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THE SOUTH INDIA TEXTILE RESEARCH ASSOCIATION
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AN OVERVIEW OF SITRA'S R&D WORK AND SERVICES - 2017-18

The membership of SITRA at the close of the financial year stood at 168 mills, comprising 224 units which included spinning mills, composite mills, fibre and machinery manufacturers, etc. Besides, a total of 32 small scale textile units also availed services under the Technical Support Scheme. The needs of various powerloom, knitting and processing units in the decentralised sector were attended to by SITRA's Powerloom Service Centers set up at 7 different locations in Tamilnadu. The financial position of SITRA during the year has been satisfactory.

During the year under review, SITRA had provided various services which were well received by the textile industry.

SITRA had been working on as many as 56 projects, of which 25 were completed.

The highlights of the research findings and work done in different areas are given below:

FIBRE TO YARN CONVERSION

The study on performance characteristics of sewing threads evaluated major quality parameters that are required of sewing threads by potential users of the threads. The parameters included tensile strength & elongation, unevenness, hairiness, twist per inch, yarn abrasion, yarn to metal friction, seam slippage, sewability (breaks per lakh metre during stitching) and also the other parameters like boiling water shrinkage, hot air shrinkage, spin finish applied, etc. of sewing threads.

A unique auditing system for machinery condition viz., "Assessment of machinery condition based on a comprehensive checklist" covered the entire machinery in a spinning mill including post spinning machines, humidification plant, OHTC, AWES and yarn conditioning plant. SITRA has completed development of a tab-based application which encapsulates a comprehensive checklist suitable for each type of machine to assess the machinery health. Audits carried out by SITRA in some spinning mills using the new methodology have proved to be very useful to the mills. The application would help textile mills to identify the lapses in their maintenance schedules and machines that are responsible for poor yarn quality or lower productivity.

The study that observed the changes in the fibre quality during drafting in cotton spinning has revealed that there are significant fibre damages causing a reduction in UQL and increase in SFC values while drafting to lighter mass using low levels of break draft. However, as the break-draft increased, there was a significant improvement in mean length and a reduction in SFC. Based on the trials, a significant modification to the ring frame drafting arrangement was conceived and the prototype manufacturing work was completed. Further studies are going on.

A study has been carried out to estimate the yarn contraction based on yarn diameter, linear density of yarn, twist multiplier and spindle speed, covering four yarn counts namely Ne 20, Ne 40, Ne 60 and Ne 80 on 100% polyester material. The study was conducted on both compact and conventional ring spinning systems using 6 twist multipliers with identical process parameters. All the yarn samples were evaluated for their yarn contraction and yarn diameter. A prediction formula for the yarn contraction will be developed out based on analysis of data which is under process.

The project on the influence of combing of polyester/ viscose blended material on yarn quality compared to the traditional process, is a new approach of blow room blending (Blended combing – pre opened viscose with polyester processed through combing process). Two yarn counts of Ne 40 yarns and Ne 60 yarns in the blend ratio of 65:35 were produced with two different denier/ length of polyester and viscose fibres. The yarns produced were tested for their Index of blend irregularity, tensile strength, evenness and imperfections, yarn hairiness & classimat yarn faults. The results were found to be encouraging and this process could be used for making yarns for weaving high quality suitings and shirtings.

The project, "Evaluation of the Effect of Compacting Zone Draft on Yarn Quality" was an attempt at optimization of tension draft level in the compact zone for various yarn counts for cotton and manmade fibre materials. The study was conducted on four counts namely 40s C-Comp., 60s C-Comp., 60s PSF Comp. and 60s P/C Comp. with the tension drafts ranging from 1.003 to 1.18. The yarns produced under different tension drafts were studied and analyzed for their yarn quality attributes.

The project on "Product development using banana / cotton fibre blends" has been an attempt to produce eco-fashion garments using banana/ cotton blended yarns. Banana/cotton blended

yarns (Blend ratio 20:80) was produced in Ne 21 count through the ring spinning process and the yarns were converted into garments.

The cut-resistance of fabrics is an important attribute for some special technical applications such as protective fabrics, gloves, etc. Under a study carried out for the purpose, cut resistant garments were manufactured using ZYLON filament meant for the operators of the glass industry. The garments not only ensure adequate safety for the operatives but also greater wear comfort.

Energy Management

Based on a study carried out in Air vortex/ Jet spinning units, attempts are being made to develop normalization factors for assessment of specific energy consumption (SEC) in Air vortex/Jet spinning. Ne 18 to Ne 60 counts spun out of viscose and micro modal fibres from air vortex spinning were studied, with the major count being Ne 30. It is proposed to develop Ne 30 UKG conversion factors for air vortex / jet spinning system similar to Ne 40 UKG conversion factors for cotton spinning system.

In another study on "Energy consumption on projectile and air jet looms at different speeds", the energy consumed by looms in terms of units/meter of the fabric produced was studied. It was found that the energy consumption was influenced by various factors like variation in loom speed, picks inserted per inch and loom width. It is proposed to equate mills' energy consumption in terms of Units/meter to the energy consumption of a SITRA standard loom (SSLC) and also come out with standard conversion factors.

Operational Studies

The study on "Online survey of yarn selling price and raw material cost", initiated in May 2013 has till date seen completion of 59 studies. As many as 80 mills from different parts of the country have been participating in this study every month. The study covers data like yarn selling price (Rs/kg), raw material cost/clean cotton cost (Rs/kg), net output value, techno-commercial index, overall techno commercial index, RMC as a percentage of YSP, yarn realization and production/spindle or rotor/ 8 hours.

SITRA has been regularly conducting a unique inter-mill study on Costs, Operational performance and Yarn quality since 1997. The study covers the various key aspects like factors affecting cost of production, productivity and profit of spinning mills. Up to now, 32 studies have been completed and around 150 mills including high productivity mills have been participating and availing the benefits.

The 7th inter-mill study on fibre to yarn conversion cost, based on the conversion cost particulars collected from the mills during the 33rd CPQ study covering data during the 3rd quarter of 2017 –18 has done a detailed analysis of different counts, varieties of yarns and identified the reasons for wide inter-mill differences in the conversion cost.

A new study has been initiated during the year to study the staffing pattern in spinning mills. This study attempts to help textile mills to compare and judge the staffing pattern in relation to other mills and suggest suitable norms for requirements of manpower at all levels - managerial, supervisory as well as administrative cadres. More than 75 mills responded to the survey. Efforts are being taken to bring more number of mills to participate in the survey.

Chemical processing

Towards identifying an alternate method to eliminate the usage of salt during dyeing, SITRA took up a study on salt free dyeing of cotton materials. Cationisation of cotton fabrics prior to reactive dyeing was carried out by employing two approaches, 1) Two step pre-reatment process in which the bleaching is followed by cationisation in a separate bath 2) Single step pre treatment process in which bleaching and cationisation were carried out in the same bath. Single jersey knitted fabrics were pretreated and dyed using different classes of reactive dyes such as RGB, HE, etc. The dyed fabrics were evaluated for colour strength using a computer colour matching system, colour fastness to washing, rubbing, light, presence of formaldehyde, etc. It was noted that the dyeing with different light, medium and dark shades was found to be uniform on cationised and dyed fabrics. Overall, it was noted that cationising treatment with the chemical formulated has resulted in darker and even shades with better fastness properties. The characteristics of the effluents resulting from dyeing in both the process routes are also being analysed in detail.

A detailed study was taken up to establish the inter-relationship between physical and chemical properties namely, micronaire, maturity co-efficient, fluorescence value, colour grade, convolutions per inch, honey dew content and wax content of various cotton varieties and their

individual and combined effect on the dyeing behaviour of the selected fibres. A wide variation was observed between the dyeing behaviour of various fibres in relation to their varying physical and chemical properties. It is planned to study other properties like crystalinity, convolutions per inch, fluorescence value, etc of the fibres and relate them with the dyeing behavior.

As a continuation of a previous work which dealt with development of infant baby wear clothing, a new natural mordant for natural dyes for cotton fabrics was identified and the extraction process was optimized. Using this natural mordant, three different shades namely olive green, biscuit beige and choco brown were developed and infant baby wears were made from them. Further, a liquid mordant was also identified and it was employed for the dyeing of natural dyes on cotton fabric. This resulted in two new shades namely lavo pink and light orange.

A study was carried out with an aim to commercialize the application of natural dyes on polyester wool worsted suitings to meet the increasing demand for eco-friendly processes. Polyester wool blended worsted suiting fabrics were successfully dyed using eco-natural dyes and the wash fastness properties of all the dyed samples were in the acceptable range. While yellow and orange dyed samples showed poor fastness, the green fabric sample showed good overall performance properties. The % of shrinkage for all the samples dyed with natural dyes was well within the standard specification while the rating for pilling resistance was poor.

An attempt to develop baby clothing using an eco-mordant for natural dyes on cotton wool blended fabrics has resulted in the development of red and green dyes which gave good performance. Further pilot scale work is under process for making baby wear using the cotton wool blended yarns. It is also planned to develop a gamut of colours using the eco-mordant.

A DST - SERB sponsored study taken up during the year, has attempted identification of nano sized fumed silica particles and low cost cross linking agents to replace the high cost silicon cross linkers and their formulation and application on the fabric surface by pad-dry-cure process in order to change the surface tension of the textile materials. The resulting fabrics will be used as base textile materials for developing home textile products with specialty applications. Product areas will include water repellent jackets, rain coats, umbrellas etc. Further, the project will study the physical characteristics of the fabric and will evaluate the functional properties using standard test methods with and without silica.

Another study sponsored by the Ministry of Textiles, GoI., taken up during the year aimed at identification of unexplored natural eco-reducing agents and their extraction, its application for the reduction of natural indigo and also to find commercial alkaline source for the dyeing process and its application on fibres such as organic cotton, regenerated cellulose and blends for safe and eco-friendly clothing. It is hoped that the effluent load will be reduced and the process will be more sustainable.

Stickiness arises when excessive sugars present on fibers are transferred to equipment / machine parts and interfere with processing. Honeydew, when present in sufficient quantity, is the main source of sugars that can result in sticky lint. A study was taken up to understand the various sugars present in the sticky cotton using available methods and a solution that can minimize stickiness has been identified. Work is currently on to check the commercial feasibility of the prepared solution to mitigate the stickiness of cotton in ginning and spinning industries.

It is proposed to use readily available biopolymer sericin, also known as silk gum protein that is produced by silkworms and attained from cocoon, silk fabric and silk waste or from the degumming liquor of silk industry, for the development of protective textiles. The plan of study involves isolating the sericin from silk cocoon, study its characteristics and applying it on the cotton fabric by Pad-Dry-Cure process. It is also planned to evaluate the UV protective and antimicrobial properties of finished fabric and the durability of the finishes after several washing cycles.

In another project which has commenced this year, it is proposed to study the problems associated with single bath bio-polishing, a cellulase enzyme based process that durably improves the quality of cellulose based fabric preventing pilling and fuzziness.

Medical textiles

Under a Ministry of Textiles sponsored project, SITRA carried out a study to develop a low cost instrument to assess the resistance of materials used in medical facemasks to penetration by high velocity stream of blood that potentially contains

blood– borne pathogens. Different types of nonwoven medical facemasks were used in the process of calibration of the instrument against the test results obtained from an accredited foreign laboratory equipment for different type of surgical facemasks. Based on the results, the test procedure for quality evaluation of surgical facemasks was standardized.

It is important to measure the fluid handling capacity of wounds before opting for a specific dressing material. SITRA has attempted to develop an instrument - SITRA Fluid Handling Capacity Tester (SFHCT) - to assess the characteristics of fluid handling capacity of wound care dressings since there is no indigenous instrument to assess the same. Three different dressings were tested to examine the versatility of the SFHCT. In order to make some assessment of the repeatability of the test method in its final form, three samples of Foam dressings with gentle adhesive layer were tested. The results clearly established the repeatability of the test results using the instrument.

Amongst the newer methodologies for administration of medicines these days is the use of transdermal approaches, which involve a method of delivering medication through the skin in a non-invasive manner. Four different cardiovascular drugs were worked with. Soluble microneedles were fabricated using carboxy methyl cellulose (CMC). These needles will reach upto the dermis layer and dissolve the needle and deliver the drugs into the system. Secondary level tests are on to test the methodology.

Under a Ministry of Textiles sponsored project, SITRA attempted to develop an indigenous viral barrier personal fabric for protection against epidemic and panepidemic diseases such as EBOLA, SARS, Avian Flu, etc., without any compromise on breathability. A new barrier membrane with good performance and breathability was developed using 3 approaches 1) Use of Monolithic films as barrier membranes 2) Electrospinning technique to produce micro-nano fibres and 3) Salt leaching technique to produce micro-nano membranes. Assessment of the working performance of the multi-layered laminated fabric with the developed barrier membrane is currently on.

Under a project sponsored by DST-Nano mission, SITRA has attempted to develop a nanofibrous membrane for wound healing by controlled release of Indian honey and Curcumin. The nanofibrous membrane was developed using electro spinning. The fabricated membrane was evaluated for Cytotoxicity and Invitro wound healing effects. The Invivo animal trials using the membrane are currently in progress.

With the risk of infection high, new puncture resistant materials are being developed for the use of health care professionals / workers for protection against needle stick injuries. With no equipment available to test the efficacy of the materials to provide the assured protection, SITRA, under a project sponsored by the Department of Science and Technology, Ministry of Science and Technology, designed and fabricated an instrument, working under the constant rate of extension principle, to assess the puncture resistance of surgical material. Work is also on to evaluate the accuracy and repeatability of test results of the instrument with inter-laboratory comparisons with universal tensile testing machines and standardize it.

An attempt has been made to explore the possibility of using coffee powder for treating wounds that are infected with single or polymicrobes. The selected variety of coffee powder has shown higher anti-bacterial activity against both gram positive and gram negative organisms in both individual as well as polymicrobial. Infected wounds of animals treated with coffee powder healed within 16th day of treatment when compared to control animals. Histopathological analysis has shown increased proliferation of fibroblasts, early re-epithelisation of tissues and fibrocollagenases formation when compared to untreated animals.

In another study, an attempt was made to develop sponges with expandable and blood coagulating properties which can be used for gunshot wounds as they require rapid treatment by first responders to prevent blood loss, disability and save life.

Mopping pad or laparotomy sponge is a common product found in surgical kits used to absorb blood & other fluids, especially in the abdomen, during surgery and also finds various other applications inside the operation theatre. Currently laparotomy sponges are made of woven gauze material of multiple layer structure; the woven laparotomy sponges have a lower fluid holding capacity and hence require frequent changing of materials. Hence SITRA took up a project to redesign the structure of the laparotomy sponge material with lesser number of plies that would reduce dry and wet lint during surgery, be used multiple times on a person for the surgery and create lesser biomedical

waste. The water and blood holding capcity of the sponges are being tested.

Six different types of spunlace nonwoven fabrics were developed and compared in order to study the effect of different fabric structures on the liquid transport and exudates handling characteristics of nonwoven surgical pad. The performance assessment of the developed nonwoven surgical pads is in progress.

Though the primary purpose of sterilising an item is to destroy all living micro organisms and reducing the hospital acquired infections, the impact of sterilisation may alter the properties of the sterilised materials. Manufacturers of operation theatre apparels specify the properties of the materials used before sterilization and are mostly not aware about the changes in the properties on post sterilization materials. SITRA has just initiated a study to conduct an elaborate research work on the effect of sterilization on the properties and performance of operation theatre disposable apparels, as there is no concrete study till now on the effect of sterilisation.

CONSULTANCY SERVICES

SITRA attended to consultancy assignments on wide areas of specialisation based on request from mills. During the year, the consultancy assignments were sought by around 43 member mills and close to 135 non-member units.

TESTING AND CALIBRATION SERVICES

SITRA's physical, chemical and biological laboratories have been accredited by NABL for ISO / IEC - 17025 for the various fibre, yarn and fabric samples tested for their properties. Several mills exporting yarns are seeking SITRA test reports with NABL logo which provides an assurance of quality of the product. The year witnessed 72504 samples of fibre, yarn and fabric being tested for their physical, chemical and biological properties.

Since 2016, SITRA's physical and chemical testing laboratories have started functioning in two shifts with an aim to provide test results to the mills on a fast track. The introduction of the dual shift system has helped in quickening the testing process by reducing the turnaround time to process a request.

During the year, 700 calibration certificates were issued to 77 mills, in addition to 2 performance certificates. (for testing of quality control instruments). Testing the quality of spinning and weaving accessories / spares in order to select the right quality is another service being offered by SITRA. A total of 2,301 samples covering various accessories like carton boxes, paper cones, rings and travellers, tubes, kraft papers, paper cores, worm & worm gear wheel, ring spinning spindles, cots, partition pad, etc., were tested based on requests from 857 units.

TRAINING

During the year under review, SITRA organised 16 different training programmes for supervisory and managerial personnel that were attended by 650 persons. Under operatives training, 816 operatives were trained during the year on right methods of working in textile mills for effective performance. Moreover, 1404 persons were trained under the ISDS of Ministry of Textiles, Government of India and 1169 persons were trained by the CoE-Meditech under different programmes.

SERVICES TO DECENTRALISED SECTOR

As a part of SITRA's services to the decentralised sector, 7 powerloom service centres (PSC) and 2 Technical Service Centres in Tamil Nadu, managed by SITRA, address a wide range of services. A total of 32,525 samples comprising of yarn and fabrics were tested and 989 persons were trained on various aspects like loom maintenance, operation of shuttleless looms, calculation of fabric production, etc. The PSCs had also attended to 168 consultancy assignments and created 263 designs.

MOUs Signed

During the year, Memorandums of understanding were signed with the following organisations/ Institutions/agencies:

- The Tashkent Institute of Textile and Light Industry, Tashkent, Uzbekistan towards establishing friendship and cooperation and promote exchanges between the two institutes in the area of textiles, specifically in the area of technology and scientific research, joint studies and surveys and training programmes.

- Centre for materials for electronics Technology (C-MET), a scientific society of the Ministry of Electronics and Information Technology, Government of India to develop a knowledge base in the electronic materials

and their processing technology and to develop a wearable device to screen breast cancer.

- Nitta Gelatin, a Japanese company and a leading manufacturer of Gelatin for pharmaceutical and edible applications in India, to work on targeted and controlled drug delivery system for medical applications.

- APRUS Bio-Medical Innovations Pvt. Ltd. ("APRUS"), a science-focused, technology-driven, forward-facing start-up company based out of Bangalore, India, to develop biodegradable hygiene products using biopolymers.

- Radeecal communications, Ahmedabad to work jointly towards conducting Meditex conference for the next five years.

- Maxtech Industries, Mumbai for transfer of technical knowhow for the production of technical facemasks.

- The Synthetic & Art Silk Mills' Research Association (SASMIRA) to work jointly and sharing information in the area of R & D for the development of various products / processes.

- Applied Automation Systems Private Limited, Coimbatore a leading Industrial Automation company providing Automation solutions to several Engineering machine builders, to promote and support jointly applied and technological research and development in realms related to Textile Technology and Textile Manufacture.

- Hydra, a firm with specialization in supply chain management, value chain engineering, cluster science and developmental work, offering solutions and services to SMEs, to promote and support joint applied and technological Research and Development in their respective institutions, in realms related to Textile Technology, in general, and with emphasis on waterless dyeing or any other eco-friendly processing of textiles, in particular.

- Deven Supercriticals Private Limited, Pune, a company designing, manufacturing and supplying Supercritical fluid processing equipment, to partner with SITRA to design, manufacture, and supply the Supercritical fluid processing pilot plant equipment and also provide technical support, scaling up and commercialisation based on the research inputs developed by SITRA and DSPL.

- Sree Chitra Tirunal Institute for Medical Sciences and Technology (SCTIMST), Tiruvananthapuram an Institute under the aegis of Department of Science & Technology, Govt. of India, for collaborative works for providing technical / testing / fabrication support for the development of variety of biomedical devices.

PUBLICATIONS

During the year, SITRA brought out 24 publications which included 2 research / inter-mill study reports, 12 online reports, 6 focus, 1 trend and 5 SITRA News. SITRA scientists published 4 research papers in technical journals and presented 6 papers in conferences and seminars.

MEMBERSHIP

The total membership of SITRA during the year was 168, comprising of 224 units (Table 1). During the year, 5 mills, comprising of 4 full members and 1 associate member enrolled newly as members.

SITRA is pleased to extend a warm welcome to the following 4 mills which enrolled as full members during the year:

1. Senthilkumar Textile Mills Pvt. Ltd., Erode
2. V.R.Textiles, Coimbatore
3. S.P Apparels (Spinning Unit), Tirupur
4. SRG Apparels, Tirupur.

SITRA also extends its welcome to the following mill which enrolled as an Associate member:

1. Siddhi Industries Limited, Ahmedabad.

SITRA's services are also utilised by 32 small mills under the Technical Support Scheme. In all, 256 units have access to SITRA's services, apart from many units in the decentralised sector which utilised the services offered by 7 Powerloom Service Centres, one Textile Service Centre and 4 CAD Centres.

FINANCE

The financial position of SITRA continued to be satisfactory during the year that ended with a surplus of income. The total recurring expenditure of SITRA during the year after depreciation and appropriation from reserves was Rs 10.27 crores The total income, including the grants from the Ministry of Textiles, Govt. of India was Rs 10.63 crores.

SPONSORED PROJECTS

During the year under review, SITRA was involved in 12 sponsored research projects, 9 of which were sponsored by the Ministry of Textiles (MoT), Government of India and 3 projects sponsored by the Department of Science and Technology, Govt. of India.

Work relating to the following 3 MoT sponsored projects was completed and reports sent to the Ministry :

1. Design & fabrication of an instrument to evaluate resistance of face mask to penetration by high velocity of blood from a punctured wound

2. Design & fabrication of instrument to evaluate characteristics of fluid handling capacity of wound care dressings

3. Development of a heat & moisture exchange filter

Work relating to the following 3 projects, initiated last year, has also been completed.

1. Development of an indigenous viral barrier fabric

2. Development of nanoparticle based trans-dermal patches of selected cardiovascular drugs

3. Development of Anterior Cruciate Ligaments (ACL) using textile matrices

Table 1 Region-wise membership

Region	Spinning mills	Composite mills	Fibre manufacturers, Machinery manufacturers and others	Total
SITRA zone	120	19	4	143
Other States	14	7	2	23
Overseas	1	1	-	2
Total members	135	27	6	168
Total units	171	47	6	224

During the year, the Ministry of Textiles sanctioned grants for the following 3 projects :

1. Polyester vascular graft implant process optimisation and production scale up

2. Development of total comfort index paradigm for textile structures

3. Development of eco-clothing by greener reduction process of natural indigo dye

The following projects sponsored by DST/SERB were also initiated during the year.

1. Development of nanofibrous membrane for wound healing by controlled release of Indian honey and curcumin

2. Design and fabrication of an instrument to assess the puncture resistance of surgical material by using sharp edge puncture probe/syringe needles

3. Durable non-fluorinated functional textiles using fumes silica sols

Work relating to all the 6 ongoing sponsored projects are making good progress.

MACHINERY AND EQUIPMENT

SITRA has made significant capital investments during the last decade to equip its laboratories/pilot mills with state-of-the-art machinery/instruments. During 2017-18, more than Rs 1.2 crores were invested to procure important machinery/ equipment to modernise its testing laboratories, pilot mill and the incubation centre of CoE- Meditex. The major machinery/equipment purchased during the year include BOD Incubator, Turbo Ventilator, Desk Loom Warping machine, Elitex OE Machine, Bacteriological Incubator, UV VIS Spectrophotometer - Specord 200PI and Wet Bacterial Penetration tester.

STAFF

The staff strength of SITRA was practically the same as last year at 100 as against 101 last year. The number at the PSCs has marginally came down to 34 during the year, as against 37 last year.

CONVERSION OF FIBRE TO YARN

PERFORMANCE CHARACTERISTICS OF SEWING THREADS

Four brands of spun polyester sewing threads coded as T, S, C and V of four different counts viz., 3/63s (27 tex), 3/70s (24 tex), 2/63s (18 tex), 2/20s (60 tex) sourced from each major brand available in the market were used in the study.

The thread samples of the four brands were assessed for the quality parameters like tensile strength & elongation, unevenness, hairiness, twist per inch, yarn abrasion, yarn to metal friction, seam slippage test, sewability test (breaks per lakh metre during stitching) and also included parameters like boiling water shrinkage, hot air shrinkage, spin finish applied, etc. Interaction with the users of sewing threads revealed that the two major attributes sought are i) uninterrupted sewing and ii) shade matching.

Tensile strength

A total of 16 sewing threads were tested for their tenacity and elongation on Zwick Roell UTM machine at different gauge lengths namely 33.75, 67.5, 125, 250 and 500 mm. An interesting observation was that while the gauge length had a significant effect on tenacity for most of the threads, the yarn elongation decreased with an increase in gauge length. The variability in tenacity and elongation was quantified by Weibull Analysis.

In order to assess the variability of the strength, Weibull Analysis was done as the mean value of strength did not take into account the individual variations. Weibull Modulus (ß) is an indicator of scatter. The higher the Weibull Modulus, lower is the scatter and vice versa. The characteristic life (α) represents the predicted strength based on the observations at any test length. In the case of sewing threads, one would expect a higher value of "ß" indicating lesser variability in the strength characteristics. The best line of fit was also calculated with regression (R^2) values. While using Weibull analysis, one can make comparisons about the reliability of competing products. The "ß" value indicates whether the variability is increasing or decreasing.

Uneveness and Hairiness (as per ASTM D 1425)

Higher imperfections and hairiness in yarn will affect the sewability of the yarn and could influence the flow of yarn through the needle during sewing operation in terms of needle blocks or yarn breakages.

2/20s (60 tex)

	U %	CVm %	Thin -50%	Thick +50%	Neps +200	DR 1.5m 5%	H
T	6.43	8.13	0	5	5	10.6	9.29
S	6.86	8.68	0	5	8	16.3	9.32
C	5.82	7.3	0	1	0	5.8	9.09
V	5.67	7.14	0	3	2	6.3	8.4

2/63s (18 tex)

	U %	CVm %	Thin -50%	Thick +50%	Neps +200	DR 1.5m 5%	H
T	8.81	11.09	1	6	10	30. 2	6.88
S	9.17	11.56	1	8	13	20.3	6.08
C	8.42	10.6	0	4	6	18.6	5.87
V	8.37	10.51	0	4	9	9.9	7.11

3/63s (27 tex)

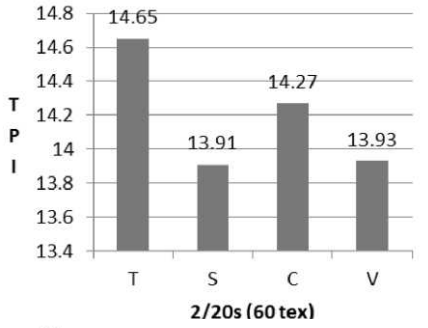
	U %	CVm %	Thin -50%	Thick +50%	Neps +200	DR 1.5m 5%	H
T	7.5	9.45	0	3	5	13.9	6.41
S	7.47	9.39	0	2	3	16.5	6.53
C	6.86	8.65	0	1	2	6	7.07
V	7. 12	8.96	0	1	4	3.8	6.33

3/70s (24 tex)

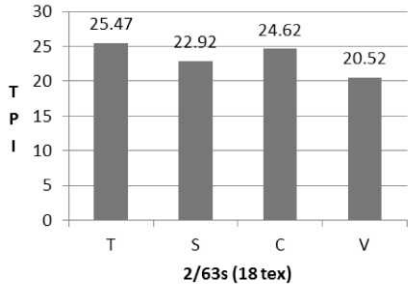
	U %	CVm %	Thin -50%	Thick +50%	Neps +200	DR 1.5m 5%	H
T	7.68	9.68	0	4	6	17.7	7.13
S	8.43	10.7	1	19	16	13.4	6.91
C	7.75	9.76	0	4	8	10.4	7.32
V	7.01	8.81	0	1	2	3.6	6.4

Twist per inch (as per ASTM D 1423)

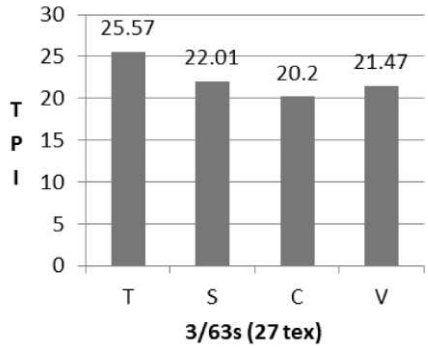
The twist per inch will affect the strength and also the bending rigidity of the yarn. A higher TPI could result in snarling that can affect the sewability and could also result in puckering.



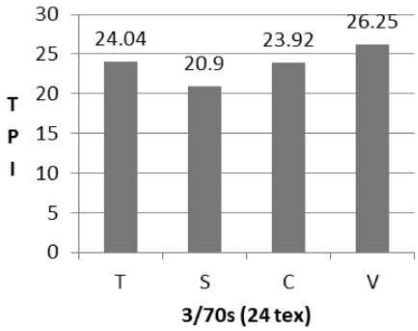
2/20s (60 tex)



2/63s (18 tex)



3/63s (27 tex)



3/70s (24 tex)

Yarn abrasion

The abrasion characteristics define the consistency and life time of the seam during use. The mean abrasion values (number of strokes to break) for various counts are summarized below.

Sample Id.	Mean abrasion values (number of strokes)			
	2/20s (60 tex)	3/63s (27 tex)	3/70s (24 tex)	2/6 3s (18 tex)
T	461	516	403	220
S	446	363	367	225
C	581	403	515	268
V	589	383	477	205

Metal to yarn friction test (as per ASTM D 3108)

The yarn to metal friction test was carried out to find the frictional characteristics of the sewing threads. Frictional property plays a very important role for effective sewability of a sewing thread.

Sample Id.	Coefficient of friction (μ)			
	2/20s (60 tex)	3/63s (27 tex)	3/70s (24 tex)	2/6 3s (18 tex)
T	0.11	0.11	0.11	0.11
S	0.11	0.14	0.12	0.14
C	0.11	0.12	0.11	0.16
V	0.11	0.11	0.12	0.13

SEWABILITY STUDY

Details of Sewing Machine used	
Two Thread chain lock	Remoldi
Maximum Machine Speed	6,500 stitches per min
Needles used	14 - 90
Stitches per inch	10
Details of fabric used	
Woven Dyed Fabric	Polyester / Viscose (70/30)
Type of Weave	1/1 Plain Weave
No of Fabric Layers used	3 & 50,000 stitches
Fabric weight/sq.mtr	212

2/20s (60 tex)	REMARKS
T	MAX SPEED- NO BREAKS
S	MAX SPEED- NO BREAKS
C	MAX SPEED- NO BREAKS
V	MAX SPEED- NO BREAKS

3/63 s (27 tex)	REMARKS
T	MAX SPEED-NO BREAKS
S	MAX SPEED- 1 BREAK AND NEEDLE EYE BLOCK OBSERVED
C	MAX SPEED- 1 BREAK AND NEEDLE EYE BLOCK OBSERVED
V	MAX SPEED-NO BREAKS

3/70s (24 tex)	REMARKS
T	MAX SPEED - NO BREAKS
S	MAX SPEED - NO BREAKS
C	MAX SPEED - NO BREAKS
V	MAX SPEED - NO BREAKS

2/63s (18 tex)	REMARKS
T	MAX SPEED - NO BREAKS
S	SPEED 4500/MIN - 6 BREAKS, 2 NEEDLES CHANGED DUE TO EYE BLOCK
C	MAX SPEED - NO BREAKS
V	MAX SPEED - NO BREAKS

Seam slippage test was carried out as per ISO 13936 and the results showed that there was considerable variation between the counts.

Measurement of shrinkage of sewing threads is very important because poor dimensional stability may cause puckering along seams and thus could adversely affect the seam appearance. The 4 counts were also compared for their boiling water shrinkage and hot air shrinkage.

Eighty percent of envisaged work in this study is complete involving characterization of the sewing thread quality parameters, chemical tests concerned with identifying the nature of the spin finish used in finishing and evaluation of the bending rigidity of the threads is in progress. Although the same thread linear densities of the four brands were used for comparison of the various quality characteristics, one could see a wide variation in the tested attributes. In this context, a single quality indicator was arrived at as

Yarn Quality Index (YQI) =

(Tenacity (cN/tex) x Elongation %) / U %

for defining the requirement from usage point of view. A holistic indicator of quality taking into account all essential physical attributes and performance related parameters like tenacity, elongation, U%, imperfections, hairiness, coefficient of friction, shrinkage, seam slippage, Weibull modulus of tenacity and elongation, etc., is being worked out.

ASSESSMENT OF MACHINERY CONDITION – A NEW APPROACH

SITRA has proposed a unique auditing system for machinery condition viz., assessment of machinery condition based on a comprehensive checklist which would cover the entire machinery in a spinning mill including post spinning machines, humidification plant, OHTC, AWES and yarn conditioning plant. The 'Checklist Manual' which runs into around 150 pages, has already been prepared. The benefits of the system are given below.

- Overall rating of machines either individually or as a group/department-wise can be arrived at.
- Components which would require immediate attention (repair / renovation / replacement) would be helpful for the management to take a decision on modernizing (renovation/replacement) the machines and also for budgeting.
- Mills can identifiy machines that are responsible for poor yarn quality or low machine productivity (if any).
- Mills can revisit the frequencies of various maintenance schedules. Introduction of new maintenance schedules/activities will also be possible, so as to ensure better upkeep of the machines.
- Streamlining the material flow for a given product-mix i.e. allocation of suitable machines in the manufacturing line towards achieving the required yarn quality/output will be possible.
- This audit would also be helpful for the mills to identify the machines that are responsible for certain market complaints.

The audit system is further enhanced by making it more user friendly; SITRA has developed a tablet based application which encapsulates a comprehensive checklist suitable for each type of machine. Using this tab based application, machinery health audit was conducted in a few leading textile mills. The observed audit findings were highlighted to the respective mill managements for necessary corrective action. The deviations in the machinery parts / components were corrected by the concerned mills. The difficulties faced during auditing with the tablet application were sorted out and the application has been made more user-friendly. On request from the mills, SITRA will be able to conduct machinery audit using this system.

AN INVESTIGATION INTO THE CHANGES IN FIBRE QUALITY DURING DRAFTING IN COTTON SPINNING

In order to understand the changes in fibre quality during drafting in cotton spinning system, trials were carried out at SITRA pilot mill. The following changes were observed:

- Until before drafting to a lighter mass (roving & yarn), the fibre length increases and SFC value reduces- from bale to finisher draw-frame sliver.
- While drafting to lighter mass, there are significant fibre damages causing a reduction in fibre length (UQL) and an increase in SFC values.
- An interesting phenomenon occurs at lower break-drafts. In the drafted fleece delivered by the front roller of the ring spinning machine, there is a reduction in the mean length and an increase in SFC. However, as the break-draft is increased, there is a significant improvement in mean length and a reduction in SFC. This phenomena perhaps can be attributed to the breaking of the twist binding force (at higher break drafts), and thus allowing for free fibre movement as discussed earlier; any reduction in frictional resistance would reduce the stress on fibres.
- With closer nip openings, due to more frictional contacts, the fibre damages are high.
- Changes in fibre strength and elongation characteristics were insignificant at lower levels of break draft employed in the study.

Based on trials, a significant modification idea of the ring frame drafting arrangement was conceived and the prototype manufacturing work was completed. A patent application was also filed for this design modification. A MoU has been signed with a leading machinery manufacturer to conduct extensive trials in various counts and materials using the new design.

YARN CONTRACTION IN 100% POLYESTER YARNS

In the manufacturing of staple fibre yarns, twist is inserted into the fine strand of fibres to hold the constituent fibres together and thereby to impart desired properties to the spun yarns. Without twist, the fine strand of fibres would be very weak and of little practical use. A change in the level of twist also changes the yarn properties, such as strength and softness.

Twist may be defined as the spiral disposition of the components of a thread, which is usually the result of relative rotation of the two ends. Twist is generally expressed as the number of turns per unit length of yarn, e.g. turns per inch (tpi), turns per metre (tpm), etc. The twist in the yarn can be either in 'Z' direction or 'S' direction, depending on the orientation of the surface fibre in relation to the yarn axis. Due to the twist in a yarn, the fibres on yarn surface take a roughly helical configuration around the yarn. When the yarn is under tension, these surface fibres are also under tension. However, because of the helical configuration, part of the tension is diverted radially, which creates a radial pressure.

Twist contraction

When a bundle of parallel fibres are twisted, the distance between the two ends of a fibre will decrease, particularly for fibres near the surface of the twisted bundle. As a result, the overall length of the twisted bundle is shorter than its length before twist insertion. The reduction in length due to twist insertion is known as twist contraction. The following formula is used to calculate the amount of twist contraction:

$$\% \text{ Twist contraction} = ((Lo - Lf) / Lo) \times 100$$

Where
Lo = Original length before twisting
Lf = Final length after twisting

It should be noted that because of twist contraction and the associated change in length, the count of a yarn will change slightly when twist in the yarn is changed. Twist contraction increases the yarn count (tex), because the weight of the yarn is distributed over a shorter length. The following formula can be used to calculate the change in count due to twist contraction.

$$N_f = (No / (1- C))$$

Where,
N_o = count (tex) before twisting
N_f = count (tex) after twisting
C = % contraction

The linear density of the twisted yarn on bobbins is always coarser than the strand developed by the front roller nip because of the contraction due to twisting.

In the present study, yarn samples were produced in 4 counts (20 Ne, 40 Ne, 60 Ne and 80 Ne) from 100% polyester material in compact and also in non-compact spinning systems. The study was conducted using 6 twist multipliers with identical process parameters. All the yarn samples were evaluated for their yarn contraction and yarn diameter. Measuring the diameter and density of a yarn using Uster tester4-SX with OM module was

found to be a simple and practical method. In order to find the diameter of the yarn, the yarn samples were tested in Uster tester 4-SX with OM module. This equipment measures the yarn diameter and its variability. The OM module is incorporated with an optical sensor, which measures the yarn diameter by projecting two parallel light beams perpendicular to each other, on the yarn. The actual yarn contraction is measured manually by using the length measuring method. In this method, the difference between the delivered lengths of yarn from the front roller to that of the length of yarn wound on the bobbin is the contraction due to the twist.

The fibre quality attributes of the polyester fibre material is shown in Table 2.

Table 2 Quality attributes of raw material

Mixing	100% Polyester
Length	38 mm
Denier	1.0

The experimental plan for the study is shown in Table 3.

Table 3 Experimental plan

Particulars	No.of counts	Compact system	Non - Compact system	No.of Tms	No.of spindle speeds	No. of trials
TM based trials						
Polyester (100%)	4	1	1	6	1	48
Spindle speed based trials						
Polyester (100 %)	4	1	1	1	2	16
Total number of trials						64

The studies were conducted on LMW LR6/S pilot ring frame which has a P 3-1 drafting system and a “Suessen” compact system, under identical conditions. The important process parameters are shown in Table 4.

Table 4 Process parameters in ring frame

Parameters	100% Polyester (Compact/non-compact system)			
Count (Ne)	20	40	60	80
Twist Multiplier	2.5, 2.8, 3.2, 3.6,4.0 and 5.5			
Avg.Spindle Speed (rpm)	16500	18000	18000	18000
Max. Spindle Speed (rpm)	20000	22000	22000	22 000
Min. Spindle speed (rpm)	12000	12000	12000	12000
Traveller	3/0	9/0	12/0	16/0
Spacer (mm)	4.0	3.5	3.0	3.0

Yarn contraction was seen to vary between compact and non-compact systems. The major influencing factors of yarn contraction were spindle speed, twist multiplier and yarn count. Further, the yarn diameter differed between conventional and compact yarns.

Effect of twist multiplier on yarn contraction %

Yarn contraction is directly proportional to twist multiplier. Irrespective of the yarn count, an increase in twist multiplier shows an increase in the yarn contraction and vice versa. The yarn contraction for conventional and compact yarns is shown in Figures 1(a) and 1(b). It is observed from both the figures that the yarn contraction shows an increasing trend with an increase in twist multiplier for both conventional and compact yarns.

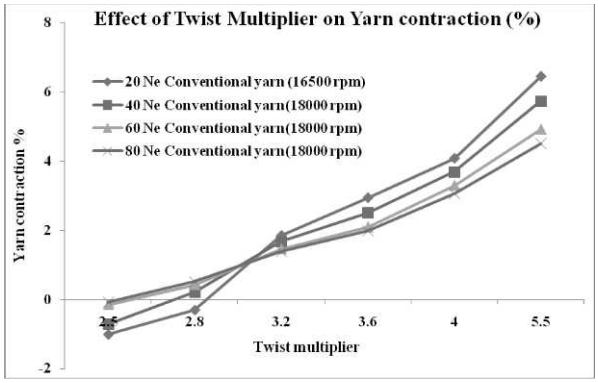


Figure 1a Conventional yarns

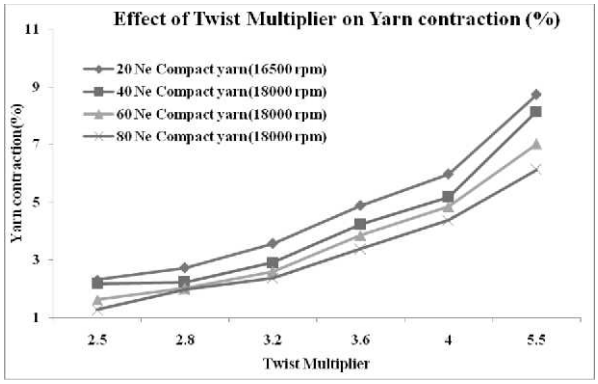


Figure 1b Compact yarns

In non-compact ring yarns, the yarns spun at 2.5 TM, yarn contraction depicted an anomalous behaviour which was found to be on negative side (i.e. extension). It might be due to the uncontrolled stretch between the front roller and the package. This had resulted in yarn extension which is independent of counts. However, the contraction was found to be on the positive side from 2.8 TM for the counts Ne 40, Ne 60 & Ne 80.

Effect of yarn count on yarn contraction%

The effect of yarn contraction on yarn count are shown in Figures 2 (a) & 2 (b). It was observed that in all the counts spun in non-compact and compact systems, yarn contraction decreases as the count becomes finer. Above 3.2 TM, the yarn contraction in non-compact yarn reduces by 1.6% (absolute values from 2.0 % to 0.4%). In compact yarns, at all the TM levels, the contraction reduces by 1.7% (absolute values 2.6% to 0.9%) as observed in all the counts.

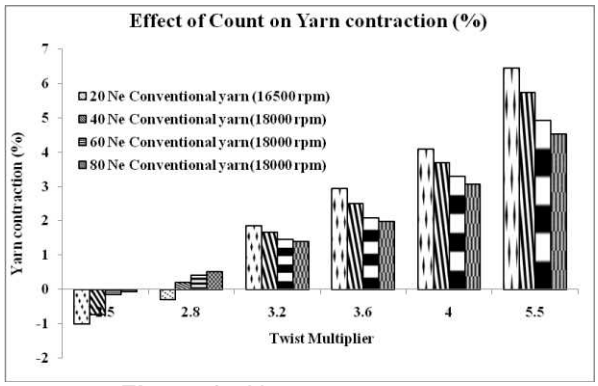


Figure 2a Non-compact yarns

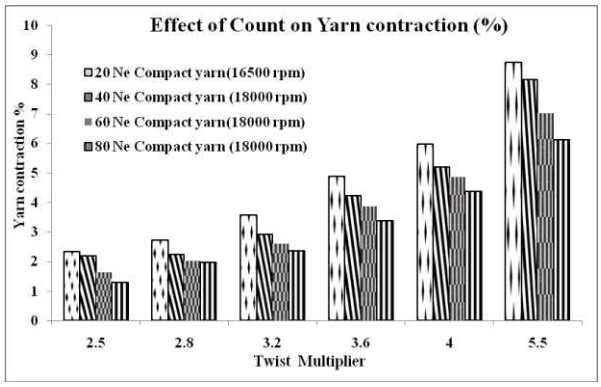


Figure 2b Compact yarns

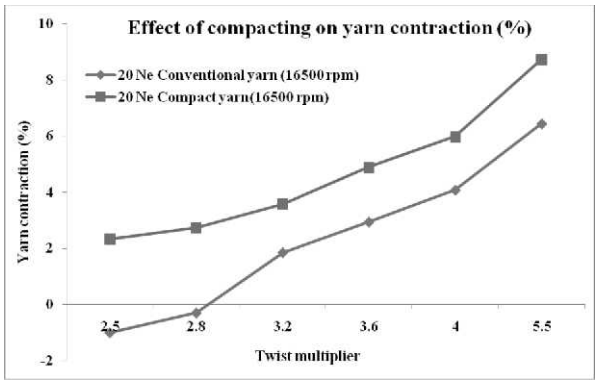
This phenomenon may be because of the change in the number of fibres in yarn cross-section contributing to twist insertion and twist flow distribution through the yarn structure.

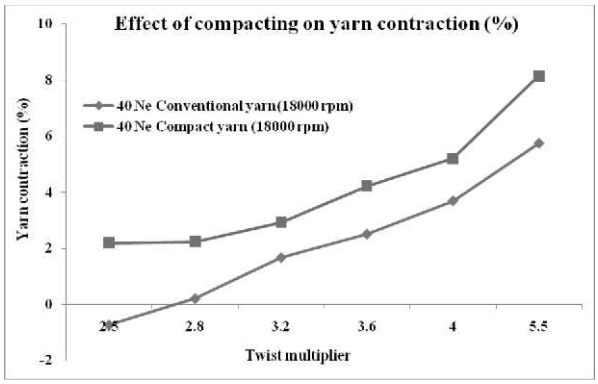
Effect of yarn compacting on yarn contraction

Fibre strand width at delivery nip of front rollers determines the extent to which the twist flows to the nip and size of the spinning triangle. If the strand width is reduced, the spinning triangle diminishes

and the twist flows right up to the nip, which in turn increases the compactness of the yarn.

Yarn contraction (absolute values) increases by 1.2% to 3.0 % with an increase in TM in compact yarns as compared to non-compact ring yarns in all the counts studied. During compacting, all the fibres tend to move towards the core and due to the reduction of spinning triangle, the twist flows uniformly. Further, the inter-fibre friction increases compacting, which in turn reduces the stretch between the lappet eye and the package. Figures 3(a) and 3(b) show the yarn contraction for Ne 20 and Ne 40 of conventional and compact yarns. A similar trend was also observed in Ne 60 and Ne 80 also. However, with the conventional yarn at 2.5 TM, the yarn contraction was found to be on the negative side (i.e. extension) because of stretch between lappet eye and package occurring due to reduced binding of fibres in 20 Ne and 40 Ne yarns.





Figures 3 (a) and 3(b) Effect of compacting on yarn contraction

Effect of yarn diameter on yarn contraction

Yarn diameter of non-compact yarn is 4% to 6% bigger than that of the compact yarns. It was observed that in non-compact and compact yarns, the yarn diameter becomes smaller with an increase in the spindle speed. Similarly, with an increase in the twist multiplier, the yarn diameter decreases due to better binding of the fibres. On the other hand, the yarn contraction reduces with an increase in the spindle speed and vice versa for the same twist multiplier.

In the study of the influence of yarn diameter and contraction with an increase in twist multiplier and spindle speed, the yarn diameter has to be considered as a prime factor for the derivation of prediction formula for yarn contraction.

Effect of spindle speed on yarn contraction%

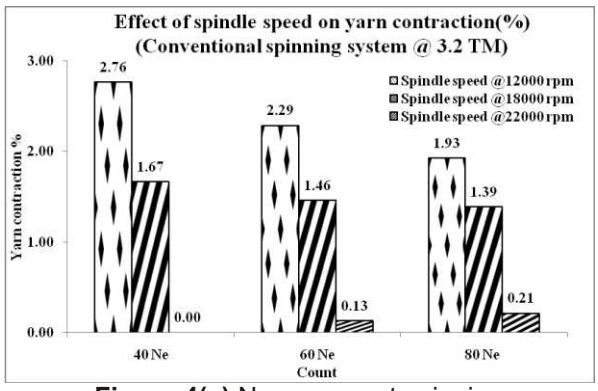


Figure 4(a) Non-compact spinning

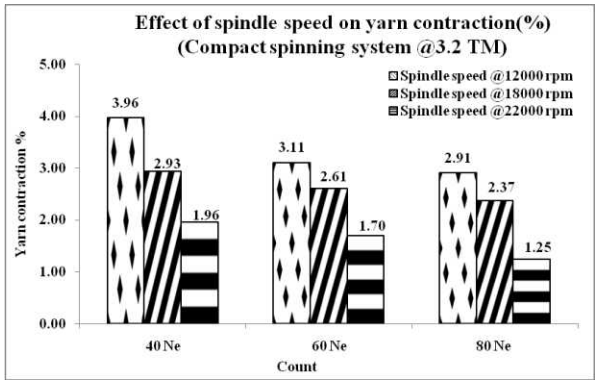


Figure 4(b) Compact spinning

The yarn contraction % changes in relation to the spindle speed are shown in the Figures 4(a) and 4(b). These results clearly indicate that there is an uncontrolled stretch between the front roller and the package, due to an increase in the balloon tension with increase in spindle speed. This has resulted in the reduction of yarn contraction % with the increase in spindle speed.

Conclusion

1. Yarn contraction increases with the increase in TM. However at a TM of 2.5, yarn contraction was found to be negative in non-compact ring yarn in all the counts studied.

2. The yarn contraction values were found to be comparatively less in non-compact yarns as compared to compact yarns.

3. In both non-compact and compact spinning, the spindle speed had a significant influence on the estimation of yarn contraction %; higher the spindle speed, lower the yarn contraction at the same TM level.

4. In both the spinning systems, as the count became finer, the yarn contraction is seen to decrease.

A prediction formula for the yarn contraction is being worked out and the data analysis is under process.

INFLUENCE OF COMBING OF POLYESTER/VISCOSE BLENDED MATERIAL ON YARN QUALITY COMPARED TO THE TRADITIONAL PROCESSES

Blending is one of the vital stages in yarn manufacture and proper blending ensures the desired characteristics of the end product. It is done with a view to attain certain improvements in the functional properties of end products which otherwise cannot be achieved. The fibre constituents in the blending yarn should be thoroughly mixed and intermingled. Any variation in the properties of one of the components in the blend along with the yarn length affects tensile, evenness as well as dyeing characteristics of the blended yarn.

In general, blow room blending is preferred when two types of fibres like manmade and regenerated fibres are to be blended and spun into yarn like polyester and viscose. In the case of blow room blending, polyester is blended with pre-opened viscose in blow room.

Shortcomings of the above blending methods:

Earlier studies on fibre damage in the pre-carding zone in the cards, have revealed a significant breakage of fibres leading to an increase in the short fibre content. So, even regular blow room blending, while processing the blended material through cards, there would be some fibre damages to both polyester and viscose resulting in generation of short fibres in the card sliver. Since there is no subsequent process (combing) for removal of these short fibres, the same could deteriorate the yarn quality significantly.

Hence, a detailed study was conducted by SITRA with a new approach of combing the blow room blended polyester / cotton material. The yarn results were compared with the regular blow room blending process (blending polyester and combed cotton fleece).

Polyester / cotton blended combing offered the following advantages compared to conventional blend process.

- Ø Between blow room normal blending and blow room blended combing, there was a reduction of about 70% to 80% in normal imperfections for warp counts and 80% to 90% for hosiery counts respectively. Further, there was also a reduction of 70% to 75% in extra sensitive imperfections for warp counts and 75% to 80% for hosiery counts.

- Ø Blended combing showed improved blend homogeneity by 9% to 13% as compared to normal blow room blending. This is expected to help in reducing the yarn strength variations and shade variations in dyed fabrics.

- Ø The strength of the yarn produced by blended combing showed an improvement of 4.8% to 10% with 1.0D polyester blend and 3.3% to 4.3% with 0.8D polyester blend, respectively.

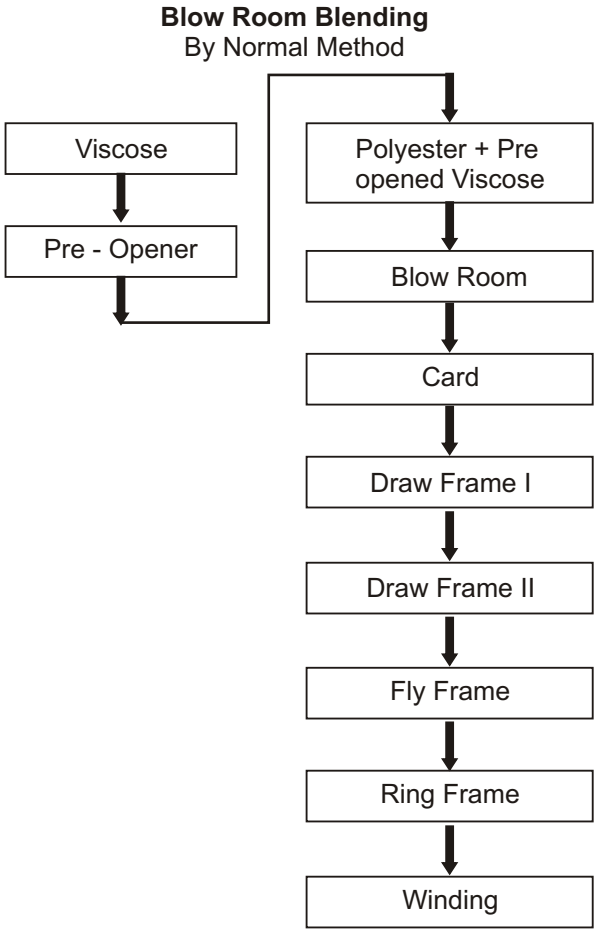
- Ø While using blended combing method for normal as well as for micro denier polyester, the hairiness levels was observed to be lower in both warp and hosiery yarns considerably. In the case of normal polyester blends, a reduction of 14% in hairiness index was noticed for both warp and hosiery yarns. In Zweigle S3 hairiness, around 35 % to 55% reduction was noticed for hosiery and warp counts respectively. In the case of micro denier polyester blends, there was a reduction of around 9% in hairiness index for both warp and hosiery yarns and 25% reduction in Zweigle S3 hairiness, in hosiery and warp yarns respectively.

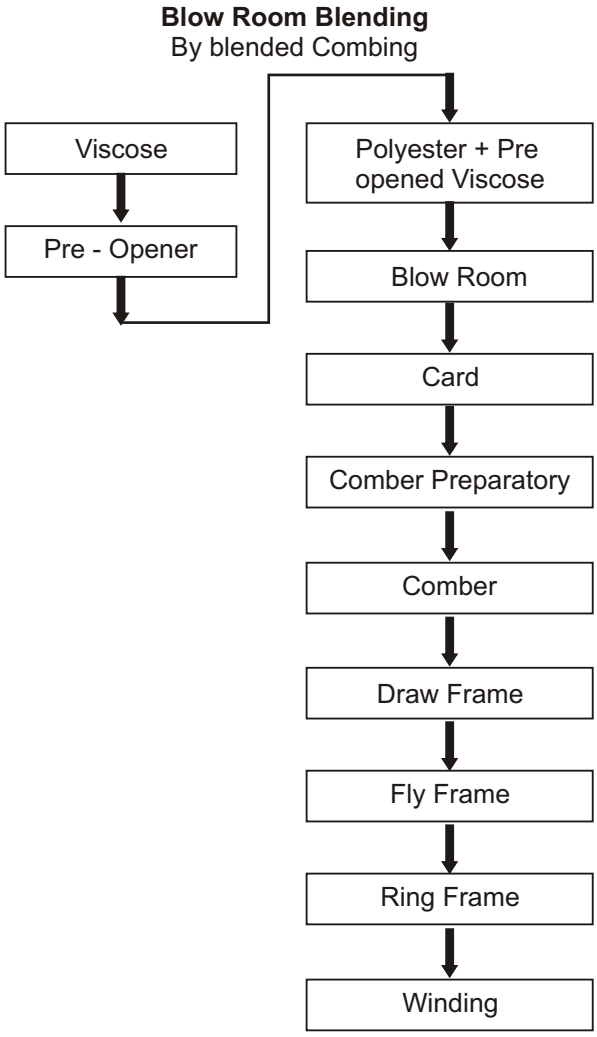
- Ø Using blended combing method for normal as well as for micro denier polyester, the classimat levels decreased considerably for both warp and hosiery yarns. In the case of normal polyester blends, there was a reduction of 33% to 47% in total NSL faults and 65% reduction in long thin faults as compared to the normal blending technique.
- Ø In the micro denier polyester blends, a reduction of 25% in total NSL faults and 10% to 35% in long thin faults were observed as compared to normal polyester blend counterparts.
- Ø While using blended combing method for normal as well as micro denier polyesters, the yarn body level was found to decrease for both warp and hosiery yarns. This indicates an improvement in the compactness of yarn structure while using blended combing method. The same level of NSL clearer setting in auto coner will result in a lower level of clearer cuts in the case of blended combed yarns when compared with normal blended yarns.

Considering the advantages mentioned above, trials are planned to process polyester /viscose blend to study the improvement in the yarn quality.

Process flow chart for the new approach

Blow room blending (Blended combing – Pre opened viscose with polyester processed through the combing process)





Spinning of two yarn counts of Ne 40 yarns and Ne 60 yarns in the blend ratio of 65:35 have been planned using two different denier/ length of polyester and viscose fibres with the two blending methods,

i. Normal blending method (Blow room blending with pre opened viscose with polyester)

ii. Blended combing method (Pre opened viscose with polyester processed through combing process)

The fibres, blend combinations and the counts to be spun are shown in Table 5

Table 5 Fibre, blend and yarn counts

Trials	Polyester fibre	Viscose fibre	Blend ratio	Count to be spun
1.	0.8D* 44 mm	1.5D* 44mm	65/35	40s and 60s Ne
2.	0.8 D* 38mm	1.2D* 38mm	65/35	40s and 60s Ne

Yarns will be tested for the following characteristics:

- Index of blend irregularity
- Tensile behaviour
- Evenness and imperfections
- Yarn hairiness
- Classimat infrequent yarn faults

The different fibres required for these trials have been procured and further work is under process.

EVALUATION OF THE EFFECT OF COMPACTING ZONE DRAFT ON YARN QUALITY

All the new spinning processes developed in the past few decades were aimed at achieving the highest production per spinning unit. However, ring spun yarns have always been and continue to set higher quality bench marks. Although ring spun yarn set a benchmark for yarn quality, it is nevertheless not perfect in its yarn structure. It is due to the uncontrolled fibres in the spinning triangle in which the peripheral fibres are either lost or are attached in some way or the other in an uncontrolled manner to the already twisted yarn. The development of compact spinning is an improvement over the conventional ring spinning by minimizing or reducing the problems associated with the spinning triangle at the delivery of the front rollers. In compact spinning, the tension draft zone between the drafting unit and yarn formation condenses the fibres laterally by suction. Since the spinning triangle is virtually small, all the fibres from the spinning triangle get collected and fully integrated in the yarn. The result is a better yarn structure with improved yarn quality.

In the condensing zone of front top roller and delivery top roller, absence of tension draft may cause disturbance of fibre straightening and orientation resulting from condensing effect. This is because condensing forces (suction) act almost in a perpendicular direction to the fibre movement and the direction of fibre orientation. Hence, a tension draft is required to overcome the perpendicular component of force acting on the fibre. In the processing of manmade fibre and blends, tension draft has to be varied due to the difference in density of the component fibres. This is for achieving a better condensing effect.

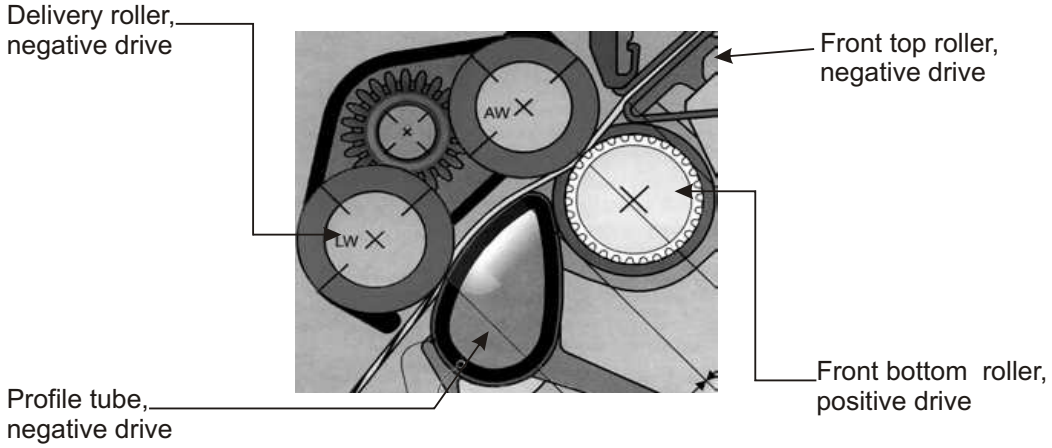


Figure 5 Drive to condensing zone

In this study, an attempt has been made to optimize the tension draft level in the compact zone for various yarn counts for cotton and manmade fibre materials. The yarns produced using different tension drafts were studied and analyzed for their yarn quality attributes.

- Ø Compact yarns were manufactured with the following process parameters for different counts and materials.
- Ø Compact system: Retrofitted Sussen compact set in LMW LR6/S ring frame with P3/1 top arm drafting.
- Ø Yarn counts: Ne 40 C-Comp., Ne 60 C-Comp., Ne 60 PSF Comp and Ne 60 P/C Comp.
- Ø Tension draft: 1.00 to 1.18
- Ø Tension draft recommendations by the machinery manufacturer.

· 100% cotton : 1.055 to 1.065
· Synthetic and cotton blends : 1.025
· 100% synthetics : 1.000

Yarn samples produced were evaluated for their yarn properties like

- · Single yarn strength (UTJ) and Elongation %
- · Unevenness U%, and Normal / Extra sensitive imperfection levels
- · Yarn Hairiness (Hairiness Index and Zweigle)
- · Classimat faults

Spinning trials on the influence of tension draft from 1.065 to 1.180 were completed in all the above-mentioned counts with tension draft ranging from 1.00 to 1.065. The 4 draft settings were 1.065, 1.11, 1.15 and 1.18. The yarn irregularity (U% & CVm) Derivation Rate (DR%) and cut length CV % (1m%), yarn imperfections, yarn hairiness and seldom occurring faults were compared at each of these draft settings for Ne 40C compact, Ne 60C compact, Ne 60 PSF and Ne 60 PC yarns.

Summary of the results

- Ø In all yarn counts and material (100% cotton, 100% polyester and polyester cotton blends) the U% and CVm increased at all tension draft levels from the standard/recommended tension draft of 1.065

Following are the observations with respect to other yarn quality characteristics at various tension draft levels when compared to 1.065 tension draft.

- Ø In DR%(1.5m,5%) values, no significant difference was observed between different counts and materials
- Ø No significant difference was observed in cut length of CV of 1 meter between the trials.
- Ø An increase in thin, thick and total imperfections at both sensitivities (normal and extra sensitive) were observed in counts of Ne 40 C, Ne 60 C and Ne 60 PSF counts. Interestingly, the behaviour is reversed in Ne 60 PC blended yarn.
- Ø Hairiness (S3) values were lower in all the counts and materials. Hairiness index (H), however showed an increasing trend due to poor consolidation of shorter fibres (less than 3mm) with an increase in tension draft.
- Ø Yarn tenacity and elongation were found to decrease with an increase in tension draft, except in 60s PC blends with tension drafts of 1.11 and 1.15. However, it showed a reduction in strength at 1.18 tension draft.
- Ø Objectionable faults were observed to be lower at all three tension drafts for all counts and materials.
- Ø From the above findings, among four tension draft levels (1.065,1.1,1.15&1.18), the tension draft of 1.065 was better in quality aspects like U%, Cvm, DR%, imperfections and tenacity. However, among all the tension draft studied, the hairiness (S-3) values were lower with tension drafts between 1.11 and 1.18.

Table 6 Proposed number of spinning trials

Material	Count	Process	Type	Tension draft	No. of trials
100 % Cotton	2	Combed	Compact	1.0 -1.18 (7 drafts)	14
Synthetic & blends	2	-	Compact	1.0 -1.18 (7 drafts)	14
Total number of trials					28

In the spinning of 60s PC blended yarn (with surface characteristics and fibre densities), following were the observations at tension drafts of 1.11 and 1.15

- No significant impact on yarn irregularities
- No significant impact on thin places and neps at both the sensitivities
- Significant reduction in hairiness S-3 value accompanied by an improvement in tenacity and elongation.

The same trials are being conducted at tension drafts 1.000 and 1.065 to evaluate the yarn quality at still lower tension drafts .

PRODUCT DEVELOPMENT USING BANANA / COTTON FIBRE BLENDS

(Sponsored by Industry)

India is the world's largest banana producer with an annual output of 24.8 million tonnes followed by China, Philippines, Ecuador and Brazil. India accounts for 22 per cent of the global banana production. Apart from its usage in textiles, banana fibres provide employment opportunities to thousands of low earning income groups in India. In general, banana plant is harvested two to four times in a year and the stems are usually cut and thrown away as waste. Banana fibre is also a major substitute for the pulp industry

Banana fibres can be utilized to produce yarns of different fineness to make textile products with different qualities for specific end uses. In olden days, extracted banana fibre was used for making rugs, ropes and for tying flowers.

The quality of the banana fibres varies within a single stem.

I. Inner fibres

These inner fibres are characterized by their fine, smooth and natural shine and can be used for producing smooth textile material like kimonos and saris.

II.Outer strands

The outer strands are coarser in nature and can be used for weaving baskets and handbags.

Banana fibre has the following physical and chemical characteristics that make it a fine quality fibre.

- Appearance of banana fibre is similar to the bamboo fibre and ramie fibre, but its fineness and spinnability is better than the two.
- The chemical composition of banana fibre is cellulose, hemicellulose and lignin.
- It is a strong fibre with lower elongation.
- It has a strong moisture absorption quality. It absorbs as well as releases moisture very fast.
- It is bio- degradable and has no negative effect on the environment and thus can be categorized as an eco-friendly fibre.

Banana / Cotton yarn was developed using the ring spinning process and the process parameters

Table 7 Process parameters for Banana / Cotton blend (20%\80%)

Mixing / Blowroom FibreMixing particulars	
Cotton	Wetting agents applied
Fibre length (28 to 30 mm)	
Banana	Wetting agents applied
Fiber length (around 30mm)	
Lap Weight	360 GSM
Carding (C 1\3)	
Cylinder speed (RPM)	360
Flat speed (inches/min)	10
Licker in speed (RPM)	750
Doffer / Delivery speed (m/min)	25
Delivery sliver hank (Ne)	0.10
Drawing (DO/ 2S)	
No of Doublings	5
Feed sliver hank(Ne)	0.10
Delivery sliver hank (Ne)	0.10
Simplex (LFS 1660)	
Spindle speed (RPM)	350 rpm
Roving hank (Ne)	1.05
Draft	10.5
TPI	1.80
Spinning (G5/1)	
Roving Hank (Ne)	1.05
Feed	3 Ply
TPI	27
Yarn Count (Ne)	21
Spindle Speed (RPM)	8500

The fabrics developed out of these yarns were converted into garments by the industry partner who had sponsored the project.

DEVELOPMENT OF CUT - RESISTANT TECHNICAL FABRICS (Sponsored by Industry)

The cut-resistance of a fabric is an important attribute for some special technical applications. Cut-resistant fabrics are made with elongated thin metal wires, high-performance fibres such as Nylon, Loyotropic polymer made fibres, HDPE (High-density polyethylene) and thermo tropic liquid crystal polymer made fibres. The cut-resistant fibres are used to produce protective fabrics, gloves, sportswear, etc.

Hand injuries represent an important source of occupational accidents (close to 17%). Among hand injuries, more than half are caused by cuts and punctures. The use of protective gloves with the right level of protection against mechanical risks is therefore at the center of an employer's and occupational safety agencies' priorities. Cut resistant garments need to provide a comfortable environment for the wearer and consequently need to be able to handle moisture vapour and sweat produced by the body.

Development of cut resistant garment for glass handling industry operators

Based on the previous research work carried out by SITRA, a cut resistant garment was manufactured using ZYLON filament cut resistant fabric. Zylon Polybenzoazole (PBO) – Zylon is a synthetic fibre developed by "Toyobo" a company headquartered in Osaka, Japan. Zylon – the strongest man-made fiber in the world – has four extraordinary characteristics.

Cut resistance fabric sandwiched T shirt

- – High tensile strength – it is stronger than steel and twice as strong as Kevlar.
- – Remarkably high modulus (Resistance of fibre to stretch) – also twice as high as Kevlar
- – Flame resistance – It will burn only when exposed to atmospheric conditions consisting of at least 68% oxygen, a state that is not naturally encountered in earth's atmosphere
- – Incredible thermal stability – It will decompose only at temperatures in excess of 1470^0 Fahrenheit.

The Zylon cut resistant fabric was sandwiched between 2 layers of cotton knitted fabric. The inner layer coming into contact with body is the cotton knitted fabric, the middle layer in the area where safety against the danger of cut marks during handling tough glasses is of Zylon fabric and the outer layer is of cotton knitted fabric. The garment was stitched on both the sides and the under arm where the inner layer and outer layer is in contact. This will transfer the moisture absorbed by the inner layer to outer layer and evaporate. Hence, the wearer will experience comfort during working.

It is proposed to explore possibilities of developing multiple end-use garments using the cut-resitant fabrics.

DEVELOPMENT OF HIGH PRODUCTIVITY HAND OPERATED CHARKHA (Sponsored by the Directorate of Science & Technology, Office of the Commissioner KVIC, Mumbai)

The Khadi industry is one of the largest employment generation initiatives in the country. In 2017, a total of 460,000 people were employed in industries making khadi products. Production and sales rose by 31.6% and 33% in 2017 over the 2016 figures.

A project has been undertaken to help the khadi spinners to earn a better wage in their rural home itself by redesigning the spinning wheel and adding some more spindles without unduly enlarging the size of the spinning machine.

An innovative concept of hydraulic multiplication power transmission is proposed which will be useful to double the spindle speed from the existing level of 9000 rpm. The economy, efficiency and productivity, will be improved proportionately. If the production gets doubled, a person will get about twice the remuneration in line with the production.

Speed multiplication system to be incorporated in high speed charka

In the existing charka the speed ratio of the spindle

drive is maintained in the ratio of 1:150. Hence, if the operator rotates the hand wheel for 60 times in a minute the spindle speed will be 9000rpm. To increase the speed, the drive system should be modified in such a way that the number of revolutions of the hand wheel made by the operator ensures double the number of rotations of the spindle. If, however, a simple open gear mechanism is incorporated, it will increase the transmission load for the operator when he rotates the hand wheel. Hence, the objective is to double the speed, with a minimal increase in load.

In order to have the required speed, the following concepts are under consideration. (Figure 6 & Figure 7)

1. Simple speed multiplier gear box with

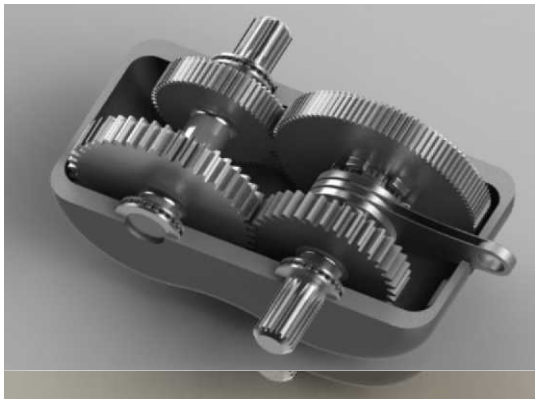


Figure 6 Simple speed multiplier gear box with hydraulic oil

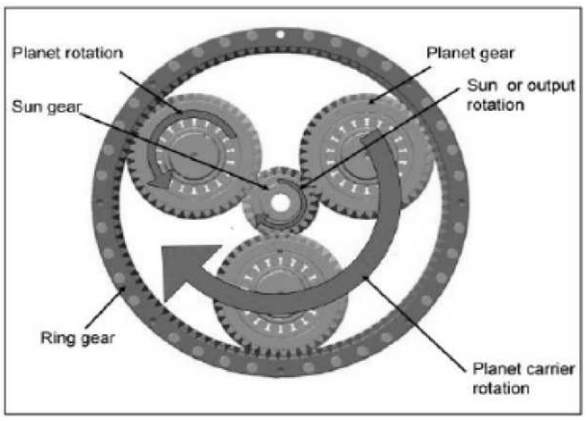


Figure 7 Planetary speed multiplier gear box with hydraulic oil

The fabrication of the charkas is under progress.

CHEMICAL PROCESSING

A STUDY ON THE SALT-FREE DYEING OF COTTON MATERIALS

Cotton is the most widely used fibre in the manufacture of apparels / garments. For textile dyeing, reactive dyes have been used very often and they are, by consumption, the most important textile dyes. High popularity of reactive dyes is based on the brilliant and fast colours with a wide range of shades using various environment friendly procedures. Reactive dyes stand out from other dyes from their ability to make covalent bonds between carbon atoms of dye reactive group and oxygen atoms of cotton hydroxyl groups under alkaline conditions. However, all the reactive dyeing systems require a huge amount of electrolyte and alkali to exhaust and fix the dye respectively.

These electrolytes are neither exhausted nor destroyed and hence remain in the dye bath after dyeing. Even with the use of salts, generally the exhaustion of dyes does not exceed 80% to 85% in the case of reactive dyes under normal dyeing conditions. Further, when alkalinity is introduced in the bath in order to facilitate the formation of covalent bond between the fibre and the functional groups of the reactive dye, the abundance of hydroxyl ions causes significant hydrolysis of reactive dyes. Those hydrolyzed dyes are called 'dead' dyes as they have no affinity towards cotton and hence remains in the dye bath, deposition of the same on the fibre significantly lowers the fastness properties that calls for severe wash-offs.

The effluent thus generated pollutes the environment by discharging highly coloured reactive dye bath and higher electrolyte concentration. The presence of salts in the effluent causes increase in the 'Total Dissolved Solids (TDS)'. Higher TDS level in the effluent results in the following:

1)Makes it difficult to reuse the water, even if it is colourless, for processing because of the salinity which interferes during processing and can result in uneven / patchy dyeing.

2)In the present scenario, processing units treat the effluent water using reverse osmosis (R.O) plant and the reject is further concentrated using multiple effect evaporators. The reduction of TDS

in effluent water through R.O and evaporation are very much energy intensive and are expensive as well. Hence, the presence of high level of TDS in effluent water increases the cost of effluent treatment.

3)The treated / untreated effluent with high TDS, if let into the surface / land, results in clogging of pores of soil and affects the fertility of the soil. Also, the chemicals which get carried along with the dissolved solids are toxic in nature which in turn hinders the growth of plants.

4)Presence of Sodium component in excess in the effluent water increases the 'Sodium Adsorption Ratio (SAR)' of water. For water to be used for agriculture purposes, the SAR needs to be maintained below 18.

5)It also leads to toxicity to aquatic living organisms and through bio-magnification affects the human beings as well. It disturbs the delicate biochemistry of water organisms.

6)In the present scenario, water is a precious commodity. Hence, recycling of water is must in order to save our environment. The presence of high level of TDS, which in turn is caused by the use of sodium salts during reactive dyeing for exhaustion purpose, makes it difficult and expensive to recycle the water.

Cationisation of cotton

In order to counter the above, researches are going on in areas such as i) reducing the cost of effluent treatment ii) eliminate / minimise the use of salt during dyeing. The later methodology calls for physical and chemical procedures for modification of cellulose fibres in order to increase reactive dye exhaustion & fixation degree and saving electrolytes. The pre-treatment to improve functionality and dyeing ability of cellulose fibres, using cationic agents, has attracted attention recently.

In the present study, cotton knitted fabric was treated with a cationising chemical derived by mixing a quaternary ammonium salt and a mild resin in order to enhance the affinity between the cotton fibre and reactive dyes with various functional groups. Two sets of fabrics were dyed i) by normal scouring and bleaching process followed by dyeing with the use of salt ii) normal scouring & bleaching followed by cationisation using the chemical formulated and later dyed without using salt. Further, the dyed fabrics were evaluated for colour strength, L, a, & b values, colour fastness to rubbing, washing and light. The results were then compared and interpreted.

Cotton single jersey knitted fabric made of Ne 40 Combed Hosiery yarn (mass per unit area: 125 g/sq. m) was taken. Several chemicals including the commercial chemicals such as Ecofast CR 2000 from Dow chemicals, Eco NSD from Eco star chemicals were tried as cationising agents. Based on the results obtained, a combination of two chemicals in a particular ratio was made to formulate the cationising chemical namely CAT 17.

The knitted fabric was pretreated in the normal sequence (i.e) scouring followed by bleaching using Sodium Hydroxide, Hydrogen Peroxide, wetting agent, etc. Pre-treatment of the fabric was carried out in a pilot scale 5 Kg. soft flow machine. After pre-treatment, it was noted that the absorbency of the fabric was 2 to 3 seconds (drop test) with a pH of around 6.0 to 6.5.

Cationistion of cotton

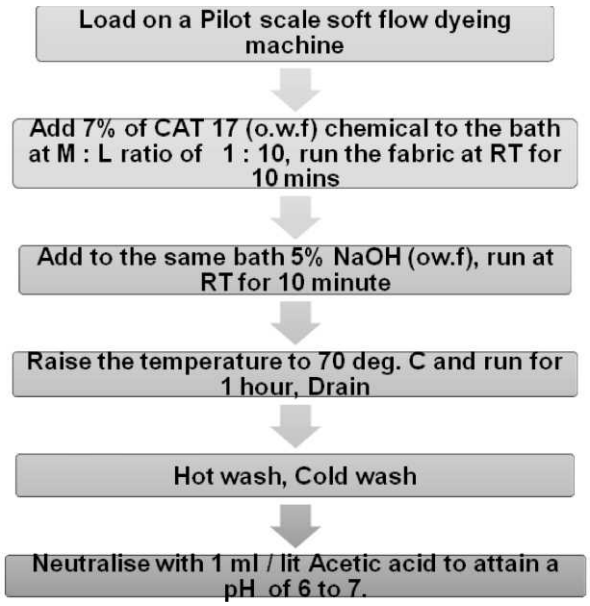
Formulation of the cationising chemical was carried out based on the results of preliminary trials conducted using commercially available chemicals. Two chemicals were chosen; chemical A – mixture of Quaternary ammonium salt, acrylic emulsion & softener and chemical B – mixture of cross linking resin and softener, and were mixed in a particular ratio. The chemical mixture was stirred and stored overnight to obtain a homogenous mixture. The resultant chemical was named CAT 17.

Trials were conducted for cationistion of the fabric using the 2 recipes given below and it was noted

Chemical	Recipe 1	Recipe 2
CAT 17	5.0%	7.0%
Sodium Hydroxide	3.5%	5.0%

that the recipe 2 was found to give uniform dyeing. One portion of the knitted fabric was cationised using the formulated CAT 17 chemical as per the process sequence given below using recipe 2:

Process sequence followed for Cationisation



Another portion of fabric was taken as it is in the pre-treated fabric and dyeing trials were conducted on both cationised and uncationised fabrics.

Dyeing trials

Dyeing of the cationised and uncationised fabrics were carried out covering light and medium shades using Procion RGB and HE classes of dyes.

Dyeing with RGB dyes

The dyeing plan and recipe followed for RGB class of dyes are given in Table 8

Dyeing with HE dyes

The dyeing plan & recipe followed for dyeing of HE class of dyes are given in Table 9:

Dyeing methodology

Dyeing of the cationised and uncationised fabrics was carried out as per the recipe and process sequence. While dyeing cationised fabrics, no salt was added and while dyeing the uncationised fabrics, salt quantity as given in the recipe was added. Dyeing was carried out on RBE Laboratory dyeing machine under identical conditions and the resultant fabrics were evaluated for various parameters.

Evaluation of parameters

The fabrics dyed using the conventional methodology and the fabrics dyed after

Table 8 Dyeing plan and recipe followed for RGB class of dyes

S. No.	Name of the dye	0.25% shade		2% shade	
		Con. dyed	Cat. & dyed	Con. dyed	Cat. & dyed
	Procion RGB dyes				
1	Chemifix Golden yellow RGB	Salt: 25 g/l Soda: 10 g/l	Salt: Nil Soda: 10 g/l	Salt: 60 g/l Soda:15 g/l	Salt: Nil Soda: 15 g/l
2	Chemifix Red RGB				
3	Chemifix Navy blue RGB				
4	Chemifix Ultra Turquoise 3 D				

Table 9 Dyeing plan and recipe followed for HE class of dyes

S. No.	Name of the dye	0.25% shade		2% shade	
		Con. dyed	Cat. & dyed	Con. dyed	Cat. & dyed
	Procion HE dyes	Salt: 25 g/l Soda: 10 g/l	Salt: Nil Soda: 10 g/l R. Salt: 1 g/l	Salt: 60 g/l Soda:15 g/l	Salt: Nil Soda: 15 g/l R. Salt: 1 g/l
1	Coracion yellow HE 6G				
2	Coracion blue HE GN				
3	Coracion green HE 4B				
4	Coracion red HE 7B				
5	Coracion T. Blue HE G				

cationisation of the fabric without using salts were evaluated for various quality parameters such as colour strength, colour fastness to washing, colour fastness to rubbing, colour fastness to light, pH of aqueous extract, free formaldehyde content, etc.

Evaluation of color strength

The dyed samples were evaluated for their color strength by determining the K/S values using a Gretag Macbeth7000 eye (USA) Computer Color Matching System. An average of four readings, taken at four different sample areas, were used to get the reflectance values and the Kubelka Munk function (K/S) was evaluated.

$$K/S = (1-R)^2 / 2R$$

where, R is the reflectance at complete opacity, K is absorption coefficient and S is the Scattering coefficient. Dyed fabrics were also evaluated in terms of CIE LAB color space (L*, a* and b*) values using the Gretag Macbeth7000 eye (USA) system. The colour strength of conventional dyed fabric and cationised & dyed fabrics were compared and rating given.

Evaluation of wash, light and rubbing fastness

Dyed fabrics were tested for color fastness to washing according to the ISO Method, ISO 105-C10/B (2). Dyed fabrics were tested for colorfastness to washing according to ISO Test Method, ISO 105-C10:2006. Dyed fabrics were tested for colorfastness to light according to AATCC Test Method 16-2004 for 10 hours exposure. The samples were compared with the standard scale of blue wool and graded. Colour fastness of rubbing was evaluated as per the standard test method ISO 105 X 12:2016 and the results were graded on a scale of 1 to 5.

Determination of formaldehyde content

The total formaldehyde content of the dyed fabric with and without salt were determined as per ISO 14174-Part 1: 2011 (E) standard (water extraction method). Formaldehyde was extracted from a textile sample with water at 40°C. The amount of formaldehyde was then determined calorimetrically. Each test was performed in duplicates.

Conclusion

The cationised and dyed fabrics, with both RGB & HE dyes, were found to have dyed darker than the conventional dyed fabrics for the same shade %.

- Ø The dyeing was found to be uniform and the increase in colour strength of cationised and dyed fabrics is attributed to the better exhaustion of dyes.
- Ø The effluent from the cationised and dyed bath had literally no / less colour compared to the conventional dyed bath.
- Ø The K / S graphs also indicated that the K / S values of the cationised & dyed fabrics were higher than the respective values of conventional dyed fabrics.
- Ø The washing fastness of cationised and dyed fabrics, with both RGB & HE dyes, were found to be at par with that of conventional dyed fabrics in the case change in colour and staining on cotton.
- Ø Colour fastness to staining on other fibres such as wool, nylon, etc., were found to be superior at 4-5.
- Ø In the case of Ultra Turquoise 3D, the fastness was found to be superior by 0.5 grade on cationised & dyed fabrics when compared to conventional dyed fabric.
- Ø The fastness to rubbing of conventional dyed fabrics and cationised & dyed fabrics were rated similar in almost all the colours, shades and class of dyes.
- Ø Wet rubbing fastness of cationised & dyed fabrics were generally found to be good in spite of the shade being darker than the conventional dyed fabrics.
- Ø The colour fastness to light of cationised and dyed fabrics, with both RGB & HE dyes, were found to be on a par with that of conventional dyed fabrics in most cases.
- Ø The light fastness of cationised & red dyed fabrics, with both RGB & HE dyes, was found to be slightly inferior by 0.5 grade when compared to conventional dyed fabrics.
- Ø The above results were found to be common in both light and medium shades.

Further, the characteristics of effluent arising out of both conventional dyeing process and cationised dyeing process are being evaluated to arrive at the overall techno-economics of the cationisation process.

A STUDY ON THE INTER RELATIONSHIP BETWEEEN VARIOUS PHYSICAL PROPERTIES AND THE DYEING BEHAVIOUR OF COTTON FIBRES

The study was carried out to understand the inter-relationship between fibre micronaire, maturity co-efficient, fluorescence value, colour grade, convolutions per inch, honey dew content and wax content of various cotton varieties and their individual and combined effect on the dyeing behaviour of the selected fibres.

Imported and Indian cotton varieties with a wide range length, fluorescence value, color grade (Rd & +b values), maturity co-efficient, etc,, were collected. Characterisation of the collected fibre varieties for physical and chemical properties were carried out. The different cotton varieties were dyed using reactive dyes and compared with each other. The results of the various physical and chemical properties of the selected varieties are reported here. Efforts will be made to find the inter-relationship between the physical and chemical properties of cotton fibres viz., Colour grade (Rd & +b Values), fluorescence value, maturity co-efficient, convolutions per inch, wax content, honey dew content, etc and the dyeing behaviour of respective cotton fibres. This exercise is expected to establish the relationship between these properties and also serve as a tool for selection of cotton bales for mixing.

About 30 cotton varieties such as Bunny, MCU 5, LRA, Suvin, DCH 32, PIMA, Organic cotton, BCI 43, West African cotton, Ganga cotton, Bellary, BB cotton, etc,, from different origins were collected and tested for various physical and chemical properties. The fibres were also dyed using reactive dyes covering light and dark shades on a laboratory dyeing machine and the results are reported.

It was noted that there was a wide variation between the dyeing behaviour of various fibres as the physical and chemical properties also vary significantly between each other. Further, the properties such as crystallinity, convolutions per inch, fluorescence value, etc, of the fibres will be evaluated and will be related with the dyeing behavior and other physical properties of the fibres.

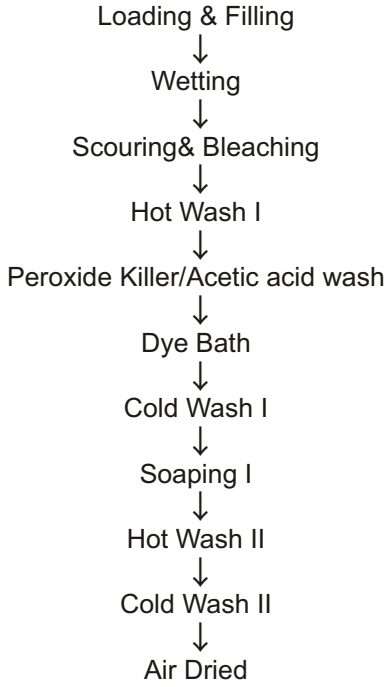
DEVELOPMENT OF BABY CLOTHING USING AN ECO-MORDANT FOR NATURAL DYES ON COTTON FABRICS

The present project is a continuation of a previous work which dealt with development of infant baby wear clothing where a new natural mordant was identified and also the extraction process was optimized for the same. Using this natural mordant three different shades namely olive green, biscuit beige and choco brown were developed and successfully infant baby wears were made. Further, a liquid mordant was identified and employed for dyeing on cotton fabric using the natural dyes which resulted in two new shades namely Lavo pink and light orange.

Based on the suggestions, it has been proposed to take up a study with the objective of identification and extraction of mordant material from unexplored natural sources and their application as natural mordant for the improved eco-colouration using natural dyes on cotton knitted fabrics.

Process flowchart

The regular process sequence followed for dyeing of cotton fabrics is given below.



2.1 Extraction of colorants

2% (W/V) natural dye stock solutions were made by boiling 20 g. of dye powder in 1000 ml water for 2 hours. The content was cooled and the extract was filtered, made to 1000 ml using water and employed for dyeing process.

2.2 Mordanting methodology

For the present work for orange and yellow colour natural dyes, simultaneous mordanting methodology was employed for the natural dyeing process. Eco-friendly mordant 10% (v/v) over total liquor was employed, the mordant was added during the dyeing process itself. In case of green colour natural dyes, pre-mordanting method was employed using the conventional mordanting agents namely tannin (10% owf) treatment at 60°C for 1 hour followed by 15% owf natural alum for 1 hour and squeezed the fabric and employed the mordanted fabric for the subsequent dyeing process.

2.3 Dyeing methodology

The % shade used for dyeing on polyester wool blended fabrics was 20% (owf). Dyeing was carried out in a sample winch dyeing machine, keeping the liquor to material ratio of 25:1. The fabric was introduced into the dyeing solution at room temperature and slowly the temperature was raised to 90°C. The dyeing was continued medium at this temperature for 60 minutes. After dyeing, the fabrics were rinsed and soaping was carried out at 70°C using eco-soaping agent for 20 minutes. After soaping, a hot wash followed by 2 cold washes and then the fabrics were removed, hand squeezed and air dried.

2.4 Analysis of performance properties and Functional property

1. Determination of pH of the fabric
2. Determination of formaldehyde content
3. Determination of extractable heavy metal from the fabric
4. Colour fastness to saliva and perspiration
5. Evaluation of wash and light fastness

Results and discussions

Dyeing & shade obtained on the fabric

Results with respect to dyeing and shade obtained on the cotton fabric with natural dyes namely orange, yellow and green (shade, 20%) obtained using with and without mordants are given in Table 10. The results indicate that the orange natural on cotton resulted in light pinkish orange shade and darker pinkish orange shade with and without mordanting respectively. In the case of yellow natural dyes, when eco-mordanting agent was added into the dye bath, there was no colour uptake on the cotton fabric. This may be due to the change in the chromophoric structure of yellow dye leading to no colour fixation on the cotton fabric. Further, a similar result was obtained in the case of green dyes when employed without a mordant.

pH of the fabric

The pH values of polyester wool blended fabrics dyed with all three natural dyes (shade 20 % owf), without mordant were evaluated. The pH of all the dyed fabrics was in the range of 6.0 to 6.2, (Table 10) which was well within the Oeko-tex limit range, i.e., 4.0 to 7.5 specified for baby clothing.

Table 10 pH, wash and light fastness ratings of natural dyes dyed cotton fabrics with and without mordants

Natural dye (Shade, 20%)	Mordants (%)	Fabric pH	Wash Fastness		Light fastness	Remarks
			Change in colour	Staining on adjacent fabrics		
Orange	Nil	6.53	2-3	4-5	3	Light pinkish orange
	10% NLM	6.68	4	4-5	3-4	Darker Pinkish Orange
Yellow	Nil	6.43	1-2	3-4	1-2	Lemon Yellow
	10% NLM	NA	NA	NA	NA	No dye up take
Green	Nil	NA	NA	NA	NA	No dye up take
	10% Tannin + 15% Alum	6.71	4	4-5	3-4	Dark Green

Light fastness rating:1-poor,2-fair,3-moderate,4-good,5-better,6-very good,7-best & 8-excellent, Wash fastness rating: 1-poor, 2- fair, 3-good, 4-very good & 5-excellent.

Table 11 Colour Fastness to Saliva and Perspiration ofnatural dyes dyed cotton fabric with and without mordant

Mordant, (%)	Natural dye (Shade, 20%)	Staining on filter paper		Test results
		Solution A	Solution B	
Oeko Tex - Baby Limits		No	No	FAST
Nil	Orange	No	No	FAST
10% NLM		No	No	FAST
Nil	Yellow	No	No	FAST
10% Tannin + 15% Alum	Green	No	No	FAST

Colour fastness to saliva and perspiration

It is also necessary to assess the potential risk of textile materials in terms of colour fastness to saliva and perspiration to wearers, mainly for sensitive persons such as allergy sufferers, pregnant women, infants, elderly people, etc. The results of colour fastness to saliva and perspiration are given in Table 11. In both A and B solution of colour fastness to saliva and perspiration, the cotton samples with and without eco-mordant and dyed with all three dyes showed no staining on the filter papers.

Colour fastness to washing & light

The wash and light fastness properties of cotton mordanted and dyed with natural dyes are given in Table 1. The wash fastness properties with respect to change in color were of the order of 4 (midway between very good to excellent) were observed in case of orange using eco-mordant and green when conventional mordanting system was employed, which is quite acceptable. The staining of all three natural dyed samples revealed good fastness with a grade 4-5. Poor wash fastness was observed in case of yellow natural dyed cotton sample. The light fastness was in the range of 3-4 i.e., moderate to good for cotton simultaneous mordanted with eco-mordant and dyed with orange dyes and also conventionally mordanted and dyed using green natural dyes. Poor light fastness was observed in case of yellow natural dyes.

Formaldehyde content

The formaldehyde content of the fabric was determined as per ISO 14174-Part 1: 2011 (E) standard (water extraction method). The cotton fabrics dyed with all three natural dyes, with and without eco-mordant, resulted in fabrics free from formaldehyde content, i.e., formaldehyde was not detected, which again complies with Oeko-Tex criteria for baby wear clothing.

Extractable heavy metal from the fabric

The extractable heavy metal content from the pre-mordanted and natural dyes dyed cotton fabric were extracted using standard test method ISO 105-E04-Color fastness to acid perspiration as per the Oeko-Tex eco-label. The results clearly indicate that all the fabrics eco-mordanted and a subsequently dyed with turmeric and eco-orange natural dyes showed the absence of extractable heavy metals i.e., not detectable. Hence, all the dyed fabrics mordanted using eco-mordant meets the requirement of Oeko-Tex eco labeling for baby wear.

Further work is under process to compare the conventional alum based mordanting system for natural dyes and also to replace the alum with a suitable natural mordant for the fixation of natural colourants, which is in high demand in the baby wear sector

DEVELOPMENT OF POLYESTER WOOL BLENDED KIDS OVERCOAT CLOTHING USING ECO- FRIENDLY NATURAL DYES

Today, the use of blended fabrics has tremendously increased in India. In the case of suiting material, choosing the fabric for a suit is one of the most significant choices one must make when investing in a new suit. Factors such as cost, breathability, wear-ability and care levels are all influential in making the final decision. The properties of the fibres are combined when blending is carried out and also results into a modified state as the fabric is made. If blending is done carefully, the good

qualities of the fibres are emphasized, thus minimizing the poor qualities.

Hence, this project was initiated to carry out eco-friendly dyeing of Polyester- Wool (55/45) blended woven fabric using natural dyes and development of kids overcoat.

Extraction of colorants

2% (W/V) natural dye stock solutions were made by boiling 20 g of dye powder in 1000 ml water at boil for 2 hours. The content was cooled and the extract was filtered, made to 1000 ml using water and employed for the dyeing process.

Dyeing methodology

The % shade used for dyeing on polyester wool blended fabrics was 20% (owf). Dyeing was carried out in a sample winch dyeing machine, keeping the liquor to material ratio of 25:1. The fabric was introduced into the dyeing solution at room temperature and slowly the temperature was raised to 90°C. The dyeing was continued in acidic medium at this temperature for 60 minutes. After dyeing, the fabrics were rinsed and soaping was carried out at 70°C using an eco-soaping agent for 20 minutes. After soaping, a hot wash was followed by two cold washes and then the fabrics were removed, hand squeezed and air dried.

Evaluation of performance properties

Determination of pH of the fabric: pH values of the fabric were determined as per the standard test method ISO 3071: 2005 (E). The pH value of an aqueous extract of a textile material is measured electrometrically at room temperature by means of a glass electrode.

Colour fastness to washing: Dyed fabrics were tested for color fastness to washing according to the ISO method, IS 105-C10/B (2).

Colour fastness to dry-cleaning: Dyed fabrics were tested for color fastness to dry-cleaning according to the ISO Method, IS4802.

Colour fastness to sublimation: Dyed fabrics were tested for color fastness to sublimation according to the ISO method, IS4636 under mild condition 150±2 °C.

Relaxation shrinkage (%): Dyed fabrics were tested for relaxation shrinkage (%), both in warp and weft directions according to the ISO Method, IS2977.

Evaluation of light fastness: Dyed fabrics were tested for color fastness to light according to AATCC test method 16-2004 as per blue wool scale 2 (10 hours).

Determination of solvent extractable matter (%): Dyed fabrics were evaluated for solvent extractable matter according to according to the ISO method, IS 4390, using petroleum ether as solvent.

Pilling resistance: Dyed fabrics were tested for pilling resistance characteristics as per the standard method IS 10971 for 18000 revolutions.

Results and discussion

pH of the fabric

The pH values of polyester wool blended fabrics dyed with all three natural dyes (shade 20 % owf), without mordant were evaluated. The pH of all the dyed fabrics was in the range of 6.0 to 6.2, (refer Table 12) which was well within the Oeko-tex limit range, i.e., 4.0 to 7.5 specified for baby clothing.

Table 12 pH, wash and light fastness ratings of natural dyes dyed polyester wool blended fabrics

Natural dye (Shade, 20%)	Fabric pH	Wash Fastness		Light fastness	Dry cleaning	
		Change in colour	Staining on adjacent fabrics		Change in colour	Staining on adjacent fabrics
Orange	6.34	4	4-5	2	4	4
Yellow	6.52	3-4	4-5	1-2	4-5	4
Green	6.21	4	4-5	4	3-4	4

Light fastness rating:1-poor,2-fair,3-moderate,4-good,5-better,6-very good,7-best & 8-excellent, Wash fastness rating: 1-poor, 2- fair, 3-good, 4-very good & 5-excellent.

Table 13 Relaxation shrinkage (%), sublimation fastness, solvent extractable matter (%) and pilling resistance ratings of natural dyes dyed polyester wool blended fabrics

Natural dye (Shade, 25%)	Relaxation shrinkage (%)		Sublimation		Solvent extractable matter (%)	Pilling rating
			Staining on adjacent fabrics			
	Warp (%)	Weft (%)	Wool	Polyester		
Orange	0.3	0.5	4-5	4-5	0.18	1H
Yellow	0.2	0.1	4-5	4-5	0.25	2H
Green	0.4	0.3	4-5	4-5	0.13	1H

H- Hariness index,1-poor, 2- fair, 3-good, 4-very good & 5-excellent.

Colour fastness to washing

It is evident from Table 12 that after washing there was a very slight change of colour in case of polywool blended sample dyed using yellow natural dyes. Negligible to very slight change in colour was observed when the samples were dyed with orange and green natural dyes. Best results were obtained in the case of samples dyed with orange and green natural dyes.

Colour fastness to light

It is evident from table 13, that, the light fastness rating was in the range of 1-2 (on a blue wool scale rating of 1 to 8) for polywool blended sample dyed with natural dyes namely yellow and it was 2 for orange dyed fabric. However, samples dyed with green natural dyes showed an improved fastness properly rating of 4, which is quite acceptable.

Colour fastness to Dry-Cleaning & Sublimation fastness

It is evident from table 13, that the dry-cleaning fastness rating was in the range of 4 for all the three samples dyed using all three natural dyes namely orange, yellow and green, which is quite acceptable. Further, the staining on adjacent fabric rating was also very good (rating 4). Similarly, results of sublimation fastness were excellent at 150^{o}C (rating 4-5).

Relaxation Shrinkage (%)

The relaxation shrinkage (%) with respect to warp direction and weft direction is shown in Table 13 for all the three natural dyes. The shrinkage (%) in warp and also weft direction was in the range of 0.1 to 0.5, which was well within the standard limit range, i.e., 2 specified for polywool worsted suitings.

Solvent extractable matter (%) & pilling resistance

It is evident from Table 13 that, the solvent extractable matter (%) of all the three natural dyes dyed polyester wool blended fabrics was in the range of 0.13% to 0.25% which is still within the range of 1.0 as specified by the standard for polyester wool worsted suiting. In the case of pilling resistance, overall the three natural dyes dyed samples showed poor to fair rating.

DEVELOPMENT OF BABY CLOTHING USING ECO-MORDANT FOR NATURAL DYES ON COTTON WOOL BLENDED FABRICS

Cotton/wool blended fabrics are growing in popularity, due to increased consumer demand for styling, comfort and for natural fibers. Wool fiber provides warmth property due to its scaly surface, as air entrapped in the scales acts as an insulator. In addition, wool contributes resiliency, abrasion resistance and good drapability. Cotton adds strength and reduces the cost of the yarn and fabric. Both fibres are absorbent and can be blended to make a comfortable, durable fabric. Wool: cotton blends for apparel fabrics combine comfort with exceptional aesthetic appeal. The popularity of these blends is due to their light weight, good strength, drapability, easy washability together with low cost.

Based on the above a study was taken up to create a eco-friendly dyeing process of cotton-wool (70/30) blended knitted fabric using natural dyes and development of baby clothing.

Extraction of colorants

2% (W/V) natural dye stock solutions were made by boiling 20 g. of dye powder in 1000 ml water at boil for 2 hours. The content was cooled and the extract was filtered, made to 1000 ml using water and employed for the dyeing process.

Knitting and pre-treatment

The cotton wool blended grey yarn was knitted in a FAK knitting machine and the knitted sample was scoured and bleached using conventional process. Further, the pre-treated blend sample was employed for the dyeing process.

Dyeing methodology

The % shade used for dyeing on cotton wool blended fabrics using orange dye was 20 % (owf), for yellow was 20% (owf), for red and green was 30% (owf). Dyeing was carried out in a fastness tester, keeping the liquor to material ratio of 20:1. The fabric was introduced into the dyeing solution at room temperature and slowly the temperature was raised to 90°C. The dyeing was continued at this temperature for 60 minutes under acidic condition. After dyeing, the fabrics were rinsed and soaping was carried out at 70°C using eco soaping agent for 20 minutes. After soaping, a hot wash followed by 2 cold washes and then the fabrics were removed, hand squeezed and air dried.

Determination of pH of the fabric

pH values of the fabric were determined as per the standard test method ISO 3071: 2005 (E). The pH value of an aqueous extract of a textile material is measured electrometrically at room temperature by means of a glass electrode.

Colour fastness to washing

Dyed fabrics were tested for color fastness to washing according to the ISO method, IS 105-C10/A (1).

Evaluation of Light fastness

Dyed fabrics were tested for color fastness to light according to AATCC test method 16-2004 as per blue wool scale 2 (10 hours).

Results and discussion

pH of the fabric

The pH values of polyester wool blended fabrics, dyed with all four natural dyes, were evaluated. The pH of all the dyed fabrics was in the range of 6.2 to 6.53, (Table 14) which was well within the Oeko-tex limit range, i.e., 4.0 to 7.5 specified for baby clothing.

Colour fastness to washing & light

It is evident from Table 1 that after washing there was a negligible to very slight change of colour in the case of cotton wool blended sample dyed using red and green natural dyes. The orange dyed sample showed slight change in color and the samples dyed with yellow dyes showed poor wash fastness. Best results were obtained in the case of samples dyed with red and green natural dyes. Similar results were observed in case of fastness to light where red and green dyes dyed cotton wool blended sample showed better fastness in the range of 4 to 4-5 respectively, which is quite acceptable.

Table 14 pH, wash and light fastness ratings of natural dyes dyed cotton wool blended fabrics

Natural dye (% shade, owf)	Fabric pH	Wash Fastness		Light fastness
		Change in colour	Staining on ad jacent fabrics	
Orange (20%)	6.34	3	4-5	3
Yellow (20%)	6.52	1	3-4	2-3
Red (30%)	6.42	4	4-5	4
Green (30%)	6.21	4	4-5	4-5

Light fastness rating:1-poor,2-fair,3-moderate,4-good,5-better,6-very good,7-best & 8-excellent, Wash fastness rating: 1-poor, 2- fair, 3-good, 4-very good & 5-excellent.

Further pilot scale work is under process for making baby wear using the cotton wool blended yarns. Further work is in progress for the development of a gamut of colours on cotton blended fabrics using natural mordants for the improvement of colour depth and also performance properties.

DURABLE NON-FLUORINATED FUNCTIONAL TEXTILES USING FUMED SILICA SOLS (Sponsored by the Ministry of Textiles, Govt. of India)

The aim of the project is to develop durable non-fluorinated functional textiles using fumed silica sols. The project focuses on identification of nano sized fumed silica particles and low cost cross linking agents to replace the high cost silane cross linkers and their formulation and application on the fabric surface by pad-dry-cure process in order to change the surface tension of the textile materials. The resulting fabrics will be used as base textile materials for developing home textile products with specialty applications. Product areas will include water repellent jackets, rain coats, umbrellas, etc. The project also proposes to study the fabric's physical characteristics for functional properties using standard test methods with and without silica. The process developed in this project is expected to be more efficient, more durable, and relatively less expensive as compared to conventional chemical processing.

Specific objectives of the study include,

- Ø To study the characteristic of fumed silica (both hydrophobic and hydrophilic form) and its sol formulation for application as non-fluorinated finishing chemical for cotton textiles.
- Ø To develop chemical formulations to impart low surface tension on cotton by replacing high cost silane cross linkers with low cost cross linking agents for cotton surface modification.
- Ø To impart an enhanced functional finish namely water repellent finish by Pad-Dry-Cure process of cotton substrate. To evaluate the durability of finish after repeated laundering.
- Ø To develop home textile products using the formulated chemical and to study the feasibility of commercialization.

DEVELOPMENT OF ECO-CLOTHING BY GREENER REDUCTION PROCESS OF NATURAL INDIGO DYE (Sponsored by the Ministry of Textiles, Govt. of India)

Indigo has been used for the colouration of textiles since antiquity. Natural indigo extracted from the Indigofera tinctoria plant species maintained its dominant position in the international market until the synthesis of indigo in 1897. The natural indigo dye is insoluble in water and requires a reducing agent in order to dye cotton fabrics.

After several decades of research and development there is still no commercial eco-reducing technology available today that can replace sodium dithionite in all areas of vat dye applications.

In view of above, the present study focuses on identification of unexplored natural eco-reducing agents and their extraction, application for the reduction of natural indigo to replace sodium dithionite, or sulphide replacement and also to find commercial alkaline source for the dyeing process and its application on fibres such as organic cotton, regenerated cellulose and blends for safe and eco-friendly clothing for babies. Further, effluent load will be reduced and the process will more sustainable in nature.

The eco-reducing agents are not only pollution free but hold prospects for improved process stability, especially for natural indigo. Further, it would be easy to develop an industrialized process and can be popularized among the natural dyers for eco-clothing market.

Aim of the project

- Ø To develop a green and eco-friendly process for the reduction of natural indigo dyes- vat dyes
- Ø Identification of an eco-reducing agent from unexplored natural sources and also eco-friendly alkaline source
- Ø Application on cotton, regenerated cellulose and blends
- Ø Commercial trails, to deliver a totally safe and eco-friendly green process and clothing.

The project has just been initiated.

DETERMINATION OF SUGARS IN STICKY COTTON AND DEVELOPMENT OF AN EFFECTIVE METHOD FOR THE MINIMIZATION OF STICKINESS

Stickiness arises when excessive sugars present on fibers are transferred to equipment and interfere with processing. Sugars may be insect- or plant-derived. Though sugars are ubiquitous in lint, they usually occur at levels that pose no processing difficulties. Honeydew, when present in sufficient quantity, is the main source of sugars that can result in sticky lint. Honeydew is excreted by certain phloem-feeding insects including such common pests of cotton as aphids and whiteflies. These insects are capable of transforming ingested sucrose into over twenty different sugars in their excreted honeydew. The major sugars in cotton insect honeydew are trehalulose, melezitose, sucrose, fructose and glucose.

This study was carried out to,

- Ø determine various sugars present in the sticky cotton using available methods.
- Ø select a suitable method which implies the direct measurement of stickiness.
- Ø collect cotton samples from different places and determine stickiness causing sugars using appropriate methodology.
- Ø find solutions for the minimization of stickiness.
- Ø check the commercial feasibility of the derived solutions to mitigate the stickiness of cotton in ginning and spinning industries.

Treatment for the minimization of stickiness

Spinning mills are currently using the solutions in the name of Tempanil and HiTECH solution. But the composition of these solutions is not exactly known. As per the spinning mills feedback they are not solving the problem of stickiness. Hence, SITRA has attempted to minimize the stickiness of cotton during spinning and ginning. Initial trials were performed at different concentration of active materials. The solutions are named as Spin aid 1 & Spin aid 2.

Spin aid 1 & 2 both are carbohydrate based enzymes which are easily biodegradable and will not affect the properties of the fiber. The results are tabulated below.

10 g of sample was taken for the trials. The experiments were performed by spraying different concentration of the solutions. The results are tabulated below.

The determination and quantification of individual sugars using HPLC and bulk trials in spinning and ginning mills are in progress.

Table 15 Reducing sugars by Perkin's method after spraying HiTECH and tempanil solutions

Sample ID	Solution: water	Spray volume (mL)	Before treatment	HiTECH solution (reducing sugars as glucose %)	Tempanil solution (reducing sugars as glucose %)
MPF-51	1:1	10	0.70	0.55	-
MPF-51	1:4	10	0.70	0.60	-
MPF-51	1:20	10	0.70	0.68	-
MPF-51	1:20	20	0.70	0.66	
MPF-51	Mixture of Tempanil powder and Tempanil solution	10	0.70	-	0.64

Table 16 Reducing sugars by Perkin's method after the treatment with Spin aid 1, Tempanil, HiTECH solution and Spin aid 2

Sample ID	Spin aid 1			Tempanil solution			Hi-TECH Solution			Spin aid 2		
	Spray Vol (mL)	Sugar content as Glucose (%)		Spray Vol (mL)	Sugar content as Glucose (%)		Spray Vol (mL)	Sugar content as Glucose (%)		Spray Vol (mL)	Sugar content as Glucose (%)	
		BT	AT		BT	AT		BT	AT		BT	AT
MPF-51	15	0.70	0.77	10	0.77	0.66	10	0.77	0.64	10	0.77	0.58
MPF-51	15	0.71	0.78	10	0.78	0.67	10	0.78	0.65	10	0.76	0.57

BT-Before Treatment, AT- After Treatment

DEVELOPMENT OF MULTIFUNCTIONAL PROTECTIVE COTTON FABRICS USING BIOPOLYMERS

Minimum exposure of UV radiation is essential for the production of Vitamin D in people, but overexposure may result in acute and chronic health effects on the skin, eye and immune system. UV rays cause cutaneous malignant melanomas and non-melanoma skin cancers developing in different cell layers of the skin (squamous cell carcinomas and basal cell carcinomas), sunburn, skin photo ageing, cortical cataracts (eye lens opacities), pterygium (a fleshy growth on the surface of the eye), reactivation of herpes of the lip (cold sores) and the rare squamous cell carcinomas of the eye.

The project has been conceived to use readily available biopolymers for the development of protective textiles. Biopolymer sericin also known as silk gum protein is produced by silkworms and is attained from cocoon, silk fabric and silk waste or from the degumming liquor of silk industry. Due to the several inherent properties, such as biocompatibility, biodegradability, antibacterial, UV resistance, oxidative resistance, and moisture absorption ability, sericin has become an appealing product for its versatile applications in different fields, including pharmaceuticals, cosmetics, and textiles.

Objective of the project:

1. To isolate the sericin from silk cocoon and study the characteristics of sericin.
2. To apply sericin on the cotton fabric by Pad-Dry-Cure process.
3. To evaluate the UV protective and antimicrobial properties of finished fabric and the durability of the finishes after several washing cycles.
4. To develop an eco-friendly protective textile fabric using biopolymer and to study the feasibility of commercialization.

Work done

- Ø Sericin was isolated from silk cocoon without using any chemicals.
- Ø The extract was freeze dried to make a sericin powder.
- Ø The characteristics of sericin was studied using UV-Vis spectroscopy, IR Spectroscopy and other testing methods.
- Ø Sericin powder was applied on the fabric using cross linking agents.
- Ø The antimicrobial and UV protective functional properties of finished fabric were evaluated.

The use of alkali and acid for the extraction of sericin have a degrading effect on proteins such as sericin and they can get damaged while extraction. Hence, the isolation and characterization of sericin was performed in a careful way by confirming that there is no loss of any amino acids. The presence of all amino acids was confirmed by UV-Vis spectroscopy.

FT-IR shows the characteristic peak at 1621 cm-1 corresponds to C-O stretching of amide, peak at 1538 cm-1 corresponds to secondary N-H bending of amide and the peak at 1240 cm-1 corresponds to C-N and N-H functionalities of amide group.

Test for the presence of amino acids:

Biuret test:

This test is used to detect the presence of peptide bond. When treated with copper sulphate solution

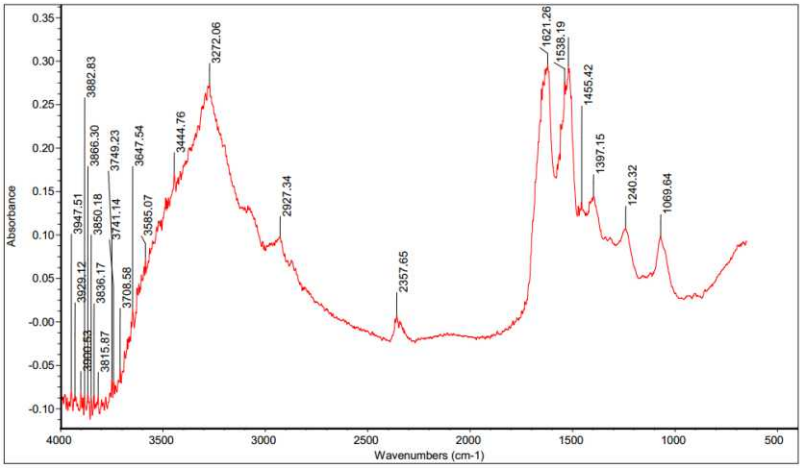


Figure 8 FT-IR spectrum of extracted sericin

with copper (II) ions to form a violet coloured complex called biuret.

Xanthoproteic test

It is an identification test of protein and it gives a positive result with those proteins with amino acid carrying aromatic group. When protein is treated with hot concentrated nitric acid, a yellow coloured substance was formed. The yellow colour is due to xanthoproteic acid which is formed by the nitration of certain amino acids present in protein such as tyrosine and tryptophan.

Ninhydrin test

This is a test for amino acids and proteins with free –NH2 group. When such an –NH2 group reacts with ninhydrin, an intense blue coloured complex is formed.

Millon's test

Millon's test is specific to phenol containing structures (tyrosine is the only common phenolic amino acid). Millon's reagent is concentrated HNO3, in which mercury is dissolved. As a result of the reaction a red precipitate or a red solution is considered as positive test.

Test for Tryptophan

Under certain conditions, at room temperature, per chloric acid converts tryptophan to a yellowish green fluorescent compound. It has now been found that a small amount of dichromate considerably increases the sensitivity of this reaction and that the test may also be applied to certain compounds which are related to tryptophan.

The results were found to be useful for the development of multifunctional protective textiles using biopolymer nano composites. The dyeability of the finished fabric will also be studied.

A STUDY ON THE PROBLEMS ASSOCIATED WITH SINGLE BATH BIO-POLISHING AND DYEING OF COTTON KNITTED FABRICS

Sticking of fibres onto the fabric surface is a major problem faced by the processing industry during bio-polishing. The appearance of fabrics is marred by the presence of these fibres and may lead to rejection of lots. SITRA has developed a recipe for effective removal of the fibres from the fabric surface during bio-polishing.

Introduction

Biopolishing is a process of removing the protruding fibres cellulase enzyme based process that durably improves this quality of cellulose based fabric preventing pilling and fuzziness.

There are two types of biopolishing enzymes

a) Acid biopolishing enzymes
b) Neutral biopolishing enzymes

The biopolishing is facilitated normally on bleached fabric for better performance in removal of protruding fibres to obtain a smooth, and clean surface appearance.

Problems associated with Bio-Polishing

The cotton lints or detached fibre substances from knit fabric assume a negative charge (-ve) and is attracted by mono valent, highly reactive TDS

(Sodium salts (+ve change)) and in turn firmly affixed in to the –ve change of the fabric as white deposit causing ugly appearance subsequently. Also the use of high amount of salt in exhausting the dye, aggravates the situation (further) in affixing more and more cotton lints onto the fabric surface due to electro static force of attraction between them.

SITRA's methodology to counter this problem

Use of Magnesium Chloride in the biopolishing bath and also in the pretreatment bath to the tune of say 1g/L has helped removal of suspended cotton lints (against electro static force of attraction of NaCl / Na_2SO_4) by more than 25% as against the process without $MgCl_2$ 6 H_2O (as reported by the industry). Magnesium Chloride is a bivalent alkaline earth metal and is less reactive and has more electro negative character when compared with either NaCl / Na_2SO_4.

Preventive measures

i. Immediately after biopolishing and after deactivating the cellulase enzyme by increase thetemperature, drain the bath, wash at Room Temperature in a fresh bath and then start dyeing. This will result in use of one additional bath. However, will help in minimizing the lints on surface.
ii. Reduction of salt / saltless dyeing helps reducing the electrostatic force of attractive between salt, cotton lints and fabric surface.
ii. New chemical formulation having electro negativity like $MgCl_2$ should be incorporated either in the biopolishing / washing bath helps complete removal of cotton lints.

A STUDY ON THE BULK SCALE REMOVAL OF RUST STAINS FROM GARMENTS, KNIT AND WOVEN DYED FABRICS

In this project, SITRA has developed recipes for effective removal of rust stains from white as well as dyes fabrics. Trials were also conducted at mills. More than 3000 kg of dyed knitted fabrics have been cleared-off the rust stains at one of the mills using this recipe and the rejection of fabric was avoided.

Introduction

Stains occupy a part of day to day life. We have various type of stains, ranging from oil stain, grease stain, blood, ink stains including rust stain. Each type of stain demands a particular solvent either pure water or some organic solvent, without damaging the quality / property of the article. Likewise textile industry also faces stains of different kind like colour stains, knitting oil stains, and in particular iron stains.

What is rust stain?

When a piece of iron is left exposed to ordinary moisture air, it is found covered with a reddish brown coating known as rust. The process of formation of rust is called “Rusting”.

Probable causes of rust stains on textiles

1. Water passing through worm out pipes carrying dissolved iron and gets contacted with textile during wet processing.
2. Steam passing through non – IBR iron tubes carrying iron particles gets dissolved in water and to fabric causing catalytic damage (pin holes etc)
3. Worn out steam valves splashing live steam contaminated with Iron particles and falling on the surface of fabric during sanforizing or compacting.
4. Unloading of wet fabric on a plastic platform with rusted iron bolts and nuts.
5. Rusted processing machine parts / etc.

Remedial Process

SITRA method 1 - Spot removal of rust stains (on white / light shade) (Hand Process)

Stains nature : Light or deep iron stains.

Application : Apply 2 or 3 drops of glacial acetic acid on rusted spot followed by a pinch of hydrose and gently rub with a wet (1/2 bleached cloth) cloth. The stains are instantly removed.

Note: As the pH of reactive mixture ($CH_3COO+Na_2S_2O_4 2H_2O$) is 7, neither the whiteness of garment goes dull nor the colour of the garment is affected.

SITRA Method 2 -Removal of rust stains from 1/2 white fabric: (Hot Process)

This method is applicable for half white or white fabric having deep rust stains.The fabric with stains is treated with the following recipe in a Jigger:

Step 1

Treatment with
Astol A – 0.25%
Non-ionic wetting agent -0.50% at cold for 20 min.

Step 2

Treatment with
Astol A – 0.15%
Non-ionic detergent – 0.25%
Glacial acetic acid – 2% (owf) (pH 2 to 4)-20 min.

Step 3

Sprinkle sodium hydro sulfite (2%) to the above bath and treat at cold for further 20 minutes. Treat the fabric at 85°C-95°C for 1 hour. Further, the fabric is neutralized and dried. It was noted that the rust stains were completely removed.

Alternatively, use of 0.2% Oxalic acid alongwith 0.25% Astol A, 2% Ammonium Sulphate for treating the said fabric with rust stains at room temperature for 20 to minutes followed by neutralization and drying also has resulted in good degree of removal of stains.

SITRA Method 3 - Removal of the rust stains from dyed cloth (hot process)

This methodis suitable for removal of rust stains from dyed fabrics. In this method, the fabric with rust stains is treated with the following recipe and sequence.

Step 1
Treatment with Astol A – 0.25%, Non-ionic wetting agent – 0.50%, Ammonium sulphate – 2% and Oxalic Acid – 0.2%at cold for ½ hr. Then the liquor is drained and washed at room temperature for 15 minutes.

Step 2
The fabric from Step 1 is further treated with Oxalic acid – 0.50% at 50°C – 60°C for ½ hour which is followed by cold wash, neutralization and drying.

It was observed that the stains were completely removed without affecting the shade / tone of fabric. This method is recommended for high value dyed goods with rust stains.

OPERATIONAL STUDIES

ONLINE SURVEY OF YARN SELLING PRICE AND RAW MATERIAL COST

SITRA had initiated this unique monthly online inter-mill study of RMC and YSP in May 2013. Till March 2018, 59 studies have been completed. As many as 80 mills from different parts of the country have been participating in the study every month. It covers the following data relating to around 250 different counts (ranging from below 10s to over 120s) and varieties of yarns (carded, combed, hosiery, compact, doubled, high twist, slub, etc.), predominantly cotton counts.

Yarn selling price (YSP) (Rs/kg) Raw material cost (RMC) (clean material cost) (Rs/kg of yarn) Net output value (NOV) (Rs/kg of yarn & Rs/ spl./8 hrs.) TCI (techno -commercial index) OTCI (overall techno - commercial index) RMC as a % of YSP Yarn realisation (%) Production/spindle (rotor)/8 hours (g)	Yarn quality - Count CV% - Strength CV% - CSP - U% - Imperfection s/1000 m - Hairiness Index

On the 21st of every month, the survey report, numbering around 70 pages, is being uploaded in the web portal “rmcysp.sitraonline.org”. The speciality of this online survey is the built-in database supported queries in the web portal, using which a participant mill can access the count-wise data quickly without going through the voluminous survey report. Besides the above, trends in the movement of average YSP, RMC and NOV between months for 13 popular counts are also being uploaded every month – both tabular and graphical forms. Figures 9 and 10 show the trends in the movement of RMC, YSP and NOV of 40s C and 60s C-Comp. yarns during the past 59 months (based on the April 2013 to February 2018 study).

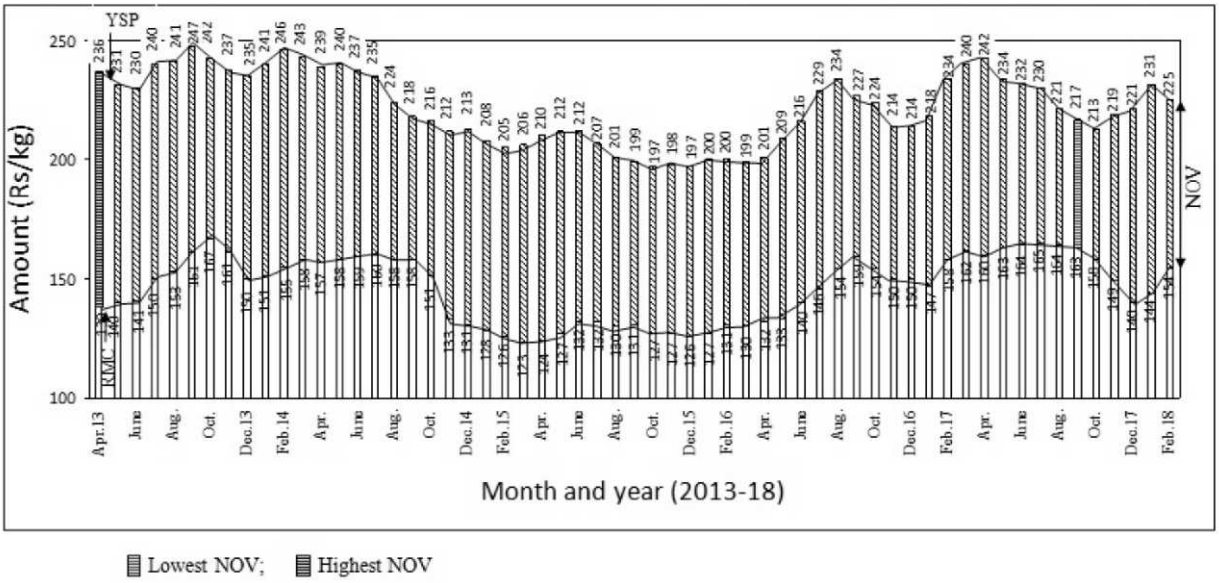


Figure 9 Movement of YSP, RMC and NOV between months (40s C)

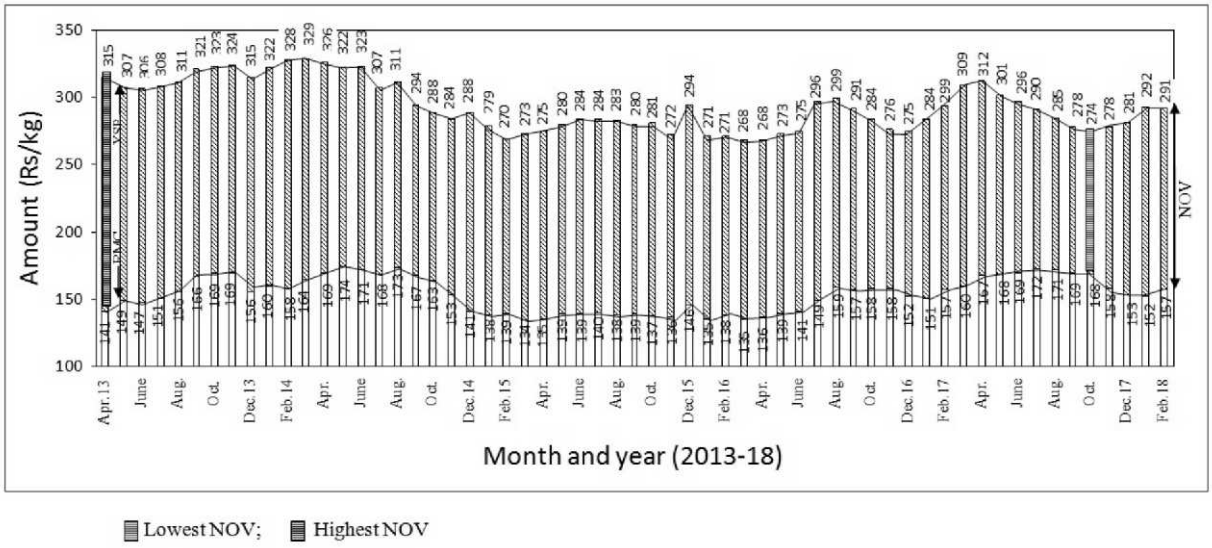


Figure 10 Movement of YSP, RMC and NOV between months (60s C-Comp.)

In the 59th study (February 2018 data), 66 mills had furnished the count-wise production data using which the Overall Techno Commercial Index (OTCI) has been estimated and each mill was ranked which would enable them to know about their status in comparison with their competitors.

Between mills, the OTCI varied widely from as high as 154 to a low of 62. In 32% of the mills, the overall techno-commercial performance in February 2018 was almost at par with their competitors' performance (OTCI: 102 to 98). On the other hand, about 40% of the mills had maintained better performance (OTCI>102) and another 30% of the mills had recorded lower performance (OTCI<98).

Market Performance Evaluation Index (MPEI) (based on the April '13 to February '18 study)

To substantiate the fluctuations / volatility in the commercial efficiency, SITRA has developed an index called "MPEI" which clearly portrays the commercial efficiency of the cotton spinning industry. MPEI is an arithmetic index that is derived having April 2013 as the base month and the base index set to 100 for that month. The calculation of MPEI is based on the average net out-put value [yarn selling price – raw material cost] in terms of Rs per kg of yarn for the 12 popular counts (40s K, 40s C, 60s C, 80s C, 100s C, 40s C-Comp., 50s C-

Comp., 60s C-Comp., 80s C-Comp., 30s CH, 40s CH and 30s CH-Ex.).

The trend in the movement of MPEI for the past 59 months (i.e. from April 2013 – February 2018) has been shown in Figure 11.

Since October 2017, the market started to move in favour of the industry with a reduction in the raw material cost and a slight increase in the yarn selling price and had continued till January 2018. However, in February 2018, there was a significant increase in the raw material cost (RMC) index at 111 (Figure 12) as against 106 in January 2018. On the other hand, yarn selling price (YSP) index had registered only a marginal increase (YSPI: 98) which in turn could not offset the increase in raw material cost, leading to reduction in MPEI by 3 points (MPEI: 85).

Conversion cost under standard operating conditions

For a spinning mill to earn profits, their earnings due to commercial efficiency must off-set the expenditure incurred due to yarn conversion. The conversion cost in terms of Rs/kg and Rs/spindle/shift expected under standard operating conditions for different cotton counts are shown in Table 17.

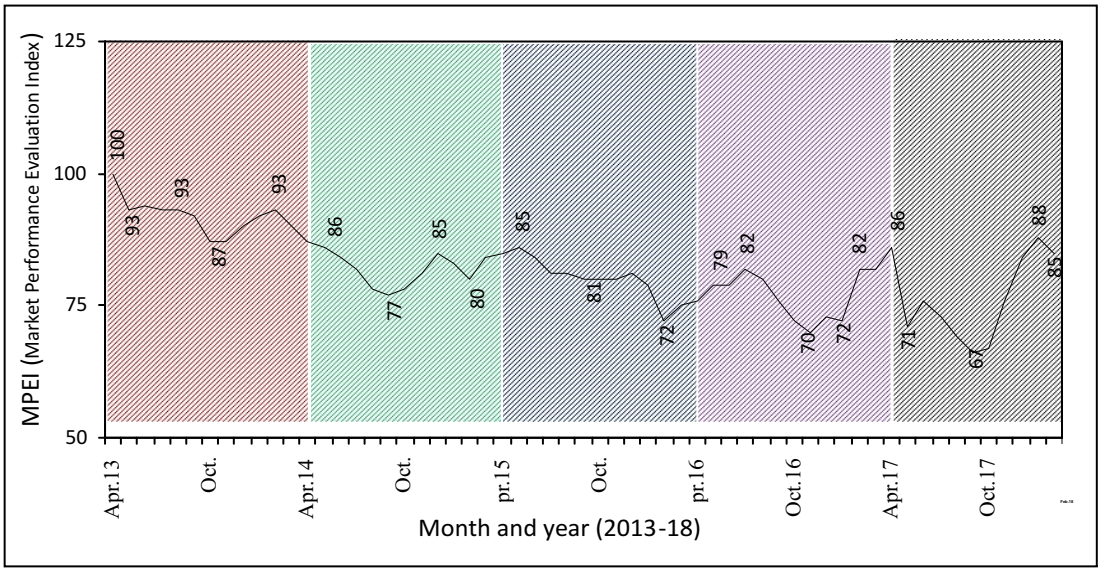


Figure 11 Market Performance Evaluation Index (MPEI)

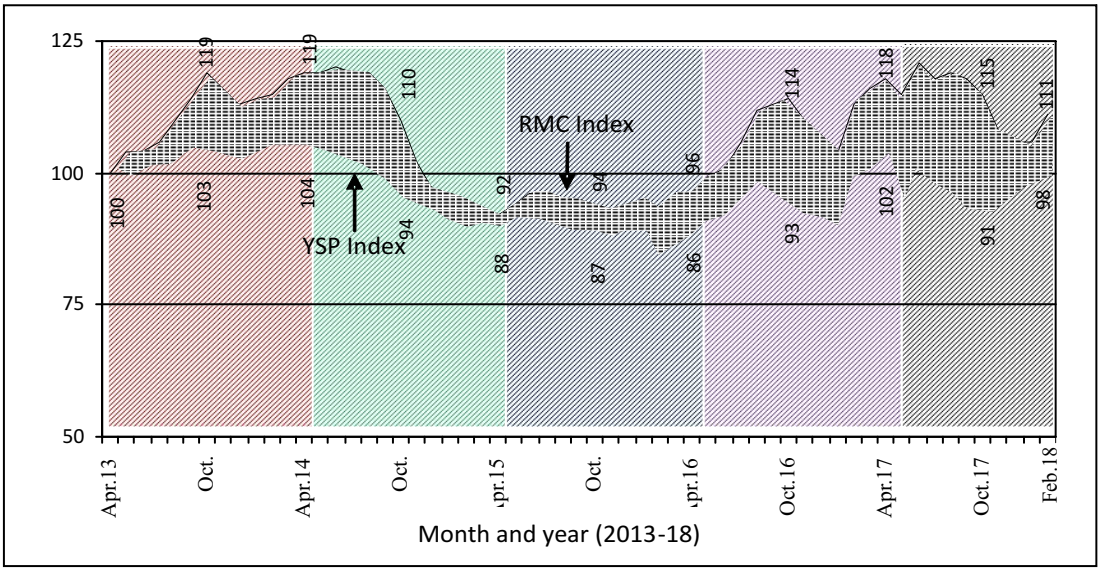


Figure 12 Yarn selling price index (YSPI) and Raw material cost index (RMCI)

Table 17 Conversion cost under standard operating conditions

Count	Prodn./spl./ 8 hrs.(g)	Conversion cost (CC)	
		Rs/kg	Rs/spl./8 hrs.*
30s K	159	60.5	9.6
40s K	110	76.1	8.4
40s C	134	77.3	10.4
40s C -Comp.	141	81.6	11.5
60s C	73	112.3	8.2
60s C -Comp.	77	118.8	9.1
80s C	48	151.3	7.3
80s C -Comp.	50	163.7	8.3

'' Rs/spl./8 hrs. = (Prodn per spindle per 8 hours /1000) x CC Rs/kg*

The above table shows that the conversion cost averages at Rs 2.0 per count per kg and was found to hover between Rs 1.87 and 2.05 between counts. The same in terms of Rs/kg was found to increase along with an increase in the yarn count. However, the same gets normalized when converted into Rs/spl./8 hrs. Under standard operating conditions, the conversion cost in terms of Rs/spl./shift was found to vary between 8.4 and 9.6 in the carded counts, 7.3 to 10.4 in combed counts and between 8.3 and 11.5 in combed compact counts that have been considered in the above table.

Identification of profit making counts

The monthly online surveys have provided hands-on information to the participant mills with regard to the trend in the movement of commercial efficiencies of their mill in comparison with the other mills. In addition, it also provides the information about the performance of all the other counts which the mill has not produced.

Based on a discussion with a group of mills, SITRA has initiated a study to identify the profit making counts in the recent months based on the findings of the monthly online survey, so as to help the mills in selection of their product-mix.

Consider a case study mill having an average conversion cost of Rs 9/spl./8 hrs. To get a profit margin of atleast Re 1/spl./8 hrs., the mill must select a count in which the commercial efficiency i.e., NOV (net out-put value) in terms of Rs/spl./8 hrs. is 10 and above.

Based on the count-wise and mill-wise data built-up at SITRA through the monthly online survey, a mill can identify the counts in which the NOV in terms of Rs/spl./8 hrs. is in excess of 10 (Figure 13). The actual NOV (Rs/spl./8 hrs.) values for the counts shown in Figure 13 is given in Table 18.

Figure 13 Counts with higher NOV (Rs/spl./8 hrs.) based on April 2017 – March 2018

Table 18 Count-wise net out-put value (Rs/spl./8 hrs.)

S. no.	Count	Net out-put value (Rs/spl./8 hrs.)
1.	40s C -Comp.	11.0
2.	20s CH	14.6
3.	24s CH	13.6
4.	30s CH	11.8
5.	32s CH	11.6
6.	24s CH -Ex.	11.8
7	30s CH -Comp.	12.9
8.	40s CH -Comp.	11.8
9.	40s CH -Comp. -Ex.	11.3

COSTS, OPERATIONAL PERFORMANCE AND YARN QUALITY: INTER-MILL SURVEY OF KEY FACTORS (OCTOBER-DECEMBER 2017)

Since 1997, SITRA has been regularly conducting a unique inter-mill study on "Costs, operational performance and yarn quality" covering various key

parameters affecting cost of production, productivity and profit of spinning mills. So far 32 studies have been completed. Around 150 mills from different parts of the country, including a number of high productivity mills, used to participate in the CPQ studies and utilise the benefits. Based on the findings of the studies, a number of measures have been initiated by the mills to reduce costs, realise higher yarn selling price and change of product-mix in order to maximise profits.

Besides, the regular information such as yarn selling price, raw material cost, salaries & wages cost, power cost, contribution, labour and machine productivity, yarn realisation, quality of yarn and raw material and product diversification, the 33rd CPQ study also covered count-wise fibre to yarn conversion cost.

For the year 2017-18, the 33rd study has been launched covering the period October-December 2017. Analysis of the 33rd CPQ study has been completed and the reports have been dispatched to all the participant mills.

INTER-MILL STUDY ON FIBRE TO YARN CONVERSION COST: 7TH STUDY

This study was conducted based on the conversion cost particulars that were collected from the mills in the 33rd CPQ study, covering data for the 3rd quarter of 2017-18 (October – December).

Of the three parameters that decide the profit margin in a spinning mill viz., yarn selling price, raw material cost and conversion cost, the last mentioned one, to a large extent, is within the control of the managements. By utilising the various resources such as man, machine and material efficiency, the conversion cost can be controlled to a great extent.

A detailed analysis is being done for different counts and varieties of yarns. The reasons for the wide inter-mill differences in the conversion cost are also being critically analysed. The preparation of a detailed report is under progress and would be circulated to the participants and SITRA member mills.

STAFFING PATTERN IN SPINNING MILLS

Planning of human resources is very essential in textile mills in order to ensure that there are the right number and the right kind of people at the right places, at the right time, doing work for which they are economically most useful. This involves the three aspects of developing, controlling and forecasting. The textile industry is constantly in need of skilled manpower and this need of the industry has been rising steadily over the years. The acquisition process is necessary not only to cope with the expansion that has taken place during the five year plans but also to meet the demand from the industry arising out of the application of modern concepts of Scientific Management.

The primary objective of planning regarding staff content is basically to determine actual manpower requirements and adequately deploy them with proper control, and thereby keep the wage and salary costs within tolerance limits. Further, it assures that a desired number of persons with appropriate skills will be available at some specific time in future. It would also give an indication of the lead times that is available to select and train the required additional manpower. By keeping an inventory of existing personnel in a mill by skills, position, training, educational qualifications and work experience, it will be possible to utilise the existing resources more productively in relation to the job requirements, before further manpower additions or deletions are made.

The study has been undertaken with the aim to help textile mills compare and judge their staffing pattern in relation to other mills. This has been carried out by analysing the staffing pattern in a particular cross section of spinning mills and suggesting norms for manpower requirements of managerial and supervisory staff at technical and administrative levels. It is also proposed to investigate the extent of specialized management activities practiced in the textile industry.

Data was collected through a soft copy of the questionnaire which elicited information regarding year of establishment of the mills, size in terms of spindles, number of operatives and number of staff employed, days worked in a week, shifts worked per day, sales turnover, technical and administrative staff employed in different sections / departments, staff employed for specialized management services, staff turnover, etc.

ENERGY MANAGEMENT

DEVELOPMENT OF NORMALIZATION FACTORS FOR ASSESSMENT OF SPECIFIC ENERGY CONSUMPTION (SEC) IN AIR VORTEX / JET SPINNING

In recent years, the number of installations of air vortex/jet spinning machines are on the rise in the spinning/yarn manufacturing sector and there is a growing need for energy consumption standards and a method to assess specific energy consumption (SEC) of air jet/air vortex yarns. This requires development of normalization/conversion factors which will be useful to mills with air jet/air vortex spinning machines and the designated consumers/energy intensive textiles mills under PAT scheme.

Type of raw material for air-jet spun yarns

The type of material mostly processed in air jet/vortex spinning is regenerated cellulosic fibres, polyester and its blends. Polyester is used only in a few mills. In SITRA 'energy audited mills', the count of air-vortex yarns produced was found to lie between 18s to 60s of mostly viscose and micro modal fibres with the major count being 30s.

Machinery set up in a typical air vortex spinning mill

Table 19 shows the number of machines and the production rate in various process centres / departments of a typical air vortex spinning mill.

Table 19 Machinery set up and production rate
Vortex yarn production / shift: 5100 kg, 30s count

S. No.	Department	Count / Hank (Ne)	Delivery speed (mpm)	Production / shift /machine (kg)	No. of machines
1	Air Vortex spinning m/c	30	500	426	12
2	Draw frame finisher (Single delivery)	0.12	450	900	6
3	Draw frame breaker (Double delivery)	0.12	450	1810	3
4	Cards	0.12	190	427	12
5	Blowroom (Chute feed)	--	--	5207	1 line

UKG in a typical Air vortex spinning mill.

Recently SITRA conducted a detailed energy audit in a spinning mill producing 30s VSF air vortex spun yarns and the pattern of energy consumption measured in terms of Units per kg of yarn (UKG) is given in Table 20. It is evident from the table that the compressor accounts for nearly 50% of the total energy consumption.

Table 20 Department-wise actual UKG and as% of total for a typical

Department	Actual UKG	As % of total
Blow room	0.065	3.4
Cards	0.135	7.2
Draw frame	0.069	3.7
Vortex Spinning	0.487	25.9
Humidification	0.194	10.3
Compressor	0.918	48.9
Lighting	0.012	0.6
Grand Total	1.880	100

Methodology

Initially, the yarn production and energy consumption data were collected from the mill records. Energy consumption and rate of production measured in different machines during SITRA energy audits conducted in few other mills producing air-vortex yarn were used to compute standard UKG for different counts of air-vortex yarns. UKG of all departments from blowroom to air-vortex spinning and ancillary systems such as humidification, compressor and lighting systems were considered. Since the average count in the mills manufacturing air vortex yarn was found to be around 30s, the conversion factors for all counts and type of air-vortex yarns in the range of 10s to 80s were computed to express mill's energy consumption in different counts to equivalent consumption of 30s viscose yarn.

Table 21 Actual UKG in Air vortex spinning mills

S.No.	Mill code	Average count		Actual UKG
1	A	30s	VSF*	2.09
2	B	35s	VSF*	1.88
3	C	30s	VSF*/ MMD*	2.13

** Viscose staple fibre (VSF), Micro modal (MMD)*

Figure 14 shows that UKG has a linear relationship with various counts of air vortex spun yarn.

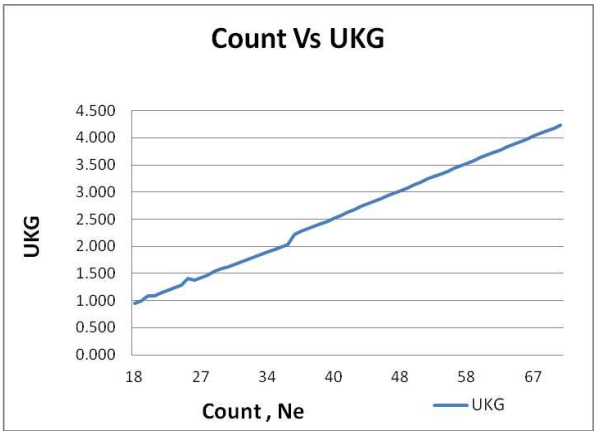


Figure 14 Air Vortex yarn counts and their UKG

The range of counts spun on air vortex/jet spinning system is about 18s to 80s from regenerated cellulosic fibres.

DEVELOPMENT OF NORMALIZATION FACTORS TO ASSESS SPECIFIC ENERGY CONSUMPTION (SEC) FOR WEAVING

SITRA has been a pioneer in establishing the methodology for assessing specific energy consumption (SEC) i.e., 40s converted UKG for single yarn manufacturing process and its value addition. Bureau of Energy Efficiency (BEE) acting under Govt. of India is promoting activities to increase energy efficiency in all sectors of economy and has adopted SITRA's method for spinning sector to assess the performance of designated consumers / energy intensive mills in textile sector coming under PAT Scheme. There is a need for the development of similar methodology / Normalisation factors for assessing SEC of weaving process and studies have been conducted to establish the relationship between speed, production parameters and energy consumption of all machines used in weaving mills. Energy consumption of all types of existing looms, preparatory and utility machines and their SEC indices are under evaluation / measurement.

Weaving process includes warping, sizing, weaving on looms, inspection and packing operations, including utility systems such as humidification, air compressors and lighting. In weaving process, the power cost accounts for about 35% of total conversion cost in different type of looms. A study was carried out in three types of looms available at SITRA and the details are given below.

Energy consumption and production in different types of looms				
PARTICULARS		RAPIER	AIRJET LOOM	PROJECTILE LOOM
Loom make; model; year		PICANOL; GTX Plus; 2004	TOYOTA; JAT 710 - JA2S; 2004	SULZER RUTI; PU; 1986
Attachments - dobby/jacquard		Electronic dobby	---	Mechanical dobby
Reed width; Cloth width		190 cm; 160 cm-63"	190 cm; 160 cm -63"	390 cm; (160*2)cm-(63x2)"
Warp x Weft yarn count		2/20s x 2/20s cotton	2/100s x 40s cotton	40s x 40s
Reed count		2/29s	2/131s	2/84s
Ends/inch x Picks/inch		32 x 32	134 x 62	88 x 76
Number of heald frames		4	4	6
Cloth design		Plain 1/1	Plain 1/1	Plain
Speed (PPM)		387	610	227
Loom Efficiency %		73.6	65	90.8
Total picks inserted/hr		17090	23790	24734
Weft insertion rate (WIR) m/min		619	976	726
Weft colours		4 (max.8)	2	2
Prod., in m/loom/hr at	100% eff.	18.43	14.99	9.10
	Actual eff.	13.57	9.75	8.27
Units (kWh)/hr		6.28	2.324+3.6*	2.223
kW/metre		0.341	0.395	0.244
*Compressor power consumption				

The details of a study conducted in a weaving mill, revealing the relationship between loom speed and power, is furnished in the following table.

Energy consumption study on Projectile and Air-jet looms at different speeds

S.No.	Speed (PPM)	Units /hour	Speed (PPM)	Units /hour	Speed (PPM)	Units /hour
	Projectile Looms*				Air-jet Looms**	
	Sulzer PU-5		Sulzer TW II		JAT710 (Cam)	
1	207.4	1.907	164.4	1.314	650	1.302
2	225.0	2.110	178.4	1.474	700	1.456
3	244.0	2.319	199.0	1.726	750	1.663
	JAT710 (Dobby)#		JAT710 (Dobby)**			
1	700	2.219	650	1.737		
2	750	2.445	700	1.931		
3	800	2.640	750	2.125		

Fabric construction particulars

* (27 x 26) / (2/38s x 16s) - all poly acrylic yarn, plain weave.
** (66 x 84) / (30s x 60s) - all cotton yarn, plain stripes, dyed yarn.
# (68 x 132) / (40s x 40s) - all cotton yarn, Twill 2/1, dyed yarn.

Normalisation of energy consumption of looms

Since energy consumed by looms in terms of Units/m of fabric produced is influenced largely by variation in loom speed, pick inserted/inch and loom width, normalisation / conversion of mill energy consumption and production corresponding to mill parameters to the following standard parameters are considered.

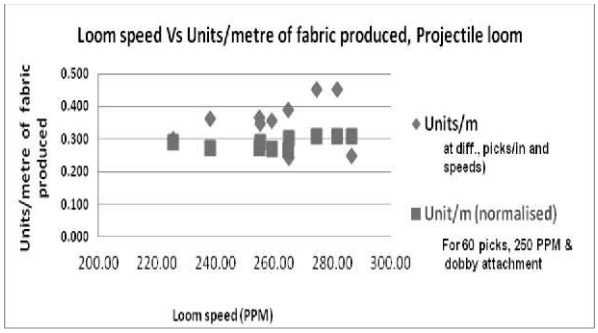
Different types of loom in weaving mills	Power consumption will be Normalised to	Standard Units/metre of fabric
Projectile looms	60# picks/in, 250 ppm, 390cm width with dobby	0.300
Air - jet looms	60 picks/in, 800 ppm, 190cm width with dobby	0.370*
Rapier looms	60 picks/in, 350 ppm, 190cm width with dobby	0.341

** Including compressor consumption;*
 # 60 picks/in is chosen for normalisation of weaving production in BEE's PAT scheme.

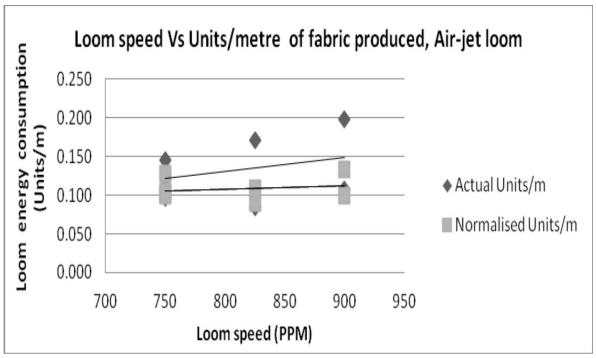
In a weaving mill, the energy consumed by projectile looms running with widely varying machine and operating parameters was measured and was normalised to the standard parameters mentioned above for projectile looms and the details are furnished below in the table and graphical form.

Actual and normalized / converted SEC in projectile looms

Loom no	Speed (PPM)	Cloth width (cm)	Units/hour	Units/metre of fabric produced	
				Actual (at different PPI and PPM)	Normalized (to 60 PPI and 250 PPM)
30	259.13	305	1.766	0.358	0.287
29	264.78	305	1.970	0.391	0.281
48	238.12	305	1.650	0.364	0.311
21	286.57	290	2.255	0.248	0.308
10	254.94	305	1.771	0.365	0.296
3	265.08	290	2.033	0.242	0.318
1	225.50	357	1.659	0.299	0.310
4	255.30	320	1.885	0.349	0.315
22	274.50	305	2.369	0.453	0.317
18	281.60	305	2.435	0.454	0.312



Similarly in another weaving mill, the energy consumed by air-jet looms running with widely varying machine and operating parameters was measured and was normalised to the standard parameters mentioned above for air-jet looms and the details are furnished below in table and graphical forms.



Actual and normalized / converted SEC in Air -jet Looms

Loom no	Speed (PPM)	Cloth width (cm)	Units/hour	Units/metre of fabric produced		
				Actual (at different picks/inch and speeds)	Normalized (to 60 PPI and 800 PPM)	
					M/C Power	Including Air compressor power
9	750	175	1.66	0.096	0.099	0.348
7	750	166	2.44	0.145	0.127	0.386
5	750	175	2.12	0.123	0.105	0.354
3	750	170	2.04	0.128	0.100	0.346
6	825	175	2.16	0.171	0.090	0.331
3	825	122	1.92	0.084	0.109	0.411
6	900	122	2.64	0.107	0.133	0.438
3	900	175	2.64	0.198	0.099	0.348

Converting mill's consumption to equivalent SITRA Standard Loom Consumption (SSLC) - 0.370 Units/m

Sort wise "converted production" can be calculated using the formulae given below for different types of looms:

Type of loom	Converted production in metre for a given sort =
For projectile looms	P_m *(PPI_m / 60) * (PPM_m / 250) * (Cam / Dobby factor) 1.233
For Air-jet looms	P_m *(PPI_m / 60) * (PPM_m / 800) * (Cam / Dobby factor) 1.000
For Rapier looms	Pm *(PPIm / 60) * (PPMm / 350) * (Cam / Dobby factor) 1.085

Where,

Pm - Mill's actual production in a given sort
PPIm - Mill's PPI in a given sort
PPMm - Mill's average PPM in a given sort
Cam / Dobby shedding factor; 0.91 for cam drive, 1.0 for dobby drive

Mill's SSLC = Consumption of the Mill in Units(kWh) for looms / Total converted production.

The concept/methodology will be extended to include energy consumption of other machines / departments in a weaving mill such as warping, sizing, packing and utility areas so that mill's overall SSLC can be computed.

STUDY OF ENERGY CONSUMPTION IN ULTRA MODERN SPINNING MILLS

SITRA energy audits conducted particularly during the last decade in about 100 mills have revealed that the energy efficiency of a large segment of spinning industry has improved / increased immensely as is evident from the less than 4.5 UKG (40s) achieved by some mills by timely modernisation of machinery while newly constructed mills are targeting a 40s UKG of 4.0. In the last two decades, Indian textile industry has been facing steeply declining profit margins due to stiff domestic and global competition, shortage of skilled labour and economical power supply and sluggish market conditions. The above problems have also percolated to textile machinery manufacturing industry and this has necessitated / triggered the manufacture of machinery with high level of automation and energy efficiency. Therefore, UKG is to be analysed in ultra modern mills compared to existing mills that have regularly modernised their existing old / outdated machinery.

Automatic bale pluckers, chute feed blowroom and carding machines with Automatic Waste Evacuation System (AWES), combers with AWES and auto lap transport systems, draw frame with auto-levellers, simplex with auto-doffing and auto restart and automatic bobbin transport to ring spinning and empties to simplex, ring frame with compact system, auto doffing, link coners which facilitate automatic transport / handling of material between ring frame and cone winding, automatic ring frame pneumafil and OHTC waste collection and compacting, winders with automatic bobbin transport and loading, automatic full cone transport, inspection and packing, automatic waste baling of blowroom and comber waste are generally found in ultra modern spinning mills.

Apart from the above features, fork lift for transport of fibre bales from godown to blowroom also forms an integral part of a modern spinning mill. Larger cans in preparatory for better quality and efficiency, online monitoring of production, quality and performance, automatic humidification plants, energy efficient centralised compressors, energy efficient lighting system are some of the characteristics of state-of-the-art ultra modern spinning mills. With high speeds and high production levels in all machinery, a productivity level of upto 120g/spindle/shift (40s) is seen in ultra modern spinning mills.

Therefore, a thorough study of energy consumption of all machinery and systems in an ultra modern mill from energy efficiency point of view has been proposed by SITRA towards cost effective modernisation of existing mills.

MEDICAL TEXTILES

DESIGN AND FABRICATION OF AN INSTRUMENT TO EVALUATE RESISTANCE OF MEDICAL FACEMASKS TO PENETRATION BY HIGH VELOCITY STREAM OF BLOOD FROM A PUNCTURED WOUND (Sponsored by Ministry of Textiles, Govt. of India)

The main objectives of the project was to develop a low cost instrument to assess the resistance of materials used in medical facemasks to penetration by high velocity stream of blood that potentially contains blood – borne pathogens.

Table 22 Comparison of test results of SITRA – ASRT and a foreign laboratory instrument

S.no	Type of surgical facemasks	Results obtained from SITRA – ASRT			Results obtained from a foreign laboratory		
		Splash pressure in mmHg	Number of sample pass	Number of sample fail	Splash pressure in mmHg	Number of sample pass	Number of sample fail
1)	2 layer facemasks	120	3	29	120	1	31
2)	3 layer facemasks	160	31	1	160	32	0
3)	4 layer facemasks SMSS type	160	32	0	160	32	0
4)	4 layer facemasks SMMS type	160	32	0	160	32	0

Synthetic blood, a mixture of a red dye/surfactant, thickening agent, surfactant and distilled water and having a surface tension and viscosity equivalent to that of actual blood was used it for the entire experiment.

Four different types of nonwoven medical facemasks were fabricated and the same were used for the calibration of the instrument. The details of the fabric samples are as follows.

1) 2 layer facemasks
2) 3 layer facemasks
3) 4 layer facemasks SMSS type
4) 4 layer facemasks SMMS type

SITRA designed and fabricated a splash resistance tester using the following principles

i) Measurement of splash resistance of surgical materials at various liquid pressures and different distances between the splash point and facemasks.

ii) Sensing the presence or otherwise of blood traces on the back side of the fabric specimen using industrial colour sensors.

The instrument works as per ASTM F 1862 – 07.

Different varieties of surgical facemasks were tested for their splash resistance using the SITRA Advanced Splash Resistance Tester (SITRA – ASRT) as per ASTM F 1862 – 07. The same facemasks were tested for splash resistance in an accredited laboratory in the USA which certifies fabrics for their protection properties. (Table 22).

It is discernible from Table 22 that for the entire surgical facemask specimens taken for experimentation, the results obtained from SITRA – ASRT are found to be matching with that obtained from the foreign laboratory. Hence, the reliability of SITRA – ASRT for evaluating the particle filtration efficiency of surgical facemasks and other types of fabrics has been established.

DESIGN AND FABRICATION OF AN INSTRUMENT TO EVALUATE CHARACTERISTICS OF FLUID HANDLING CAPACITY OF WOUND CARE DRESSINGS (Sponsored by Ministry of Textiles, Govt. of India)

An ideal wound dressing should have the characteristics of the absorbing excess fluid (exudates) from the wound surface, maintaining a moist environment at wound/dressing interface; allow the gaseous exchange and protecting the wound from bacterial infection, etc. Amongst all the other characteristics, fluid (exudate) handling capacity of the wound care dressings plays a vital role in the wound healing process. The choice of primary and secondary wound care dressings are based on the fluid (exudate) handling capacity. Therefore, it is necessary to measure the fluid handling capacity before opting for a specific dressing material. Since there is no indigenous instrument to assess the fluid handling capacity characteristics, SITRA has taken up the work of developing an instrument for the purpose .

The fabrication of the Fluid Handling Capacity Tester (SFHCT) was done after taking note of the

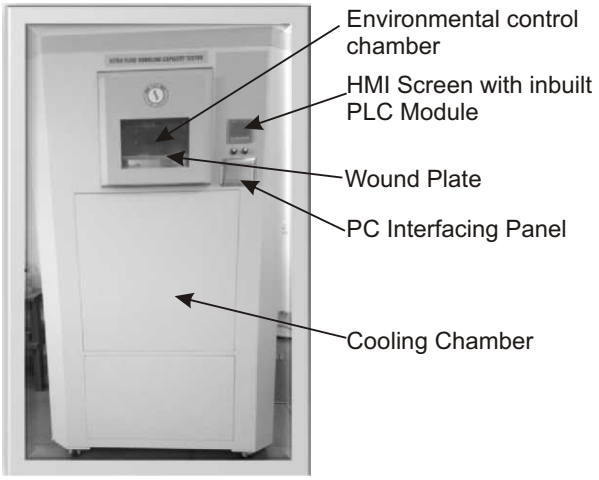


Figure 14 SITRA Fluid Handling Capacity Tester (SFHCT)

Test methodology

A flow diagram of the test methodology adopted to test the fluid handling by the SFHCT is shown in Figure 15.

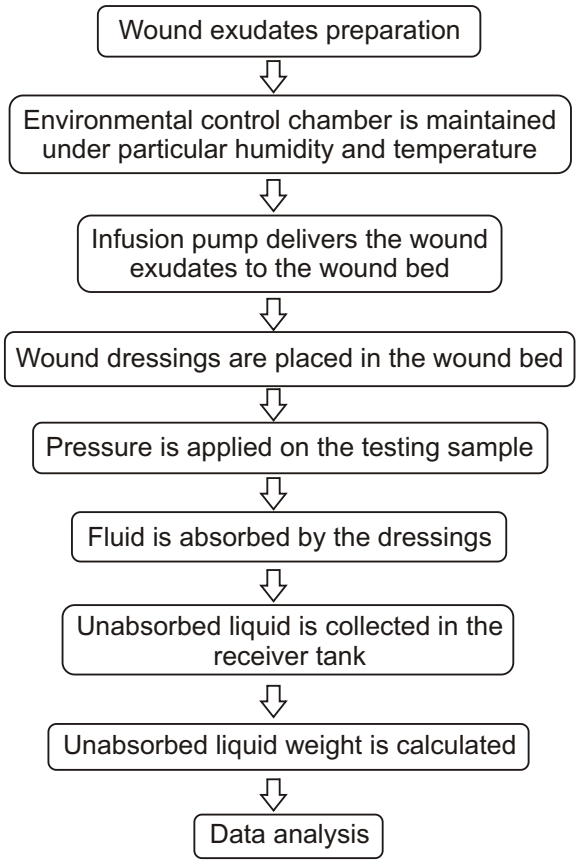


Figure 15 Test Methodology adopted in the SFHCT

The wound dressing is placed on to the wound plate which is kept in an environmental control chamber. The vertical strike-through plate is placed on the back of the dressing and a suitable weight added to the back to produce the required level of pressure. The vertical strike-through plate is then connected to the detection apparatus. Once the equipment reaches the required temperature and relative humidity, the balance is zeroed and the infusion pump, balance data logger and strike-through data logger are switched on.

The test fluid is applied to the wound plate convoluted path through one of the ports from the infusion pump. Majority of the test fluid will be absorbed by the dressing. Any unabsorbed fluid continues to pass along the convoluted path. Finally, it passes through the second port of wound plate into the fluid receiver which is kept in the weight measuring device, causing a change in the balance reading. The amount of fluid absorbed in this way is inversely proportional to the absorbency of the dressing. The weighing balance readings are recorded by the data-logger. A highly absorbent dressing will take up all the liquid that is applied to it, while the less absorbent products will absorb only for a short time or it will take a little while to reach maximum absorbency. During testing, therefore, the maximum weight of fluid that can be taken up by a dressing is determined by the flow rate of the infusion pump. The apparatus is calibrated by running blanks, replacing the test dressing with a totally occlusive non-absorbent film. This provides a measure of the dead volume within the system and an accurate measure of the flow rate, details of which are required for meaningful interpretation of the data.

Results validation studies: – Phase 1

Three different dressings were tested to examine the versatility of the SFHCT and provide some indication of its ability to show differences between groups of dressings, some of which were considered to be interchangeable in use.

There were marked differences in the ability of each of the three dressings to absorb and retain the test solution. The fluid handling capacity of non adhesive wound dressings was lower compared with the other two products.

Results validation studies: – Phase 2 – Reproducibility of the results

In order to make some assessment of the repeatability of the test method in its final form,

three samples of foam dressings with gentle adhesive layer were tested. The results clearly confirmed the repeatability of the test results of the fluid handling capacity tester.

DEVELOPMENT OF NANOPARTICLE BASED TRANSDERMAL PATCHES FOR SELECTED CARDIOVASCULAR DRUGS (Sponsored by the Ministry of Textiles, Govt. of India)

Transdermal patches comprise a method of delivering medication through the skin in a non-invasive manner. During transdermal drug delivery, a patch is adhered to a patient's skin. The patch contains the drug and is designed in such a way that the medication permeates the skin in a controlled fashion thus attaining more steady levels of the drug in the body. These patches are secured with adhesives, which are designed to adhere comfortably to the skin which in turn allows a patient to use the patches for as long as advised by the physician.

Transdermal patches are simple to use and constitute a simple /efficient method for medication delivery. One side of the patch contains the drug, which is formulated with the skin contact adhesive and adheres to the skin.

Transdermal patches offer many benefits over traditional pill, powder or liquid medication delivery methods namely 1).direct-to-blood stream delivery while bypassing the liver's metabolic activity, 2) gradual and constant rather than in a large, single dose supply of medication, 3) allows a medication to bypass the acidic environment found in the digestive system thus reducing the risk of side effects and 4) patches are painless, eliminating the need for injections that can cause a patient irritation and discomfort.

The transdermal medication delivery is most often administered using a patch. It is quick and effective, increasing the skin's permeability and making it easier for drugs to be absorbed into the bloodstream.

Under this project, a microneedle (soluble microneedle) based transdermal drug delivery system for four selected cardiovascular drugs namely, Indapamide, Nicardipine, Captopril and Atorvastatin is planned to be developed.

Drug Loading Polymer (DLP) and drug are dissolved in dichloromethane (DCM) and Twine-80 solution is added to polymer solution and the turbid solution is centrifuged to separate the nano particles. The synthesized nano particles are characterized by using FE-SEM, particles, which are formed in the nano size distribution. The Fe-SEM images are shown in Figure 16.

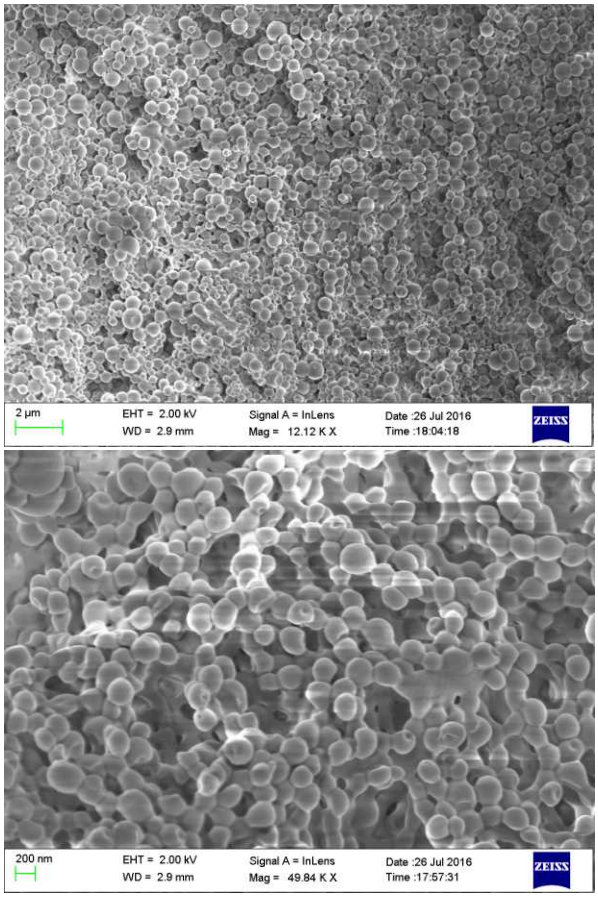


Figure 16 Nano particles under Emulsion method (Mechanical stirrer)

Probe sonication method

DLP and drug are dissolved in DCM. PVA is dissolved in double distilled water. Polymer solution and PVA solution are mixed together using sonication for a duration of 20 minutes under ice-bath. After completion of the sonication, the emulsion solution is poured into the PVA solution.

The turbid solution is centrifuged to separate the nano particles.

The synthesized nano particles are characterized using FE-SEM. The particles are formed in nano size distribution. FE-SEM images are shown in Figure 17.

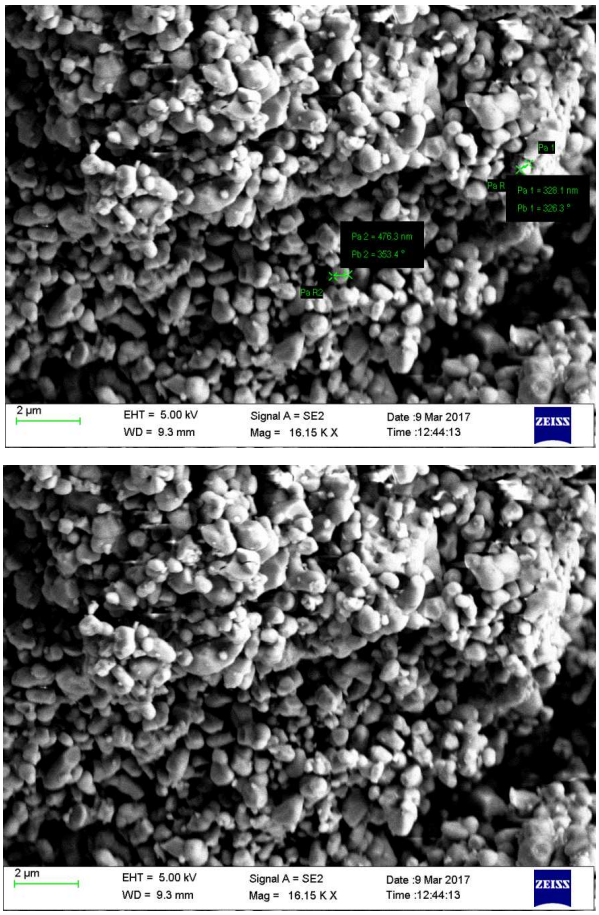


Figure 17 Probe sonication method for nano particles preparation

Electro spraying method

10 mg of DLP polymer and 2.5 mg of drug was dissolved in DCM. The polymer solution was filled in a 5 ml syringe and kept in a syringe pump. Flow rate was fixed at 500 µl per hour and with 18 KV potential differences. Polymer particles were collected on an aluminum foil and the experiment is continued till the solution was exhausted. Polymer particles were collected and stored under refrigeration. The synthesized nano particles were characterized using FE-SEM, where particles were formed in micro size distribution. FE-SEM images are shown in Figure 18.

Four different cardiovascular drugs were worked with and the nano particles preparation methodology was chosen based on the nature of the drug. The drug loaded nano particles were characterized by FTIR spectroscopy to confirm the presence of drugs in nano particles. Figure 19 shows the FTIR spectrum of captopril loaded

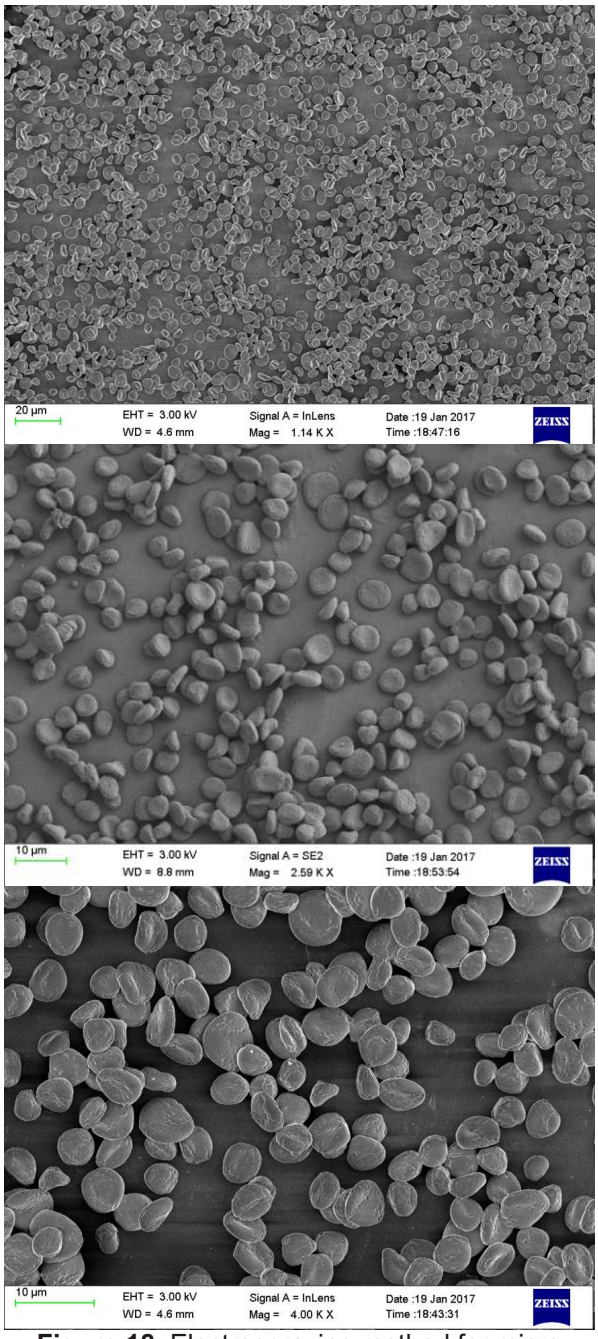


Figure 18 Electrospraying method for micro particles preparation

nanoparticles, the spectrum of DLP, caoptopril and captopril loaded DLP nano particles was observed using Nicoat i10 FTIR ATR mode spectroscopy. The three spectroscopy results were compared and the presence of captopril was confirmed with the stretching at 1630 cm-1 (-C=O) in drug loaded particles. The lower intensity of the peak at 1630 cm^{-1} was due to the lower concentration of drug.

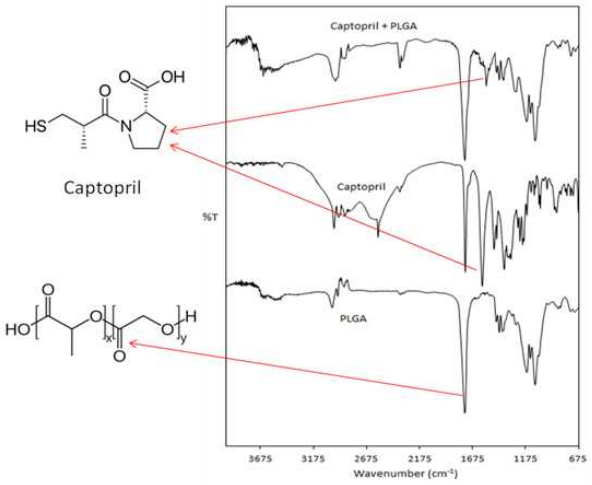


Figure 19 FTIR spectrum DLP, drug and drug loaded DLP nano particles

Further, the nano particles were analyzed using Differential Scanning Calorimetry (DSC) for the confirmation of presence of the drug (Figure 20).

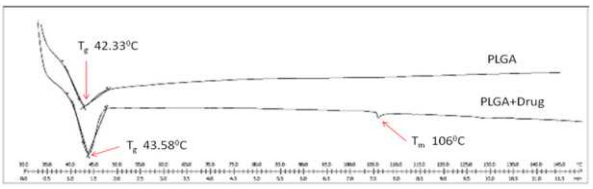


Figure 20 DSC analysis of drug loaded nano particles

Soluble microneedle made of Silicon encapsuled with carboxy methyl cellulose (CMC) were fabricated. CMS was dissolved in water at appropriate concentration and the drug loaded nano particles were dispersed into the CMC solution. A schematic diagram of the soluble microneedle is given in Figure 21

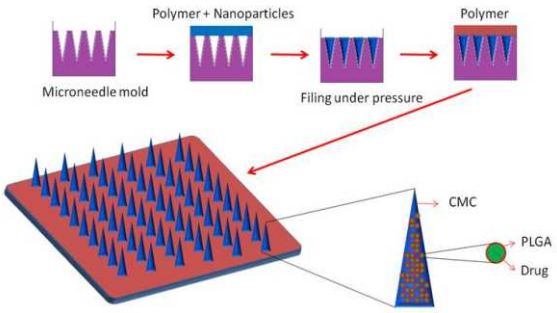


Figure 21 Graphical representation of soluble microneedle fabrication

The microneedle was fabricated with green fluorescent tagged nano particles and imaged in optical microscopy under fluorescent light.

The graphical representation of soluble microneedle drug delivery is shown in Figure 22, in which the microneedles penetrate into the dermis layer and the tip of the needles dissolve, to finally deliver the drug into the system.

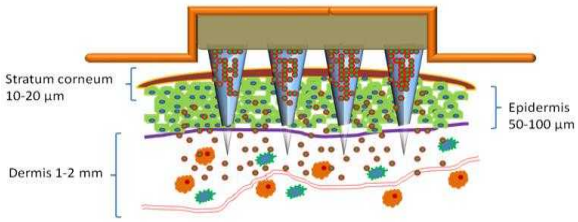


Figure 22 Graphical representation of drug delivery

DEVELOPMENT OF AN INDIGENOUS BREATHABLE VIRAL BARRIER FABRIC (Sponsored by the Ministry of Textiles, Govt. of India)

The project was taken up to develop an indigenous viral barrier personal protective fabric for epidemic and panepidemic diseases such as EBOLA, SARS, Avian Flu etc without any compromise in breathability.

Commercially available barrier samples were procured and evaluated. The procured barrier samples were tested as per standards to understand the dynamics (properties) of the same. A new barrier membrane with good performance and breathability was developed using various approaches:

Approach 01 : Use of monolithic films as barrier membranes.

Approach 02 : Electrospinning technique employed to produce micro-nano fibres.

Approach 03 : Salt leaching technique to produce micro-nano membranes.

The properties of different layers required in the proposed barrier fabric were studied and the developed barrier film was laminated with the proposed fabric.

The following tests were conducted for both films and for the different layers

a. Hydrostatic resistance test (AATCC 127)
b. Water vapour transmission rate (ASTM E96)
c. FTIR (Fourier Transform Infrared Spectroscopy)
d. Air permeability
e. Synthetic blood penetration test (ASTM 1670)

The working performance of multi-layered (laminated fabric) with the developed barrier membrane was assessed. The developed film exhibited excellent barrier performance and very good breathability (Table 23). It also demonstrated the feasibility of laminating in a commercial setup without any hindrance. It had more than 7000mm.wc of hydrohead strength and very good water vapour permeability, when compared to the commercial ones.

Table 23 Results of Synthetic Blood Penetration Resistance Test (SBPRT) and viral penetration of the developed film.

Sample	SBPRT Pass/Fail	Viral Pass/Fail
110 CP (Developed Sample)	PASS @ 2PSI	PASS @ 0 PSI

DEVELOPMENT OF NANOFIBROUS MEMBRANE FOR WOUND HEALING BY CONTROLLED RELEASE OF INDIAN HONEY AND CURCUMIN (Sponsored by the Ministry of Textiles, Govt. of India)

The current work focuses on the identification and use of Indian honey with potentially rich medicinal properties for use in wound healing. To overcome the limitations in conventional method of applying honey over the wound, it is proposed to fabricate a nanofibrous membrane using honey, along with curcumin which would act as an anti-oxidant.

An Indian honey variety, with high medicinal value, was identified. A bio-degradable and natural polymer was selected. The ratio of Honey : Polymer was optimised. Using electrospinning a nano fibrous membrane was fabricated and its cytotoxicity evaluated along with its in vitro wound healing effects.

In vivo animals trials are in progress.

DESIGN AND FABRICATION OF AN INSTRUMENT TO ASSESS THE PUNCTURE RESISTANCE OF SURGICAL MATERIAL BY USING SHARP EDGED PUNCTURE PROBE/SYRINGE NEEDLES

(Sponsored by the Department of Science and Technology, Ministry of Science and Technology)

One of the important quality requirements of surgical gloves is their puncture resistance performance in a manner representing actual use as it might occur when the surgical gloves are exposed with syringe needles, scalpels, etc. At present an equipment to assess the characteristic of surgical gloves against puncture resistance is not indigenously manufactured. The development of a low cost instrument will make the process of quality evaluation of surgical gloves for their resistance to puncture relatively cheaper.

Hence, a project was taken up to develop an instrument to assess the puncture resistance of surgical material as well as geotextiles material by measuring the force required to cause a sharp – edged puncture probe to penetrate through the specimen and to standardize the test procedure to be adopted for quality evaluation of puncture resistance of surgical materials and geotextiles materials.

SITRA puncture probe tester

The planned instrument setup of SITRA puncture probe tester is as shown in Figure 23. The instrument under fabrication is being developed under the constant rate of extension principle.

The instrument has the following essential components.

- Puncture probes fabricated with stainless steel attached to a penetrometer

- The penetrometer with an up and down movement along with the puncture probe to measure the force and corresponding deflection of the fabric required to make the hole on the specimen using the puncture probe.

- To facilitate a wide range of sample testing, the following three types of sample holders are planned to be fabricated.

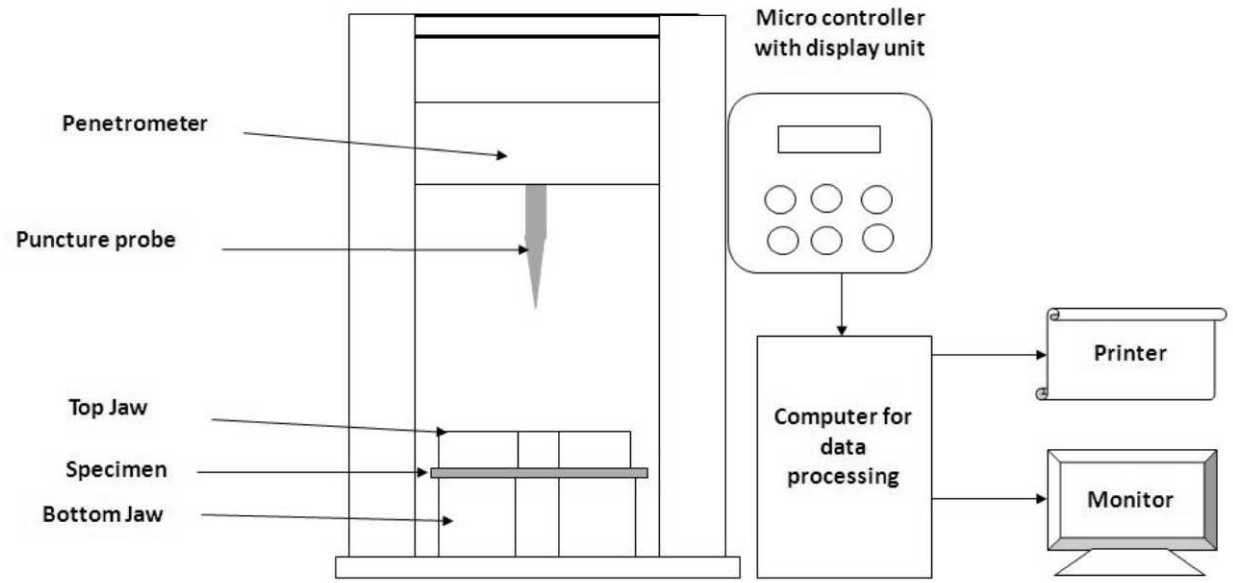


Figure 23 Schematic diagram of SPPT

* Sample holder for surgical gloves holding
* Sample holder for protective textiles / packaging material
* Sample holder for geotextiles

Load cell

The instrument would have three types of load cells to measure the penetration force range from 0 to 1600kg. The accuracy of the load cell is assigned as per the International standard ISO 7500.

The proposed instrument is under fabrication. After the completion of fabrication of the instrument, the instrument will be evaluated for its accuracy and repeatability of test results. It is also planned to conduct inter-laboratory comparison between test results obtained from the developed instrument and the test results obtained from universal tensile testing instrument.

DEVELOPMENT OF COFFEE POWDER BASED DRESSING FOR INFECTED WOUNDS

One of the most common problems associated with chronic wounds is bacterial infection. These infections can prolong or impair wound healing, contributing to tissue morbidity and in extreme cases result in sepsis. These bacteria when they form a biofilm, affect the bodily tissues and lead to chronic infections thereby delaying the healing process. Current therapies to treat bacterial biofilm and tissue defects of chronic wounds rely on the systemic administration of antibiotics, topical application of pharmaceutical formulations and drastic operative interventions such as skin graft, biological dressings made of collagen, hyaluronic acid and growth factors, etc.

Most dressings, though effective in improving the healing, are highly priced. Hence, in the present study, an attempt was made to explore the possibility of using coffee powder for treating wounds that are infected with single or polymicrobes. The chemical constituents of coffee powder such as phenolic compounds and their derivatives like (chlorogenic acids, alkaloids (caffeine in particular), diterpenoid alcohols, etc, are reported to have various biological activities such as anti-bacterial, anti-viral, anti-inflammatory, protection of macromolecules from oxidative damage and reduce the expression of metalloproteinase.

It is proposed to study the effect of coffee powder in treating infected wounds using in vitro and in vivo models.

a. Selected variety of coffee powder has shown higher antibacterial activity against both Gram positive and Gram negative organisms in both individual as well as polymicrobial.

b. Infected wounds of animals treated with coffee powder healed within 16th day of treatment when compared to control animals (Figure 24), which almost a month to heal.

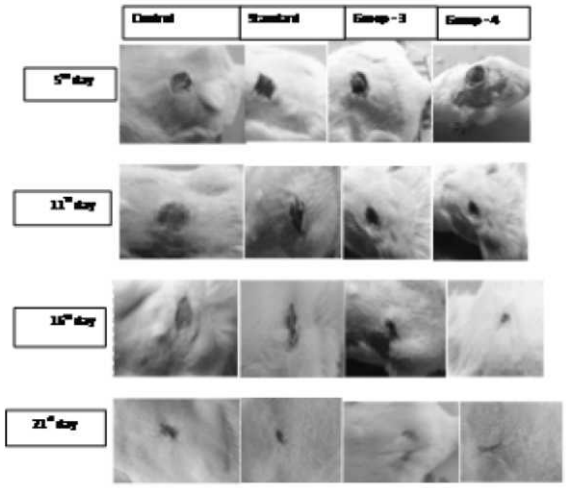


Figure 24 Effect of coffee powder in healing the wounds infected with polymicrobial culture.

c. Histopathological analysis has shown increased proliferation of fibroblasts, early re-epithelisation of tissues and fibrocollagenases formation when compared to the controls.

DEVELOPMENT OF CELLULOSE AND CHITOSAN BASED SPONGES FOR GUNSHOT WOUNDS

Gunshot wounds require rapid treatment by first responders to prevent blood loss, disability and save life. Often, this involves stuffing lots of gauze and applying pressure to prevent blood from exiting the wound. While effective in its own right, this can be difficult and can eat up precious time during a serious situation. To address this issue, an attempt has been made to develop sponges with expandable and blood coagulating properties.

Specific objectives of the project are to ..

- Develop and characterize the sponges for their physical properties.
- Impregnate X ray detectable marker.
- Characterize the sponges for biological properties.
  - Biocompatibility evaluation as per ISO 10993 – cytotoxicity, skin irritation and sensitization and hemocompatibility.
  - Biodegradability.
  - Antimicrobial activity using single and polymicrobial cultures.
- Develop gunshot/cavity wounds and evaluate their properties of coagulating blood.

Antimicrobial coated (Chitosan) cellulosic sponges of size range between 0.8 cm to 1.2 cm were designed. These sponges showed > 90 % activity within 1 hr against S.aureus, E. coli, P. aeruginosa and polymicrobial culture when tested according to ASTM E 2149. Compressed sponges (Zwick roell, Model: Z005; Force: 400 N, holding time: 2 min) absorbed 0.8 to 1.0 ml of blood immediately whereas uncompressed absorbed 1 ml of blood in the duration of 1 min. Hemocompatibility test confirmed the sponges being non-toxic to blood cells. It was also found that the compressed and chitosan coated sponge was stable when it was immersed in blood for about 1 hr when compared to uncompressed sponges.

Further work on bio-campatability of the sponsges is under progress.

DESIGN AND DEVELOPMENT OF A HIGH PERFORMANCE LAPAROTOMY SPONGE

Mopping pad or laparotomy sponge is a common product found in surgical kits used to absorb blood & other fluids, especially in the abdomen, during surgery and also finds various other applications inside the operation theatre. They distribute the pressure evenly which helps in arresting bleeding at the punctured site.

Currently, laparotomy sponges are made of woven gauze material of multiple layers which have a lower fluid holding capacity and hence require frequent changing of materials. Non-woven materials which are also used in the laparatomy sponges have higher absorbency rate and wicking rate in comparison with the woven gauzes thus reducing the frequency of the removal of the dressing. As the fibres are distributed over the nonwoven fabric, it helps in holding more fluid by reducing evaporation and act as the barrier against microbes. However, the wet strength of the nonwoven sponges is less compared to woven sponges along with high wet lint generation. It is therefore essential to optimise the textile structures like woven, nonwoven, knitted with different patterns, weight/unit area, tensile strength and flexural rigidity could play a vital role in the performance of the laparotomy sponges.

Hence, a project was taken up to redesign the structure of the laparotomy sponge material with lesser number of plies that would reduce dry and wet lint during surgery, be used multiple times on a person for the surgery and create lesser biomedical waste.

Commercially available different woven gauze material used in the laparatomy sponge were procured from the various manufacturers as listed in Table 24.

Table 24 Details of woven gauze material

Sample ID	End/Inch	Picks/Inch	Warp count in Ne	Weft count in Ne	GSM
WG1	38	20	30	24	54
WG2	32	22	40	30	35
WG3	26	18	40	40	30
WG4	26	16	40	40	26
WG5	20	14	40	40	23
WG6	18	14	40	40	23
WG7	16	14	40	40	20
WG8	26	16	40	40	25
WG9	18	14	40	40	17
WG10	20	14	50	40	20
WG11	32	28	40	40	40

Seven different types of spun-lace nonwoven were produced at SITRA and three commercial samples were procured.

The water holding capacity and blood holding capacity of the woven and non-woven gauze materials were compared.

Analysis of wet and dry linting properties of developed nonwoven gauze materials are in progress.

DEVELOPMENT OF SPUNLACE NONWOVEN SURGICAL PADS

Spunlace is a nonwoven production technology where fibers are laid into a web and then entangled together by application of high pressure water jets. Its main advantage is that the fabric produced is of high purity and free from any chemicals and toxins. Spunlace nonwoven fabrics are used in various hygiene products ranging from baby diapers, to adult incontinence products. They are used as an alternative to traditional textiles due to their absorption properties, softness, smoothness, comfort. Spunlace nonwoven textiles aids as an excellent surgical dressing material by means of its larger surface area and high porosity that serves as an open structure for the drainage of exudates and lessens the risk for secondary infection.

Hence, it was proposed to develop surgical pads using spunlace non-woven material and study the effect of the fabric structure on the liquid transport and exudate handling characteristics of nonwoven surgical pad.

Six different surgical pads were made combining the spunlace nonwoven and cotton wadding (Table 25). The size of the developed surgical pads were10x10 cm.

Table 25 Developed Spunlace Non-woven

Sample ID	Fibers used	Fibre composition in %	GSM
NWS1	Polyester	100	90
NWS2	Viscose	100	100
NWS3	Viscose	100	70
NWS4	Polyester/Viscose	30:70	90
NWS5	Polyester/Viscose	45:55	100
NWS6	Polyester/ Viscose	30: 70	70

The performance assessments of developed nonwoven surgical pads are in progress.

ATRAUMATIC WOUND DRESSINGS FOR BURN WOUNDS

There is an increasing acknowledgement that pain is a major issue for patients suffering from many different wound types particularly burn wounds. Some of the more modern dressings, in particular, hydrocolloid dressings have a strong tendency to adhere to wounds and cause tissue trauma. In order to avoid the trauma and the skin stripping caused during the dressing change, SITRA has taken up a study wherein hydrogel is synthesized on to the fabric for easy removal of the dressings and a test method was adopted to evaluate the peeling force.

The surface of a knitted fabric was functionalized in order to assist the growth of hydrogel onto the same. Assembly of the hydrogel onto the fabric was observed. As expected, the sample with hydrogel displayed more swelling when compared to the control sample (Figure 25). The developed sample demonstrated lower peeling energy when compared with a commercial sample, clearly indicating the decrease in the adherence of the dressing (Figure 26).

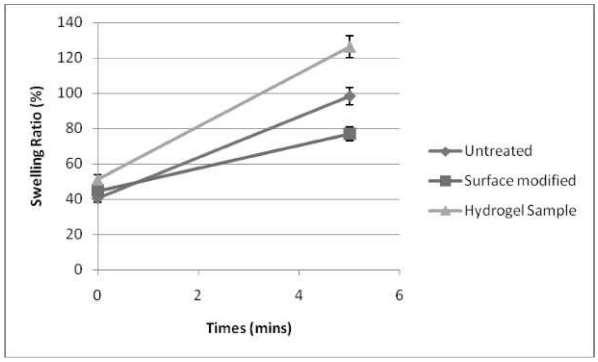


Figure 25 Swelling ratios of the untreated, treated and CH grown hydrogel sample

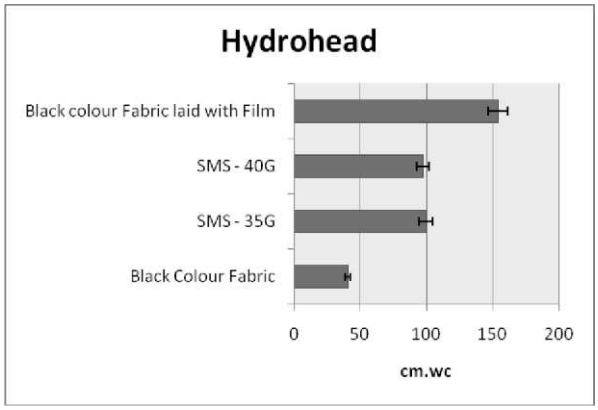


Figure 26 Peeling force of the commercial sample and the developed sample

Further work is on to study other quality parametrs of the wound dressings.

FACTORS INFLUENCING THE FILTRATION EFFICIENCY OF SURGICAL FACEMASKS

A study was undertaken to identify the reasons/factors influencing the filtering efficacy of surgical face masks. The study will also try to understand whether non-woven material from different manufacturers have similar filtration properties.

Different layered combinations of facemask structures involving spunbond and meltblown material of varying GSM combinations were taken up for study along with certain commercial samples. A detailed analysis of pore size analysis, pore distribution, air permeability factor, particle filtration, bacterial filtration, splash resistance has been carried out and a relationship has been derived for determining the filtration efficiency.

Efficiency with relation to defined fiber arrangement and defined pore arrangement has to be studied. Reusability of facemask is also to be determined to reduce biomedical waste.

DEVELOPMENT OF A NOVEL, BIODEGRADABLE ADULT INCONTINENCE DEVICE

Urinary incontinence leads not only to lot of health problems, but also to significant self-embarrassment in the elderly limiting their mobility and thus quality of life. While a number of adult incontinence devices are available in the market the price for a single unit ranges from at the low-end of Rs 45/ piece to Rs 95/ piece putting it beyond the reach of majority of aged in India. Furthermore, the environmental impact of the current devices on emerging countries, particularly in India, which has underdeveloped waste management services, is particularly devastating and this is only set to worsen.

A project was taken up to develop cost-effective, fully biodegradable / compostable urinary incontinence/ sanitary devices. It is proposed to completely replace the use of environmentally harmful materials in the construction of sanitary devices with natural, eco-sustainable, bio-degradable materials with high absorbency and anti-microbial properties.

Bioactive polymer and bioplastic were procured and their physio chemical properties analysed. The

formulation for the adult incontinence device was developed. The format for Adult Incontinence Device & Quantitative analysis MIC, MBC, ZOI of antimicrobial studies against broad-spectrum pathogens including S.aureus, P.aurigenosa and activity against the prevalent Lactobacillus strains were created. Antimicrobial and biodegradability studies were carried out on the samples which were followed by field trials. Procurement of raw materials is in progress.

EFFECT OF STERILIZATION ON THE PROPERTIES AND PERFORMANCE OF OPERATION THEATRE DISPOSABLE APPARELS

The primary purpose of sterilising any item is to destroy all living microorganisms and reduce the hospital acquired infections. However, the impact of sterilisation may alter the properties of the sterilised materials. Till now, the manufacturers of operation theatre apparels specify the properties of the materials before sterilization and may not be aware about the changes in the properties of materials after sterilization. As a result, a product designed successfully could be transformed into an unrecognized piece of material. There is no concrete study on the effect of sterilisation on the properties and performance of the operation theater apparels. Hence, SITRA has initiated an elaborate research work on the “Effect of sterilisation on the properties and performance of operation theatre disposable apparels”.

Different kinds of raw material used in operation theatre apparels were procured from various manufacturers. The details of the raw materials are given in Table 26.

Table 26 Details of raw materials

Sample ID	Type of Nonwoven	GSM
S1	SMS	35
S2	SMS	43
S3	SMS	50
S4	Antistatic SMS	35
S5	Antistatic SMS	50
S6	Alcohol Repellent and Antistatic SMS	35
S7	Alcohol Repellent and Antistatic SMS	45
S8	SMMS	35
S9	SSMMS	35
S10	SSMMS	43
S11	SSMMS	50
S12	Absorbent laminated	40
S13	Absorbent Spunbond Laminated	70
S14	Absorbent Spunbond Laminated	105
S15	Spunbond Laminated	40
S16	BVB	70

Barrier performance testing before sterilisation for all the samples as per AAMI PB70 international standard has been initiated.

DEVELOPMENT OF ANTERIOR CRUCIATE LIGAMENTS (ACL) USING BRAIDED TEXTILE MATERIAL **(Sponsored by the Ministry of Textiles, Govt. of India)**

ACL is a key fibrous connective tissue that maintains the stability of the knee joints and is most commonly injured ligament of the knee. It is a pair of Cruciate Ligaments (Anterior and Posterior Cruciate Ligaments) as they are arranged in a crossed formation.

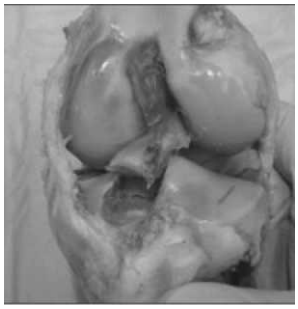


Figure 27 Torn ACL

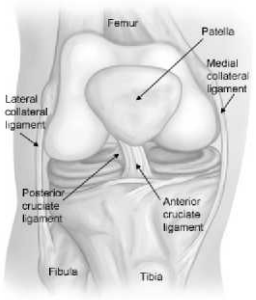


Figure 28 Parts of Knee

If the ACL is damaged, it will affect one's walking motion fully and also create discomfort while walking. ACL reconstruction is a surgical tissue graft replacement of the anterior cruciate ligament, located in the knee, to restore its function after an anterior cruciate ligament injury. The torn ligament is removed from the knee before the graft is inserted.

The main objective of the project was to develop Ultra High Molecular Weight Polyethylene (UHMWPE) yarn braided ligaments for reconstruction of the Anterior Cruciate Ligament (ACL).

Table 27 Tensile properties Ultra High Molecular Weight Polyethylene (UHMWP) yarn

dtex	Denier	Time to break (sec)	Breaking force (gF)	Elognation (%)	Tenacity (gF/denier)	Breaking work (gF.cm)
220	202.59	0.16	6442	2.70	31.80	4079
440	396.00	0.18	10430	2.96	26.33	7679
880	792.08	0.16	19320	2.71	24.39	13300
1760 (880x2)	1695.00	0.16	33710	2.62	23.89	23800

UHMWPE has been the most commonly used bearing material in total joint arthroplasty. Wear and oxidative fatigue resistance of UHMWPE are regarded as two important mechanical properties to extend the longevity of knee prostheses.

Presently, ACL is constructed by many techniques like braided, knitted or woven. It is proposed to develop ACL ligaments using UHMWPE yarn using braiding technology. The load bearing capacity and tissue compatibility were studied towards standardizing the material.

The prosthesis would be developed based on size of the ACL , body gender and age. The materials and methods are described below.

Type of Machine – Manual Braiding Machine
No.of Spindles – 16
Machine RPM – 25
Yarn Tension – Altered Manually

The UHMWPE yarn of various deniers of 220dtex, 440dtex and 880dtex was procured and tested under the gauge lengths of 500mm with a speed of 5000 mm/min. The results of the same are shown in Table 28.

By using the above Ultra High Molecular Weight Poly Ethylene yarns single braided, double braided and triple braided structures were made by using conventional type braiding machines of 12 carrier and 16 carrier. The mechanical properties of various braided structures were tested and the results are given in Table 29.

The tensile characteristics of the ACL materials were analysed using INSTRON tensile testing instrument with following testing parameters.

a) Load cell capacity : 500kg,
b) Gauge length : 200mm and
c) Traverse speed : 100mm/min.

As the breaking force of the above samples do not match / nearer to the natural ACL tensile strength, 880dtex yarns were plied (parallel laid in single carrier), represented as 1760dtex was braided using 12 carrier and 16 carrier. The above result also showed that there is no significant difference in tensile strength between single layer, double layer and triple layer braided structures made from same

Table 28 Mechanical properties of various braided structures

Sample No.	Breaking Force N		
	Single Braided	Double Braided	Triple Braided
220 dtex – 12 carrier	345.75	348.10	344.02
440 dtex – 12 carrier	556.75	548.61	552.74
880 dtex – 12 carrier	1059.00	1039.56	1047.25
220 dtex – 16 carrier	437.96	436.25	439.26
440 dtex – 16 carrier	761.60	758.60	759.40
880 dtex – 16 carrier	1412.25	1410.20	1428.0

yarns and same number of carriers. Hence, the single braided structure was produced using 880dtex parallel yarns in one carrier. The tensile strength and elongation are given in Table 29.

Table 29 Mechanical properties of 1760dtex single braided samples

Sample No.	Breaking Force N	Elongation in %
12C 1760Dtex	2120	3.5
16C 1760Dtex	2520	3.9

As evident from the table, both samples are nearer to the tensile properties of natural ACL, both the samples were plasma treated.

Plasma and cationized gelatin with hyaluronic acid coating method

The UHMWPE samples were modified in the plasma apparatus by using oxygen gas (70V, under vacuum) and then dipped in γ- methacryl-oxypropyl trimethoxysilane for 1hr and dried overnight. Then, the samples were again modified in same plasma apparatus at 70V for 10mins, washed with 75% ethanol aqueous solution of γ- methacryl-oxypropyl trimethoxysilane for 1hr. The samples were then washed with pure water and dried at 37°C. Finally the samples were used for further processing.

The plasma modified samples were treated with 0.1% HCL solution for 20min at room temperature, placed in 0.1% HA solution for 1min and subsequently rinsed with pure water. Then they were dipped in 0.1wt% CG solution for 1min followed by the same rinsing procedure. Ten layers of hyaluronic acid and cationized gelatin were prepared by repeating this deposition process 10 times and dried at 37°C for 48hrs.

FTIR was performed for the UHMWPE samples along with control samples to identify the difference on the surfaces of the sample as well as control. In control, there is no evidence of coated materials on the surface. Self assembling peptide peaks were clearly observed in the case of coated samples. It clearly showed that the coating is properly done and the material has been successfully coated on the surface of the sample.

FE SEM results

SEM images were taken by UHMWPE samples before and after coating process. Increase in the sample size indicated that the coating was successfully carried out.

Materials used

* PBS
* Ethanol Solution

Procedure

The samples were washed twice with PBS, immersed in PBS containing 1% glutaraldehyde for 12 hrs. Then they were dehydrated in a series of solution of increasing ethanol concentration (from 20%-100%) and dried. The UHMWPE was gold sputtered under vaccum and examined under scanning electron microscope for the morphological observation.

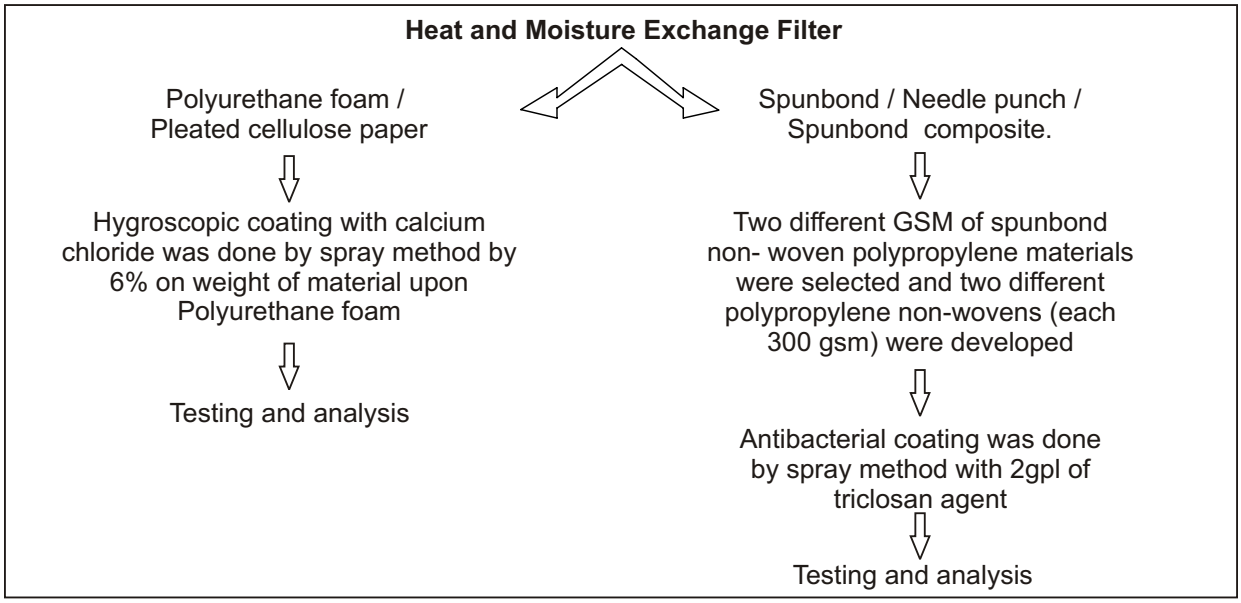
SEM images were taken to confirm the coating of materials on the surface of the samples. In case of control no coating was observed.

Further product qualification testing is in progress.

DEVELOPMENT OF HEAT AND MOISTURE EXCHANGE FILTER (Sponsored by the Ministry of Textiles, Govt. of India)

The main objective of the project is to develop a non-woven filter for breathing system in clean anesthesia oral lowing ICU circuits, to keep them patients free of micro-flora.

Polypropylene staple fibres of 2.5 denier with 51mm length and 6.0 denier with 61mm length were sourced from an indigenous supplier to make a needle punched non-woven filter. The polypropylene spunbond non-woven filters of different GSM (18 and 25 GSM) and Meltblown non-woven material sourced from our internal source at SITRA were used to make a filter. Reticulated polyurethane foam (polyester based) was sourced from an indigenous supplier.



Spun bond non-woven fabric (Top layer and bottom layer), Needle punch non-woven fabric –SITRA developed (Middle layer) and pleated cellulose paper

The polypropylene spun bond non-woven fabric (Top layer and bottom layer) and the polypropylene needle punch non-woven fabric (middle layer) was tested for weight per sq. meter (GSM), thickness, density and pore size using capillary flow porometer. The test results are given in Table 30.

The spunbond material was used as a top layer of the composite. The selection of the polypropylene material is due to its low specific gravity, low thermal conductivity, resistance to bacteria and micro-organisms, environmental effect, resistance to chemicals like acid and base, etc. and the selection of spunbond fabrics was due to its excellent heat and chemical stability, porosity, etc.

The needle punch material was used as a middle layer of the composite. The selection of needle punched material was due to its excellent water permeability, filter stability, high abrasion resistance, excellent puncture and penetration resistance, etc. The pleated cellulose paper material was used as a moisture and heat energy retaining medium.

Reticulated polyester based polyurethane foam test

The reticulated polyester based polyurethane foam was selected due to its freedom of formulation, intrinsic flame lamination properties and excellent cell size control, resistance to a wide range of solvents, ability to perform quite well in fungal and microbial growth. This foam material is used as a moisture and heat energy retaining medium by the way of giving adequate heat energy and humidity to the inhaled respiratory gas because of which, the foam material maintains a 50% humidity and around 22°C temperature. So this should be

Table 30 Spun bond, needle punched non-woven fabric and pleated cellulose paper test results

S.No.	Parameter	Top layer	Bottom layer	Middle layer	Pleate d cellulose paper
1	Type of material	Polypropylene	Polypropylene	Polypropylene	Cellulose
2	Weight per square meter (GSM)	19.74	27.48	278.37	68.00
3	Density (g/cc)	0.90	0.82	0.82	1.36
4	Mean pore size (microns)	117.66	168.68	63.92	7.45
5	Thickness (mm)	0.16	0.20	3.00	0.67

conditioned by collecting and condensing of moisture vapour particles and heat energy from the exhaled gas by coating it with a hygroscopic chemical, calcium chloride. The reason behind this is that the exhaled gas has 100 % humidity and around 37°C temperature which is required for the normal respiration to human being. This is a cyclic process to respire a human being normally. The test results are given in Table 31.

Moisture vapour transmission rate test

The specimen to be tested was placed on an electronically heated porous plate with conditioned air ducted to flow across and parallel to its upper surface.

The moisture retention capacities of different samples are tabulated in Table 32.

Table 31 Polyurethane foam test results

S. No.	Parameter	Values
1	Type of material	Reticulated polyester based polyurethane foam
2	Weight per square meter (GSM)	370.66
3	Density (g/cc)	1.19
4	Mean pore size (microns)	284.28
5	Thickness (mm)	7.50
6	Moisture Vapour Transmission Rate (grams/m^2/24hrs)	2632.80

Table 32 Moisture vapour transmission (Breathability) of hygroscopic coated polyurethane foam

Sample ID	Material	Type of sample	Chemical name	Concentration %	Result (g/m^2/24h)
1	Polyether Urethane foam	Commercial 1	-	-	1897.44
2	Polyether Urethane foam	Commercial 2	-	-	1756.08
3	Polyurethane foam	Sourced	-	-	1897.44
4	Polyurethane foam	Sourced	-	-	1957.92
5	Polyurethane foam	Sourced	$CaCl_2$	2	2400.96
6		Sourced		4	2085.12
7		Sourced		6	2583.60
8		Sourced		10	2482.80
9		Sourced		20	2159.76
10	Polyurethane foam	Sourced	Uncoated	-	1969.32
11	Polyurethane foam	Sourced	$CaCl_2$	10	2274.72
12			LiCl	5	1796.40
13			LiCl	15	1705.92
14			LiCl	25	1685.04
15	Polyurethane foam	Sourced	CaCl2	2	2222.04
16			CaCl2	6	2632.80
17			CaCl2	10	2243.16
18	Polyurethane foam	Sourced	-	-	1505.88
19	Polyurethane foam	Sourced	-	-	2000.88
20	-	Sourced	-	-	1978.20
21	-	Sourced	-	-	2190.12
22	PP spunbond Non woven– white - 18 gsm)	Sourced	-	-	2169.84
23	PP spunbond Non woven (Blue – 18 gsm)	Sourced	-	-	1866.84
24	PP spunbond Non woven (Blue– 25gsm)	Sourced	-	-	2457.60

The moisture vapour transmission rate results indicate that the sourced polyurethane foam with 6% calcium chloride coating gives better results. So the results were optimized at this concentration.

FE – SEM analysis

The morphology of the anti-bacterial coated (Triclosan) spunbond non-wovens (top and bottom layers) and needle punch non-woven (middle layer), hygroscopic coated (Calcium chloride) reticulated polyester based polyurethane foam and pleated cellulose paper were observed with Field emission – scanning electron microscope (FE-SEM)

The FE-SEM images have shown that coating agents like calcium chloride and triclosan were present on the surface of the materials.

Antibacterial activity assessment of textile materials: Parallel streak method (AATCC-147)

The anti-bacterial coated polypropylene spunbond non woven bottom layer (25 gsm) of composite filter was tested and it was found that the concentrations of 1 gpl, 2 gpl and 5 gpl of triclosan agent were effective in resisting the growth of particular micro organisms such as Staphylococcus aureus (ATCC 6538) and Klebsiella pneumoniae (ATCC 4352). But the activity of 2.0 gpl concentration performed better in both anti-bacterial qualitative and quantitative tests when compared to the 1.0 gpl concentration which means that best results were achieved with minimum concentration of chemicals.

Drop tests were carried out and the results of different composite filter samples indicate that all the materials such as polypropylene and polyurethane are hydrophobic in nature except pleated cellulose paper which is hydrophilic in nature.

Determination of antibacterial finishes on textile materials by AATCC 100

The results of anti-bacterial reduction % from both 0.5 gpl impregnation method and 2.0 gpl spray method coated spunbond non-woven fabric are given in Table 34.

Fourier Transform Infrared (FTIR - Spectrum)

The FTIR results indicate that the polypropylene non-woven top layer, middle layer and bottom layer of composite samples have strong and broad level of intensity in the range of 500 to 1500 wave number per cm. Polypropylene together with triclosan agent and polyurethane foam has strong and broad level of intensity in the range of 700 to 1750 wave number per cm. Polyurethane foam together with calcium chloride agent and pleated cellulose paper has strong and broad level of intensity in the range of 800 to 1750 wave number per cm.

Pore size analysis of two different deniers of polypropylene fibres

Capillary flow porometer 'CFP-1200A', manufactured by Porous Material Inc., (PMI) was used to test the pore diameter of composite layers

Table 33 Results of determination of antibacterial finishes on textile materials

S. No.	Sample particulars	No. of Swatches *	Bacterial reduction (%)	
			Staphylococcus aureus ATCC 6538	Klebsiella pneumoniae ATCC 4352
1	Bottom layer (0.5gpl - impregnation method)	2	0 (Contaminati on observed)	0 (Contamination observed)
2	Bottom layer (2.0gpl – spray method)	2	99.99	99.99
3	Top layer (0.5gpl - impregnation method)	2	0 (Contamination observed)	0 (Contamination observed)
4	Top layer (2.0gpl - impregnation method)	2	99.99	99.99

* 4.8 ± 0.1 cm in dia.

for 2.5 denier and 6.0 denier, reticulated polyester based polyurethane foam and pleated cellulose paper. Pore size of composite layers around 30 microns (based on reference sample) is suitable for heat and moisture exchange filter.

The pore size results indicate that 2.5 denier composite sample and 2.5 denier composite sample with polyester woven single layer, 6.0 denier composite sample and 6.0 denier composite sample with polyester woven single layer pore size resemble the reference samples.

Bacterial filtration efficiency test

The results of bacterial filtration efficiency for all the composite samples developed at SITRA are given in Table 35.

The results of bacterial filtration efficiency indicate that the composite with melt blown layer of 2.5 denier has the highest efficiency.

Particulate filtration efficiency test

The test procedure measures filtration efficiency by comparing the particle count in the feed stream (upstream) to that in the filtrate (downstream).
The particulate filtration efficiency% results indicate that the composite non-woven filter samples together with atleast one meltblown non-woven layer give filtration efficiencies in excess of 90%.

Pressure drop test

The test procedure measures pressure drop by comparing the pressure value in the feed stream (upstream) to that in the delivery (downstream).

The pressure drop results for both commercial samples and the samples developed at SITRA are given in Table 35.

The pressure drop of samples developed by SITRA was found to be lower when compared to commercial samples (see in S. No. 1 to 9 in Table 16) which indicate that samples developed by SITRA can ensure trouble-free respiration.

Table 34 Results of bacterial filtration efficiency of different composite samples

S. No.	Denier	Length	Test particulars	Bacterial reduction (%)
1	2.5	51 mm	Composite with meltblown single layer	98.2
2			Composite with meltblown double layer	99.7
3			Composite with Polyester single layer	98.0
4			Composite with Polyester single layer and meltblown single layer	99.4
5	6.0	61 mm	Composite	56.6
6			Composite with meltblown single layer	96.6
7			Composite with meltblown double layer	99.6
8			Composite with Polyester single layer	91.7
9			Composite with Polyester single layer and meltblown single layer	99.2

Table 35 Test results of pressure drop of commercial and SITRA developed samples

S. No	Description	No. of composite layers	Types of sample	Sample ID	Denier	Pressure drop (kpa)
1	Filter only	3	Commercial	1	-	0.1157
2	Foam and Filter	3	Commercial	2		0.0951
3	Foam and Filter	3	Commercial	3		0.1128
4	Foam and Filter	3	Commercial	4		0.0873
5	Foam only	-	Commercial	5		0.0167
6	Paper only	-	Commercial	6		0.1177
7	Filter and Paper	3	Commercial	7		0.1088
8	Composite filter	3	Developed	SITRA	2.5	0.0265
9	Composite filter	3	Developed	SITRA	6.0	0.0294
10	Composite filter with meltblown single layer	4	Developed	SITRA	2.5	0.1275
11	Composite filter with meltblown double layer	5	Developed	SITRA		0.2236
12	Composite filter with PET woven single layer	4	Developed	SITRA		0.1461
13	Composite filter with meltblown single layer and PET woven single layer	5	Developed	SITRA		0.2461
14	Composite filter with meltblown single layer	4	Developed	SITRA	6.0	0.1432
15	Composite filter with meltblown double layer	5	Developed	SITRA		0.2295
16	Composite filter with PET woven single layer	4	Developed	SITRA		0.1098
17	Composite filter with meltblown single layer and PET woven single layer	5	Developed	SITRA		0.2039
18	HME empty device	-	-	-	-	0

POLYESTER VASCULAR GRAFT IMPLANT – PROCESS OPTIMIZATION AND PRODUCTION SCALE-UP

A vascular graft is a surgical procedure performed to redirect blood flow in a region of the body. It is commonly performed due to inadequate blood flow (ischemia) and as a part of organ transplantation. In general, someone's own vein is the preferred graft material (or conduit) for a vascular bypass, but other materials such as ePTFE, Dacron or a different person's vein (allograft) are also commonly used. Arteries can also be redirected and serve as vascular grafts.

Polyester (Polyethylene terephthalate - PET) has been used in different blood contacting applications such as vascular grafts, heart valve sewing cuffs and annuloplasty rings. PET offers biocompatibility, sterilizability, retention of mechanical strength over long periods of time, fatigue resistance, good flexibility and handling characteristics, and suturability to the above implants. Fabrics can be woven to produce the desired shapes and porosity.

Vascular graft implants are not manufactured in India and indigenous technology to produce fabric based vascular grafts did not exist in India till SITRA developed a product and process technology for PET vascular grafts.

In this project, it is proposed to develop defect-free grafts of different sizes. A new loom has been finalized for further weaving of vascular grafts and product commercialization will be done after completion of the project .

SERVICES TO MILLS

As in the previous years, the range of services offered by SITRA continued to be effectively utilised by its members this year as well. The services availed by the mills during 2017 - 18 are given in Table 36.

Table 36 SITRA's services availed by textile mills during 2017 - 18

Type of service	Member units	Non members
Fibre, yarn and fabric testing	196	768
Consultancy services	79	102
CPQ study and Online survey on RMC & YSP	107	74
Training: Executives, supervisors and operatives	85	134
Accessories testing & instrument calibration	83	169

Testing of fibres, yarn and fabric was the most preferred service during the year, being patronised by 196 mills, representing almost 88% of SITRA's membership. Apart from 196 member units, 768 non-member units also utilised this service. The number of samples received from the mills remained more or less the same as last year at 72534 (Table 37).

A mill sent, on an average, samples on more than 38 occassions during the year, each sample involving 3.4 tests. More than 15% of the mills sent samples for testing regularly, ranging from one sample every week to more than one sample a day. On the other hand, around 14% of the mils availed this facility on only one occasion during the year.

The "Costs, Operational Performance and Yarn Quality" study (CPQ) covering key areas of a mill's functioning, initiated by SITRA 20 years ago, has been receiving good appreciation from mills. During the year 2017-18, 120 mills availed this service.

The monthly online survey of raw material cost and yarn selling price, initiated by SITRA in April 2013, has been receiving good response from the mills and during the 2017-18, on an average, 84 mills participated in the 12 surveys.

The training programmes offered for the managerial, supervisory and operative personnel were utilised by 85 (around 38%) of the member units while 134 non-member units also availed this service. Further details regarding the training programmes are given in the section under 'Training and development programmes and labour training.

SITRA undertook a number of consultancy services during the year. Thirty five percent of SITRA's member units and more than 100 non-member mills retained SITRA for consultancy assignments on various operational problems, techno-economic studies, energy conservation studies and other technical/techno-economic problems. Some of the important assignments that were handled by SITRA during the year, are listed below.

- Energy audit
- Study on compressed air system
- Machinery valuation
- Study on fabric costing
- Assessment of residual life and value of machines

Table 37 Testing services offered by SITRA during 2017 - 18

Material	Commercial		Project and Others	
	Samples	Tests	Samples	Tests
Fibres	37184	130566	152	409
Yarns	15426	31546	280	671
Fabrics	1775	2935	58	171
Chemical testing	11077	16784	321	694
CoE tests	6261	7700		
Total	71723	189531	781	1945

- Water consumpton audits
- Comments on the modernisation proposal
- Cost reduction study
- Inspection of mills for NHDC, Noida
- Performance audit
- Techno-eEconomic viability study
- TFR report for modernisation proposal
- Yarn realisation study
- Assessment of laboratories for compliance to ISO/IEC 1705:2005
- Yarn costing study
- Consultancy on process standardisation
- Technical troubleshooting service for processing units
- Study of soft flow dyeing machines and yarn dyeing machines

Details of the individual consultancy services that were offered to the mills are presented in Annexure V.

COMPUTER AIDED TEXTILE DESIGN CENTRES

With good response from the industry to its first Computer Aided Textile Design Centre (CAD), that was established in the year 1995, SITRA established 3 more centres, as a part of the PSCs. These 4 centres are functioning under SITRA's control without any financial assistance from the Ministry. The CAD system facilitates the creation of numerous designs quickly which can be varied or changed instantly depending upon the requirement of the customers. Computerised card punching, an intermediate technology, which will reduce the cost in both handloom and powerloom sectors, is also offered by the CAD centres. Table 38 shows the various services of these centres that were utilised by the decentralised weaving sector.

Table 38 Services offered by the CAD centres during 2017 - 18

S.No.	Type of service	No. of services
1.	Designs development /graph printouts	243
2.	Card punching	960
3.	Training programmes (persons trained)	4 (17)

POWERLOOM SERVICE CENTRES

To cater for the requirements of the decentralised powerloom sector, SITRA has set up powerloom service centres at various places of powerloom concentration. The first of its kind was established at Somanur three decades ago. Since then, six more centres have been established and all these 7 centres are sponsored by the Ministry of Textiles, Government of India. The centres are located in Tamil Nadu at Karur, Komarapalayam, Palladam, Rajapalayam, Salem, Somanur and Tiruchengode. SITRA also operates a textile service centre at Chennimalai for the benefit of both handloom and powerloom units in that region.

The PSCs (Powerloom Service Centres) have conducted a number of interactive sessions with powerloom entrepreneurs under the TUF scheme. Various consultancy services like cluster development programme, machinery buyer-seller meet, exposure visits with Association & Society members to best practices following units at various places in India, entrepreneur development programmes, etc., were offered during the year. The centres also carried out many machinery inspections under the credit linked capital subsidy scheme. Weaving units are also continuously getting the service of the centes for various aspects like new project report preparation, machinery valuation, techno-economic viability study, project appraisal, textile extension study tour, etc.

Many units in Coimbatore, Erode, Namakkal and Salem districts that have installed rapier looms in recent times have immensely benefitted from the various services offered by the centres.

The buyer-seller meets have created a good platform for manufacturers and have contributed to the huge volume of Indian poplin and cambric fabrics exported from these units.

Efforts taken by the SITRA powerloom service centres to implement the welfare schemes, under the Group Insurance scheme of Government of India, have benefitted about 43,632 workers engaged in weaving, twisting, warping and sizing units. Many awareness programmes were conducted by the PLSCs, most prominent being the Powertex India & GST Awareness Programme, Swachhta Pakhwada", Consumer awareness and the Government of India Schemes for Powerloom Sector.

The various services rendered by these powerloom service centres are given in Table 39. There has

been a drop in the utilisation of services by the industry during the year as compared to last year.

Table 39 Services rendered by the powerloom service centres (2017 - 18)

S. No.	Type of service	No. of services
1.	Consultations	168
2.	New designs development	263
3.	Yarn / cloth / chemical samples testing	32,535
4.	Training programmes (persons trained)	71 989
5.	Liaison / request visits	3,808
6.	Number of looms inspected	31,172
7.	Number of special works	188*

** Seminars / TUF meetings / Talks*

KNITTING DIVISION

SITRA undertakes knitting trials and suitably advices the spinning mills in the region to produce the required quality yarns. Apart from the above service, the knitting division is rendering several other important services like testing the knitted fabric, technical consultations, identification of the causes for the defects, sample development, machinery valuation, etc., In addition to the above, the knitting department is conducting seminars focusing on the latest trends in the knitting industry and providing training at various levels. The following services were offered during 2017 - 18.

- Testing of various quality parameters of knitted fabrics and garments
- Fabric faults, cause and remedial measures
- Consultancy services
- Conducting training programmes
- Preparing technical feasibility reports
- Machinery valuation and inspection

Karl Mayer warp knitting and warping machines are available at SITRA for mills/parties for samples development as well as product development in medical textiles.

The various services offered by the division in the year under review are given in Table 40. Compared to the previous year, there has been a marked increase in the utilisation by the industry of all the services offered by the division.

Table 40 Services offered by the knitting division (2017 - 18)

S. No.	Type of service	No. of services
1	Testing	4432
2	Samples knitting on FAK machine	1,369
3	Knitting performance of yarn	453
4	Consultation	204
5	Training programmes (persons trained)	3 (47)

DEFECT ANALYSIS WING

SITRA established during the year 2016 a separate wing for “Defect Analysis” which enables mills to send their yarn and fabric (woven and knitted) samples for analysis of defects. Fabrics can be analysed for both weave/knit faults as well as wet processing faults. Based on the analyses carried out, mills receive reports indicating the maximum possible evidences for the root cause of the problem in the sample(s) sent for analyses.

Ø Defects analyses

The various defects that can be assessed include contamination, stain, shade variation- barre or bands in knitted and woven fabrics or patches, colouration effects, blend irregularities, stress failure, holes due to chemical, mechanical or biological damage, etc.

Ø Re-engineering and design evaluation

Mills can guided on re-engineering and design evaluation of woven and knitted fabrics (Both warp and weft knitted fabrics).

Ø Sewability

Samples sent by mills would be evaluated for the performance of sewing threads / needles on different sewing machines that are available with SITRA.

Ø Appearance / Performance of woven and knitted fabrics
Details of the running performance of the yarns during knitting and details of grey fabric appearance like thick places, thin places, long thin places, long thick places, slubs and contaminations using SITRA method as well as on a 4 Point System of inspection method.

During the year, 1,527 samples were tested for the above parameters. The major testing services offered were Fabric observations (486), yarn count (151), ends and picks per Inch (51), weight per unit area (83), crimp % (40), bowness and skewness (34), fabric structure (34), yarn twist (25), compression pressure measurement (22) and others (601).

WEAVING CENTRE

SITRA's weaving centre is fully equipped with different types of shuttleless weaving machines like, Sulzer Projectile P700 HP, Picanol GTX Plus Rapier, Toyota JAT 710 Air-jet and Dornier LWV 4/E Air-jet machines to provide the following services to the textile industry to meet the global competition.

> Preparation of project proposals, model project reports and technical feasibility study reports for weaving units under Technology Upgradation Fund (TUF) scheme.

> Entrepreneur Development Programme for new entrepreneurs to start weaving units

> Conducting weavers' and maintenance training programmes on shuttleless weaving machines

.

> Consultancy services and liaison visits

> Product development and sample weaving

> Yarn performance study in shuttleless weaving machines

> Woven fabric defect analysis

> Management development programmes for sizing units

> Supervisory development programmes

> Training programme on fabric quality inspection and cloth analysis

> In-house training programmes for weaving units

Six yarn performance studies in shuttleless looms, 4 weaving consultancy assignments, 6 woven fabric defect analysis, 6 products development work, 24 sample weavings, 2 different training programmes wherein 7 persons were trained, were the major activities of the division during the year.

TEXTILE CHEMISTRY DIVISION

SITRA 's Textile Chemistry division, with nearly 4 decades of experience, has the skilled manpower and expertise in chemical processing, effluent treatment, chemical testing, consultancy, training, etc., to meet the ever increasing demands of today's industries. The laboratory is accredited by National Accreditation Board for Testing and Calibration Laboratories (NABL) and meets the requirements of ISO / IEC 17025: 2005 and its test reports are valid across the globe. The department's eco testing, water analysis and fibre & wet processing laboratories are equipped with State-of-the-art testing equipment to carry out testing on various aspects namely,

Ø Textiles (Fibre, yarn and fabric)
Ø Textile accessories
Ø Technical textiles
Ø Medical textiles
Ø Bio-degradability of chemicals
Ø Packing materials
Ø Water (Drinking water, construction water, bore well water, mineral water, etc)
Ø Waste water / Effluent (general and as per TNPCB norms)
Ø Industrial water

The lab has increased the number of parameters in the scope of accreditation by more than 200% compared to the previous cycle of accreditation which means increased range of testing of the products and improved recognition in the global market. Now, majority of the quality control tests required by buyers are included in the NABL scope of accreditation. The lab is also equipped with facilities required to carry out the tests required for organic certifications like Eco mark in India, Global Organic Textile Standard (GOTS), Global Recycling Standard (GRS), etc and pre-requisite testing for Oeko-Tex certification. The lab also has facilities for carrying out testing of oils, wax rolls, packing materials, sizing ingredients, etc., as per the requirements of the respective standards.

The environmental lab now has facilities required to test most of the parameters listed for testing of :

o Potable drinking water as per IS 10500: 2012
o Packaged drinking water as per IS 14543: 2016

- o Water for textile industry as per IS 201:1992
- o Laboratory grade water as per ISO 3696
- o Packaged natural mineral water as per IS 13428, etc.

Following are the latest additions during the recent past:

- ➢ Fluidity tester – to test the extent of chemical degradation of textile materials
- ➢ Scorch tester – to test the colour fastness to hot pressing and sublimation
- ➢ Biodegradability incubator – to test the bio-degradability of chemicals
- ➢ Additional soft flow dyeing machine – to analyse the dyeability of different lots of yarn

The lab has been renovated recently to bring the level of laboratory at par with other international laboratories. Further, the lab is equipped state-of-the-art equipment viz., UV-Vis spectrometer, Atomic Absorption Spectrometer (AAS), High Performance Thin Layer Chromatography (HPTLC), High Performance Liquid Chromatography (HPLC), Total Organic Carbon analyser (TOC), etc for testing of eco parameters. The lab carries out testing of various samples as per national and international standard test methods such as AATCC, IS, ISO, BS EN ISO, DIN, APHA, OECD, EN.

The department is involved in addressing the needs of industry for various technical problems. The areas covered under consultancy services include water consumption audits, technical troubleshooting, process optimization, technical feasibility study, dyeing with natural dyes, etc. The Tamilnadu Pollution Control Board (TNPCB) has recognized SITRA's textile chemistry department for carrying out water consumption studies at processing units. The department also takes up project appraisal for new and expansion projects, Technical guidance for setting-up of in-house quality control laboratory, Techno-economic viability study for processing units, etc. During the year, the department attended to as many 118 consultancy assignments, apart from many adhoc problems referred by them. The major consultancy services offered were water consumption audits (95) at processing units, technical trouble shooting of process / effluents treatement (16), technical accessability study (2), natural dyeing of nylon mono filament (1), preparation of reference material positive with formaldehyde and heavy metals (3) and technology know-how transfer (1).

The department also conducts various training programmes to industry as well as educational institutions on various areas such as fibre identification and blend analysis, process and quality control in textile chemical processing, water and effluent testing, practical aspects of wet processing, evaluation of functional properties of textile materials, Introductory / value added programmes on chromatography / spectroscopy and their applications along with hands-on training on state-of-the art analytical instruments like HPTLC, HPLC, AAS, UV-Vis Spectrometer. The year witnessed 4 different programmes offered by the division wherein104 persons were trained.

Staff of the department are also accredited by NABL as assessors to carry out assessment of testing laboratories as per ISO/IEC 17025 Standards. During the year, 11 assessments were carried out.

SITRA TEXTILE TESTING AND SERVICE CENTRE, TIRUPUR

In order to cater for the requirements of the knitting industry, textile processing units, export houses etc., in the region, SITRA has established a sample collection centre at Tirupur in the year 2005. Samples collected at the centre are brought to SITRA the same day. In many cases, results are reported to the customers within 24 hours, thus reducing considerably the turn around time. Based on customers' feedback, SITRA has upgraded the centre into an extension service centre and has completed the process of setting up a laboratory with essential instruments for physical and chemical testing of knitted fabric / garments, water effluent, chemicals etc. During the year 2015, the centre had moved to a spacious building to accomodate more instruments. With additonal instruments added during the year, the centre has been able to reduce the turnaround time of sending samples to SITRA and carry out testing for water / effluent testing, fibre identification & blend analysis, etc. The number of samples tested (1644) by this centre has increased by about 23% during the year 2017-18 compared to the previous year (1333 samples) while the number of tests performed during the year also witnessed an increase of about 40% at 2557 tests compared to 1830 during the previous year.

CENTRE OF EXCELLENCE FOR MEDICAL TEXTILES

The Centre of Excellence for medical textiles was established at SITRA under Mini Mission I of

Technology Mission on Technical Textiles (TMTT), promoted by Office of the Textile Commissioner, Ministry of Textiles, Government of India during the year 2010. The centre is actively involved in various activities such as prototype development, pilot scale production, testing and evaluation, training and seminars, standard formulations, incubation services, information resources, research and development, technical consultancy and Detailed Project Reports for new ventures. It has technical collaboration with institutes like Bolton University, UK, SASMIRA, Mumbai, Kings Institute, UK and PSG Institute of Advanced Studies under separate MoUs.

The centre has been equipped with several high-tech testing instruments for measuring various parameters for medical textile products. It has also developed many equipment on its own like the Synthetic Blood Penetration Resistance Tester (SBPRT), bacterial filtration efficiency tester, compression bandage pressure measurement system and particulate filtration efficiency tester.

The centre's activities also include development of many medical textile products like Bifurcated vascular graft, 3D compression bandages for Lymphedema, spunlace non-woven wound dressings for malodour wounds, breathable surgical gowns treated with nano finishes, barbed - bi-directional surgical sutures, hospital bed linens with enhanced thermal properties for coma patients, hernia mesh, clinical heart patch fabrics, insole line for diabetic shoes, etc. During the year, the centre developed wet wipes of different types, curcumin loaded wood pulp and chitosan coated gauze for different customers.

The department had prepared several DPRs as part of its activity to help new entrepreneurs in setting up of technical textile units. It was involved in the development of specifications / standards, apart from the development of prototypes. During the year, 10 such prototypes were developed. The department also offered consultancies on 10 different assignments.

Another activity of the department includes training of personnel from industry as well as fresh entrepreneurs on avenues in medical textiles. During the year, the department trained 1169 persons under 57 different programmes.

Staff of the department are also registered with the Bharathiar University, Coimbatore to guide students for their M.Phil and Ph.D. in Medical Textiles. Staff of the department also guided 4 masters students for their final year projects during the year.

SITRA MICROBIOLOGY AND BIO-TECH LABORATORIES

Towards providing diversified services under chemical testing, SITRA had started the microbiology testing facilities as an extension of its chemical laboratory in the year 2009. This NABL accredited laboratory is now under the CoE-Meditech and is well equipped to test samples as per international test standard of ASTM, AATCC,APHA and IS and has the facility to test samples for bacterial filtration efficiency, anti-bacterial activity assessment of textile materials : parallel streak method, anti-bacterial finishes on textile materials: assessment of testing for antibacterial activity and efficacy on textile products, anti-fungal activity, assessment on textile materials: mildew and rot resistance of textile materials, anti-microbial activity assessment of carpets, determining the anti-microbial activity of immobilized anti-microbial agents under dynamic contact conditions, anti-microbial susceptibility tests, methods of sampling and microbiological examination of water, heterotrophic plate count, ETO Sterilization, resistance of materials used in protective clothing to penetration by blood-borne pathogens using Phi X174 bacteriophage penetration as a test system, textile fabrics-determination of antibacterial activity-Agar diffusion plate test and determining the activity of incorporated anti-microbial agent(s) in polymeric or hydrophobic materials. During the year 2017-18, a total of 728 samples were tested by the microbilology laboratory and 638 samples by the biotech laboratory.

TEXTILE ACCESSORIES TESTING

SITRA offers testing service to evaluate the quality of spinning and weaving accessories / spares as per BIS standards. Moreover, training is imparted to the mill technicians on aspects like evaluation of quality characteristics, sampling procedures, etc. A total of 2,301 samples from 857 units covering various accessories like carton boxes, paper cones, rings and travellers, tubes, kraft papers, ring spinning bobbins, paper cones, etc., were tested during the year under review which is marginally higher than the numbers compared to the previous year.

SITRA CALIBRATION COTTONS

SITRA has been involved in the supplying calibration cottons to help mills in calibrating their High Volume Testing equipment. Currently available cottons include LL4, SL4, LM3 & HM3. During the year 2017-2018 the response from mills using SITRA calibration cottons have been overwhelming and SITRA has been receiving enquires from mills all over India. SITRA has supplied about 500 packets of calibration cotton to the mills during this period. Process to release a new set of calibration cotton sort is being made and will be available in the forthcoming months.

CALIBRATION AND PERFORMANCE CERTIFICATION FOR INSTRUMENTS

Calibrating testing equipment and maintaining their reports is a requirement as per quality systems like ISO and TQM. Many mills are seeking SITRA's help to get a "Calibration Certificate" for their textile testing and quality control instruments. SITRA's certificates are rated as equivalent to the national standards of the National Physical Laboratory (NPL), New Delhi. During the year under review, as many as 77 spinning, weaving and knitting units availed the service of SITRA to receive calibration certificates for 700 textile testing and quality control instruments. Testing the performance of instruments developed by SITRA and manufactured by its licensees is another important service rendered by SITRA. During the year, 2 instruments were thoroughly checked for their performance and certificates were issued.

PREPARATION OF TRAINING MANUAL FOR JOB ROLES IN TEXTILE MILLS

SITRA had been assigned the task of preparing National Occupational Standards and Qualification Packs(QPs) for various job roles in the textile sector by the Textile Sector Council (TSC) of the National Skill Development Council (NSDC) working under the Ministry of Skill Development, Govt. of India during the year 2015. Accordingly, SITRA has prepared the QPs for 12 job roles under the textile testing category, apart from the job role of powerloom operator. Subsequent to the validation of these QPs by the industry, they have been made available for the industry to carry out training under various job roles. Under PMKVY-2 it is mandatory that a training centre also maintains a manual of each job role under which training is carried out. Last year, SITRA prepared the manual for the job role of auto cone winding tenter. During the year, SITRA prepared the manual for the job role of powerloom operator.

TRAINING SERVICES

1. STAFF TRAINING

During the year under review, SITRA offered 17 different training programmes which include 16 functional programmes and 1 international training wherein a total of 1830 persons were trained. The details of the various programmes are given in Table 44.

A. Functional Programmes

SITRA's 38th Management Development Programme

The Management Development Programme organised every year by SITRA attracts young entrepreneurs interested in understanding the various aspects of textile mill management. Many young executives have immensely benefitted from this programme that have been conducted in previous years.

The intensive 2 months programme covers all the major aspects of mill management - material management, production and productivity, statistics and quality control, maintenance, financial management, energy management, personnel management, etc. Five young executives attended the programme which was held during October-November 2017.

Value added course on “New trends in textile printing”

As a part of the value addition course for their students, a private Engineering College in Coimbatore sought SITRA's services to conduct a three day programme during March 2017 covering the following topics:

- Pretreatment of textiles
- Introduction, styles, machines and methods of printing
- Practical demonstration of pigment & batik printing
- Digital printing
- New trends in printing
- Practical demonstration-tie & dye, sublimation print, transfer print

Industrial visits to 2 different manufacturing units at Tirupur carrying out digital and rotary printing on textile materials, screen preparation activities were also arranged to provide practical exposure to the students.

Table 41 SITRA's training and development programmes (2017-18)

S. No.	Name of the programme	Duration (in days)	Category		
			A	B	C
	Functional programmes				
1.	37th Management Development Programme	60	1	10	10
2.	Value added course on "New trends in textile printing"	3	1	1	35
3.	Training programme on quality assurance	2	1	1	15
4.	Two-day training programme on "Energy management in spinning mills"	2	1	24	77
5.	Technical awareness programme	2	1	1	80
6.	Training programme on "Energy management in spinning mills"	2	1	42	56
7.	Technical training programme	3	1	1	
8.	Training programme on "Maintenance management in spinning mills"	2	1	43	60
9.	In-House training programme on "Energy management in spinning mills"	2	1	23	30
10.	Value added course on Water Analysis	3	3	1	66
11.	Supervisory Development Programmes	3	3	3	80
12.	Training programme for production executives of AP Spinning Mills Association, Guntur.	2	1	48	60
13.	Training programmes on "Functional skills in testing & quality control for lab technicians"	3	1	17	31
14.	In-House technical awareness programme	5	1	1	7
15.	Technical awareness programme	3	1	1	25
16.	Training programmes under medical textiles	1-6	57	328	1169
	International programme				
17.	SITRA's 66th international training programme	60	1	16	29
	Total	-	77	-	1830

Note : A - Batches B - Orgnisations C - Participants

Training programme on quality assurance

At the request from a spinning mill in Mettupalayam, SITRA conducted a two-day training programme for quality control staff of their units. The focus of the programme was to highlight the testing procedures, measurement of various fibre properties, cotton specification in HVI & ICC modes, fibre yarn relationship, etc. Fifteen staff members attended the programme.

Two-day training programme on "Energy management in spinning mills"

Under request from AP Spinning Mills Association (APSMA), Guntur, SITRA conducted a 2 day training programme on the above subject during 9th and 10th September, 2017. Sixty seven electrical engineers from various member units of APSMA participated. Some of the topics covered in the programme included performane assessment of energy efficiency in electrical system, a holistic approach for PF improvement in a harmonic rich environment, energy conservation in humidification system, energy conservation in textile machines, calculation of UKG adjusted to 40s count, electrical failures from power quality perspective and power consumption in different types of yarns.

Technical awareness programme

At the request from a spinning mill in Coimbatore, SITRA conducted a two day training programme for their workers towards sensitizing them on various technical aspects. The topics covered in the programme included present textile scenario, work methods, duties and responsibilities of operatives in mills, etc. Eighty trainees attended the programme in four batches.

Training programme on "Energy management in spinning mills"

With a focus on the need for the textile industry to manage energy by ensuring its effective usage and conservation, SITRA conducted a training programme on "Energy management in spinning mills" during 21st and 22nd August, 2017. Fifty six participants representing 42 mills comprising of general managers, electrical engineers and electrical supervisors attended the programme which covered various topics like Importance of and economics of an energy conservation programme, performance assessment of energy efficiency in electrical system, energy conservation in textile machines and ancillaries, a holistic approach for PF improvement in a harmonic rich environment, calculation of UKG adjusted to 40s count & power consumption in different types of yarns, energy saving opportunities in lightings and pneumatic fittings, air leakage quantification and control methods, etc.

Supervisory development programme

At the request of a spinning mill in Guntur, Andhra Pradesh, SITRA conducted a two day training programme for their technical staff towards sensitizing them on the various technical aspects. The topics covered in the programme included production and productivity, quality control in spinning, online and offline process control, etc. Thirty trainees attended the programme.

Technical training programme

On request from ICAR, SITRA conducted a three day training programme for six of their technical officers. Various topics like process control in spinning, quality aspects, production and productivity, etc., required by the technical personnel for their day to day operations were covered during the programme.

Training Programme on "Maintenance management in spinning mills"

At the request from Andhra Pradesh Spinning Mills Association (APSMA), Guntur, Andhrapradesh, SITRA conducted a two-day training programme on maintenance management for the maintenance in-charges of the various members units of APSMA. Sixty participants spanning 43 units attended the training programme which covered a diverse range of topics of maintenance including facets of maintenance in spinning mills, key aspects of maintenance for quality assurance, maintenance of critical areas from blow room to winding, impact of maintenance on energy conservation, machinery audit lubricants and lubrication methods in maintenance, compressed air quality and its usage in machines and importance of inventory control in maintenance management.

In-House training programme on "Energy management in spinning mills"

Under request from Rajapalayam Mills Ltd., Rajapalayam, SITRA organised a two-day training programme on 17th and 18th November, 2017 at their unit. The programme focused on the need for managing energy by ensuring its effective usage and conservation. Thirty participants took part in the programme which covered variouse topics like economics of an energy conservation programme, energy management in textile machines and ancillaries, PF improvement in a harmonic

environment, calculation of UKG adjusted to 40s count, power consumption for different yarns, air leakage quantification and control methods, performance assessment of energy efficiency in electrical system, energy saving opportunities in lightings and pneumatic fittings, air leakage quantification and control methods, etc.

Value added course on water analysis

As a part of the value addition course for their students, a private Arts and Science college in Coimbatore retained SITRA's services to conduct a three day programme on water analysis during December 2017. Sixty six students, in 3 batches, attended the programme which covered both theoretical classes and practical demonstrations. The topics covered during the course were, introduction to water, volumetric analysis, analysis of anions and cations, analysis of BOD, COD, UV Vis, TOC & AAS and effluent analysis.

Supervisory Development Programmes

Under request from three different spinning mills, SITRA conducted in-house Supervisory Development Programmes for the supervisors of each unit. The programmes, conducted during September 2017 and the 2nd and 3rd week of February 2018 respectively, had a total of 80 participants taking part. Some of the topics that went into the training programme included, present textile scenario, process control in spinning, quality management in spinning mills, production and productivity, key maintenance issues for spinning mills, etc.

In-House technical awareness programme

At the request from Rajapalayam Mills, Rajapalayam, SITRA conducted a five-day training programme for their middle-level staff members. The programme covered the topics like raw materials in textile processing, fibre and yarn properties and the importance of their evaluation towards quality control, fabric defects and identification of their causes, quality control in chemical processing of yarns and fabrics, purity analysis, etc.

Training programme for production executives of AP Spinning Mills Association, Guntur.

Under request from the AP Spinning Mills Association, SITRA conducted a two-day training programme for the production executives of the various members units of the association. Key topics covered during the progamme included production planning and control, process issues affecting quality in spinning, effective maintenance practices for seamless production, productivity concepts and productivity improvements measures for spinning units. Sixty technicians, representing 48 units of the association, attended the programme.

Training programmes on "Functional skills in testing & quality control for lab technicians"

A 3-day training programme for the technicians working in quality control / testing laboratories, merchandisers, exporters, etc., was conducted in March 2018. Totally 31 participants attended this programme which covered topics like sampling techniques, testing of construction parameters of woven and knitted fabrics, colour theory & computer colour matching, colour fastness, inspection of garments and specific tests for garments, care label instructions, eco parameters, etc. Apart from the theoretical sessions, participants also had the opportunity to have practical demonstrations at the laboratories.

Technical awareness programme.

At the request of Rieter India Pvt. ltd., SITRA conducted a three day training programme for their service engineers towards sensitizing them on the various technical issues in spinning mills and the trouble shooting mechanisms for the same. Twenty five service engineers of the company attended the three day programme held during March 2018.

B. International Training Programme

International training, a programme sponsored by the Ministries of External Affairs and Economic Affairs, Govt. of India, under their sponsoring schemes viz., ITEC (Indian Technical and Economic Co-operation Plan) and Colombo Plan, is a regular feature of SITRA's training activity since 1974. More than 1650 participants from over 66 countries have so far been benefitted out of SITRA's expertise in textiles.

The 66th batch of this programme commenced on 11th October 2017 and was inaugurated by Dr. Prakash Vasudevan, Director, SITRA. Two courses, Textile Mill Management & Textile Testing & Quality Control were offered under this scheme. Twenty nine participants from 16 different countries, Afghanistan, Bangladesh, Belarus, Botswana, Egypt, Ethiopia, Guatemala, Nigeria,

Oman, South Sudan, Sudan, Swaziland, Tanzania, Uzbekistan and Zimbabwe attended the programme.

The valedictory function of the programme was held on December 10, 2017. Dr. Prakash Vasudevan, Director, SITRA presided over the valedictory function and distributed course completion certificates to the participants.

2. Labour Training

SITRA has been regularly conducting training programmes for the textile mill workers for the past 35 years. Many mills have utilized SITRA's services in this area this year as well, with as many as 752 shop floor workers being trained during the year. All the training programmes (51 batches) were organized at mills' premises in the respective regional languages (Table 42).

Table 42 Training programmes offered for shop floor workers in 2017-18

S. no.	Type of programme	Number of		
		Mills	Batches	Partici-pants
1.	Operatives training	13	44	732
2.	Ancillary labour training	3	6	70
3.	Training of Trainers	1	1	14
	Total	17	51	816

(I) Pre-employment and retraining programmes

Pre-employment training for new entrants and retraining programmes for the experienced workers were conducted in 19 mills, covering 732 operatives in 44 batches. Significant improvement was achieved in key elemental timings, incidence of waste, production rate and quality of output in all the programmes. Details of the operatives training programmes for spinning mills conducted in 2017 - 18 are shown in Table 43.

ii) Ancillary labour training

Retraining programme was conducted for 70 ring frame doffers in 3 mills. The doffers were trained to doff full cops and replenish empty cops using both the hands while doffing ring frames. Significant improvement was achieved in doffing time and controlling double gaiting.

Table 43 Break-up of operatives training programmes for spinning mills conducted in 2017-18

S. no.	Tenting jobs	Number of		
		Mills	Batches	Partici-pants
1.	Preparatory	2	4	60
2.	Ring frames	10	28	476
3.	Ring frame doffers	3	6	106
4.	Open end spinning	1	1	18
5.	Auto cone winding	2	4	59
6.	TFO	1	1	13
	Total	19	44	732

iii) Training of Trainers

A mill in Tamilnadu availed SITRA's services for the "Training of trainers programme" programme. The aim of the programme was to sensitize the trainers on key aspects at work that would enable them to to effectively discharge their roles and functions and achieve improvement in the mills' working. The important topics covered in the programme included productivity, quality management, waste reduction, proper planning and scheduling of activities, methods of training, identification of training needs, training evaluation, right work methods to be followed and effective communication and inter-personnel skills. A total of 14 trainers attended the programmes.

3. Skills Development Training Programmes Under SITRA – ISDS

The "Integrated Skill Development Scheme" initiated by the Ministry of Textiles, Govt. of India, aims to leverage the strength of institutions like SITRA to augment the skills of the personnel in industry for enhancing their capabilities. Under the main phase of this scheme in the 12th Plan period, SITRA is offering skill development programmes in the spinning, weaving and garment sectors. During the year, SITRA trained a total of 1404 persons in 109 batches.

ANCILLARY SERVICES FOR TEXTILE MILL OPERATIVES

1. Aptitude tests

Since the jobs in textile mills are mostly semi-skilled, repetitive and monotonous, it is of utmost importance to select only those individuals who would have these characteristics and would desire to do these jobs. By doing so, mills can not only ensure more productivity but also greater commitment and involvement amongst the employees.

SITRA's aptitude tests are exclusively designed to meet the specific requirements of assessing the ability or aptitude of employees to do the expected activities in the various departments of a textile mill. These tests are being effectively used by around 200 member mills for the selection of employees and they are appreciative of the effectiveness of these tests. The tests measure whether an individual has the capacity or latent ability to learn and perform a given job if adequate training is provided. The use of aptitude tests is advisable for fresh applicants who have little or no experience and may be used by the mills interested in selecting employees for whom training will result in greater performance. The tests are designed to cover the operatives for preparatory, spinning and weaving departments. Most of the jobs in these departments involve I) Visual acuity eg., ability to note end breakages, ii) Two hand coordination for working at machines eg., operations like piecing and knotting, iii) Finger dexterity eg., operations like piecing and knotting iv) Eye and hand coordination for operating the state-of-the-art machines and v) quick reaction time to respond to emergencies at the work place. All these psychophysical attributes are measured by using the three tests in the SITRA Aptitude Test Kit.

Since 2005, SITRA has included another sub-test to the Kit - colour blindness. Many times, it is observed that operatives suffering from colour blindness are unable to distinguish the subtle differences in colour variations as also identify the basic colour combinations. In order to ensure the best fit of operatives with the job, it is essential to screen out persons with this defect. During the year 2017-18, 13 aptitude test kits were purchased by the textile mills.

2. Multimedia DVDs on work methods

A new version of multimedia training materials, in DVD format, for the benefit of spinning mill operatives was released by SITRA in the year 2013. Like the earlier version of VCDs released by SITRA, this DVD version also will serve as a handy tool for spinning mills to educate operatives on the right ways and means of working in spinning mills. All departments from mixing to reeling are covered. The highlight of the DVD is the option available to users to select any of the 5 languages voice-over namely, Tamil, Telugu, Malayalam, Kannada and Hindi. An English version of the DVD is also available separately.

Departments covered: Mixing, blowroom, carding, combing, drawing, speedframe, ring spinning, open end spinning, manual cone winding, auto cone winding, ring doubling, two for one twisting and reeling.

During the year 2017-18, 13 DVDs were purchased by the textile mills.

CONFERENCES AND SEMINARS

Rajapalayam Spinners Forum (RSF), a consortium of spinning mills in Rajapalayam approached SITRA to conduct an awareness seminar towards identifying key areas that need attention in spinning mills and also to advise them on the possibilities for diversification. A seminar entitled, “Critical areas of focus for spinning mills and diversification possibilities” was held on 5th January, 2018. Dr.Prakash Vasudevan, Director, SITRA welcomed the delegates and Shri A.Ilavarasu, President, R.S.F. inaugurated it. The following papers were presented during the seminar :

- Market performance evaluation and its implications on the profitability of spinning mills - Mr.J.Sreenivasan, SITRA.
- Significance of energy management and why mills should undertake an energy audit regularly - Mr.M.Muthukumaran,
- Operational and process parameters influencing quality management in modern spinning mills - Mr.D.Jayaraman, SITRA.
- Diversification possibilities in speciality fibres - Mr.S.Kannappan, Product Development Manager, S.A. Anandan Spinning Mills, Rajapalayam.
- Polyester fibre solutions offered by Grasim - Mr. M.Natarajan, Asst. Vice President, Grasim Industries Ltd.
- Polyester- An engineered fibre - Mr.K.Pothiraj, Consultant -Techno Commercial-PSF, Shubhalakshmi Polyesters Ltd.

MOUs signed

During the year, Memorandums of Understanding were signed with the following organisations/ Institutions/agencies:

- The Tashkent Institute of Textile and Light Industry (TITLI), Tashkent, Uzbekistan towards establishing friendship and cooperation and promote exchanges between the two institutes in the area of textiles, specifically in the area of technology and scientific research, joint studies and surveys and training programmes.
- Centre for materials for electronics Technology (C-MET), a scientific society of the ministry of electronics and information technology, Government of India to develop a knowledge base in the electronic materials and their processing technology has signed MoU with SITRA COE to develop wearable device to screen breast cancer.
- Nitta Gelatin, a Japanese company and a leading manufacturer of Gelatin for pharmaceutical and edible applications in India, to work on targeted and controlled drug delivery system for medical applications.
- APRUS Bio-Medical Innovations Pvt. Ltd. ("APRUS"), a science-focused, technology-driven, forward-facing start-up company based out of Bangalore, India, to develop biodegradable hygiene products using biopolymers.
- Radeecal communications, to work jointly towards conducting Meditex conference for the next five years.
- Maxtech, for transfer of technical knowhow for the production of technical facemasks.
- The Synthetic & Art Silk Mills' Research Association (SASMIRA) to work jointly and for sharing of information in the area of R & D for the development of various products / processes.
- Applied Automation Systems Private Limited, a leading industrial automation company providing automation solutions to several engineering machine builders, to promote and support jointly applied and technological research and development in realms related to textile technology and textile manufacture in their respective organizations.
- Hydra, a niche consulting firm with specialization in supply chain management, value chain engineering, cluster science and developmental work, offering solutions and services to SMEs, to promote and support joint applied and technological Research and Development in their respective institutions, in realms related to textile technology, in general, and with emphasis on waterless dyeing or any other eco-friendly processing of textiles, in particular.
- Deven Supercriticals Private Limited(DSPL), Pune, a company designing, manufacturing and supplying Supercritical fluid processing equipment, to partner with SITRA to design, manufacture, and supply the Supercritical fluid processing pilot plant equipment and also provide technical support, scaling up and commercialisation based on the research inputs developed by SITRA and DSPL.
- Sree Chitra Tirunal Institute for Medical Sciences and Technology (SCTIMST), an Institute under the aegis of Department of Science & Technology, Govt. of India, for collaborative works for providing technical / testing / fabrication support for the development of variety of biomedical devices.
- AIC-NIFT-TEA Incubation Centre for Textiles and Apparels (supported by NITI-Aayog, Govt. of India), NIFT-TEA Knitwear Fashion Institute, Tirupur with the objective of encouraging cooperation between the two institutes to work in areas like sharing of faculty, documents and participation by observers in certain meetings/events and to recognize the developments made by each institute for mutual benefit.

COMMUNICATION

Library

SITRA library with its large collection of books and periodicals continued to attract many technicians from member mills as well as students from colleges and universities. During the year, close to 3000 visitors which included technicians, students

and outside specialists visited SITRA for utilising its rich collection of books and journals. Two hundred and thirty six books have been added to the existing bank of more than 26,000 books on various technical subjects, apart from textiles and management. SITRA has also been receiving more than 100 Journals on varied aspects on textiles and allied disciplines.

Publications

During the year, SITRA brought out 24 publications which included 2 research / inter-mill study reports, 12 online reports, 4 focus, 1 trends and 5 SITRA news publication (Annexure III).

SITRA scientists published 4 research papers in technical journals and presented 6 papers in conferences and seminars (Annexure VI).

ANNEXURE I

THE STAFF

DIRECTOR
Dr.Prakash Vasudevan, M.Sc. (Textile Engineering), Ph.D (Leeds)

SPINNING
Head of Division:
D.Jayaraman, M.Tech.

Senior Scientific Officers:
Nagarajan, M.Tech.

Scientific Officers:
M.K.Vittopa, M.Tech., A.M.I.E.
V.Vijayajothi, M.Tech.
R.Soundararajan, B.E.
S.Balamurugan, B.Tech.

WEAVING AND KNITTING
Assistant Director & Head of Division:
K.Balasubramaniyan, M.Tech.

Senior Scientific Officer:
S.Sounderraj, M.Tech.

Scientific Officers:
C.Vanithamani, B.Tech.
Vignesh Dhanabalan, M.Tech.

LIAISON AND CONSULTATION
Senior Scientific Officer & Head in-charge of Division:
J.Sreenivasan, M.Tech.

Senior Scientific Officers:
N.K.Nagarajan, M.Tech., MBA.
P.Subash, M.Tech.
N.Ravichandran, M.Tech.

Scientific Officers:
G.Santhana Krishnan, M.Tech.
Sambhaji Shivaji Chavai, M.Tech.

TEXTILE ENGINEERING & INSTRUMENTATION
Principal Scientific Officer & Head of Division:
M.Muthukumaran, B.E.

Senior Scientific Officers:
M.Muthuvelan, B.E., PGDBA., M.B.A., M.Phil (Mgmt).
N.Vasanthakumar, B.Sc., A.T.I.

Scientific Officers:
G.Ilango, DME.
S.Chandirasoodan, M.Tech.

TEXTILE PHYSICS
Senior Scientific Officer & Head in-charge of Division:
R.Pasupathy, M.Tech., M.B.A., A.M.I.E.
Scientific Officer:
M.Kumaran, M.Tech.

TEXTILE CHEMISTRY
Senior Scientific Officer & Head of Division :
S.Sivakumar, M.Tech., D.T.P

Senior Scientific Officer:
Dr.K.H.Prabhu, M.Tech., Ph.D

TRAINING
Principal Scientific Officer & Head of Division:
Dr.K.Sajjan Rao, M.Sc., M.Phil., Ph.D., PGDPM&IR, DIC.

CENTRE OF EXCELLENCE FOR MEDICAL TEXTILES
Principal Scientific Officer & Head of Division:
Dr. Ketankumar Vadodaria, M.Tech., Ph.D.

Senior Scientific Officers:
Dr.E.Santhini, M.Sc., Ph.D.
T. Sureshram, M. Tech.

Scientific Officers:
D.Veerasubramanian, M.Tech.
Abhilash Kulkarni, M.Sc., (Tech.)

ADMINISTRATION
Head - Finance and Cost Accounts:
K.Vadivazhaki, B.Com., A.C.A.

Head - HR:
R.Sivaram, MHRM, M.B.A.

Stores Officer:
M.Babu, B.E.

Principal Scientific Officer:
R.Suganthi, M.Sc., M.C.A., M.C.S.D., Net 07, OCA & OCP.

Secretary to Director:
N.Saradha Jayalakshmi, M.Sc., M.B.A.

Junior Officers:
V.Gopalakrishnan, M.A., M.L.I.S.
K.Prabha, M.Com., PGDCA

ANNEXURE I (Contd..)

THE STAFF

Total staff strength as on 31st March 2018

Officers	*:.....40*
Scientific/Technical assistants	*:.....33*
Administrative staff	*:.....9*
Skilled/Semi skilled & maintenance services	*:.....15*
Technical assistants on contract	*:.....3*
Total	***:..... .....100***

Powerloom service centres (Govt. sponsored)

Officers	*:.....3*
Scientific/Technical assistants	*:.....27*
Skilled/Semi skilled	*:.....4*
Total..: 34	

ANNEXURE II

VISITORS

Dr. Acquino Vimal, Joint Secretary (CNV & I division), Ministry of External Affairs, Govt. of India

Mr. H B Patil, Assistant Director, Karnataka State Textile Infrastructure Development Corporation Ltd. (KSTDC), Bengaluru.

Mr. P K Sharma, Scientist, Defence Research & Development Establishment (DRDE)

Dr. S B Singh, Director General, Life Sciences, Defence Research and Development Organization (DRDO)

Mr. Srikanth, Assistant Director, Department of Handlooms, Government of Andhra Pradesh.

Ms. Stephanie Leannne Dick, CEO and **Ms. Rebecca Barbara Unsworth,** Executive Director, Textile Institute, UK.

Mr. P Vinoth and Ms. M Subbalaskshmi, Scientists, Defence Research and Development Organization (DRDO), Bengaluru.

Mr.Anil.B.Joshi, Independent Director, **Mr.Devendra Daga**, Independent Director, National Textile Cooperation, New Delhi.

ANNEXURE III

SITRA PUBLICATIONS DURING 2017 - 2018

1. Research / Inter-mill study reports :

How to estimate sort-wise yarn to grey woven fabric conversion cost correctly? - SITRA Method.

Costs, operational performance and yarn quality: Inter-mill study of key factors (33nd study)
- *J.Sreenivasan and P. Subash*

2. Focus:

How techno-commercial parameters of compact yarn had changed during the last 8 years - *J.Sreenivasan, N.K. Nagarajan & Sambhaji S.Chawal*

Machinery audit in spinning mills :- A case study - *Soundarajan.R, N.K. Nagarajan & D.Jayaraman*

Market performance evaluation for cotton yarns - *J.Sreenivasan*

Top roller loading variations in ring frame and its impact on yarn quality : Case Study - *R.Soundararajan, S.Balamurugan & D.Jayaraman*

Effect of conditioning on snarling behaviour of yarns for weaving process : Some case studies - *M.K. Vittopa, J.Sathish, G.Nagarajan & D. Jayaraman*

How RMC and YSP had fluctuated in 2017-18? - An analysis - *J.Sreenivasan & Vinay Kulkarni.*

3. SITRA Trends:

Fibre to yarn conversion cost in 2016 - *J.Sreenivasan & P.Subash*

4. SITRA Etechletter:

5 issues

5. Other Publications:

Annual report 2016-17

ANNEXURE IV

SITRA DEVELOPMENTS

1. Machinery

Storage positive feed system for knitting machines
High speed reeling machine
High production cutting machine
High speed blending draw frame single delivery machine
"Spinfan" system for fancy yarns
SITRA - VOLKA ring frame
"Enerspin" drive system for ring spinning & doubling frames
SITRA "miniSPIN" - Miniature spinning plant for test runs
SITRA ENERCONER - Energy efficient drive control system for automatic cone winding machines
Energy and production information system for ring spinning frames "SITRA EnerInfosys"
Ener TFO
SITRA CIM
SITRA Microcontrol
Weavability Tester
High performance jute flyer spinning frame - SITRA Jute Flyspin
Micro controller based energy saving & information system for air compressors used in textile mills - SITRA PCRA ENERCOMP
SITRA PCRA Climocontrol

2. Fibre and Yarn Testing Instruments

Fibre bundle strength tester
Trash separator
Electronic twist tester
Electronic lea strength tester
Semi - Automatic twist tester
Motorised twist tester
Nep counter
SITRA motorised multi-board yarn appearance winder
Electronic load indicator for conventional lea strength tester (ELCONLEA)
SITRA rapid sample conditioner
SITRA- ABRATEST - Yarn abrasion resistance tester
Single yarn strength tester
Schnidt model yarn tension meter
Roving strength tester

3. Others

SITRAlised energy saving spindle tapes
SANTIMIT
Weft feeler mechanism to stop the loom for pirn changing
Energy efficient fans - SITRA excel fan
Infra colour dyeing machine
Shore hardness tester
Cyberscan bench top PH meter
Fabric stiffness tester
Drapemeter
Fabric thickness tester
MRG crimp tester
Fabric elongation tester
Fabric roughness/friction tester
UV Photocatalytic reactor
Self anchor suturing machine
CSP system and fabric strength tester
Fabric winding mechanism for powerlooms
Arterial prosthetic graft
SITRA pneuma kit
SITRA motor relay tester
Lab fabric dyeing machine
Soxhlet extraction mantles
Microprocessor based electronic balance
Launderometer
Crease recovery tester
Perspirometer
SITRA Enercool
Fabric compression tester
SITRA's Bacterial Filtration Efficiency Tester
SITRA's blood penetration resistance tester

SITRA may be contacted for the addresses of the Licensees

ANNEXURE V

LIST OF STUDIES / SERVICES RENDERED TO MILLS

Mills utilised SITRA's services and expertise for a wide range of their requirements. Some of the studies/services attended during 2017 - 18 were:

Water consumption and time study of soft flow dyeing machines (78), Technical troubleshooting at processing mills (20), Assessment of laboratories for NABL accreditation purpose (16), Machinery valuation (15), Technical consultancy for NTC group of mills (12), Techno economic viability study of spinning mills (12), Energy audit (7), Study on the process route and characteristics of cutting waste bleaching units (7), Humidification plant study (6), A study on yarn costing (2), Assessment of laboratories for NABL accreditation purpose (2), ACS for humidification plants and compressors (2), Cost reduction study in a spinning mill (2), Residual value and life of machines (2) .

Apart from the above, the following studies were also undertaken: Assessment of laboratories for NABL accreditation purpose, Compressed air system study, Dyeing of nylon monofilament using Haematin Black, Fabric costing study, Performance audit, Preparation of reference material containing Formaldehyde for a PT provider, Process optimization of printing on banana fibre mats, Production capacity assessment certificate for combers, Study on technical feasibility of setting-up a yarn and garment dyeing unit, Study on the water consumption of continuous dyeing and sizing machines, Technical feedback report (TFR) on modernisation valuation, Techno-economic viability study, Transformer loss evaluation study, Warping breakage study, Yarn costing study, Yarn realisation study, Characterization of facemasks, Spunlace application in Medical Textiles Segment, Designing of reusable face masks, Manufacturing technique on clean room garments, Design optimization of sanitary napkin, Optimization of wet and dry lining on surgical dressings, Characterization of reusable facemasks & sanitary napkin, Standardization of wet linting for BIS standards, Spunlace conversion using Vicose fibre for medical application, Technical specification on sanitary napkin.

ANNEXURE VI

PAPERS PUBLISHED IN JOURNALS AND PAPERS PRESENTED IN CONFERENCES

PAPERS PUBLISHED

D.Jayaraman, M.K.Vittopa & Prakash Vasudevan	"Influence of combing of polyester / cotton blended material on yarn quality compared to the traditional processes".	Asian Textile Journal, June 2017, Page No. 57 – 64.
R.Pasupathy, K.P. Chellamani B. Dhurai & V.Subramaniam	"Study on frictional characteristics of medical wipes in contact with mechanical skin equivalents".	Fibres & Textiles in Eastern Europe 2017; 25, 2(122): 120-127. DOI: 10.5604/12303666.1232874.
R.Pasupathy, K.P.Chellamani B.Dhurai, S.P.ThankaRajan B.Subramanian, E.Santhini	"Antimicrobial characteristics of pulsed laser deposited metal oxides on polypropylene hydroentangled nonwovens for medical textiles.	Fibres & Textiles in Eastern Europe 2017; 25, 2(122): 112-119. DOI: 10.5604/12303666.1228192.
E.Santhini and Ketankumar Vadodaria	Novel textiles in managing burns and other chronic wounds.	Advanced textiles for wound care, In: 8., Elsevier publications. 2018.
E.Santhini, S. Perumalsamy, R.Krishnakumar & Ketankumar Vadodaria	Mesh materials and hernia repair.	Biomedicine. Sep; 7(3): 16. (ISSN 2211-8039).
Abhilash Kulkarni and Ketankumar Vadodaria	Textile-based scaffolds for tissue engineering.	Advanced textiles for wound care, In: 12., Elsevier publications, 2018.

PAPERS PRESENTED

D.Jayaraman	Perspectives of the increasing significance of man-made fibres	Inauguration of SRTEPC regional office, SIMA, Coimbatore.
M.Muthukumaran	Energy management in spinning mills.	Technical seminar organized by M/s. Grasim Industries ltd., 22 May, 2017 at Dhaka, Bangladesh.
D.Jayaraman	Operational and process parameters influencing quality management in modern spinning mills.	Seminar on, "Critical areas of focus for Spinning mills and diversification possibilities", conducted by SITRA for the Rajapalayam Spinners Forum (RSF), Rajapalayam, 5th January, 2018.
M.Muthukumaran	Significance of energy management and why mills should undertake an energy audit regularly.	
J.Sreenivasan	Market performance evaluation and its implications on the profitability of spinning mills.	
E Santhini	Fabrication of wound dressings.	One day National Seminar on "Recent developments in Antimicrobial Textiles" organized by the Department of Textiles and Apparel Design" Periyar University, Salem, 27th Feb, 2018.
J.Srinivasan	Market performance evaluation and its implications and profitability of spinning mills.	Textile Research conclave organized by Tirupur Exporters Association(TEA) at IKFA convention center, Tirupur, 9th February 2018.
T. Sureshram	Medical textiles – products & opportunities for Tirupur industries	
S. Sivakumar & K H Prabhu	"A roadmap to sustainable textile processing – saltless dyeing & natural dyeing"	
S. Sivakumar	"Saltless dyeing of cotton material"	National level seminar held at PSG College of Technology, Coimbatore 28th April 2017.

ANNEXURE VII

MEMBERS OF COUNCIL OF ADMINISTRATION

Elected members

1. Dr. K.V.Srinivasan, Managing Director, Premier Mills Pvt. Ltd., Coimbatore. (Chairman).
2. Mr.Sanjay Jayavarthanavelu, Chairman & Managing Director, Lakshmi Machine Works Ltd., Coimbatore. (Vice - Chairman)
3. Mr. S.Dinakaran, Joint Managing Director, Sambandam Spinning Mills Ltd., Salem.
4. Mr. Durai Palanisamy, Managing Director, Shri Cheran Synthetic India Ltd., Pallipalayam
5. Mr. Gopinath Bala, Technical Director, Sri Venkatalakshmi Spinners (P) Ltd., Udumalpet.
6. Mr. K.Harish Kapil Kumar, Technical Director, Sri Kumaran Mills Pvt. Ltd., Coimbatore.
7. Mr. Prashanth Chandran, Managing Director, Precot Meridian Ltd., Coimbatore.
8. Mr.E.Sathyanarayana, Managing Director, Sree Sathyanarayana Spinning Mills Ltd., Tanuku.
9. Mr. J.Thulasidharan, Managing Director, The Rajaratna Mills Ltd., Coimbatore.
10. Mr. S.Venkat Kumar, Managing Director, Selvaraja Mills P. Ltd., Coimbatore.

Permanent Members

11. The Managing Director, National Textile Corporation, Southern Regional Office, Coimbatore.
12. The President, Madura Coats Pvt. Limited, Bengaluru.
13. The Wholetime Director, The Lakshmi Mills Co. Ltd., Coimbatore.

Directors of the Textile Research Associations of India

14. Dr. Anjan Kumar Mukhopadhyay, Director, The Bombay Textile Research Association, Mumbai.
15. Dr. Arindam Basu, Director General, Northern India Textile Research Association, Ghaziabad.
16. Dr. Harish Bisht, Officiating Director, The Ahmedabad Textile Industry's Research Association, Ahmedabad.
17. Dr. Prakash Vasudevan, Director, The South India Textile Research Association, Coimbatore.

Scientific / Technical Members

18. Dr. A.N.Desai, Retd. Director, The Bombay Textile Research Association, Mumbai.
19. Dr. J.Srinivasan, Professor and Head, Dept. of Fashion Technology, Kumaraguru College of Technology, Coimbatore.

Representatives of the Ministry of Textiles, Government of India.

20. The Additional Secretary & Financial Adviser, Ministry of Textiles, Govt. of India, New Delhi.
21. The Joint Secretary (R&D), Ministry of Textiles, Govt. of India, New Delhi.
22. The Textile Commissioner, Office of the Textile Commissioner, Govt. of India, Mumbai.

Representative of the Government of Tamil Nadu

23. The Commissioner of Handlooms and Textiles, Govt. of Tamil Nadu, Chennai.

Representative of the Tamil Nadu Handloom Weavers' Co-operative Society Ltd., Chennai.

24. The Managing Director, The Tamil Nadu Handloom Weavers' Co-operative Society Ltd., Chennai.

Representative of the Southern India Mills' Association

25. Chairman, The Southern India Mills' Association, Coimbatore.

Special invitees

1. The Director, Ministry of Textiles, Govt. of India, New Delhi.
2. The Chairman, Confederation of Indian Textile Industry, New Delhi.
3. The Director, Central Leather Research Institute, Chennai (CSIR representative).
4. Mr. Divyar S. Nagarajan, President, Dyers Association of Tirupur.
5. Ms. Kothai, Managing Director, Sree Jeya Soundaram Textile Mills P. Ltd., Aruppukottai.
6. Mr. Raja M. Shanmugam, President, Tirupur Exporters Association, Tirupur.
7. Dr. K.S Sundararaman, Executive Director, Siva Texyarn Ltd., Coimbatore.
8. Mr. Suresh Manoharan, Executive Director, Best Color Solutions (I) Pvt. Ltd., Tirupur.
9. Mr. Thiyagu Valliappa, Executive Director, Sree Valliappa Textiles, Ltd, Bangaluru.

ANNEXURE VIII

MEMBERS OF SUB-COMMITTEES

(A) Finance and machinery sub-committee

Dr. K.V.Srinivasan (Chairman)	Premier Mills Pvt. Ltd., Coimbatore.
Shri Sanjay Jayavarthanavelu (Vice-Chairman)	Lakshmi Machine Works Ltd., Coimbatore.
Shri E.Satyanarayana	Sree Satyanarayana Spinning Mills Ltd, Tanuku.
Dr. Prakash Vasudevan	Director, SITRA, Coimbatore.

(B) Staff and awards sub-committee

Dr. K.V.Srinivasan (Chairman)	Premier Mills Pvt. Ltd., Coimbatore.
Shri Sanjay Jayavarthanavelu (Vice-Chairman)	Lakshmi Machine Works Ltd., Coimbatore.
Shri J.Thulasidaran	The Rajaratna Mills Ltd., Palani.
Shri S.Venkat Kumar (Whole Time Director)	Selvaraja Mills Pvt. Ltd., Coimbatore.
Dr. Prakash Vasudevan	Director, SITRA, Coimbatore.

ANNEXURE IX

MEMBERS OF RESEARCH ADVISORY COMMITTEE

Members

1. Dr. K.V.Srinivasan, Premier Mills Private Limited, Coimbatore. (Chairman)
2. Mr. Sanjay Jayavarthanavelu, Chairman cum Managing Director, Lakshmi Machine Works Limited, Coimbatore (Vice Chairman)
3. Dr. Prakash Vasudevan, SITRA, Coimbatore. (Director)
4. Dr. Anjan Kumar Mukopadhyay, Director, The Bombay Textile Research Association, Mumbai.
5. Dr. Arindam Basu, Director General, Northern India Textile Research Association, Ghaziabad.
6. Shri. S. Dinakaran, Joint Managing Director, Sambandam Spinning Mills Ltd., Salem.
7. Shri. Gopinath Bala, Technical Director, Sri Venatalakshmi Spinners Pvt. Ltd., Udumalpet.
8. Dr. Harish Bisht, Director, The Ahmedabad Textile Industry's Research Association, Ahmedabad.
9. Shri. Harish Chandravel, Executive Director, Ram Narayana Mills Limited, Coimbatore.
10. Shri Kanthimanthinathan, President, Rajapalayam mills Limited, Rajapalayam.
11. Dr. Kavitha Gupta, The Textile Commissioner, Ministry of Textiles, GoI, Mumbai.
12. Ms. N. Kothai, Managing Director, Jeya Soundaram Textile Mills Private Ltd., Aruppukottai.
13. Shri. M.Muthupalaniappa, Vice President (Technical), representing Mr. T.Kannan, Thiagarajar Mills Ltd., Madurai.
14. Mr. B.K. Patodia, Vice Chairman-cum-Managing Director, GTN Textiles Ltd., Alwaye.
15. The Chairman & Managing Director, National Textile Corporation Ltd., New Delhi.
16. The Chairman, The Southern India Mills Association, Coimbatore.
17. The Commissioner of Handlooms and Textiles, Govt. of Tamil Nadu, Chennai.
18. The Director, Central Leather Research Institute, Chennai.
19. The Joint Secretary (R&D), Ministry of Textiles, Government of India, New Delhi.

Invitees

1. Shri. Ashok kumar, Technical Director, Saranya Spinning Mills Pvt Ltd., Namakkal.
2. Shri. K.Balasanthanam, MD, Kongoor Textile Process, Tirupur.
3. Dr. V.R.Giridev, Asst. Professor(Sr. Grade), Dept. of Textile Technology, AC College of Technology, Anna University, Chennai.
4. Dr.Peer Mohammed, Professor and Head, AC Tech, Anna University, Chennai.
5. Shri. Prashanth Chandran, Joint Managing Director, Precot Meridian Ltd, Coimbatore.
6. Shri. S Rajasekar, Joint Managing Director, Theni Gurukrishna Textile Mills Pvt Ltd., Theni.
7. Dr R Rajendran, Associate Professor, Dept. of Microbiology, PSG College of Arts & Science, Coimbatore.
8. Dr. A. Ramamoorthy, Coimbatore.
9. Shri. Sethuramalingam, Chief General Manager, Eveready Spinning Mills, Dindigul.
10. Dr. J.Srinivasan, Professor, Dept of Fashion Technology, Kumaraguru College of Technology, Coimbatore.
11. Shri. Sri Hari Prasad, MD, Kadri Wovens, Unit of Kadri Mills, Perundurai.
12. Dr. V.Subramaniam, Director, Dept. of Textile Technology, Jaya Engineering College, Chennai.
13. Dr. S. Surees Kumar, Registrar, Department of General Surgery, Sri Ramakrishna Hospital, Coimbatore.
14. Dr. Umamaheswari. K, Associate Dean, Dept. of Medical Nanotechnology, School of Chemical & Biotechnology, SASTRA.

ANNEXURE X

COMMITTEES IN WHICH SITRA STAFF REPRESENTED

Chairman, Hosiery Sectional Committee, TX 10, Bureau of Indian Standards, New Delhi.

Chairman, Medical Textiles Committee Tx 36, Bureau of Indian Standards, New Delhi.

Member, Advisory committee for AIC NIFT TEA incubation centre for Textiles and Apparels.

Co-opted member of Governing committee NIFT - TEA.

Member, Sub-committee for manpower planning for the textile engineering industry constitued by India ITME Society, Mumbai.

Member, Project management committee for Mini Mission III and Mini Mission IV of Jute Technology Mission.

Supervisor, Ph.D & M.Phil. Programmes (Textile Technology), Anna University, Chennai.

Member, TX 0I & TX 05 Committees, Bureau of Indian Standards, New Delhi.

Member, Panel of Experts for the Constitution of Selection/ Assessment Committees in Textile Technology, National Institute of Science Communication.

Member, Board of Studies in Textile Technology, PSG College of Technology, Coimbatore.

Member, Council of National Jute Board, Kolkata.

Member, All India Powerloom Board, Ministry of Textiles, Government of India, New Delhi.

Member, Advisory Committee & member, Staff Selection Board, Textile Technology Department, Kumaraguru College of Technology, Coimbatore.

Member, Council of Administration, SIMA Cotton Development & Research Association.

Member, Cotton Advisory Board, Ministry of Textiles, Govt. of India.

Member, Cotton Development & Research Association, New Delhi.

Member, Board of Examiners of Indian Institute of Handloom Technology, Salem.

Member, CII, Southern Region, Textile Sub-committee.

Expert member, Board of studies in Textile Technology, Bannari Amman Institute of Technology (Autonomous), Sathyamangalam.

Member, Confederation of Indian Industries (CII), Coimbatore zone.

Member, Sardar Vallabhbhai Patel International School of Textiles and Management, Coimbatore.

Member, Cotton Selection/purchase committee, KVIC, Chitradurga.

Member, Technical Sectoral Expert Committee of Textile Sector under PAT Scheme of Bureau of Energy Efficiency (BEE), New Delhi.

Member, Board of Studies (BoS) in Textile Technology (TT) Karpagam University, Coimbatore.

Member Board of Studies (Bos) in Psychology, PSG College of Arts & Science, Coimbatore.

Member Board of Studies (Bos) in Psychology, Govt. Arts College, Coimbatore.

Member, Board of Studies (BoS) in Psychology, Bharathiar University, Coimbatore.

Member, Board of studies (BoS) in Textile Technology and Textile Chemistry departments of Anna University, Chennai.

Member, Textiles speciality chemicals and Dyestuffs sectional committee, TXD 07, Bureau of Indian Standards, New Delhi.

ANNEXURE XI

SITRA MEMBER MILLS

Full Members

1 Adwaith Textiles Limited
1 Adwaith Textiles Limited
2 Alagendra Textiles Limited
3 Amarjothi Spg. Mills Ltd.
4 Anna Co-op. Spg. Mills Ltd.
5 Annamalaiar Mills Private Ltd.
6 B K S Textiles Private Limited
7 B R T Spinnerrs Limited
8 Best Cotton Mills (P) Ltd
9 Cardwell Spinning Mills Limited
10 Chenniappa Yarn Spinners (P) Ltd
11 Chida Spg. Mills (P) Ltd.
12 Coimbatore Polytex Private Ltd.
13 D B V Cotton Mills (P) Ltd.
14 Eastman Spinning Mills (P) Ltd.
15 Emperor Textiles (P) Ltd
16 Ennar Spinning Mills (P) Ltd
17 G T N Industries Ltd
18 G T N Textiles Ltd.
19 G V D Textiles (P) Ltd
20 Gokak Mills (4)
21 Gopalakrishna Textile Mills Pvt. Ltd
22 Harshini Textiles Ltd
23 Himatsingka Seide Limited
24 Hindustan Cotton Spinning Mills
25 Jai Sakthi Mills
26 Jay Textiles -Unit II (Super Sales India Ltd.)
27 Jayavarma Textiles (P) Ltd - Unit 2
28 JVS Spinners (India) Limted
29 K K P Spinning Mills Ltd
30 Kallam Spinning Mills Ltd
31 Kandagiri Spg. Mills Ltd - Unit I
32 Kaveri Yarns and Fabrics Ltd.
33 Kayaar Exports Private Limited
34 Kesharinandan knit fabrics P Ltd
35 L S Mills Ltd.
36 Lakshmi Machine Works Ltd.
37 Madura Coats Private Limited (4)
38 MAG Solvics (P) Ltd
39 Mallur Siddeswara Spg. Mills Pvt. Ltd.
40 Maris Spinners Ltd.
41 Marudhamalai Sri Dhandapani Spinning Mills
42 Modern Cotton Yarn Spinners Limited
43 NKCM Spinners Pvt Ltd
44 Nandhi Vardhana Textile Mills Limited
45 Narasu's Spg. Mills
46 National Textile Corporation (TN&P) Ltd. (16)
47 Prabath Spinner India
48 Prachidhi Spinners Pvt. Ltd,
49 Precot Meridian Ltd. (5)
50 Premier Mills Private Ltd.
51 Premier Spg. & Wvg. Mills Ltd.
52 Premier Tex Products P.Ltd
53 Prithivraj Textiles
54 Rasi Tex (IN) P. Ltd.
55 Rithanyaa Textiles
56 S.A. Aanandan Spinning Mills (P) Ltd
57 S C M Textile Spinners
58 S P Spinning Mills Ltd.
59 S.P Apparels - Spinning Unit
60 S.S.K.Textiles
61 Sahana Textiles
62 Salona Cotspin Limited
63 Sangeeth Textiles Ltd.
64 Sarmangal Synthetics Limited
65 Saudagar Enterprise
66 Selvaraja Mills Pvt. Ltd.
67 Senthilkumar Textile Mills Private Limited, Erode
68 Seyad Cotton Mills Ltd.
69 Seyadu Spinning mills
70 Shanmugappriya Textiles Ltd.
71 Shiva Texyarn Limited
72 Shri Cheran Synthetics India Ltd
73 Shri Govindaraja Mills Ltd,- B Unit
74 Shri Ramalinga Mills Ltd.
75 Shri Santhosh Meenakshi Textiles Private Limited
76 Soundararaja Mills Ltd.
77 Southern Spinners and Processors Limited
78 Sowmiya Textiles Private Ltd
79 SP Superfine Cotton Mills (P) Ltd
80 SRG Apparels
81 Sree Ayyanar Spg. & Wvg. Mills Ltd - Unit (2)
82 Sree K N M Spg. Mills (P) Ltd.
83 Sree Narasimha Textiles (P) Ltd.
84 Sree Satyanarayana Spg. Mills Ltd.
85 Sri Gomathy Mills Private Limited
86 Sri Kannapiran Mills Ltd.
87 Sri Kannattal Mills P. Ltd.
88 Sri Karthikeya Spg. & Wvg. Mills Ltd.
89 Sri Karunambikai Mills Pvt. Ltd
90 Sri Kumaran Mills Limited.
91 Sri Lakshmi Saraswathi Textiles (Arni) Ltd.
92 Sri Mahasakthi Mills Ltd
93 Sri Muni Pachaiyappan Textiles (P)Ltd.
94 Sri Nachammai Cotton Mills Ltd.
95 Sri Ramakrishna Mills (CBE) Ltd.
96 Sri Ramnarayan Mills Ltd.
97 Sri Ranga Textiles (P) Ltd.
98 Sri Sharadhambika Spintex P.Ltd
99 Sri Shanmugavel Mills Pvt. Ltd.
100 Sri Varadaraja Textiles Ltd.
101 Sri Venkatalakshmi Spinners (P)Ltd.
102 Sri Vasudeva Textiles Limited Unit III
103 Sri Vignesh Yarns (P) Limited
104 Subadra Textiles Pvt. Ltd.
105 Super Spg. Mills Ltd. (5)
106 T T Limited-(Unit Tirupathi Spinning Mills)
107 The Banhatti Co-op. Spg. Mills Ltd.
108 The Bharathi Co-op. Spg. Mills Ltd.
109 The Kadri Mills (CBE) Ltd. (13)
110 The Lakshmi Mills Co.Ltd. (4)
111 The National Sewing Thread Co.Ltd
112 The Palani Andavar Mills Ltd.
113 The Pondicherry Co-op. Spg. Mills Ltd.
114 The Pudukkottai District Co-op Spg Mills Ltd
115 The Rajaratna Mills Ltd. (2)
116 The Ramanathapuram District Co-operative Spg Mills
117 The Southern Textile Ltd
118 The Tamilnadu Handloom Weavers' Co-p. Society Ltd
119 The Tamilnadu Textile Corporation Ltd
120 Tirupur Textiles Private Ltd. (3)
121 Tirupur Thirukkumaran Textiles (P) Ltd
122 Tradeline Enterprises Pvt Ltd
123 Umayal Spinners (P) Ltd
124 V.R.Textiles
125 Veejay Lakshmi Textiles Limited (2)
126 Veejay Syntex Pvt. Ltd.
127 Vijay Velavan Spinning Mills (P) Ltd
128 Vishnu Lakshmi Mills (P) Ltd
129 Viswabharathi Textiles Ltd.

Associate Members

1 Ashoka Multiyarn Mills Limited
2 Br.Sheshrao Wankhede Shetkari Sahakari Soot Girni Ltd
3 Eurotex Industries & Exports Ltd.
4 Gimatex Industries Pvt.Ltd
5 Ginni Filaments Ltd
6 Gloster Jute Mills Ltd
7 Gujarat Heavy Chemicals Ltd. Unit : Sree Meenakshi Mills
8 Kanco Overseas
9 Kangwal Textile Company Limited,
10 Keshar Multiyarn Mill Ltd
11 Loyal Textile Mills Ltd.
12 Mahalakshmi Fibres & Industries Ltd.
13 Maharaja Shree Umaid Mlls Ltd
14 Nagammal Mills Ltd.
15 Nagreeka Exports Ltd.

Note: Figures in brackets indicate number of units

ANNEXURE XI (Condt..)

SITRA MEMBER MILLS

16 P B M Polytex Ltd. (2)
17 Pee Vee Textiles Limited
18 Pratibha Syntex Limited
19 PT. Indo Liberty Textiles
20 Rajapalayam Mills Ltd.
21 Rieter India (P) Ltd
22 RSWM Limited (4)
23 Reliance Industries Ltd.
24 Rishab Spinning Mills (Prop.Nahar Exports Ltd.)
25 Sambandam Spg Mills Ltd.
26 Shetkari Sahakari Soot Girni Ltd.
27 Siddhi Industries Limited
28 Sree Valliappa Textiles Ltd.
29 Sri Jayajothi & Co Ltd
30 STI India Limited
31 Suryalakshmi Cotton Mills Ltd.
32 The Gobald Textiles Pvt. Ltd.
33 The Jamshri Ranjitsinghji Spg.& Wvg.Mills Ltd.
34 The Suguna Mills Pvt. Ltd.
35 Thiagarajar Mills Ltd. (2)
36 Vardhaman Yarns & Threads Limited
37 Vippy Spinpro Ltd
38 Visaka Industries Ltd.
39 Voltas Ltd.

Technical Support Scheme Members

1 Prathishta Weaving and Knitting Co Ltd
2 Anithaa Weaving Mill (P) Ltd
3 Sri Choleeswarar Spg. Mills,
4 East India Commercial Co. Ltd.,
5 Bio-Craft
6 Jayanthi Textile Products
7 A.R.Appasamy
8 Fangle Exports.
9 Golden Fashions (India) P Ltd
10 Lakshmi Spinners
11 S.N.N. Textiles Private Limited
12 Kanakalakshmi Mills (P) Ltd.,
13 Kikani Exports Pvt Ltd
14 Nilgiri Textiles(P)Ltd
15 Sri Jagannatha Spinners Pvt.Ltd
16 Veejay Terry Product Ltd.,
17 Sre Venkatachalapathy Textile
18 PEE AAA IMPEX
19 Hanjung Exim Private Limited
20 Unique Multichem
21 Techno Electronics & Instruments
22 Muthu Spinning Mills Private Ltd.,
23 Sri Krishna Textiles Palladam
24 Anishkumar Spinning Mill
25 Rimtex Engineering Pvt. Ltd.,
26 Yuvraj Lube and Petrochemical Pvt Ltd.,
27 Dhanalakshme Textiles
28 Jacquard Fabrics (India) P.Ltd.,
29 V.Thangavel & Sons Private Limited
30 Arunachala Weaving Mills
31 Irulappa Mills India P Ltd
32 Amman Spinning Mills

FINANCIAL STATEMENTS
AS ON
31st MARCH 2018

THE SOUTH INDIA TEXTILE RESEARCH ASSOCIATION

COIMBATORE - 641 014

Independent Auditor's Report

To
The Members of The South India Textile Research Association

Report on the Financial Statements

1. We have audited the accompanying financial statements of The South India Textile Research Association(the "Association"), which comprise the Balance Sheet as at March 31,2018 and Income and Expenditure Account for the year then ended.

Management's Responsibility for the Financial Statements

2. The Association's Management is responsible for the preparation of these financial statements that give a true and fair view of the financial position and financial performance of the Association. This responsibility includes the design, implementation and maintenance of internal control relevant to the preparation and presentation of the financial statements that give a true and fair view and are free from material misstatement, whether due to fraud or error.

Auditor's Responsibility

3. Our responsibility is to express an opinion on these financial statements based on our audit. We conducted our audit in accordance with the Standards on Auditing issued by the Institute of Chartered Accountants of India. Those Standards require that we comply with ethical requirements and plan and perform the audit to obtain reasonable assurance about whether the financial statements are free from material misstatement.

4. An audit involves performing procedures to obtain audit evidence, about the amounts and disclosures in the financial statements. The procedures selected depend on the auditors' judgment, including the assessment of the risks of material misstatement of the financial statements, whether due to fraud or error. In making those risk assessments, the auditors consider internal control relevant to the Association's preparation and fair presentation of the financial statements in order to design audit procedures that are appropriate in the circumstances, but not for the purpose of expressing an opinion on the effectiveness of the entity's internal control. An audit also includes evaluating the appropriateness of accounting policies used and the reasonableness of the accounting estimates made by Management, as well as evaluating the overall presentation of the financial statements.

5. We believe that the audit evidence we have obtained is sufficient and appropriate to provide a basis for our audit opinion.

Opinion

6. In our opinion, and to the best of our information and according to the explanations given to us, the accompanying financial statements give a true and fair view in conformity with the accounting principles generally accepted in India:

   (a) in the case of the Balance Sheet, of the state of affairs of the Association as at March 31, 2018; and
   (b) in the case of the Income and Expenditure Account, of the Excess of Expenditure over Income for the year ended on that date.

7. We report that:

   (a) We have obtained all the information and explanations which, to the best of our knowledge and belief, were necessary for the purpose of our audit;

   (b) The Balance Sheet and Income and Expenditure Account dealt with by this Report are in agreement with the books ofaccount;

For P.N.RaghavendraRao& Co.,
Chartered Accountants
Firm Registration Number: 003328S

Pon Arul Paraneedharan
Partner
Membership Number:212860

Coimbatore
August23, 2018

THE SOUTH INDIA TEXTILE RESEARCH ASSOCIATION

BALANCE SHEET AS AT 31ST MARCH 2018

Amount in "Rs."

Particulars	Schedule No.	2017-18	2016-17
LIABILITIES			
Corpus/Capital Fund	1	2,80,51,468	2,78,51,604
Capital Grant from Ministry	2	39,33,32,003	38,09,63,325
Reserves and Surplus	3	59,65,38,010	58,51,01,895
Current Liabilities and Provisions	4	8,75,23,847	10,34,53,653
TOTAL (A)		**1,10,54,45,328**	**1,09,73,70,477**
ASSETS			
Fixed Assets - Net Block	5 & 6	53,30,61,876	52,29,20,873
Investments	7	40,24,63,628	41,73,16,133
Sponsored Projects - Grant Receivable	8	1,84,04,520	75,68,628
Current Assets, loans, Advances etc	9	15,15,15,304	14,95,64,843
TOTAL (B)		**1,10,54,45,328**	**1,09,73,70,477**

"Vide our report of even date"
For P.N.Raghavendra Rao & Co.,
Chartered Accountants
Sd/-
(Pon Arul Paraneedharan)
Partner

Place : Coimbatore
DATE: 23/08/2018

(Sd/-) K V Srinivasan (Chairman)
" Prakash Vasudevan (Director)
" E Sathyanarayana

THE SOUTH INDIA TEXTILE RESEARCH ASSOCIATION

INCOME AND EXPENDITURE ACCOUNT FOR THE YEAR ENDED 31ST MARCH 2018

Amount in "Rs."

Particulars	Schedule No.	2017-18	2016-17
INCOME			
Income from Services	10	7,84,95,844	7,04,01,727
Membership/Ministry Contribution	11	1,64,98,548	2,11,77,030
Sponsored Projects - Overhead Recoveries	12	30,14,263	42,35,151
Interest Income	13	31,15,222	31,00,421
Other Income	14	52,19,105	34,92,958
TOTAL (A)		**10,63,42,981**	**10,24,07,287**
EXPENDITURE			
Establishment Expenses	15	8,41,25,235	8,26,50,565
Administrative Expenses	16	1,73,71,511	1,72,32,803
Repairs and Maintenance	17	95,06,062	75,06,607
Stores Consumed	18	32,78,792	27,59,270
Finance Charges	19	14,030	9,896
Sponsored Projects - SITRA Contribution	20	44,58,250	31,87,531
Depreciation	21	86,02,493	81,37,667
TOTAL (B)		**12,73,56,373**	**12,14,84,339**
Balance being excess of Expenditure over Income for the year		(2,10,13,391)	(1,90,77,052)
Appropriated from Corpus fund for R&D		2,93,733	-
Appropriated from Infrastructure Dev. & Maintenance Reserve		21,11,354	12,31,044
Appropriated from Staff Benefit Reserve (Payment of Terminal Benefits)		1,94,17,399	2,10,75,383
Appropriated from Depreciation Reserve		17,86,948	17,00,103
Appropriated from General Reserve		10,10,399	10,53,557
Balance Surplus		**36,06,442**	**59,83,035**
Transfer to Staff Benefit Reserve		30,00,000	50,00,000
Transfer to General Reserve		**6,06,442**	**9,83,035**

"Vide our report of even date"

Place : Coimbatore
DATE: 23/08/2018

For P.N.Raghavendra Rao & Co.,
Chartered Accountants
(Sd/-)
(Pon Arul Paraneedharan)
Partner

(Sd/-) K V Srinivasan (Chairman)
" Prakash Vasudevan (Director)
" E Sathyanarayana

THE SOUTH INDIA TEXTILE RESEARCH ASSOCIATION

Schedules to Balance Sheet for the year ended 31.03.2018

Amount in "Rs."

Schedules	2017-18	2016-17
Sch - 1		
Corpus/Capital Fund		
Contribution from Member Mills	2,78,51,605	2,81,91,057
Add: Received during the year	3,32,660	5,27,750
	2,81,84,265	2,87,18,807
Less: Profit / (Loss) on Disposal of Assets	(1,32,797)	(8,67,203)
Total	**2,80,51,468**	**2,78,51,604**
Sch - 2		
Capital Grant from Ministry		
Cotton Textile Fund Committee	12,53,791	12,53,791
Council of Scientific and Industrial Research	22,69,513	22,69,513
Ministry of Textiles	29,66,019	29,66,019
MOT/Office of the Textile Commissioner - Spon Projects	10,94,43,581	10,91,32,492
Ministry of Textiles - Sponsored CAD Centre	48,82,780	48,82,780
Ministry of Textiles - Centre of Excellence - Meditech	21,49,97,720	20,58,16,760
MOT/Office of the Textile Commissioner - PLSC	5,75,18,599	5,46,41,970
Total	**39,33,32,003**	**38,09,63,325**
Sch - 3		
Reserves & Surplus		
General Reserve	19,77,24,075	18,35,26,634
Asset Stabilisation Reserve	5,96,44,646	6,67,14,596
Corpus fund for Research and Development Reserve	9,18,67,688	8,77,07,022
Infrastructure Development and Maintenance Reserve	6,26,22,450	6,10,65,450
Staff Benefit Reserve - SITRA	5,19,21,764	6,36,86,424
Staff Benefit Reserve - PLSC	1,26,75,566	86,45,332
Depreciation Reserve Invt.Interest	12,00,81,821	11,37,56,437
PLSC/CAD Centre Reserve	(75,80,517)	(76,02,241)
Less: Transferred to Sitra General Reserve	75,80,517	76,02,241
Total	**59,65,38,010**	**58,51,01,895**
Sch - 4		
Current Liabilities & Provisions		
Current Liabilities		
Unspent grant		
Unspent grant - SITRA	41,35,715	15,67,071
Unspent Grant - Integrated Scheme PSC's	31,99,213	52,00,000
Unspent grant - ISDS	2,58,98,048	3,82,70,365
Unspent grant - COE	3,62,13,281	4,17,41,467
Liability For Expenses & Others	64,13,867	88,99,724
Total (A)	**7,58,60,124**	**9,56,78,627**
Provisions		
ISDS Provision for Expenses	72,37,258	-
Provision for Expenses -SITRA	42,43,308	60,78,910
Provision for Expenses - PLSC	1,83,157	16,96,116
Total (B)	**1,16,63,723**	**77,75,026**
Total (A + B)	**8,75,23,847**	**10,34,53,653**

THE SOUTH INDIA TEXTILE RESEARCH ASSOCIATION

Schedules to Balance Sheet for the year ended 31.03.2018

Amount in "Rs."

Schedules	2017-18	2016-17
Fixed Assets		
Sch - 5		
Gross Assets		
Lands	7,83,712	7,83,712
Building - SITRA	3,47,27,334	3,47,27,334
Building - COE	8,51,76,526	8,51,76,526
Building - ETP WIP	7,72,315	-
Plant and Machinery	13,85,15,333	13,23,12,985
Furniture & Fittings	80,51,234	77,13,463
Computer And Accessories	86,86,386	78,84,027
Library	30,09,571	28,21,534
Vehicle	14,89,840	14,89,840
Total	**28,12,12,251**	**27,29,09,421**
Sch - 6		
Fixed Assets under Sponsored Projects		
The South India Textile Research Association	6,75,21,427	6,90,38,853
Integrated Skill Development Scheme	2,42,91,138	2,42,91,138
Centre of Excellence - Meditech	21,87,44,557	21,12,77,026
Powerloom Service Centre (Including own Assets)	5,81,09,979	5,52,53,546
Total	**36,86,67,101**	**35,98,60,563**
Total Gross Block	**64,98,79,353**	**63,27,69,984**
Depreciation Reserve		
Depreciation Reserve - Building	1,50,58,245	1,28,05,878
Depreciation Reserve - Computer & Accessories	29,32,054	27,34,518
Depreciation Reserve - Furniture And Fixtures	26,04,052	24,20,269
Depreciation Reserve - Plant & Machinery	9,05,61,725	8,73,13,840
Depreciation Reserve - Vehicles	4,33,007	3,52,604
Depreciation Reserve - Library	6,24,809	3,14,606
Depreciation Reserve - ISDS	46,03,585	39,07,396
Total	**11,68,17,477**	**10,98,49,111**
Net Block	**53,30,61,876**	**52,29,20,873**
Sch - 7		
Investments		
Depreciation Reserve Investment - SITRA	19,52,55,805	19,39,48,335
Corpus Reserve for Research and Development Investment	7,12,84,148	6,88,98,330
Infrastructure Development & Maintenance Reserve Investment	5,93,11,500	6,04,48,161
Staff Benefit Reserve Investment - SITRA	4,56,67,832	3,53,05,348
Staff Benefit Reserve Investment - PLSC	35,41,748	40,99,438
General Reserve Investment	2,74,02,595	5,46,16,521
Total	**40,24,63,628**	**41,73,16,133**
Sch -8		
Sponsored Projects - Grant Receivable		
As per Schedule	1,75,26,889	57,90,997
Non Plan Grant Receivable	-	9,00,000
Grant Not Realised	8,77,631	8,77,631
Total	**1,84,04,520**	**75,68,628**

THE SOUTH INDIA TEXTILE RESEARCH ASSOCIATION

Schedules to Balance Sheet for the year ended 31.03.2018

Amount in "Rs."

Schedules	2017-18	2016-17
Sch - 9		
Current Assets, loans, Advances etc		
Sundry Debtors		
Sundry Debtors	66,41,497	32,11,566
Total	**66,41,497**	**32,11,566**
Cash & Bank Balances		
Cash on Hand	2,14,055	2,14,328
Cash at Bank	53,84,254	59,49,433
Cash at Bank Sponsored Project	7,68,87,651	9,24,34,286
Cash at Bank PLSC	35,88,429	87,04,909
Total	**8,60,74,389**	**10,73,02,956**
Loans & Advances		
Deposits - Others	27,03,469	27,08,729
Accrued Interest	3,00,93,340	1,85,55,509
Advances for Purchases and Others	1,52,81,931	94,24,908
Tax Deducted at Source	1,07,20,678	83,61,175
Total	**5,87,99,418**	**3,90,50,321**
Grand Total	**15,15,15,304**	**14,95,64,843**

THE SOUTH INDIA TEXTILE RESEARCH ASSOCIATION

Schedules to Income and Expenditure Account for the year ended 31.03.2018

Amount in "Rs"

Schedules	2017-18	2016-17
Sch - 10		
Income from Services		
Testing and Investigation Fee	7,39,17,211	6,46,14,731
HRD Education Receipts	43,79,140	53,00,394
Publication Income	1,99,493	4,86,602
Total	**7,84,95,844**	**7,04,01,727**
Sch - 11		
Membership/Ministry Contribution		
From Ministry of Textiles	1,00,00,000	1,40,00,000
From Membership Contribution	62,64,964	69,01,897
From Technical Service Card Membership Fees	2,33,584	2,75,133
Total	**1,64,98,548**	**2,11,77,030**
Sch - 12		
Sponsored Projects - Overhead Recoveries	30,14,263	42,35,151
Total	**30,14,263**	**42,35,151**
Sch - 13		
Interest Income		
Interest Income from Investment and Advances	31,15,222	31,00,421
Total	**31,15,222**	**31,00,421**
Sch - 14		
Other Income		
Rent Receipts	24,83,295	17,33,937
Miscellaneous Income	18,08,127	8,56,218
Allocation of Expenses incurred by SITRA for PLSC	9,27,683	9,02,803
Total	**52,19,105**	**34,92,958**
Sch - 15		
Establishment Expenses		
Salary and Other Allowances	7,30,99,436	6,39,42,219
Payment towards Terminal benefits	1,32,28,918	1,83,37,275
Sitra Contributory PF and other Funds	47,10,711	49,67,395
	9,10,39,065	8,72,46,889
Less: a) Allocated to Ministry Sponsored Projects	29,52,309	35,22,698
b) Allocatd to Internal Project from Corpus Fund for R&D Reserve	18,00,269	-
c) Allocated to ISDS	21,61,252	10,73,626
Total	**8,41,25,235**	**8,26,50,565**

THE SOUTH INDIA TEXTILE RESEARCH ASSOCIATION

Schedules to Income and Expenditure Account for the year ended 31.03.2018

Amount in "Rs"

Schedules	2017-18	2016-17
Sch - 16		
Administrative Expenses		
Travelling Expenses	15,62,624	11,50,905
Printing & Stationery	10,05,936	8,00,036
Publication Expenses	1,15,495	2,56,596
Postage, Telegrams and Telephone Charges	10,76,736	12,61,988
Journals and Periodicals	2,72,603	3,75,058
Electricity Charges	70,70,256	66,45,267
Building & Fire Insurance	11,85,995	13,58,449
Rent, Rates and Taxes	6,00,436	1,67,386
Advertisement Charges	1,00,048	62,721
Training Course Expenses	5,38,050	6,43,989
Conferences, Seminars and Meetings	5,74,475	15,12,315
Professional Charges	8,16,115	6,59,647
Office Expenses	5,77,620	7,77,786
Testing expenses	8,31,276	59,942
SITRA Textile Service Centre Expenses	10,43,847	9,09,945
Provision for Bad & Doubtful (up to 2013-14)	-	5,90,773
Total	**1,73,71,511**	**1,72,32,803**
Sch - 17		
Repairs & Maintenance		
Maintenance of Motor Cars and Vehicles	82,273	90,352
Maintenance of Machinery	59,90,408	45,53,158
Maintenance of Building & Staff Quarters	33,26,882	28,14,370
Maintenance of Furniture and Office Equipments	1,06,499	48,727
Total	**95,06,062**	**75,06,607**
Sch - 18		
Stores Consumed	27,66,089	19,55,713
COE - Food & Polymer Lab Expenses	5,12,703	8,03,557
Total	**32,78,792**	**27,59,270**
Sch - 19		
Finance Charges		
Bank Charges and Commission	14,030	9,896
Total	**14,030**	**9,896**
Sch - 20		
Sponsored Projects - SITRA Contribution	44,58,250	31,87,531
Total	**44,58,250**	**31,87,531**

THE SOUTH INDIA TEXTILE RESEARCH ASSOCIATION

Schedules to Balance Sheet for the year 2017 - 2018

DEPRECIATION FOR THE YEAR 2017 - 2018

Schedules 21

Amount in "Rs."

S.No.	Name of the Asset	COST				DEPRECIATION			WDV	
		Value as on 01.04.2017	Additions During 2017-2018	Deletion During 2017-18	Value as on 31.03.2018	Depreciation As on 01.04.2017	Deletion During 2017-18	Depreciation for the year 2017-18	Closing W.D.V As on 31.03.2018	W.D.V As on 31.03.2017
1	Land	7,83,712			7,83,712	-	-	-	7,83,712	7,83,712
2	Library	28,21,535	1,65,184		29,86,719	3,14,606	-	3,10,203		
3	ISDS - Library	34,12,659			34,12,659				57,74,568	59,19,587
4	Building	3,39,05,249			3,39,05,249					
	ETP Building WIP		7,72,315		7,72,315	96,00,045		4,12,527	2,56,68,169	2,53,08,381
5	ISDS - Building Renovation	10,03,177			10,03,177		-			
6	Auditorium	5,03,235			5,03,235	2,14,245	-	4,711	2,84,279	2,88,990
7	Staff Quarters	2,37,543			2,37,543	1,12,864	-	2,032	1,22,647	1,24,679
8	Furniture	47,67,447	2,74,770		50,42,217	21,98,655	-	1,71,999	51,21,240	50,18,469
9	ISDS - Furniture	24,49,677			24,49,677					
10	Electrical Fittings	81,307			81,307	67,743	-	453	13,111	13,564
11	Sitra Furniture at PLSC	27,685			27,685	17,402	-	343	9,940	10,283
12	Machinery	11,19,76,784	85,45,998	4,20,255	12,01,02,527	6,69,74,466	16,34,127	46,82,883	9,06,33,981	8,55,56,994
13	Sponsored Projects - Assets	4,05,54,676			4,05,54,676					
	Machinery WIP	34,63,388		34,63,388	-					34,63,388
14	ISDS - Machinery	1,34,70,102			1,34,70,102	30,05,252	-	5,38,940	99,25,910	1,04,64,850
15	ISDS-PSC-Machinery	36,00,001			36,00,001	8,34,372	-	1,42,430	26,23,199	27,65,629
16	ISDS - Machinery Phase II	3,55,523			3,55,523	67,772	-	14,819	2,72,932	2,87,751
17	Sitra Machinery at PLSC	4,33,949			4,33,949	2,19,689	-	11,034	2,03,226	2,14,260
18	Computer	65,38,637	1,09,359		66,47,996	27,34,518	-	1,97,536	37,15,942	38,04,119
	ERP WIP	13,45,390	6,93,000		20,38,390	-	-	-	20,38,390	13,45,390
19	Motor Cars	13,78,119			13,78,119	3,14,740	-	75,181	9,88,198	10,63,379
20	Motor Cycles & Scooters	1,11,721			1,11,721	37,864	-	5,222	68,635	73,857
21	CoE Building Electrical Equipments	1,31,46,233			1,31,46,233	10,95,668	-	4,02,489	1,16,48,076	1,20,50,565
22	COE Building	8,51,76,526			8,51,76,526	23,78,527	-	13,49,607	8,14,48,392	8,27,97,999
23	COE Furniture & Fixtures	26,17,044			26,17,044	1,91,868	-	81,001	23,44,175	24,25,176
24	COE Assets	35,93,916	16,25,848		52,19,764	3,12,702	-	1,99,083	47,07,979	32,81,214
	Sponsored Projects -Assets									
25	UNDP Jute Project Machinery	1,50,62,257		18,60,518	1,32,01,739	-	-	-	1,32,01,739	1,50,62,257
26	COE Assets	21,12,77,026	74,67,531		21,87,44,557	-	-	-	21,87,44,557	21,12,77,026
27	Assets under Sponsored Projects - SITRA	1,34,21,920	3,43,092		1,37,65,012	-	-	-	1,37,65,012	1,34,21,920
28	PLSC Assets	5,52,53,546	28,86,183	29,750	5,81,09,979	1,91,56,113	-	-	3,89,53,866	3,60,97,433
	Total	**63,27,69,984**	**2,28,83,280**	**57,73,911**	**64,98,79,353**	**10,98,49,111**	**16,34,127**	**86,02,493**	**53,30,61,876**	**52,29,20,873**

THE SOUTH INDIA TEXTILE RESEARCH ASSOCIATION

Schedules to Balance Sheet for the year 2017 -2018

Financial Status of Sponsored Projects : 01/04/2017 - 31/03/2018

Schedules 8 & 20

Amount in "Rs."

Sl.No.	Name of Sponsored Project	Opening Balance 2017-18		Receipts			Expenditure as at 31.03.2018			Total Expenditure as at 31/03/2018	Balance as at 31/03/2018		
		Industry	Ministry	MOT/IA Contribution	Revenue/ Appropriation	Total Receipts	Industry	SITRA	MOT		Unspent	Due from (IA/SITRA Contribution)	Due from MOT
1	**Ministry of Textile Sponsored Research Projects**												
a	Development of Special wound care Dressing made of PVA/chitosan		(36,221)			(36,221)				-	-	-	(36,221)
b	Design and Fabrication of an Instrument to Evaluate Resistance of Medical Face Masks to Penetration by High Velocity Stream of Blood from a Punctured Wound		(5,24,609)			(5,24,609)		3,15,765	8,79,413	11,95,178	-	-	(14,04,022)
c	Design and fabrication of an instrument to evaluate the characteristics of fluid handling capacity of wound care dressings		(4,89,643)			(4,89,643)		3,97,324	10,12,162	14,09,486	-	-	(15,01,805)
d	Development of a Heat and Moisture Exchange Filter		(5,26,144)			(5,26,144)		3,50,686	9,20,005	12,70,691	-	-	(14,46,149)
e	Development of Indigeneous Viral Barrier Fabric	3,54,000	31,557			3,85,557	5,44,000	5,86,752	17,16,037	28,46,789		(1,90,000)	(16,84,480)
f	Development of a Anterior Cruiate Ligaments (ACL) using Textile Matrices		1,21,711			1,21,711		10,67,363	22,52,396	33,19,759	-	-	(21,30,685)
g	Development of Nanoparticle based transdermal patches of selected cardiovascular drugs		(50,516)			(50,516)		8,23,543	18,44,625	26,68,168	-	-	(18,95,141)
h	Polyester Vascular Graft Implant-Process Optimization and Production Scale up		10,59,803	14,25,000	48,007	25,32,810		3,72,817	52,068	4,24,885	10,55,742	14,25,000	-
		3,54,000	**(4,14,062)**	**14,25,000**	**48,007**	**14,12,945**	**5,44,000**	**39,14,250**	**86,76,706**	**1,31,34,956**	**10,55,742**	**12,35,000**	**(1,00,98,503)**

THE SOUTH INDIA TEXTILE RESEARCH ASSOCIATION

Schedules to Balance Sheet for the year 2017 -2018

Schedules 8 & 20

Financial Status of Sponsored Projects : 01/04/2017 - 31/03/2018

Amount in "Rs."

Sl.No.	Name of Sponsored Project	Opening Balance 2017-2018	Receipts		Expenditure Recurring		Capital	Total Expenditure As At 31/03/2018	Balance as at 31/03/2018		
			Funds Received	Revenue / Appropriation	IA	MOT			Unspent	SITRA/IA Contribution	Due from MOT
1	Ministry sponsored powerloom service centre receipts	-	1,14,00,000		34,03,242	1,14,00,000	-	1,48,03,242	-	-	-
2	Tamilnadu Skill Development Programme Commissioner of Backward Classes	(1,78,780)					-	-	-	-	(1,78,780)
3	Integrated Schemes for PSC's	52,00,000		2,74,077			27,12,364	27,12,364	27,61,713		
4	Swachh Bharat Abhiyan		4,37,500					-	4,37,500		
5	SITRA Integrated Skill Development Scheme										
	DPR - 3	3,82,70,366		14,50,733		1,38,23,050	-	1,38,23,050	2,58,98,049	-	-
	IA Contribution										
	SITRA	-	15,37,846	18,352	25,43,097		-	25,43,097	-	(9,86,899)	-
	PLSC	-	18,46,656	22,037	29,21,011		-	29,21,011	-	(10,52,318)	-
	Provision for Expenses				15,90,722	56,46,537		72,37,259		(15,90,722)	(56,46,537)
6	International Training Programme	(34,86,084)	97,62,216			72,18,721	-	72,18,721	-	-	(9,42,589)
7	**CoE Projects**										
i	Office of the Textile Commissioner										
	a) Development of Collagen coated hernia mesh	(2,09,000)				31,000	-	31,000	-	-	(2,40,000)
	b) Development of Moppings pads using non woven & Woven structure	(2,40,000)					-	-	-	-	(2,40,000)
ii	Department of Science & Technology	(50,000)	50,000				-	-	-	-	-
iii	Establishment of Training Facilities	1,25,81,054					68,80,673	68,80,673	57,00,381	-	-
iv	Focus Incubation Centre	2,61,00,000						-	2,61,00,000	-	-
v	Design & Fabrication...Punture Resistance	21,16,849				5,68,319		5,68,319	15,48,530	-	-
vi	Dev of nanofibrous...curcumin	9,43,564				5,37,186	5,86,858	11,24,044	-	-	(1,80,480)
vii	Dev of Novel Biodegradable	-	4,64,700			330		330	4,64,370		
viii	Dev.of Total Comfort Index	-	24,00,000					-	24,00,000		
8	**SITRA DST & Inhouse Project**										
i	Durable Non-Fluorinated Functional Textiles using Fumed Silica Sols		10,30,000	3,995		40,000	2,59,022	2,99,022	7,34,973		
ii	Aramid Net Sample Development Charges		4,20,000							4,20,000	
iii	An Investigation into the changes in fibre quality drafting in cotton spinning		5,00,000							5,00,000	
		8,10,47,969	**2,98,48,918**	**17,69,194**	**1,04,58,072**	**3,92,65,143**	**1,04,38,917**	**6,01,62,132**	**6,60,45,516**	**(27,09,939)**	**(74,28,386)**

THE SOUTH INDIA TEXTILE RESEARCH ASSOCIATION

Centre of Excellence Medical Textiles

Annexure

Balance Sheet as at 31st March 2018

Amount in "Rs."

31.03.2017	LIABILITIES		31.03.2018	31.03.2017	ASSETS		31.03.2018
Rs.		Rs.	Rs.	Rs.		Rs.	Rs.
	CAPITAL GRANT				**FIXED ASSETS**		
20,11,51,247	Contribution from Ministry	20,86,18,778		21,12,77,026	- Ministry Grant		21,87,44,557
46,65,513	Interest Earnings	63,78,942	21,49,97,720	35,93,916	- Others		52,19,764
4,17,41,467	Unspent Grant		3,62,13,281		**CURRENT ASSETS**		
				3,67,525	Sundry Debtors		19,22,110
	RESERVES & SURPLUS			32,740	Loans & Advances		26,196
3,12,702	Depreciation Reserve		5,11,785	20,68,480	Advances for Purchases & others		20,49,635
57,81,449	Appropriation for Capital Expenditure		73,84,444				
8,24,386	General Reserve - SITRA		8,24,386	4,65,35,566	Bank Balance		4,05,99,182
	CURRENT LIABILITIES:				**SITRA - RESERVE ADJUSTMENT**		
2,04,72,277	Branch & Divisions	2,35,75,131		49,77,892	Asset Stabilization Reserve		65,80,887
8,78,792	Advance from debtors	10,97,417		3,51,233	Staff Benefit Fund Reserve		5,32,520
90,117	Sundry Creditors	8,16,222		9,56,063	Infrastructure & Main. Reserve		9,56,063
8,42,448	Liability for Expenses & Others	4,04,876		1,45,594	Depreciation Reserve		1,45,594
			2,58,93,646	10,53,557	General Reserve		20,63,956
				8,03,557	Corpus Fund for R&D Reserve		13,83,307
				4,99,000	Sponsored Projects - Grant Receivable		6,60,480
					INCOME & EXPENDITURE ACCOUNT		
				39,80,140	Opening Balance	40,98,248	
				1,18,109	Excess of Expenditure over Income for the year	8,42,762	49,41,010
27,67,60,398	**Total**		**28,58,25,262**	**27,67,60,398**	**Total**		**28,58,25,262**

"Vide our report of even date"
For P.N.Raghavendra Rao & Co.,
Chartered Accountants
Sd/- (Pon Arul Paraneedharan)
Partner

Place : Coimbatore
Date : 23/08/2018

(Sd/-) K V Srinivasan (Chairman)
" Prakash Vasudevan (Director)
" E Sathyanarayana

THE SOUTH INDIA TEXTILE RESEARCH ASSOCIATION

Centre of Excellence Medical Textiles

Income & Expenditure Account for the year ended 31st March 2018

Amount in "Rs."

31.03.2017 Rs.	EXPENDITURE	31.03.2018 Rs.	31.03.2018 Rs.	31.03.2017 Rs.	INCOME	31.03.2018 Rs.
74,98,370	Establishment Expenses	99,14,624		85,07,120	Testing & Investigation Fees	1,00,57,519
	Less : a) Allocated to Ministry Sponsored Projects	18,99,670				
19,38,683	b) Allocated to Internal Project from Corpus fund for R&D Reserve	5,70,250		10,07,428	HRD Education Receipts	15,44,713
55,59,687			74,44,704			
92,302	Training Course Expenses		2,19,091	19,68,019	Sponsored Projects - Overhead Recoveries	13,78,132
2,21,729	Travelling Expenses		3,07,759			
7,93,066	Stores Consumed		7,59,979	19,500	Establishment of Training Facilities - Tender Application fees	-
	Stores consumed Food Technology Lab		5,12,703			
8,03,557	Polymer & NABL Lab Expense		-	37,129	Interest Income	29,385
40,293	Building Repairs & Maintenance		38,156			
6,23,247	Maintenance of Machinery		9,76,437			
94,234	Printing & Stationery		1,29,024			
1,42,472	Office Expenses		1,74,047			
16,94,354	Electriciy Charges		14,76,318			
5,89,866	Machinery Insurance		4,97,696			
12,553	Postage & Telephone charges		11,663			
15,075	Internal Audit Fees		10,000			
14,80,266	Sponsored Projects - IA Contribution		17,35,848			
3,61,207	ETF & FIC Tender Expenses		31,606			
1,81,916	Testing Expenses		5,29,581			
1,50,632	Depreciation		1,99,083	**13,17,260**	Excess of Expenditure over Income for the year c/o	**20,43,948**
1,28,56,456	**Total**		**1,50,53,696**	**1,28,56,456**	**Total**	**1,50,53,696**

INCOME & EXPENDITURE APPROPRIATION ACCOUNT

13,17,260	Excess of Expenditure over Income for the year b/f		20,43,948	1,45,594	Transfer to Depreciation Reserve -SITRA	-
				10,53,557	Transfer to General Reserve - SITRA	10,10,399
				-	Transfer to Corpus fund for R&D	9,500
					Transfer to Staff Benefit Reserve	1,81,287
				1,18,109	Excess of Expenditure over Income for the year transferred	8,42,762
13,17,260			**20,43,948**	**13,17,260**		**20,43,948**

"Vide our report of even date"

Place : Coimbatore
Date : 23/08/2018

For P.N.Raghavendra Rao & Co.,
Chartered Accountants
Sd/- (Pon Arul Paraneedharan)
Partner

(Sd/-) K V Srinivasan (Chairman)
" Prakash Vasudevan (Director)
" E Sathyanarayana

THE SOUTH INDIA TEXTILE RESEARCH ASSOCIATION

Ministry of Textiles Sponsored Powerloom Service Centres

BALANCE SHEET AS AT 31st March 2018

Annexure

Amount in "Rs."

31.03.2017	LIABILITIES	31.03.2018		31.03.2017	ASSETS	31.03.2018
Rs.		Rs.	Rs.	Rs.		Rs.
5,44,96,000	**CONTRIBUTION FROM GOVERNMENT AND GOVERNMENT DEPARTMENTS**	5,73,54,334		5,55,26,151	**FIXED ASSETS (AT COST)**	5,83,82,584
1,45,970	Add: Interest received from MOT funds	1,64,264	5,75,18,598			
52,00,000	Unspent Grant from MOT		31,99,213		**ADVANCES AND DEPOSITS**	
				12,34,182	Sundry Deposits	12,34,182
	POWERLOOM SERVICE CENTRES RESERVE			10,89,121	ISDS - Salary & Other Expenses	12,81,974
	Closing Balance	(92,70,930)				
(93,01,992)	Less: Staff Terminal Benefits Apportioned for the year	1,83,157	(94,54,087)	4,29,482	Advances for Purchase & Others	5,00,723
					Tax Deducted at Source	21,300
	STAFF BENEFIT RESERVE APPROPRIATION FOR TERMINAL BENEFITS				Duties & Taxes	28,120
	Opening Balance	62,42,010			**CURRENT ASSETS**	
62,42,010	Add: Provision for Staff Benefit Expenses for the year	74,965		42,375	Cash on Hand	39,375
	Add: Transfer of Balance Surplus	30,00,000	93,16,975	87,04,909	Cash at Bank	63,52,429
	PSC RESERVE APPROPRIATION FOR CAPITAL EXPENDITURE			21,624	Provisions - Income	-
	Opening Balance	16,99,751		1,78,780	Grant Receivable	1,78,780
16,99,751	Add: Current year Utilisation	1,73,819	18,73,570	2,17,921	Sundry Debtors	1,37,547
	CURRENT LIABILITIES					
6,24,352	Liability for Expenses & Others		2,02,872			
3,900	Sundry Creditors		10,620			
83,34,555	Branches & Divisions		54,89,254			
6,74,44,546	**Total**		**6,81,57,015**	**6,74,44,546**	**Total**	**6,81,57,015**

"Vide our report of even date"
For P.N.Raghavendra Rao & Co.,
Chartered Accountants
Sd/- (Pon Arul Paraneedharan)
Partner

Place : Coimbatore
Date : 23/08/2018

(Sd/-) K V Srinivasan (Chairman)
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" E Sathyanarayana

THE SOUTH INDIA TEXTILE RESEARCH ASSOCIATION

Ministry of Textiles Sponsored Powerloom Service Centres

Income & Expenditure Account for the year ended 31st March 2018

Amount in "Rs."

31.03.2017	EXPENDITURE	31.03.2018	31.03.2017	INCOME		31.03.2018
Rs.		Rs.	Rs.		Rs.	Rs.
1,86,94,528	Salaries	1,28,41,430	1,14,00,000	Revenue Grant from Ministry		1,14,00,000
53,25,789	Less: ISDS Transfer	43,60,470				
1,33,68,739		84,80,960				
22,39,078	General office expenses	19,79,580	80,13,759	Income from Services	87,10,698	
			19,32,754	Less : ISDS Transfer (IA Contribution)	17,00,650	70,10,048
			60,81,005		70,10,048	
29,89,092	Rent, Rate & Taxes	28,89,864				
			2,28,998	Interest on Bank and other deposits		76,777
2,89,067	Spares, store & Consumbles	1,22,219				
9,74,931	AMC/Maintenance of Equipement	13,30,619	21,50,904	Excess of Expenditure over Income for the year c/o		-
-	Excess of Income over Expenditure for the year c/o	36,83,583				
1,98,60,907	**Total**	**1,84,86,825**	**1,98,60,907**	**Total**		**1,84,86,825**
21,50,904	Excess of Expenditure over Income for the year b/f	-		Excess of Income over Expenditure for the year b/f		36,83,583
	Calibration Charges Payable to SITRA	8,24,649	16,96,116	Appropriated from Staff Benefit Reserve - Provision for Terminal Benefits		1,83,157
28,62,060	**Balance Surplus**	37,81,068	33,16,848	Appropriated from Staff Benefit reserve for payment of Terminal Benefits		7,38,977
-	Transfer to Staff Benefit Reserve	30,00,000				
28,62,060	Transfer to PSC Reserve	7,81,068				
50,12,964		**46,05,717**	**50,12,964**		**-**	**46,05,717**

"Vide our report of even date"

Place : Coimbatore
Date : 23/08/2018

For P.N.Raghavendra Rao & Co.,
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