct the survey.

4.1.1: Description of Informants

About 50 informants were asked to participate in the research. The informants work in various positions in companies and involved in buying, manufacturing, developing and managing relationship. Their geographical locations were Delhi NCR, Ludhiana and Bangalore. Reason for this was to have a more varieties of informants so that a clear picture can be drawn.

4.1.2: Plan for Sampling and Recruitment

Sampling design refers to part of research that deals with the method of selecting items for research study. Description of Method:

Step I: Step I of sampling design is to define the population. In context to this research objective suitable age group for sampling was 28-35 years with minimum 7-8 years of experience to get the accurate input.

Step II: Sampling Technique Selection

Before asking questions directly initial interactions were conducted to get the idea about their opinion for this topic. An informal interview was conducted with 25-30 samples to find out the issues which normally occur on regular basis and affect their working and relationship with their buyer/vendor.

To get the proper results and to evaluate the opinion received from the samples a questionnaire was prepared which was covering all the 5 dimensions of a buyer vendor relationship. Next step was to float it to the samples by email. Research method, which was used to conduct this survey, was empirical research method in which informants had to answer the question based upon their experiences in industry.

Step III: Step III was to select the sample size, which can give the correct picture of the entire population. Looking at the geographical reason, age group and experience of handling buyer/vendor, 45 samples were contacted who represents approximately 3% of total target population but out of those 35 samples responded and further only 30 received questionnaires were adequate for data analysis and result.

4.1.3: Ethics

The author had obtained consent verbally before asking them to fill the questionnaire which was sent to them through email. Some samples didn’t have time to do the same so the survey was conducted through telephonic conversation so that desired number of samples response can be maintained. There will not be any benefits to the informants directly but as far as benefits to industry, it is hoped that this will provide information about major reason for conflicts between the buyer and vendor those further can be looked upon by industry experts to find solutions or way to avoid these. It may help other students/researchers who are also interested in this topic.

5. Result and Discussion

30 samples were collected which represents the target group. The method for the sample selection and research was empirical research method. The outcome of the data analysis described below.

5.1 Conflicts between Buyer and Vendor

The analyzed data through simple questions (Annexure I) reflects that every buyer and supplier face some conflicts while working together. 100% of sampling populations of buyer and vendor have faced some kind of conflicts.

5.2 Importance of Maintaining the Buyer and Vendor Relationship
Table shows that 100% of population thinks that it is very much important to maintain the buyer supplier relationship. Reason for this they think is that if it will be maintained and nourished, it will save their time and cost both and also it will help them to plan and achieve their business goal more efficiently and effectively.

### Table 5.1: Importance of Maintaining Buyer Vendor relationship

<table>
<thead>
<tr>
<th>Very much Important</th>
<th>Important</th>
<th>Not that Important</th>
<th>Relevant</th>
</tr>
</thead>
<tbody>
<tr>
<td>30</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>100%</td>
<td>0%</td>
<td>0%</td>
<td>0%</td>
</tr>
</tbody>
</table>

#### 5.3 Short Shipment Delivery

Short shipment delivery term used when shipped quantity is less than the quantity mentioned in the purchase order. Nowadays almost all the established brands have pre booked order quantity and if they receive less quantity its affect their sales and business goal for that season. Figure 5.1 shows that 7% of people say that very often it’s the main reason for their friction, whereas 50% of sampling population says often this is the main reason for their conflicts with the buyer, 27% of sampling population selected sometimes and 17% of sampling population says that hardly it is the reason for conflicts between their relationship with buyer/vendor.

![Figure 5.1: Short Shipment Delivery against the Placed Order](image)

#### 5.4 Product Quality Issues

Consumers are very much aware about the product quality and the price they pay for that product. So when they receive or find the product inferior or not up to the price they have paid, it affect their buying with that brand and also they do bad mouthing about the poor quality of the brand's product. Which also affect the brand image hence when a buyer places an order with their supplier they specifically mention all the quality related terms with them to avoid any issue at later stage. Still if a buyer receives any issue related to quality its affect their relationship, as shown in below Table 5.2 27% of sampling population says that it’s the main reason for their conflicts, 43% opted for often the reason for conflicts whereas only 23% and 7% of population says sometimes and hardly respectively as a reason for conflicts.

### Table 5.2: Quality Issues in Shipped Styles

<table>
<thead>
<tr>
<th>Never</th>
<th>Hardly</th>
<th>Sometimes</th>
<th>Often</th>
<th>Very often or almost constantly</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>2</td>
<td>7</td>
<td>13</td>
<td>8</td>
</tr>
<tr>
<td>0%</td>
<td>7%</td>
<td>23%</td>
<td>43%</td>
<td>27%</td>
</tr>
</tbody>
</table>

#### 5.5 Return of Finished Goods to the Vendor

There are so many reason for returning the goods to suppliers it can be quality related issue, late delivery by the vendor to the brand without giving any prior information and also if product is not saleable few brands return the goods which is ethically not right as supplier manufacture goods as per the brands requirements and if return, it will gave them a big loss. Hence if such kind of issues arises every season it affects the relationship between the buyer and supplier. As show in Table 5.3 that 20% of population says that if it occurs for 2-3 season they discontinue their business relationship, 27% opted for often a reason, 17% chosen sometimes, 23% and 13% says hardly and never respective for the reason for friction. It is because if there is some serious quality concern vendor don’t create any issue and accept the goods.

### Table 5.3: Return of finished goods to the vendor

<table>
<thead>
<tr>
<th>Never</th>
<th>Hardly</th>
<th>Sometimes</th>
<th>Often</th>
<th>Very often or almost constantly</th>
</tr>
</thead>
<tbody>
<tr>
<td>4</td>
<td>7</td>
<td>5</td>
<td>8</td>
<td>6</td>
</tr>
<tr>
<td>13%</td>
<td>23%</td>
<td>17%</td>
<td>27%</td>
<td>20%</td>
</tr>
</tbody>
</table>

#### 5.6 Late Delivery of Goods

Figure 5.2 shows that it’s a very crucial point as 37% of sampling population says that if delivery will be late it’s going to affect the sale for that season and will lead to markdown and subsequently to a loss that is why it’s very important for a supplier to follow the given delivery date and if they don’t adhere they discontinue working with them. 33% of sampling says
that often it’s the reason for their friction, 27% and 7% opted for sometimes and hardly respectively.

![Figure 5.2: Late Delivery of Goods](image)

### 5.7 Early Delivery of Goods

Early delivery term used when vendor supply goods before the confirmed delivery date. It happens rarely and accepted by buyers most of the time as shown in below Table 5.4, 33% of populations have chosen it never the cause of friction, 0% for very often and often. But some time it causes problem as if the goods delivered before the confirmed date then accordingly payment need to be done which can disturb financial plan of the buyer that is why here we can see that 23% and 43% of population is saying sometimes and hardly a reason for conflict.

![Table 5.4: Early Delivery of Goods](image)

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<thead>
<tr>
<th>Never</th>
<th>Hardly</th>
<th>Sometimes</th>
<th>Often</th>
<th>Very often or almost constantly</th>
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</thead>
<tbody>
<tr>
<td>10</td>
<td>13</td>
<td>7</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>33%</td>
<td>43%</td>
<td>23%</td>
<td>0%</td>
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</tbody>
</table>

### 5.8 Late Delivery Discount

When supplier gets the goods manufactured late and unable to meet the delivery date, he proposes some discount on the confirmed cost so that buyer doesn’t cancel the order. Sometimes they do it willingly but most of the time its brand who put discount after calculating their losses. Table 5.5 shows that 47% of population says that this issue often becomes the cause of friction as most of the times suppliers don’t want to give any discount on the goods manufactured. 30% says sometimes and 40% selected hardly the reason for conflicts whereas 0% of population opted it as very often and never becomes the cause for friction.

![Table 5.5: LateDelivery Discount](image)

<table>
<thead>
<tr>
<th>Never</th>
<th>Hardly</th>
<th>Sometimes</th>
<th>Often</th>
<th>Very often or almost constantly</th>
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<tbody>
<tr>
<td>0</td>
<td>7</td>
<td>9</td>
<td>14</td>
<td>0</td>
</tr>
<tr>
<td>0%</td>
<td>23%</td>
<td>30%</td>
<td>47%</td>
<td>0%</td>
</tr>
</tbody>
</table>

### 5.9 Fashion Piracy

Fashion piracy is copying styles without having any permission from the concerned authority. Sometimes it’s the buyer who picks other brand’s styles which are running with the vendor and sometimes its vendor who forward other buyer’s design to another buyer in order to get more order. In domestic apparel industry its little common but sometimes it creates issue between buyer and supplier. As shown in below Table 5.6 only 13% people selected often the reason for conflict, 30% selected sometimes and 23% hardly have any issue with it. 33% selected it never a reason for conflicts if it’s done with few changes.

![Table 5.6: Fashion Piracy](image)

<table>
<thead>
<tr>
<th>Never</th>
<th>Hardly</th>
<th>Sometimes</th>
<th>Often</th>
<th>Very often or almost constantly</th>
</tr>
</thead>
<tbody>
<tr>
<td>10</td>
<td>7</td>
<td>9</td>
<td>4</td>
<td>0</td>
</tr>
<tr>
<td>33%</td>
<td>23%</td>
<td>30%</td>
<td>13%</td>
<td>0%</td>
</tr>
</tbody>
</table>

### 5.10 Order Cancellation by Buyers

Order cancellation that is not very common in domestic apparel industry as almost all the orders are pre booked order. Perhaps that is the reason for accepting late delivery goods. After analyzing the data, it has been found that 20%, 37% and 17% of population selected sometimes, hardly and never a reason for conflicts respectively. Reason for this could be it’s not a so frequently occurring issue whereas 7% and 30% of population opted very often and often a reason for conflicts as its issue directly related to financial goal of the company.

![Figure 5.3: Order Cancellation by Buyers](image)
5.11 Changes in Style by Buyer after Order Confirmation
Frequently changes in styles after the order is confirmed create havoc which leads to short shipments, late delivery and financial losses. But again it’s not very frequent so only 17% of population selected it as a reason for conflicts, 30% population opted for sometimes and never for the reason for conflicts and 23% opted it as hardly a reason for conflicts between the buyers and suppliers.

<table>
<thead>
<tr>
<th>Never</th>
<th>Hardly</th>
<th>Sometimes</th>
<th>Often</th>
<th>Very often or almost constantly</th>
</tr>
</thead>
<tbody>
<tr>
<td>9</td>
<td>7</td>
<td>9</td>
<td>5</td>
<td>0</td>
</tr>
<tr>
<td>30%</td>
<td>23%</td>
<td>30%</td>
<td>17%</td>
<td>0%</td>
</tr>
</tbody>
</table>

Table 5.7: Changes in Style by Buyer after Order Confirmation

5.12 Unrealistic Lead Time
Lead time define the time require to complete an order by the supplier. Some buyer gives very unrealistic lead time for order processing to the supplier which initially vendor accept to increase their brand portfolio but if it happen frequently they drop that brand. Figure 5.4 shows that 3% and 27% of sampling population opted it as very often and often a reason for conflict. 20% selected it sometimes, 30% selected it hardly and 20% selected never as a reason for conflicts in their relationship with buyer/supplier.

Figure 5.4: Unrealistic Lead Time

5.13 Improper Communication between Buyer and Vendor
To maintain a healthy and long term relationship with business partners it’s very important to follow a proper communication through emails and phone. If communication is being done properly it will avoid so many problems to happen while working. And if a proper communication is not being followed it will create havoc that leads to an unhealthy relationship. Table 5.8 shows that improper communication is a cause for discontinuing the relationship, 10% selected very often, 13% selected often the reason for conflict but major population selected it sometimes, hardly and never a reason for their conflicts with the buyer/supplier.

<table>
<thead>
<tr>
<th>Never</th>
<th>Hardly</th>
<th>Sometimes</th>
<th>Often</th>
<th>Very often or almost constantly</th>
</tr>
</thead>
<tbody>
<tr>
<td>6</td>
<td>8</td>
<td>9</td>
<td>4</td>
<td>3</td>
</tr>
<tr>
<td>20%</td>
<td>27%</td>
<td>30%</td>
<td>13%</td>
<td>10%</td>
</tr>
</tbody>
</table>

Table 5.8: Improper Communication between Buyer and Vendor

5.14 Non-Profitable Prices Offered by Buyers
Reason for accepting non profitable price could be attracting vendor or large quantity but it repeatedly no vendor would like to accept the same. As shown in Table 5.9, 27% selected it often the reason for conflict whereas rest of the sampling population opted sometimes, hardly and never a reason for conflicts.

<table>
<thead>
<tr>
<th>Never</th>
<th>Hardly</th>
<th>Sometimes</th>
<th>Often</th>
<th>Very often or almost constantly</th>
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</thead>
<tbody>
<tr>
<td>4</td>
<td>4</td>
<td>14</td>
<td>8</td>
<td>0</td>
</tr>
<tr>
<td>13%</td>
<td>13%</td>
<td>47%</td>
<td>27%</td>
<td>0%</td>
</tr>
</tbody>
</table>

Table 5.9: Offering Non Profitable Price

5.15 Payment Issues after Delivery of the Goods
This is a major problem in domestic apparel industry, even though before placing order both parties confirmed the payment term but most of the time payment get delayed from buyer end which make vendor to either stop working or work on advance payment term.

Figure 5.5 shows that 27% of population selected very often and 33% population selected it often a reason for conflicts and only 40% population selected it as sometimes, hardly and never a reason for conflicts.

Texttreasure

Equipped with his five senses, man explores the universe around him and calls the adventure Science.

- Edwin Powell Hubble
5.16. Minimum Order Quantity Issue

In domestic apparel market this too is a major area of concern and a reason for not having a long-term relationship with their buyer and supplier. This issue arises because every day some new brand is being launch in the market and initially they cannot afford to have a bigger quantity or sometimes for promotional activities or to target a special group of customer company place order with less quantity, for which vendor ask for the up charge and if not they are very reluctant to accept less quantity order which make buyer to look for the new supplier. 23% and 40% of sampling population have selected it as a major reason for their conflicts with the vendor whereas only 36% of population selected sometimes and hardly a reason for conflicts.

Table 5.10: Minimum Order Quantity Issue

<table>
<thead>
<tr>
<th></th>
<th>Never</th>
<th>Hardly</th>
<th>Sometimes</th>
<th>Often</th>
<th>Very often or almost constantly</th>
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</thead>
<tbody>
<tr>
<td></td>
<td>0</td>
<td>4</td>
<td>7</td>
<td>12</td>
<td>7</td>
</tr>
<tr>
<td></td>
<td>0%</td>
<td>13%</td>
<td>23%</td>
<td>40%</td>
<td>23%</td>
</tr>
</tbody>
</table>

5.17. Factory Compliance Issue

In Indian domestic market very few brands are concern about the factory compliance most of the brand only look for the cheap cost and that is very much visible in below Table 5.11. 47% of population selected it as never a reason for conflicts and rest of the population selected sometimes and hardly a reason for conflicts.

Table 5.11: Factory Compliance Issue

<table>
<thead>
<tr>
<th></th>
<th>Never</th>
<th>Hardly</th>
<th>Sometimes</th>
<th>Often</th>
<th>Very often or almost constantly</th>
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<tbody>
<tr>
<td></td>
<td>14</td>
<td>9</td>
<td>7</td>
<td>0</td>
<td>0</td>
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<tr>
<td></td>
<td>47%</td>
<td>30%</td>
<td>23%</td>
<td>0%</td>
<td>0%</td>
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</table>

6: Conclusion

This study was done to understand and find out the reasons, which are majorly the causes for frictions between a buyer and vendor relationship and also become the obstacles in building a long term buyer vendor relationship, it was done keeping the domestic apparel industry in mind. If a buyer, supplier work together to achieve a combined objective with having trust upon each other can have a long-term relationship and they also be able to maintain it properly. It also shows that they are aware about the causes of friction between them but unable to control it and if given the opportunity they would like to work upon to have a smooth relationship. Both the parties are also aware that searching a new buyer and supplier every season will require a lot time to again building up the relationship. This study shows that very often and often the reason for the friction between a buyer and vendor relationship.
Annexure I
Survey Format

<table>
<thead>
<tr>
<th>Name</th>
<th>Age</th>
<th>Profile</th>
<th>Company</th>
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</table>

<table>
<thead>
<tr>
<th>1</th>
<th>Have you face any conflicts with your buyer / supplier</th>
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<th>Not that important</th>
<th>Important</th>
<th>Very much important</th>
</tr>
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<td>Hardly</td>
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<td>Often</td>
<td>Very often or almost constantly</td>
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<td>Changes from Buyer after order confirmation</td>
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</tbody>
</table>

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References


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Professional Awards Committee (PAC)

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The Textile Association (India)
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91, Ranade Road Extension,
Shivaji Park, Dadar (W), Mumbai - 400 028 India
Tel.: +91 22 2446 1145, Fax: +91 22 2447 4971
E-mail: taicnt@gmail.com
Website: www.textileassociationindia.org
Mr. A.R. Garde had worked for 33 years at Ahmedabad Textile Industry's Research Association, Ahmedabad, as researcher, consultant and trainer in technical and management areas before he was selected to lead in 1990 as Director. In his 7 years as the CEO, he and his dozen colleagues turned around the fortune of ATIRA: the machinery, instruments and equipment was modernized, backlogs in maintenance and employee benefits were filled in, and the depreciation and reserve funds were increased substantially.

Mr. Garde’s techno-managerial output is over 270 papers, 2 books, and contributions to 6 books; and over 100 papers presented at conferences within and outside India. After retirement, he has published 7 books on management (including in Marathi and Gujarati), 3 books on ethics. His one book on modern Hinduism (in English, Marathi and Gujarati) shows how Hinduism has adapted itself to become suitable for the 21st century, without having to compromise on any of its core principle.

Techniques of Operations Research that can find meaningful application in the textile industry are Linear Programming and Queueing Theory. Work using the Queueing Theory was done by ATIRA in the mid 1950 to find out the impact of relevant factors on the utilization of machine time when an operator minds a number of machines. The automatic looms were just being introduced in the textile industry which was accustomed to giving either two or four looms to a weaver to attend. Tables were developed to show the impact of attention time, number of looms allocated to a weaver, and the stoppage rate of the looms on the efficiency losses. It was clearly seen that as the number of looms allotted to a weaver increases, the 'machine interference' increases slowly at first and much faster after a critical number is reached. The machine interference is the amount of time a stopped loom waits for the weaver to come and restart it. The greater the time needed for 'repairing' the fault at the loom, which mainly depends on the skill of the weaver, and the greater the stoppage rate of the looms, the greater is the time lost on machine interference. In 1980s, when the use of automatic looms had increased substantially, ATIRA developed a diagnostic system for analyzing and improving loom shed efficiency by using these tables. Many mills were helped to detect whether the worker skill, the loom stoppages or the organizational factors were responsible for the low efficiency.

Looms put together the warp and weft yarns to form cloth which is sold as the final product, with or without further chemical processing such as bleaching, dyeing or printing. The average efficiency of the looms in a weaving shed - the shed efficiency - plays a major role in deciding the profit performance of the mill. When a weaver attends to 16 automatic looms, good mills achieve shed efficiencies of the order of 90% and above. A loss of just 1% in efficiency means a loss of about 1% in the profits of the mill, which range usually between 4% and 9% of sales. In other words, achieving high loom shed efficiency is key factor in managing profitability.

Adderle Overseas Call

The management of a reputed Indian group of mills had taken over the management of a mill in Sri Lanka, which was faring badly in terms of profitability. The CEO whom they had sent to turn around the mill had been in place for over a month, and the situation looked almost incurably hopeless. The efficiency of the loom shed with 384 automatic looms was of the order of 46%, which is about half of what good mills should get. The looms were purchased from an East European manufacturer because these were much less expensive than the Swiss counterpart. The weavers were young girls, freshly trained, with a large turnover of over 30%. The loom stoppages were high, also because of mechanical failures beside breakages of warp and weft yarns. The mill had realised that given these conditions of poor quality of looms and of weavers, the chances of improving loom efficiency were almost nil.

As a last resort, the CEO decided to call in ATIRA, because this group was a member of ATIRA and he was aware of the kind of work we were doing as applied research. After all, it is better for a third party to give the verdict of 'no improvement possible' rather than the mill staff saying so! But there
was some reservation on the part of the top management at the headquarters of the group. "These research fellows with their theoretical knowledge may spend too much time to even diagnose the situation. Secondly, we want a practical solution, not some theoretical advice! So, you may call only one person (not a team) as consultant and give that consultant only one week of assignment, no more." ATIRA decided to accept this challenge and sent an experienced consultant familiar with weaving as well as with spinning, since the quality of yarn influences the breakage rates at looms which in turn decide the loom shed efficiency.

The Mill Situation

On reaching the mill, it was seen that the mill had quite a few strengths:

1. The Weaving Manager, in charge of the looms, had extensive experience in erection and repairs of automatic looms of the kind that the mill possessed.
2. The management information system had all the right kind of records on all aspects of working of the mill.
3. The quality and process control system was well developed and was systematically followed.
4. The spinning machinery was reasonably modern and was well maintained by an experienced Spinning Manager, who was a textile degree holder.
5. The supervisory staff was enthusiastic; was ready to cooperate in tackling the situation.

However, all seem to have been convinced that poor quality of looms, and low skills of the girl weavers were the only reasons for the low loom shed efficiency. And also, both these factors are beyond their control.

The Diagnosis

The mill had allotted 16 looms to a weaver and had provided 1 reliever per 4 weavers as was the standard practice in developing countries at that time in 1990s. This meant that the effective loom allocation was \([4 \times 16] / (4 + 1) = 12.8\), say 13. Examination of data on warp (lengthwise yarns) breakages and on weft (widthwise yarn) breakages showed that these were much higher than the standard values for 16 loom allocation.

So, it was necessary to determine with sufficient reliability and with adequate proof the true causes for the observed low level of efficiency. This was done by using the diagnostic system developed by ATIRA (Analysis of Loom Shed Efficiency, PD Kimothi and AR Garde, 1982, ATIRA Research Note) based on the tables on Machine Efficiency Loss as expected by applying the queueing theory. An extract from these tables is shown in Table 1.

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Att. = Percentage loss in running efficiency due to weaver attending faults

Int. = Percentage loss in efficiency due to the looms waiting for attention of the weaver: machine interference loss.

Table 1 shows an extract from these extensive tables showing the losses in running efficiency of the looms as governed by the loom allocation N, average time in seconds to repair a fault, and the loom stoppages per running hour, a. Losses due to loom stoppages for causes other than these two items of fault clearance and waiting for weaver would be over and above these numbers; for example, if the repair of mechanical fault requires a skilled fitter to be able to attend the loom, it may take an hour of wait. Such losses are to be subtracted from the ‘running efficiency’ to obtain the loom shed efficiency that corresponds to the production per loom shift.

For any given average time taken to clear a fault, t, and a given rate of machine stoppages, a, the machine efficiency loss due to interference, i, increases with the number of looms allotted, N, to the weaver. The loss increase exponentially as the allotment goes higher. This effect is much greater at high levels of stoppages. As illustration, given t=55 and a =1, for n=6, the loss i is only 1%; but at 24 looms, it is 3.8%. These numbers become much higher when s=9: the loss with just 8 looms is 25% and with 24 looms it is as high as 71.7%.

The first question to be answered in this mill was, “Is the skill level of the weavers adequate?” The mill had no data on the time taken by weavers (t in table 1, column 1) to attend to different types of stoppages on the loom. To conduct time and motion studies to determine a truly representative average time for clearing a fault would have taken unduly long time and efforts. Therefore, a simpler way out was to use the ‘norm’ based on work done in other mills with similar looms. This time was taken as 50 seconds, a little more than the standard time.
of 45 seconds for this types of looms with skilled workers, to be on the conservative side in estimating the expected efficiency. We looked up Table 1 for an effective allocation of 13 looms, given the high loom stoppage rate. The expected running efficiency loss for attending is 7.7% and for interference is 43.0%. The total loss in running efficiency is thus 50.7% which should give the expected running efficiency as 49.3%. Knowing from the mill records that the efficiency loss due to other factors was about 7%, the expected shed efficiency was about 43%. With t as 45 seconds, the expected shed efficiency worked out to be 55 - 7 = 48%. But, the mill was getting actual efficiency of about 46%. This would mean that the average time for fault clearance by the weaver girls was around 48 seconds: quite good. So, the average loom efficiency was as expected from well-trained skilled weavers.

**Conclusion on day 2: Weaver skill is adequate;** low skill is not the reason for low loom efficiency.

The consultant's trust on the results of queueing theory was fine: but the conclusion that the worker skill is not inadequate was not acceptable to the loom shed supervisors as well as to the Weaving Manager and also to the CEO. Obviously, this conclusion went totally against their experience of several years! How can a person from a research institute conclude about the worker skill on the second day of visit to the mill and that, too, without even going to the loom shed and observing the girl weavers doing their work? Frankly, even the consultant was surprised at this conclusion. He decided to test it by a simple but practical way and to demonstrate to the mill that the table of interference losses does indeed work in practice.

Looking up the tables for the right number of looms to be allotted for the existing high rate of loom stoppages, he found that the number is just 9 (in place of 16 with the same allocation of 1 reliever for 4 weavers). So, he showed the machine interference tables to the Weaving Manager and the CEO, and suggested that the mill tries out this allotment in one group of 64 looms (16x4 being replaced by 9x7) and giving 2 relievers to this set of 9 weavers (one of them had to mind 10 looms). The table showed that such a change would increase the running efficiency at t=50 and N=8 (effectively) from 55% to 71%, since the machine interference loss was extremely high for 16 loom allocation. This allocation was implemented the very next day and the efficiencies of each of these 64 looms was tracked. The result was as expected — overnight, this set of looms gave running efficiency of 74% (since the time t for this mill was like 48 seconds) and actual efficiency due to stoppages for maintenance etc. was about 67%. From 46% to 67% overnight was a ‘miracle’ for the mill. The mill agreed to observe this setoff 64 looms for a week and then change over the entire loom shed to 9 looms per weaver. This result was a strong confirmation that weavers’ skill level was OK. The same set of weavers gave much higher loom efficiency!

And the same 'poor quality' looms from the East European manufacturer gave this higher efficiency. It could be seen from the interference tables, that if the existing high loom stoppage rate of about 9 per running hour could be brought down to the level of about 1 that good mills achieve, the running efficiency of the loom shed can be as high as 92-93%. Therefore, the next step was to analyse the loom stoppages in to three major categories: warp breaks, weft breaks and mechanical failures. (Fortunately, the mill had extensive detailed records on all these.) These numbers per running hour of the loom were about 4, 1 and 4 respectively. The yarn related stoppages were most likely to be due to poor yarn quality, since the maintenance of loom was quite good. The parts with which these warp and weft yarns come in contact were smooth.

The consultant sat down with the loom maintenance supervisor and did a quick exercise: how much time would it take to repair each kind of mechanical fault that occurred in an hour? A somewhat over estimate of time required showed a surprising result: the efficiency loss should be about 1% but was as high as 7%! This category wise fault analysis also showed that one particular small fault was the most recurring fault. This fault consisted of a fork (just like the fork one uses on dining table) which sensed the presence of weft on the loom was getting twisted and the weft yarn was slipping out of it. This would immediately cause the loom to stop, as if the weft is broken. Straightening the fork and inserting the weft yarn in it again was a ‘repair’ that would take only 3-4 seconds. But the efficiency loss due to this mechanical fault was very high: the loom where the weft yarn had slipped out owing to twisted fork would need to wait till the person from the maintenance team arrived at the loom to repair the fault. The system this mill followed was to send the repair mechanic on a ‘first reported, first served’ basis. This observation led the consultant as well as the maintenance supervisor to quickly change the system. Priority was to be given to repair faults that take less time over those which take more time. The machine faults were classified into three categories by the maintenance supervisor who was much more knowledgeable than the consultant in these matters. Moreover, all agreed that the straightening of the twisted fork may as well be done by the weaver/reliever weaver herself, rather than reporting about it and waiting for the mechanic to appear for this simple repair. Given these system improvements based on common sense ‘Queueing Theory’, the mill was confident that the efficiency loss due to mechanical failures would come down to about 1% as expected in a good mill.

**Conclusion on Day 4: The mechanical condition of the looms is OK:** it is not responsible for the high loss in efficiency --- the quality of manufacture of these looms

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is good, except for the quality of the weft sensing fork. Replacing the fork on all looms with a stronger version was planned to eliminate this defect. The cost of such replacement was negligibly small.

It was clear by now that even with all these improvements, the efficiency of the loom shed would not reach the 90% level, even with 9 looms allotted to a weaver. It was necessary to reduce the breakage rate of the warp yarns to about 0.5 per loom hour and that of weft yarn to 0.1 per loom hour so that high efficiency of around 90% can be achieved even with 16 looms allotted to a weaver. (The mechanical fault related stoppages reduced almost to 0.1 per loom hour, which is the norm for good mills, when the 'twisted fork' fault was taken away.) The need was to improve yarn 'quality': over to the Spinning Manager.

**Assessment of Yarn Quality**

The Spinning Manager and his colleagues were surprised to know that the quality of yarn that they supply to the weaving department was not up to the mark. The Quality Control Manager, too, was uncomfortable since the yarn test reports had consistently shown the quality to be good in comparison to the internationally accepted norms. The yarn strength and the yarn unevenness (which is a measure of how irregular the yarn is in terms of variation in thickness of the yarn) were quite good. But the fact of high breakage rates in weaving had to have reasons and these needed to be eliminated.

Applied research at ATIRA had led to two significant observations with respect to yarn quality as it influences the yarn breakages in post spinning operations of winding, warping, sizing and weaving on the loom. Firstly, not only the average quality -yarn strength or yarn unevenness -but the frequency of those rare 'outliers' that lie beyond the 'normal' variability also decide the breakage rate. When the averages are poor, the outliers become even more weak. Secondly, during winding, the elimination of unduly thick and unduly weak places in the yarn is critical to warp and weft yarn breakages on the loom. This diagnostic approach helped in tackling quickly the mill situation. In the absence of such diagnosis, the mill personnel usually take actions at several unimportant places, spend considerable time and efforts, also incur undue expenditure, but still do not get the desired result. Such a situation had prevailed in this mill also.

We first examined the setting of the electronic yarn clearers employed on the winding machines. These were improved to ensure a good removal of thick places above 3 times the average yarn thickness etc. The yarn tension level was high enough to eliminate weak places in yarn, because the yarn would break at such weak places and a knot or a splice would replace it.

Available data on single thread strength was examined for outliers i.e. values lying outside of the normal range of three times the coefficient of variation on either side of the average value for several different yarn counts. These were pooled and found to be about 14% --a very high number compared to the theoretically expected number of maximum 3%. Inspection of the ring frames (last stage of spinning where yarn is formed as a twisted thin strand of fibres) showed defects like eccentric front rollers, damaged drafting aprons, worn out rings and vibrating spindles.

This demonstration of 'poor quality' of yarn in the context of its performance in weaving was revealing to the spinning and quality control staff. They immediately decided to take appropriate maintenance and repair measures to bring down such defects to the minimum. Such corrective actions would need about a month to cover all ring frames (spinning machines) and the resultant improvement in weaving would need at least a fortnight to be detectable.

**Conclusion on Day 6:** Although the average yarn quality was good, the defectives were too many. Eliminating the defectives by specific actions would give the desired reduction in breakage rates at looms.

By the seventh day, the stipulated last day of the visit of the consultant from ATIRA, two more sections of 64 looms in the weaving shed were changed to 9 looms per weaver. Each of these also showed similar big jump in the loom efficiency. Weavers had started 'repairing' the weft fork fault enthusiastically: after all, their wages were higher wages owing to the increased productivity of their looms. The CEO, who had half -wondered whether the increase in efficiency due to change in allocation from 16 looms to 9 looms was by 'chance', was fully convinced from after his contract appointment with the making mill had turned around and was making good profits.
Graphene is a rapidly rising star in the perspective of materials science. The name graphene is given to a flat monolayer of carbon atoms strictly packed into a two-dimensional (2D) honeycomb lattice. It is considered to be a basic building block for graphitic materials of all other dimensionalities as it can be wrapped up into 0D fullerenes, rolled into 1D nanotubes or stacked into 3D graphite.

Carbon is arguably the most fascinating element in the periodic table being the base for DNA and all life on Earth. It can exist in various forms. The most common form of carbon is graphite that consists of stacked sheets of carbon with a hexagonal structure. Under high pressure diamond is formed, which is a metastable form of carbon.

Fullerenes are a new form of molecular carbon. The most common, called C60, contains 60 carbon atoms and looks like a football made up from 20 hexagons and 12 pentagons which allow the surface to form a sphere. The discovery of fullerenes was awarded the Nobel Prize in Chemistry in 1996. Similarly a quasi-one-dimensional form of carbon, carbon nanotubes, have been known for several decades and the single walled nanotubes since 1993. These can be formed from the graphene sheets which are rolled up to form tubes, and their ends are half spherical in the same way as the fullerenes.

It was well known that graphite consists of hexagonal carbon sheets that are stacked on top of each other, but it was believed that a single sheet could not be produced in isolated form such that electrical measurements could be performed.

History

Graphene may be the most remarkable substance ever discovered. Graphene-like structures were already known since 1960’s, but there were experimental difficulties in isolating single layers in a way that electrical measurements could be performed on them, and there were doubts that this was practically possible.

It is interesting to consider that everyone who has used an ordinary pencil has probably produced graphene-
like structures without knowing it. A pencil contains graphite, and when it is moved on a piece of paper, the graphite is cleaved into thin layers that end up on the paper and make up the text or drawing that we are trying to produce. A small fraction of these thin layers will contain only a few layers or even a single layer of graphite, i.e., graphene.

Thus, the difficulty was not to fabricate the graphene structures, but to isolate sufficiently large individual sheets in order to identify and characterize the graphene and also to verify its unique two-dimensional (2D) properties. This is what Geim, Novoselov, and their collaborators succeeded in doing. The Nobel Prize in Physics 2010 honours two scientists who have made the decisive contributions to this development. They are Andre K. Geim and Konstantin S. Novoselov, both at the University of Manchester, UK. They have succeeded in producing, isolating, identifying and characterizing graphene.

On one evening, in the fall of 2002, Geim was thinking about carbon. He specializes in microscopically thin materials, and he wondered how very thin layers of carbon might behave under certain experimental conditions. Graphite, which consists of stacks of atom-thick carbon layers, was an ideal material to work with, but the standard methods for isolating superthin samples would overheat the materials, destroying it. So Geim took the help of one of his new Ph.D. students, Da Jiang, the task of obtaining as thin a sample as possible—perhaps a few hundred atomic layers, by polishing a one-inch graphite crystal. Many weeks later, Jiang delivered a speck of carbon in a petri dish. But after looking into the microscopic images, it was found that the thinnest layer was not achieved.

Geim had an idea of using Scotch tape, having one of its side sticky. He peeled off the layers of carbon that make up the graphite from the pencil lead and placed it under a microscope. This time he saw that the graphite layers were thinner than any others he’d seen. By folding the tape, pressing the residue together and pulling it apart, he was able to peel the flakes down to still thinner layers. He had isolated the first two-dimensional material ever discovered: an atom thick layer of carbon, that appeared, under an atomic microscope, as a flat lattice of hexagons linked in a honeycomb pattern. Theoretical physicists had speculated about such a substance, calling it "graphene", but had assumed that a single atomic layer could not be obtained at room temperature. But Geim saw, graphene, remained in a single plane, developing ripples as the material stabilized.

![Figure 2: Graphene sheet](image)

Geim with the help of one of his Ph.D. students named Konstantin Novoselov, began working fourteen hour a day studying graphene. In the next two years, they designed a series of experiments that uncovered startling properties of the material. Because of its unique structure, electrons could flow across the lattice unimpeded by other layers, moving with extraordinary speed and freedom. It can carry a thousand times more electricity than copper.

Geim and Novoselov wrote a three-page paper describing their wonderful discoveries. But it was twice rejected by Nature where one reader stated that isolating a stable, two-dimensional material was almost "impossible," and another said that it was not a "sufficient scientific advance." But in October, 2004, the paper "Electric Field Effect in Atomically Thin Carbon Films," was first published in Science, which astonished scientists from every nook of the world.

Labs around the world started studies using Geim's Scotch-tape technique, and researchers identified other properties of graphene. Although it was found to be the thinnest material in the universe, it was around two hundred times stronger than an equivalent weight of steel—indeed, the strongest material ever found. It was also as pliable as rubber, that it could stretch to almost hundred and twenty percent of its length. The mobility—the speed at which an electric charge flows across a semiconductor was very high—of up to two hundred and fifty times that of silicon. Finally, in 2010, six years after Geim and Novoselov published first paper of their outstanding excellence on graphene, they were awarded the Nobel Prize in Physics.
Graphene's properties

Graphene is a single layer of carbon packed in a hexagonal (honeycomb) lattice, with carbon-carbon distance of 0.142 nm. It is the world's first 2D material and is one million times smaller than the diameter of a single human hair. Since graphene's isolation in 2004 it has captured the attention of many scientists, researchers and industry worldwide.

◆ It is the lightest but immensely tough
◆ It is 200 times stronger than steel, but is incredibly flexible
◆ It is the thinnest material possible to exist till now
◆ It is just one-atom thick but absorbs 2.3% of light so it can be seen with the naked eye
◆ It is a superb conductor and can act as a perfect barrier- not even helium can pass through it
◆ It is electrically as well as thermally very much conductive

It is most sought after material under research for applications.

![Graphene](image)

Figure 3: Applications of Graphene

Summary

The development of this material, opens up new existing possibilities. It is the first crystalline two-dimensional (2D) material and it has unique properties, making it very interesting both for fundamental science and for future applications. Although sporadic attempts to study graphene can be traced back to 1859, there has been an explosion in research around the material since 2004, when Professor Sir Andre Geim and Professor Sir Konstantin Novoselov of the University of Manchester discovered and isolated a single atomic layer of carbon for the first time. They received the Nobel Prize in Physics in 2010 in recognition of their outstanding breakthrough.

Bibliography


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Prof. (Dr.) Mangesh D. Teli is a senior most Professor and former Head of the Department of Fibres and Textile Processing Technology as well as former Dean at the Institute of Chemical Technology (ICT), Mumbai, India. He is a Fellow of CSIR-CNRS (France), Maharashtra Academy of Science, Honorary F.T.A and Shiksha Ratna. His research areas of interest are Natural dyes, Plasma Technology, Nanotechnology, Graphene, Super absorbents and Specialty finishes. He has guided 120 Master's and Doctoral students with over 370 publications/conference presentations and edited 25 books. He is an Independent Director of Siyaram Silk Mills, Chairman of Editorial Board of JTA and a Managing Trustee of Baha’i Lotus Temple, Delhi.
TAI Mumbai Unit successfully organized seminar on "Opportunities in the Current Challenges in Weaving Sector"

The Textile Association (India), Mumbai Unit organized One Day Seminar on "Opportunities in the Current Challenges in Weaving Sector" on 22nd April 2017 at Hotel fortune Park Galaxy, Vapi (Gujarat). The seminar was inaugurated by Mr. Ajit B. Chvan, Secretary and CEO, Textiles Committee, Ministry of Textile, Government of India, Mumbai.

Inaugural Session
Mr. V. C. Gupte, Chairman, TAI, Mumbai Unit welcomed the Chief Guest and Guests of Honour Mr. Mahesh Pandya, Director, Arvind Mafatlal Group of Industries and Mr. G. V. Aras, Director, A.T.E. Enterprises Pvt. Ltd. He also welcomed the Awardees, Speakers, Press, Media and delegates.

Mr. Haresh B. Parekh, Convener of the Seminar while giving the highlights said that in spite best efforts in modernization through various schemes such as TUFs, Technology mission for technical Textiles, the industry is still lacking in the area of up-gradation of technology in weaving. In fact, it is desirable to replace machines with appropriate choice of technology and development of modern management styles particularly for decentralized weaving sectors. Mr. Parekh said that this seminar aims to give an opportunity to the textile technologists to share their thoughts to meet these challenges and wished that the interaction in the seminar will be highly productive and beneficial.
Mr. Tapan Kumar Chandra, the Advisor of the Seminar said that the textile is essential in our day-to-day life. Twenty first century's fashion is very dynamic, trendy & versatile. Today, manufacturing of various textiles are also vast in all the areas with inclusion of speed, which is very high to serve huge population. Keeping all these in mind, lot of new development and research for the manufacturing of textile machinery; accessories would be the ongoing activities. In addition, it requires training of all the work force to have latest knowledge of latest developed machine. The Textile association has taken bold step to fulfil today's requirement and will continue to take further commitment to serve textile industry for all the new developments.

Mr. G. V. Aras, Director, A.T.E. Enterprises Pvt. Ltd. in address said that the textile industry is gearing up to its past status due to vibrant domestic and global markets. He reiterated that in the coming years, the acronym IT would stand for "Indian Textiles" as the Indian textile industry is gearing up fully to meet the global requirements with modern technologies.

Mr. Mahesh Pandya, Director, Arvind Mafatlal Group of Industries who was the Guest of Honour congratulated the TAI, Mumbai Unit for organising exclusive seminar on Weaving at Vapi.

The Textile Association (India), Mumbai Unit has set a precedent of felicitating the textile professionals for their outstanding contribution in the field of textile industry. In this Seminar, the TAI, Mumbai Unit felicitated Mr. Shyam Master, a very Senior Weaving Consultant and Mr. Hasmukh Shah, CEO, Kiran Threads with "The Lifetime Achievement Awards" as token of appreciation for their land mark achievements in the field of textiles.

Mr. Ajit B. Chavan, the Chief Guest in his inaugural address informed that Textiles Committee can take up the issues related to policy intervention to create industry friendly climate for meeting the global challenges. He appreciated the efforts of Textile Association (India), Mumbai unit in creating a platform by arranging the seminar in the vibrant textile Cluster-Vapi, Gujarat.

Mr. A. V. Mantri, Hon. Secretary, TAI, Mumbai unit, proposed vote of thanks.

Technical Session
During the technical session, following seven papers were presented by the eminent speakers.

◆ Mr. Guruprasad S. Shetty, Senior Manager (Fabric Forming), ATE Enterprises Pvt. Ltd. presented the paper on "Latest Developments in Warp Preparation (Karl Mayer)." He briefed the developments in warping and their comparative advantages in achieving enhanced efficiency and quality.

◆ Mr. Amit R. Singh, Senior Sales Manager, Itema
Weaving (India) Pvt. Ltd. expressed his views on "Innovations in Weaving". He emphasized the developments in the weaving machines towards achieving higher productivity and better quality.

◆ **Mr. Babasaheb Alugade**, Regional Sales Manager, Picanol India Pvt. Ltd. presented the paper on "Picanol - Ultimate solution for the challenges in weaving sector".

◆ **Mr. Kamal Shah**, General Manager (Mktg.), Prashant Group of Companies discussed the importance of "World Class Preparatory Machinery". He emphasized the achievements of the innovations in meeting the global demands.

◆ **Mr. P. K. Singh**, President, Luwa India Pvt. Ltd. presented the paper on "An Effective Humidification System for Weaving". He discussed the role of maintaining proper humidity to achieve the desired level of productivity and quality. Precise environmental conditions, according to him good be achieved by the Luwa humidification system.

◆ **Mr. Sanjay L. Gajul**, Sr. Marketing Manager (Technical), S. A. Pharmachem P. Ltd. made the presentation on "Size Recovery - Cost Effective and Eco Friendly" In his presentation, Mr. Sanjay discussed the salient features of the size recovery system developed by them.

◆ **Mr. Mohit Mahajan** - Territory Manager-West, ExxonMobil Lubricants Pvt. Ltd. presented the paper on "Advancing productivity with Mobil SHC in Textile Industry". Mr. Mohit spoke on the importance of lubricant in achieving the desired tribological performances in the weaving sector with special reference the synthetic lubricants being developed by them.

**Panel Discussions**

Panel discussions on "Upgrade Weaving Technology to meet export target" was moderated by **Dr. G. S. Nadiger**, Research Advisor, SASMIRA. The Panel of experts comprised of **Mr. A. A. Bambardekar**, Works Director, Raymond Limited, (Textile Division-Vapi), **Mr. A. G. Kurien Aracken**, Vice President - Q.A. (Weaving), Alok Industries Limited, **Mr. T. K. Sengupta**, Technical Advisor, Fibre2 Fashion Pvt. Ltd. and **Mr. Shyam Master**, Weaving Consultant.

Dr. Nadiger briefed the audience that 3Es and Q are the key aspects to face the challenges and avail the opportunities to meet the global demand. The 3Es included Energy, Efficiency and Environment and Q stood for quality of the output. He summarized that the seminar has so far highlighted theses issues by various speakers and further reinforcement and to conceptualize the future strategies could be done during this session by way of the brief of the experts and interaction with delegates. Each of the panel members gave their views on the theme of the panel discussion. It was followed by one to one interaction. Panel members substantiated various aspects. The interaction was quite fruitful to bring home the futuristic strategies for meeting the challenges. Delegates suggested to have similar programs be organised at Vapi as it would be quite useful for the industry.

The seminar was attended by over 200 delegates and the interactive delivery of various papers and one to one interaction during panel discussion made the seminar event very effective.
The Textile Association (India) West Bengal Unit Celebrated, 66th Anniversary and organized a half day Technological Conference with the theme "Textile Today" on 25th February 2017 at Academy of Fine Arts, 2, Cathedral Road, Kolkata.

Sri ArunavaKundu Vice Chairman of the Unit inaugurate the function with welcome address.

Technical Session Chairperson was Dr. Sadhan Ch. Roy, Ex-Professor IJT, Kolkata University and four Brilliant Papers were placed in the Technical Session as follows:

- Fire Retardant finish of Jute Textiles with Nano ZnO dispersed in polymethylsiliconate by Dr. Ashis Kumar Samanta, Department of Jute and Fibre Technology, University of Calcutta, India.
- User friendly chemical processing of Jute, Dr. SambhuNathChattopadhyay& Dr. Nimai Chandra Pan from ICAR National Institute of Research on Jute and allied Fibre Technology, Kolkata 12, Regent Park, India.

Dr. KausikBal, UGC Prof. University of Calcutta presenting his paper

Dr. SambhuNathChattopadhyay presenting the paper
How does the Fabric surface influence the warm-Cool Feeling?
By Dr. Kausik Bal, UGC Professor University of Calcutta, Kolkata, India.

A comparative Analysis of the Influence of different parameters on the production time and frequency of stitching fault in case of garment production by Sri Anirban Dutta, Asst. Professor, Department of Textile & Apparel Technology, Govt. College of Engineering & Textile Technology, Serampore, West Bengal.

56 persons participated in the Technical session from Textile, Hosiery and Garment Sector. Substantial numbers of Textile and Fashion Students also shared the session with questions and answers.

Dr. Sadhan Chandra Roy, Ex. Prof. IIT Kolkata, chairman of the technical session, conducting the session.

Sri. Asoke Kumar Mukherjee, Honorary Secretary, TAI West Bengal Unit proposing Vote of Thanks.

Sri Ashoke Kumar Mukherjee, Hon Secretary, West Bengal Unit gave vote of thanks to Authors of the four brilliant papers and the participants and members of our unit for active support to celebrate the function successfully.

There was a Tea Break and High Snacks arrangement at the end of function.

A souvenir was also published in the occasion and distributed to the participants.
TAI - South India Unit

Quarterly Seminar on
Latest Developments in Winding and Twisting

Mr. T. L. Viswanathan, presenting welcome address

Four leading textile research institutes in India viz. BTRA, Mumbai, ATIRA, Ahmedabad, SITRA, Coimbatore and NITRA, Ghaziabad have been organising Joint Technological Conferences over the years. In this annual event, latest finding of the research programs with reference to the latest technological developments are disseminated. In this context, 57th Joint Technological Conference was held at BTRA, Mumbai on 17th and 18th February, 2017. Nearly, 300 delegates from industry, trade and academics participated in this conference. The highlight of this conference was one full day on 'Geosynthetics', under the sponsorship of Textile Commissioner's Office, Ministry of Textiles, GoI and the other day was devoted to R&D in Emerging Areas, Protective Textiles, Product Development, Eco-friendly process, etc. related to traditional textiles.

The Textile Association (India) - South India Unit conducted their quarterly Seminar on "Latest Developments in Winding and Twisting" presented by ATE / SAVIO on 28th February, 2017 at Sri Kasturi Sreenivasan Textile Museum, Coimbatore.

Mr. T.L. Viswanathan, Vice President, TAI South India Unit welcomed all the participants and presented his welcome address. Mr. Mohanram, Deputy General Manager and Mr. Prabakar, Deputy General Manager, A.T.E. explained all the new developments in Winding and Twisting machines with PowerPoint Presentation and Video clippings.

Seminar was attended by about 150 members and it was well appreciated by the participants as it was very informative. There was a good interaction with the speakers.

Mr. T.A. Venkatachalam, Vice President proposed the vote of thanks.

Chief Guest Dr. Kavita Gupta, Textile Commissioner, Ministry of Textiles, GoI. Dr. Kavita Gupta, in her inaugural address, said that in India only 10% of textile products belong to technical textiles as compared to developed nations such as Germany where 50% of textile products belong to technical textile category.

Current market size of technical textiles in India is Rs. 1 lakh crore and the market is growing at 20% CAGR. In order to grow in high value technical textiles segment, we should focus on research that is demand based and market driven. Moreover, ability to translate research output in to commercialisation is the need of the hour. She stressed the importance of the link between academia and the industry.

Dr. Anjan K. Mukhopadhyay, Director, BTRA welcomed the dignitaries and the delegates.

Dr. Anjan K. Mukhopadhyay, Director, BTRA welcomed the dignitaries and the delegates. He briefed...
the audience about this conference profile and said that one full day was devoted to 'Geosynthetics' that could open up an avenue for the conventional textile manufacturers to interact with Geosynthetics manufacturers/users to know the opportunities available in terms of machinery, processes, etc. to make technical textile products, especially geosynthetics. He also said German Textile Machinery Manufacturing Companies have also taken part in this conference by way of presentations on needle-felt nonwoven and latest machine innovations on treatment of Geotextiles.

Mr. Narendra Dalmia, Deputy Chairman, Governing Council, BTRA presided over the inaugural session. In his presidential speech, he talked about the research projects of all four TRAs currently in progress and their findings as well as the operational performance. He said that innovation is the key word and this is where the Research Associations play an important role and appreciated excellent work done by all the four TRAs to help the industry in its goal to have better operational efficiency.

Mr. Rajesh Nath, the Managing Director for VDMA in India made the Key note address introducing VDMA, Textile Machinery and the solutions and competence of VDMA members also in the area of machinery, plants and components for geotextiles applications. This year, VDMA completes 125 years with its presence in Germany.

With the theme of the event being Geotextiles, he spoke about Geotextiles being ambitious textile products that are tailor-made according to the intended application. Depending on application, the soil quality has also to be considered when choosing geotextile material. Nonwovens, woven and warp-knitted geotextiles, geogrids, all of geotextiles used around the world, nonwovens were estimated to make up over 65% in terms of area.

In order to produce tailor-made geotextiles, appropriate machinery is needed and VDMA can guide the industry to the right manufacturers as per the requirement.

Dr. C.R. Prayag, Officiating Director, ATIRA proposed vote of thanks.

First day proceedings
In this two-day conference, first day was allotted exclusively for 'Geosynthetics' and personnel from geosynthetics manufacturers, users of geosynthetics and TRAs presented their papers. There were 5 technical sessions in the first day.

In the first session, chaired by Mr. S. Bagli, Chief Technology Officer, Strata Geosystems, Mumbai, two papers were presented. One is on 'Geosynthetics: Challenges in using in Navi Mumbai projects' by Prof. Anand R. Katti, Professor, Datta Meghe College of Engineering, Navi Mumbai & Managing Director, Nagar Yuwak Shikshan Sanstha, Airoli and another on 'Application of Geosynthetics in Canals' by Mr. Vivek P. Kapadia, Chief Engineer & Addl. Secretary, Water Resource, Gandhinagar, Gujarat. The papers were well received by the audience and good interaction was seen during question and answer session.

In the second session, two papers were presented. This session was chaired by Mr. Vivek P. Kapadia, Chief Engineer & Addl. Secretary, Water Resource, Gandhinagar, Gujarat. The first paper was on 'Metal net covered sand fill bags for erosion and flood control' by Ms. Sonal Kulkarni, Maccaferrri Environmental Solutions Pvt. Ltd., Gurgaon and second one was on 'Geosynthetic systems for coastal erosion control with case reference of Alleppey Kerala' by Mr. Rohit Chaturvedi, Vice President Business Development, Flexituff International Ltd., Madhya Pradesh.

The third session was chaired by Mr. Guru Vittal, Chief Scientist, CRRI, New Delhi. The following three papers were presented.

- Strengthening of road subgrade and slope stabilization using Jute Geosynthetics-Mr. Pradip Kr. Choudhury, Principal Technologist, National Jute Board, Kolkata.
- Geogrids for retaining walls - Mr. Satish Naik, Chief Executive Officer, Best Geotechnics Pvt. Ltd, Mumbai.

Prof. A. R. Katti, Professor, Datta Meghe College of Engineering, Navi Mumbai & Managing Director, Nagar Yuwak Shikshan Sanstha, Airoli, chaired the fourth session. Two papers viz., (i) Rehabilitation for existing landfills - Mr. Aditya Agarwal, CEO, Jeevan Products, Navi Mumbai and (ii) Hydraulic properties of geo-textiles: An experimental study - M/s. Seema Patel, R. V. Chikhani, Rajesh Patel and Jignesh Patel, ATIRA, were presented.

In the fifth session, Prof. S.G. Vinzenekar, Ex. Principal, VJTI, Mumbai chaired the proceedings. The following three papers were presented in this session.

- Challenges and potentials of using Geosynthetics in Road and Bridges by Mr. P. L. Bongirwar, Retired Principal Secretary, PWD.
- Vacuum PVD for fast soil stabilization by Mr. V. V. Vaishampayan, Managing Director, Soham Foundations, Navi Mumbai.
Geotechnical expertise at BTRA by Mr. Sri Ramchandran, BTRA.

Second day proceedings
In the second day, there were 7 technical sessions. Papers from all four TRAs were presented in the areas of protective textiles, emerging areas, spinning, product development, eco-friendly products, etc. In the end, there was a special session by German Textile Machinery (VDMA), in which two papers were presented. The focus of the First session was 'Emerging Areas' chaired by Dr. M.K. Talukdar, Kusumgar Corporates Pvt. Ltd., Mumbai. There were three papers in this session and all were from BTRA. Titles were as follows.

- Use of electron beam irradiation for solution of biodegradation enhancement in textile industry by M/s. SmitaDeogaonkar, Megha Patel, BTRA and Kaushlesh P. Rawat, BARC.
- Development of silver coated electro-conductive cotton fabric using electron beam radiation technology by M/s. Kumar Krishnamand and Amol G. Thite, BTRA.
- Adhesion improvement of coated textiles by atmospheric plasma treatment by M/s. Pratik Joshi and ShitalPalaskar, BTRA.

In the second session, following two papers related to 'Protective Textiles' were presented. Dr. A.K. Rakshit, Executive Director, ITTA, Mumbai chaired the proceedings.

- Protective textiles to protect against electromagnetic radiation - M/s. Pawan Sharma, Seema Patel and C.S. Vora, ATIRA.
- Development of work wear for workers working in cement industry - M/s. M.S. Parmar, ShwetaSaxena, Kushagra Prakash and M.K. Bansal, NITRA.

Prof. S.G. Vinzenekar, Ex. Principal, VJTI, Mumbai chaired the third session on 'Spinning'. The following three papers were presented.

- A new approach on study of twist contraction levels in modern ring spinning process by M/s. D. Jayaraman and V. Vijayajothi, SITRA.
- Influence of combing of polyester/cotton blended material on yarn quality compared to the traditional processes by M/s. D. Jayaraman and N. Vittopa, SITRA.
- Achievable levels of UKG in modern spinning mills (Present and Future scenario) by M/s. N. Vasanth Kumar and S. Chandirasoodan, SITRA.

Chairman of the fourth session was Dr. AnirbanGuha, Associate Professor, IIT Bombay and the session topic was 'Product Development'. The following three papers were presented.

- Concept paper on development of nano-fibre based water filtration device for human beings by Mr. Chetan Mahajan, ATIRA.
- Electronic drape tester based on image analysis technique by M/s. ArindamBasu, Sanjeev Shukla, KrishanDewan and PaurushGodhar, NITRA.
- Development of smoothness testers for finished fabrics by M/s. M.S. Parmar, NidhiSisodia, Maheshwar Singh and VasundharaVerma, NITRA.

In the fifth 'General' session, the following three papers, dealing with spinning productivity, garment workpractices and water conservation in textile wet processing, were covered. Prof. S.G. Vinzenekar, Ex. Principal, VJTI, Mumbai chaired this session.

- Productivity in spinning mills-2016 (based on SITRA's 33rd Productivity Survey) by M/s. J. Sreenivasan and P. Subash, SITRA.
- A study of work practices in Indian garment factories by M/s. Vivek Agarwal, M.M. Tiwari, ShwetaSaxena, Kushagra Prakash and M.K. Bansal, NITRA.
- Practical approaches for water conservation in textile wet processing by M/s. SanjayKadam and M.S. Kulkarni, BTRA.

Prof. D.P. Chattopadhyay, Professor, M.S. University, Vadodara chaired the sixth session on the topic of 'Eco-friendly Products'. There were two papers and the same are given as follows.

- Development of infant baby clothings using ecormontant and natural dyes on cotton fabric with antibacterial activity by M/s. K. H. Prabhu, S. Sivakumar and E. Prakash, SITRA.

In the last session, personnel from German Textile Machinery (VDMA) presented the following two papers.

- Mr. Hjalmar Schwab, Sales Manager, DILO Systems on "Latest technique and technology for the production of needle felted nonwovens and their applications".
- Mr. JuergenHanel, Business Development Manager-Technical Textiles, A. Monforts Textilmaschinen on "Latest machine innovations for treatment of Geotextiles".

In the end, Dr. Anjan K. Mukhopadhyay, Director, BTRA thanked all those who have contributed for the success of this event.
The Children & Baby Maternity Expo 2017 witnessed some great new initiatives this year like the "Fashion N Kids Conclave". This conclave was conceptualized & cumulated by Suvin Advisors on 12th April, 2017 from 10.00 am to 1.00 pm. The conclave provided a platform to the entire value chain in the kidswear segment for knowledge sharing on latest developments & provided expert opinions on safety & quality control issues in Textiles used for kidswear & Baby products.

The Session began with a welcome note by Mr. Pankaj Shende - Project head of CBME followed by Mr. Avinash Mayekar, Managing Director & CEO, Suvin Advisors' key note address on "Overview of Kids wear & specialized textiles for babies & kids."

The Conclave then addressed the various segments in kids wear value chain starting with Mr. Ritesh Khandelwal, Vice President Global Business Development, Birla Cellulose presentation on "Role of Viscose in Kids wear" providing great insights about the specialized characteristics of Viscose & how Birla cellulose viscose Fibre "Liva" is preferred by moms for its gentle feel & comfort.

He also announced that Aditya Birla group will soon be venturing into kids wear sector & launching their own kids wear brand.

Later, Mr. Sundarmurthy Krishnan, National Head-Intertek provided an informative talk on "Quality control issues in Kids wear" & how care needs to be adopted while selecting accessories for kids & babies apparels. He also highlighted the various do's & don'ts that need to be taken care of while using garment accessories such as zippers and fasteners.

Mr. Kamal Johari, Managing Director, Nobel Hygiene enlightened the delegates on "Innovation in diaper technology" presenting evolution of diapers & highlighted various difficulties faced by Indian manufacturers for producing good quality & cost-effective product. Later on Mr. Nitin Mathur - Product Manager, IIGM presented on "Innovation in Garmenting techniques" showcasing latest stitching machineries & advanced technologies available to avoid sharpened accessories & fasteners from causing injuries to the kids.

The conclave was then addressed by Ms. Manjiri Paranjape-Sr. General Manager - Rossari Biotech on "Role of Dyes & Chemicals in Kids wear" She explained how chemicals can be used to provide specialized properties like fragrance, Anti-odour, Antimicrobial, Mosquito repellent etc in kidswear & various alternatives to hazardous chemicals.

The conclave then witnessed a Panel discussion on "Environmental Evolution of Fashion on Kidswear" moderated by Mr. Avinash Mayekar & the panelist were Dr. Ullhas Nimkar - Managing Director - Nimkartek Technical Services, Mr. Vikas Sharan - Vice President - ATE Enterprises Pvt. Ltd., Manish Daga - Managing Director - Cotton Guru, Mr. Kamal Johari - Nobel Hygiene & Mr. Sundarmurthy Krishnan - Intertek. The Panel discussed on the future growth prospect in kidswear industry & provided expert opinion on international norms, Future of cotton based products, treatments to be adopted to reduce impact of effluents caused by dyes & chemicals & many other issues.

The conclave concluded with thanking note & an urge to textile Industry to come forward & create many more such events to help India become a global leader in kids wear segments.
Fast and accurate: quality assured for filament yarns

The USTER®TESTER 6-C800 is ready for the most demanding technical textiles applications.

The amazing diversity of technical textiles applications is matched by the wide variety of quality characteristics needed in the raw material used - so filament yarn producers know they must work to the most stringent specifications and standards. Quality failings, especially in the critical parameter of yarn evenness, can be expensive, but the USTER®TESTER 6-C800 provides fast, accurate testing to the tightest tolerances, protecting filament producers against customer complaints and claims.

Raw materials for technical textiles cover a wide range of end-uses and performance requirements. Viscose fibers, for instance, are found in lightweight blouses as well as in wire cording and high-speed car tires. Polyester, common in low-price clothing, is also transformed in special high-tech versions, for sophisticated sportswear and outdoor clothing.

Countless other examples of technical applications for filament yarns span sectors such as medical, industrial, transport, engineering and protective clothing.

Despite this variety of products, there is one fundamental requirement which is common to all: the absolute need for yarn evenness, measured to close tolerances, to ensure that the functional and aesthetic properties of the finished article achieve the high quality standards that customers demand.

**Reliable test results**

Efficient testing routines and the right testing equipment are the key to avoiding customer dissatisfaction, quality claims and the loss of future business for filament producers.

Evenness testing has to combine reliability, accuracy and speed. The USTER®TESTER 6-C800 is specially designed for filament yarn testing, to meet these criteria perfectly. At its heart is the new Capacitive Sensor, providing more accurate and reliable test results than ever before.

Typically, filament yarns show a CVm value around 1, so that even small deviations in evenness are likely to cause noticeable defects in the fabric. The increasing complexity of applications and performance standards - with fabrics needing to protect against water, wind, cold, heat, and even bullets - means that evenness is an absolute requirement.

For this vital parameter, spinners have for decades been depending on the USTER CVm value, now recognized as the defining global standard for evenness.

The USTER®TESTER 6-C800 combines reliability with top speed operation. All models operate at the test speed of 800 m/min. Running on the automatic setting, the high sample throughput rate gives even better detection of quality exceptions. The result is lower labor costs and improved control of quality for the business.

**See it at Texthtextil**

The latest USTER®TESTER for filament yarn will be presented at Techtextil 2017 in Frankfurt, Germany, the leading global showcase for technical textiles. The USTER display (Hall 6.1, booth B65) will present the production optimization and quality assurance benefits to show visitors.

As well as the advantages already described, the USTER®TESTER 6-C800 offers three new unique features to help yarn producers increase efficiency and improve quality. The measurement of interminglings is an innovation saving time and preventing variations in subsequent fabric appearance. An automatic twist scan facility has been developed, assist filament quality monitoring by making twister settings easier.

And the Knowledge Based System (KBS) quickly traces the cause of a quality problem on the spinning machine, with no need for extra settings or input from the machine supplier, via a single click on the spectrogram display.
Experteise inside

Built-in knowledge now comes as standard for USTER instruments, along with the renowned Swiss accuracy. The sophisticated sensor technology in the USTER® TESTER 6-C800 is rooted in continuous R&D aimed at higher performance and extended applications - echoing progress in the technical textiles yarns themselves. The new Capacitive Sensor empowers filament yarn producers with the expertise to deliver right-first-time quality, no matter how demanding and innovative the application. It creates a chain of customer satisfaction, from USTER to its customers, and on to the customer's customers…

Global Organic Textile Standard (GOTS) - New version 5.0 released

Stricter criteria for regenerated fibres & category “Combined Products” added

Version 5.0 of the Global Organic Textile Standard (GOTS) has been released. GOTS is the worldwide recognized standard for the processing of textiles made with 95 percent (label grade “organic”) or at least 70 percent (label grade “made with organic”) certified organic fibres.

GOTS’ core provisions such as the minimum content of certified organic fibers and the general bans on the use of toxic and harmful chemicals, conventional cotton, virgin polyester, GMOs, substances derived from GMOs and nanotechnology have been maintained.

The criteria for the "additional fibre material" are now stricter regarding the environmentally improved and certified regenerated cellulosic fibres: The use of Viscose and Modal is now restricted to 10% (25% for sportswear and socks). Lyocell may still be used up to 30% because of its more sustainable manufacturing processes.

For the first time GOTS will allow "Combined Products" such as prams with textile fabrics, bassinets, car seats or furniture with textile fabric upholstery to have certified and labelled fabric components.

Regarding the GOTS social criteria an explicit section on Ethical Business Behaviour including a corruption ban was added, based on the UN Global Compact Principles. The mandatory GOTS Social Compliance Management System for the first time includes guidance on the use of tools such as SAI Social Fingerprint™ to help companies measure and improve their social performance.

"Revision of GOTS always walks a fine line between strict and verifiable criteria and the needs of the market. For example, version 5.0 includes the tightening of composition requirements with respect to regenerated cellulosic fibres. On the other hand, the new possibility of combined products with fabric components certified to GOTS helps include a range of products that could not carry the GOTS label in the past. This helps to increase our contribution to sustainable development." says Rahul Bhajekar, GOTS Director Standards Development and Quality Assurance.

GOTS 5.0 is the result of a year-long revision process with multi stakeholder input which is repeated every three years. All relevant Stakeholders who operate internationally with expertise in the fields of organic production, textile colourants & chemicals, social criteria & industry, NGOs and consumer interests were invited to participate. Invited organizations included Greenpeace, Clean Clothes Campaign, Fair Labour Association, FairWear Foundation, IFOAM, ILO, Transparency International, Social Accountability International (SAI) and Textile Exchange.

The list of all stakeholders and more about the revision process can be found on GOTS website (http://www.global-standard.org/the-standard/revisionprocedure.html).

GOTS Version 5.0, the Manual for Implementation Version 5.0, a list of relevant changes and further information regarding GOTS can be found on http://www.global-standard.org.

GOTS was developed by leading international standard setters - Organic Trade Association (U.S.), Japan

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Organic Cotton Association, International Association Natural Textile Industry (Germany), and Soil Association (UK), which formed an International Working Group to define globally recognized requirements that ensure the organic status of textiles. GOTS' operating unit, the Global-Standard gemeinnützige GmbH, is a non-profit organization. For more information about GOTS see www.global-standard.org.

India ITME -2016 Exhibition awarded Exhibition Excellence Awards in EEA-2017

India International Textile Machinery Exhibitions Society (India ITME Society) is established in 1980 to support and serve the Textile Engineering Industry through exhibitions, Events, Trade Promotion Services, Education Scholarships, Student Placements, and Consultancy etc.

India ITME Society plays a pivotal role in strengthening the domestic as well as international Textile Industry by facilitating exchange of knowledge, technology transfer & encourages Foreign Direct Investments & Joint Ventures etc.

India ITME Society has been successfully serving the Industry for last 37 years and hosts 2 Mega International Textile Technology events in India addressing different aspects of industry requirements and focusing on future technology, i.e. 10International Textile Machinery Exhibitions (ITME) and 1 Global Textile Technology Engineering Show (GTTES).

As ITME Society is a public service organization, strives to create events where the focus is not in bringing in exhibitors and visitors under one roof but create conducive atmosphere, opportunity and facilitate customer connect and market access not only in domestic market but all across neighbouring regions as well as globally. India ITME Society has expanded its activities and provides support to Textile and Textile Engineering Industry in many fields.

Recently, India ITME- 2016 Exhibition was nominated and qualified for the awards under below categories:
◆ Knowledge Hub Category
◆ Best use of Technology Category
◆ Corporate Excellence Category
◆ Excellence in Operations.

India ITME Society was shortlisted out of the 10 nominations. The award function was held on 18th March 2017 at India Expo Mart, Greater Noida. This is the Second year India ITME Society is winning award.

Apart from the above awards won by India ITME Society, Ms. Seema Srivastava, Executive Director also has won an individual award under the "Distinguished Achiever in Exhibition Industry" Category.

The awards were constituted by Exhibition Showcase, supported by UFI, IAEE, IndianExhibitions Conferences & Events Services Association (IESA), Indian Exhibition Industry Association (IEIA), Indian Industries Association (IIA), PIOCCI & hosted by India Expo Mart, Noida.

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Indian Textiles and Textile Engineering Industry are honoured and feeling proud for this award.
FUTURE TEXTILE ROAD
The future of the new textile industry: a dialogue between Xinjiang, China and Europe

"Xinjiang has become one of the most competitive and rapidly developing textile zone in China, even compared with Vietnam and other regions of Southeast Asia. The industry output value is planned to increase from 30 billion RMB in 2014 to 400 billion RMB in 2023. Xinjiang is the nearest region of China to Europe with the shortest and less expensive transport time: international freight train through Xinjiang takes only 12 days to Germany. By 2023, Xinjiang will become the largest cotton textile industry base of China and the most important clothing export base in Western China" explained Liang Yong, Xinjiang Uygur Autonomous Region People's Government Deputy Secretary-General, Xinjiang Textile and Apparel Employment Leading Group Office Director.

"We are here to open a new dialogue between Xinjiang, China and Europe, a Forum which retraces the Silk Road to open a new dialogue between the Asian continent and the Mediterranean Sea on 16th May, 2017 at Urumqi, Xinjiang. The aim of the event is to build an innovative platform for the future development of the global high-end textile industry and the long-term construction of the cooperation system between different Countries aligned with The Belt and Road Initiative.

"According to the ten-year plan, by 2023, Xinjiang will build China largest cotton textile production base and the largest garment export processing base. Moreover, Urumqi will turn into a fashion capital of Central Asia" said Zhao Qing, Xinjiang Uygur Autonomous Region Vice Chairman.

Gao Yong, China Textile Industry Federation Party Secretary and Secretary General, pointed out that the Forum is expected to create an efficient platform for international cooperation, build closer and stronger network of partners, promote textile industry exchanges at a wider and higher level.
China and Europe: "Future Textile Road" stays for brand-new connections which are being established between different Countries and Regions. We want to continue to prove our commitment to the Chinese textile industry with this new important milestone in Xinjiang. Xinjiang definitely represents a great opportunity for the global textile industry" replied Ferdinando Businaro, Santex Rimar Group President.

Stefano Gallucci, Santex Rimar Group CEO added: "Santex Rimar Group wants to join The Belt and Road initiative. We want to bring our know-how and experience in providing solutions for the textile industry and help customers become successful".

Giovanni Bonotto, Creative Director, Bonotto; Cheng Yingfen, Designer Director, Xinjiang Atlas Research and Development Promotion Center; Francesco Dalla Rovere, President, Sinv Holding; Arthur Huang, CEO and Founder, Miniwiz; Pietro Pin, Head of New Technologies Research and Development, Benetton Group; Cristiano Seganfreddo, Artistic Director, Krizia; Su Xiao, President, Shangdong Ruyi Group; Sun Weiting, Chairman, Huafu Top Dyed Melange Yarn Co., Ltd; Calvin Woolley, Global Supplier Development Leader - Textiles Category Area, Ikea - gave a speech during the first day of the Forum.

Forum contents shifted from Ikea commitment to sustainability and new materials to Bonotto example of producing high quality fabrics for the most important fashion brands of the world; from cutting-edge Chinese textile companies such as Ruyi and Huafu to the high-performance applications of recycled materials of Miniwiz.

The essence of the dialogue between Xinjiang, China and Europe was perfectly represented by the Forum special content: ZHUCHONGYUN COLLECTION designed and curated by Zhu Chongyun, Founder of Marisfrolg Group, Board Chairman of Marisfrolg and Creative Director. Thanks to a unique expression of style Zhuchongyun is aiming to develop fashion into art with no distinction between the East and West. The displayed collection, named East & West Melody, combines and reshapes traditional East cultural elements with Western contemporary design techniques.

Gao Yong, China Textile Industry Federation Party Secretary and Secretary General; Yang Zhaohua, Vice president of China Textile Industry Federation, China Chairman of the China Textile Industry Association; Peng Yanli, Deputy Secretary-General of China Textile Industry Association; Qiao Yanjin, President of China Textile Industry Association, Director of Productivity Promotion Department of China Textile Industry Association, Director of China Textile Information Center were among the almost 200 people who attended the first day of the Forum.

The event represented a unique opportunity for Santex Rimar Group to join and promote a strategic
initiative: for the first time an Italian machine manufacturer has gathered some of the most important players to explore the future growth of the textile industry.

As Cristiano Seganfreddo, Artistic Director of Krizia, said during his speech: "Creativity is the new weaving machine. The yarns of this loom are dialogue between different cultures, technology, art, design, sustainability and cultural engagement. For future textile roads we need to weave new ideas and not only physical yarns!"

About the organizers:

Leading Group Office for Development of Employment-Centered Textile and Apparel Industry in Xinjiang Uygur Autonomous Region is a coordinating body established for the implementation of the strategic planning which is set up by the Chinese Central Government, namely, one million employment program in Xinjiang (2014-2023).

The office of the leading group is in the general office of the people's government of Xinjiang Uygur Autonomous Region.

Its main duties are:
1. Study and solve the major issues in the planning process, draft and report industrial policies, measures and suggestions to Central Government and the Party Committee and the people's government of Autonomous Region.
2. Supervise and coordinate the using of special fund of textile and clothing industry and evaluate the effect of fund using.
3. Conduct supervision, assessment and statistical analysis to the implementation of the program.
4. Hold industrial activities such as Asia-Europe Silk Road Fashion Festival.

China Textile Information Center (CTIC) is an authoritative information and consulting services organization in China's textile industry and also the largest comprehensive research and public service organization of the industry. CTIC is dedicated to pushing forward the development, transformation and upgrading of textile industry; promoting the spread and application of textile technology and cultural creativities; supporting closer integration of the textile industry with fashion industry, cultural and creative industry and information industry as well as emerging industries of strategic importance; and helping Chinese textile and apparel enterprises improving their product quality, market presence and international competitiveness. Headquartered in Beijing, CTIC has many branch offices spread over many cities including Shanghai, Guangdong, Fujian, Jiangsu and Zhejiang, and more than 20 wholly-owned and holding subsidiary companies.

SantexRimar Group is a machinery manufacturer and a partner for customized solutions which provides the most efficient technology in respect to productivity, energy saving and sustainability, low maintenance costs and state of the art production processes.

SantexRimar Group is present in Switzerland, China, India and Turkey with headquarters in Italy and has more than 30,000 customers throughout the world. 100 years of experience, worldwide customer sales, service and support organization together with in-house R&D, mechanical and software engineering make the Group a complete system solution provider.

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Fast forward to a million...

USTER®QUANTUM 3 Anniversary Edition boosts clearer sales to early milestone

The world-leading USTER®QUANTUM 3 generation of yarn clearing is set to reach a notable milestone in the autumn months, when the one millionth unit will be produced at USTER headquarters in Switzerland. The market success of the clearer has been accelerated by the launch of the latest version of the USTER®QUANTUM 3, which offers new features targeting intelligent quality management at specific fashion-oriented applications. USTER is preparing to celebrate the production of its one millionth USTER®QUANTUM 3 clearer, which has enjoyed unprecedented sales since its launch in 2010. Pioneering concepts such as Smart Limits and the YARN BODY have made the clearer an attractive choice for more than thousand mills worldwide, and the introduction of the USTER®QUANTUM 3 Anni-
On-trend... and on-quality
Spinning mills need to act fast to take advantage of important fashion trends. But yarns which hit the spot in terms of aesthetic appeal must also meet the exacting quality standards required in certain of these specialized applications.

The latest edition of the successful USTER®QUANTUM 3 yarn clearer addresses both these demands, thanks to new features which allow spinners to deliver yarns which are on-trend and also on-quality.

Core Yarn Clearing and Color/Shade Variation are unique innovations which put spinners in control of quality and avoid claims and complaints in important applications such as stretch denim and sportswear, and in the newly-fashionable market for mélange and subtly-colored yarns.

The Core Yarn Clearing feature with USTER®QUANTUM 3 is the first-ever automated solution to monitoring and assuring the quality of yarns with an elastane center encased by a cotton or synthetic outer. Fabrics with stretch and fancy slub effects created in this way continue to be extremely popular in both fashion items such as denim jeans and in functional garments and sports clothing. Common problems when producing these yarns can occur when the inner elastane component is either missing or positioned off-center within the wrapper element. The Core Yarn Clearing feature uses powerful sensors and algorithms to detect any such problems and ensures that downstream customers receive a stretch yarn which perfectly meets their specifications. Using the built-in Smart Limits facility, the correct tolerances can be set quickly and easily, so that any bobbins containing core defects are blocked and removed.

The new Shade Variation feature of the USTER®QUANTUM 3 overcomes several potential problems which can lead to unacceptable color and shade differences. This is particularly important for spinners operating in the growing market for mélange and color-effect yarns. Here, human error can cause bobbins of differing colors or shades to be accidentally mixed in a single yarn lot.

If that occurs, the problem can be difficult or impossible to identify in the yarn with the naked eye. And a single rogue bobbin can ruin a yarn lot, leading to disastrous and conspicuous results such as a barre effect in the final fabric. The risks of a mistake are often magnified by the insufficiently controlled process, inadequate lighting conditions in mills, and the possibility of operatives with poor eyesight or imperfect color vision.

Today, latest technology in the USTER®QUANTUM 3 and its Shade Variation (SV) facility provides a separated clearing channel which deals specifically with color deviations. When clearing limits are set, the SV feature immediately starts checking the bobbin as it runs on the winding machine, after which the Continuous Shade Variation (CSV) takes over to monitor the entire length of the bobbin, based on reference data which enables detection of even the most subtle variations in mélange yarns.

Tradition of innovation
"It’s more that we hoped for, how much the new Core Yarn Clearing and the Color/Shade Variation features
Media contact:
Edith Aepli
Senior Manager Marketing & Communication
Uster Technologies AG
Sonnenbergstrasse 10
CH - 8610 Uster / Switzerland
Direct  +41 43 366 38 80
Mobile +41 79 916 02 91
Fax     +41 43 366 39 58
E-mail edith.aepli@uster.com
www.uster.com

Lanza addresses this unmet market need for more sustainable viscose by launching EcoVero™ fibers that set a new industry standard in sustainable viscose based on three pillars: the use of sustainable wood sources (FSC® or PEFC® certified), an ecological production process (significantly lower emissions and water impact than conventional viscose), and full supply chain transparency by identifying EcoVero™ fibers in the final product.

EcoVero™ fibers - use of sustainable wood sources
EcoVero™ fibers are made from wood, a natural and renewable raw material. The wood comes from sustainable forestry plantations that are certified by industry-leading associations such as FSC®, Lenzing has a comprehensive wood sourcing policy that goes above and beyond the call of duty to ensure that the most sustainable wood sources are used for viscose production.

EcoVero™ fibers - significantly lower emissions and water impact than conventional viscose
Lenzing enforces strict environmental standards during viscose production and has invested millions over the years to achieve eco-friendly production process. For example, Lenzing’s viscose production sites where EcoVero™ fibers are produced comply with the stringent guidelines of the EU Eco Label, a world-leading environmental manufacturing standard.

The EU Eco Label is a sign of environmental excellence and is awarded to products and services meeting high environmental standards throughout their life cycle.

The environmental awareness of consumers has been growing steadily over the last decade, more recently in the fashion and textile industry. Textile consumption is expected to double by 2025, and the industry is anxiously looking for more sustainable solutions with minimal eco-footprint. Achieving low environmental impact requires developing eco-friendly raw materials and a sustainable manufacturing process.
lifecycles: from raw material extraction to production, distribution and disposal. In addition, the flagship viscose production in Austria uses a significant amount of renewable bio-energy in the manufacturing process.

**EcoVero™ fibers - full supply chain transparency**

With EcoVero™ fibers, Lenzing launches one of the most environmentally friendly viscose fibers. A special manufacturing system enables us to identify EcoVero™ fibers in the final product, long after the textile processing and conversion steps. Thus, retailers and brands are fully assured that they are indeed incorporating the eco-friendly viscose, and not a generic market viscose. "With this special identification technology for EcoVero™ fibers, we are supporting the trend in the fashion industry towards greater transparency. It is becoming increasingly important to know where the products come from and which path they have covered," Robert van de Kerkhof, Chief Commercial Officer, explains.

**Marketing Service for EcoVero™ fibers**

EcoVero™ fibers, our next milestone in Lenzing’s sustainability journey, offer an extensive marketing service package and are part of Lenzing’s Branding & Licensing Program. Fabrics containing EcoVero™ fibers can be certified at our in-house certification centers in Europe and Asia.

**Launch of EcoVero™ fibers in autumn 2017**

The new EcoVero™ fibers will be launched at the global textile trade shows from autumn on. Right now the sampling phase has started and special customers are developing products using EcoVero™ fibers.

**For more information please contact:**
Mag. Christina Kreuzwieser, MBA
Head of Marketing Communication Europe & Americas
Phone: +43 (0) 7672 701-2331
E-mail: press@lenzing.com
LIVA CRÈME Launched by Mr. Kumar Mangalam Birla

A luxuriously soft fabric from Birla Cellulose: Brand Ambassador Kangana Ranaut walks the ramp

LIVA Crème, the new age fabric from the Aditya Birla Group, was launched on 21st April, 2017 at Mumbai by Mr. Kumar Mangalam Birla, Chairman, Aditya Birla Group. Speaking on the occasion Mr. Birla stated,

"I recount that when we set out on this journey, our vision was to create value for the entire value chain of viscose based fabrics. I am so pleased to say that the ecosystem of our LAPF partners has resulted in also placing India on the global map. We are now a preferred sourcing destination of viscose based products. This is truly in the spirit of the 'Make in India' initiative of our honourable Prime Minister."

"One of the finest examples of customer centricity within the Group has been our VSF business. From being just product focused, the business has moved superbly to "providing solutions" to customers by working seamlessly with the value chain. LIVA's end-to-end ecosystem of a high quality product, continuous innovation, the LAPF network and aspiration created by communication and brand engagement is a great case study in consumer focus." added Mr. Birla.

Mr. Birla introduced the next innovation - Liva Crème fabric. Embedded in it is the core promise of Liva. Coupled with it are the enhanced features of luxurious fineness and softness. In spawning Liva Crème, he, complimented the LAPF partners who he said have embellished the product with their experience and expertise. The event was launched amidst a lot of fanfare and glitterati with Bollywood actress and Liva Crème brand ambassador Kangana Ranaut walking the ramp. Liva Crème fabric - a new variant of Liva fabric - offers consumers the luxurious soft feel which is fluid and natural.

The fashion show had modeled exclusive Spring Summer '17 collections of Allen Solly, Van Heusen Shoppers Stop, Biba and Pantaloons made in Liva Crème fabric. The Liva tagged garments will be available across premium brands like Allen Solly, Van Heusen, Shoppers Stop, Biba, Pantaloons and Lifestyle among others. Renowned designers namely Nikhil Thampi, Shivan-Naresh and Ka-Sha have created collections for Allen Solly, Van Heusen and Shoppers Stop respectively. Focus markets for Liva Crème will be Delhi, Mumbai and Bangalore. Garments made of LIVA Crème can be identified with the gold and cream coloured tag at the stores.

"Overall, the designer associations with leading brands to create exquisite Liva Crème collections, a stunning campaign with Kangana Ranaut and premium point of sale communication will all work towards positioning Liva Crème as a premium brand in the minds of consumers," added Mr. Rajeev Gopal, CMO - Birla Cellulose. While designers have loved the fabric, each
designer has interpreted Liva Crème fabric in their own creative way.

"It is always our endeavor to offer something new to our customer. Liva Crème fabric has all the attributes of Liva fabric while offering the added benefit of luxurious soft feel. The fabric has found tremendous response from women consumers, as per a research conducted in Mumbai and Delhi. The proposition of luxurious softness has been crafted basis their feedback," said Mr. Dilip Gaur, Business Director - Pulp & Fibre.

"Liva Crème fabric is very light, very airy and breathable. It has a fluid nature with a luxurious soft feel. With Liva Crème it's very easy to be comfortable and we believe in making clothes which are comfortable. It was really interesting collaboration and was fun to work with the team", said Karishma Shahani Khan (Ka-Sha) who has used Liva Crème for her exclusive collection at Shoppers Stop.

"It was a great experience designing the collection with Liva Crème fabric. It is a nature based fabric that is exquisite. It has an effortless drape and has a unique luxurious feel. We let the fabric give a design direction to us. Liva Crème was a great starting point to the collection. The fabric blend very effortlessly with the design", said the designer duo - Shivan and Naresh with respect to their exclusive Liva Crème collection for Van Heusen.

"Liva Crème is a nature based fabric which has a great balance of fluidity and luxurious softness. The fabric is fluid and premium. Liva Crème fabric was a complete dream to work with. The whole collaboration came together really well. I got to create some great designs for Allen Solly with Liva Crème. The mirage of all three brands coming together is a dream come true and I hope you all like the collection", said the enthusiastic Nikhil Thampi for his collection for Allen Solly with Liva Crème.

Brands who have partnered with Liva Crème are equally excited about this association.

"Our association with Liva Crème team has been very encouraging for our brands Haute Curry and Kashish. The entire Liva Crème team has been an integral part of our product development journey. Our association from R&D to designer collaboration have been very encouraging. A wide range of products has been showcased with detail adaptation. Support and training for our front end Customer Care Associates has been facilitated making this an end-to-end successful project. Garments made with Liva Crème fabrics are also showing good sales conversion.

Liva Crème is a promising fabric and we look forward to a long term partnership and innovation from the Liva team", said Shilpa Gulatee R. (Head Private Brands at Shoppers Stop).

About Birla Cellulose
Birla Cellulose represents the Pulp and Fiber business of the Aditya Birla Group. Birla Cellulose pioneered the Viscose Staple Fibre (VSF) in India. Birla Cellulose fibers are of 100% natural origin, highly absorbent, have good fall and feel, and are completely biodegradable. As an extremely versatile and easily bendable fibre, VSF is widely used in apparels, home textiles, dress material, knitted wear and non-woven applications. Birla Cellulose commands a major world market share in the Manmade Cellulose fiber domain.

Technical Textiles is the sunrise segment of the global textile industry. With increasing competition and diminishing margins in the production of conventional textiles, textile manufacturers in industrialised countries have switched over to production of value-added technical textiles. In India the technical textile industry contributes to roughly 12% of Indian textile industry at present which is very less compared to other developing countries like China where technical textile industry accounts for around 20% of the textile sector.

PHD Chamber in the past has actively taken up issues related to Textile Industry and technological up-gradation for the growth of the industry as well as socioeconomic growth of the economy.

Against this backdrop and to promote usage and application areas of technical textiles, PHD Chamber in association with O/o Textile Commissioner, Ministry of Textiles, Government of India and Northern India Textile Research Association (NITRA) organised a 2 day Exhibition cum Buyer-Seller Meet on Technical Textiles on 23rd-24th March 2017 at PHD House, New Delhi.

The Exhibition was inaugurated by Air Commodore Deepak Gaur, Principal Director-Medical Services, Indian Air Force, Surgeon Rear Admiral, Joy Chatterjee, Indian Navy, Dr. Arindam Basu, Director General, NITRA; Dr. V. K. Kohli, Director, Regional O/o Textile Commissioner, Ministry of Textiles, Government of India, Dr. V. K. Kothari, Professor - Textiles Department, IIT Delhi, Mr. Viren Mehta, Vice President-Marketing, Fibre2Fashion, Mr. Sanjay Aggarwal, Chairman, Industry Affairs Committee, PHD Chamber, Mr. Ram Poddar, Co-Chairman, Industry Affairs Committee, PHD Chamber and Mr. Vivek Seigell, Director, PHD Chamber.

Teach self-denial and make its practice pleasure, and you can create for the world a destiny more sublime that ever issued from the brain of the wildest dreamer.

- Sir Walter Scott
Mr. Sanjay Aggarwal, Chairman, Industry Affairs Committee, PHD Chamber

Mr. Sanjay Aggarwal, Chairman, Industry Affairs Committee, PHD Chamber in his welcome address mentioned that Textile industry in India is vital for its economic growth as it generates employment in large numbers. Mr. Aggarwal also added that the technical textile industry has been expanding proportionally in respect to the entire textile industry.

He mentioned that India's Textile growth at present is estimated at $108 billion which is expected to rise to $220 billion by 2021. He further added that Technical textiles accounted for around 29 per cent share of the global textile revenues.

Mr. Ram A Poddar, Co-Chairman, Industry Affairs Committee, PHD Chamber

Mr Ram A Poddar, Co-Chairman, Industry Affairs Committee, PHDCCI, said that India's textiles sector is one of the oldest industries in Indian economy dating back several centuries. He added that even today, textiles sector is one of the largest contributors to India's exports with approximately 11 per cent of total exports and is labour intensive.

Dr. Arindam Basu, Director General, NITRA

Dr. Arindam Basu, DG, NITRA in his address said that Textiles have over decades evolved from being used only for protection earlier to presently focusing on aesthetics and fashion side. He added that new fibres and technologies including Technical Textiles, have helped produce good quality textile products which are much more suitable for user.

Dr. Basu said that Technical Textiles presents a win-win situation for both industry as well as buyers. He explained that for Industry technical textiles gives higher residue and profit per unit is much more or buyers he mentioned that Technical textiles increases efficiency as well as provide an added protection increasing the overall quality of end product.

Dr. Arindam Basu said that over last 3 years Indian Technical Textile industry has come up and many international standard products have come up in India which has led to an increase in import substitution of textiles.

Air Cdr Deepak Gaur, Principal Director-Medical Services, Indian Air Force

Air Cdr Deepak Gaur, Principal Director, Indian Air Force focused on importance of Protective and Medical textiles within the broad classification of Technical Textiles. He said that one of the most important things for a medical textiles manufacturer is to reduce hospital acquired Infections as the bacteria, virus and fungi adversely affects the environment.

Air Cdr Deepak Gaur mentioned that in India there is space for both disposable as well as reusable technical textiles.

Air Cdr Deepak Gaur said that the lack of dynamic standards is a persistent problem with respect to Technical Textiles industry and needs to be addressed and should be done after consultations with all relevant stakeholders including centres of excellence.

He further mentioned that the Indian Defense forces including Army, Navy and Air Force aim to equip its soldiers with state of the art NBC (Nuclear Biological Chemical) warfare equipment to sustain in adverse circumstances.
Air Cdr Deepak Gaur said that Indian Air Force has suggested DRDO to tie up with foreign protective textiles manufacturers so that sophisticated and superior products can be made in India for our soldiers.

Dr. V. K. Kothari, Professor, Textiles Department, IIT Delhi
Dr. Kothari in his address highlighted the importance of Technical Textiles for India and the world. He said that the Technical Textile manufacturers in India must look to how they can diversify their product range to areas which are more promising.

He also mentioned that Indian manufacturers must focus on innovation and developing new products to make it competitive in the market. Dr. Kothari suggested the technical textile industry to collaborate with institutions like IIT Delhi for research related opportunity/problems which industry would like to work upon.

Surgeon Rear Admiral Joy Chatterjee, Additional Director General-Medical Services, Indian Navy
Surgeon Rear Admiral Joy Chatterjee said that over decades medical practices in India have grown tremendously to the extent that they have nearly caught up with the western developed countries. Adding further he mentioned that good quality surgical drapes and dressings have contributed to this.

Surgeon Rear Admiral Joy Chatterjee said that although affordability is one of the critical factors for procurement department but honesty towards patients and customers must be a priority for the hospitals. He further explained this by citing the case of many spurious products, not only drugs but also medical disposables which have come up in the market and are of poor quality. He added that these products get passed because of their lowest bid and does not set a good precedent and suggested the Chamber to intervene appropriately.

Surgeon Rear Admiral Joy Chatterjee concluded by urging the Technical Textiles industry to collaborate with DRDO and make state of the art products for Indian Navy as the demand for no. of utility suits and clothing is huge.

Surgeon Rear Admiral Joy Chatterjee, Additional Director General-Medical Services, Indian Navy checking products at display at a stall

Surgeon Rear Admiral Joy Chatterjee, Additional Director General-Medical Services, Indian Navy in his address said that requirement of textiles for the 3 defense forces of India is similar.

He mentioned that Indian Navy has 10 dedicated hospitals as compared to 12 for Indian Air Force and 140 from Indian Army. He added that level of medical care varies in these hospitals and range from small 40-50 beds to huge tertiary care hospitals of 800 beds.

A view of the gathering during the Inaugural Session

Inauguration of Buyer-Seller Meet by the dignitaries
Dr. V. K. Kohli, Director, Regional Office of Textile Commissioner, Ministry of Textiles, Govt. of India

Dr. V. K. Kohli in his address at the Inaugural Session highlighted the potential of Indian Textile Industry. He said that India has the capacity to produce wide variety of products which cater to both India as well as overseas markets. He said that technical textiles are manufactured primarily for their performance and efficiency.

Dr. Kohli mentioned that market for Technical Textiles in India stood at Rs 92,499 crore in 2015-16 and is expected to grow at a 12% CAGR and reach Rs 1,16,217 crore by 2017-18 and added that India would play a key role in shaping the global technical textiles industry with increasing power of purchasing of Indian consumers.

Dr. V. K. Kohli said that development and industrialization are the main drivers for the demand of Technical Textile products in a country and the demand for technical textiles is expected to stay steady during the period 2015-2020, due to a broadening application in end-use industries, such as automotive, construction, healthcare, and sports equipment etc.

He also mentioned that the Govt. of India has launched many schemes like TUFS (Technological Up-gradation Fund Schemes) and Amended TUFS focusing on increasing Textile Exports from India. Dr. Kohli added that the Govt. of India is also setting up of India's first integrated textile city in Andhra Pradesh.
### RESULTS FOR GMTA SECTION A/B/C - PASSED CANDIDATES - DECEMBER, 2016

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Passed 75%

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The Textile Association (India) – Central Office
2, Dvekaritath Mansion, Next to Ramesh Nursing Home, 91, Ramada Road Extension, Dadar (West), Shirdi Park, Mumbai – 400 028
Tel.: 022-24461142/24474971, E-mail: laloni@gmail.com


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ATA Part-III - Time: 10:00 a.m. to 1:00 p.m. - Compulsory Subjects
23.12.2017 Elements of Technical Textile
24.12.2017 Man-Made Fibre Technology

Optional Subjects

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<th>Fabric Manufacture Group</th>
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<th>Knitting &amp; Garment Manufacture Group</th>
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1. Last Date for receiving applications is until 25th July 2017
2. Last Date for receiving all the applications with late fee is until 25th August 2017
3. Last Date for receiving applications at the central office 25th September 2017.

Sd/-
Dr. G. S. Nadiger
Chairman, P. A. C.

Sd/-
Hansel B. Parekh
Hon. Gen. Secretary
## Schedule of G.M.T.A. Examination December 2017

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## RESULTS FOR ATA PART I - PASSED/ATAHE CANDIDATES, DECEMBER, 2016

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Result withheld for Roll No. 2016/504 for non-receipt of industrial report.

## RESULTS OF ATA PART III - PASSED CANDIDATES - DECEMBER, 2016

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<th>Fabric Manufacture</th>
<th>Textile Wet Processing</th>
<th>Knitting &amp; Garment Manufacture</th>
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<td>Indore</td>
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Ministry of Textiles, Govt. of India in association with (FICCI)

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Venue: Bombay Exhibition Centre, Goregaon (E), Mumbai
Contact: Mr. Pradeep Ahire
FICCI-MSC, Krishnamai, Plot No.33-B, Sir Pochkanawala Road, Worli, Mumbai - 400 030
M.: +91-9594933131/9324058239
E-mail: pradeep.ahire@ficci.com
Website: http://www.technotexindia.in

3rd International Textile Exhibition - Textile Expo 2017 Surat

Date: 14-16th April, 2017
Venue: SIECC Surat International Exhibition & Convention Centre, Surat
Contact: Textile Graph Event Management
S-3, Second Floor, Sardar Complex, Central Road No. 6, Udyognagar, Udhna, Surat - 394 210, Gujarat (India)
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Seminar on "Opportunities in the Current Challenges in Weaving Sector"

Date: 22nd April, 2017
Venue: Hotel Fortune Park Galaxy, Daffodil Hall, N.H. No. 08, Vapi - 396 195 (Gujarat)
Contact: Mr. Haresh B. Parekh, Convener
The Textile Association (India), Mumbai Unit
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Jesica John - +91-22-61445937
E-mail: priyanka.pawar@india.messefrankfurt.com, Jesica.john@india.messefrankfurt.com

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