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THE SOUTH INDIA TEXTILE RESEARCH ASSOCIATION
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AN OVERVIEW OF SITRA'S R&D WORK AND SERVICES - 2020-21

The COVID-19 pandemic has led to a dramatic impact worldwide on the world of work along with its devastating impact on human life and an unprecedented challenge to the public health system. While the social impact of the pandemic is there for all to see, it would take some more time for the industry to fully realize the economic disruption caused by it. SITRA lost many working days during the year because of the lockdown caused by the pandemic. The catastrophe also presented an opportunity to SITRA in the form of enormous requests from manufacturers of PPE coveralls and masks after the Govt. of India's initiative to encourage new manufacturers by permitting SITRA, albeit for a temporary period, to provide process certification for prototype coverall samples sent by manufacturers. SITRA could return to normal activity by the end of the year with most of its services beginning to be sought by the industry.

It is heartening to note that 4 mills, comprising of 3 full members and 1 associate member enrolled newly as members, despite the not-so-favourable trading conditions that prevailed during the year due to the pandemic. Three mills opted to resign from the membership mainly because of poor operating profits. The total membership of SITRA during the year was 146, comprising of 186 units. SITRA's services were also utilised by 37 small mills under the Technical Support Scheme. In all, 223 units have access to SITRA's concessional / subsidised services, apart from many units in the decentralised sector which utilised the services offered by 7 Powerloom Service Centres, two Textile Service Centres and 4 CAD Centres of SITRA.

The overall financial position of SITRA during the year had been good, thanks to large number of PPE testing carried out during the year, resulting in a surplus of income over the expenditure.

During the year, despite the COVID-19 pandemic, SITRA was working on as many as 20 projects. Of them, 6 have been sponsored projects. Work relating to 13 projects were completed during the year. Topics of wide-ranging interest to the industry have been studied in these projects.

FIBRE TO YARN CONVERSION

The study on the effect of modified cots and top roller load on yarn quality in ring frame proposes to reduce the top arm loading and maintain the same load per unit area by reducing the top roller rubber cots width and investigate the effect on the quality of Ne 20, 30 and 40 yarns in both combed and conventional carded process. Results have shown significant improvements in yarn quality by reducing the total applied load from 2.5 kg/cm^2 to 1.5 kgs/cm^2 and maintaining the same load per unit area in the drafting system (around 0.750 kg/mm for front, back rollers and 0.5 kg/mm for middle roller).

Based on a study, SITRA has come out with a formula to replace the earlier one it had first published in 1975 and then revised in 2010. Since both the formulae used 50% span length of comber sliver and lap tested using a Digital fibro-graph, which is almost obsolete in the industry, there was a need for revisiting the earlier formulae. The fibre length measured through the HVI instrument is also not accurate, reliable and repeatable due to problems in the method of sample preparation, limiting the mills to decide the comber performance based on these values. A revised combing index was derived and the results show that the new combing index to be from 0.11 (Poor) to 0.70 (Superior) between different makes and noil levels.

SITRA has sought to correlate the convolutions present in various imported and Indian cotton varieties with the length, fineness and maturity of the fibre. It is observed that the imported cottons have lower convolutions per unit length compared to the Indian cotton varieties.

The relevance of Poisson's effect, a characteristic of fabrics to undergo lateral contraction perpendicular to the direction of the applied stress during uniaxial extension, and its impact on made-up garment characteristics towards utilizing the same for their effective performance was studied. The Poisson's ratio is seen to change in the process of the extension of the fabric sample. The Poisson's ratio increases initially and then decreases slightly as the extension is increased in the machine direction. The graph flattens for cross direction after 15% extension for all the fabrics. The results lend credence to the fact that as the number of layers increase for spun bonded fabric, the value of Poisson's ratio also increases when compared with fabrics of same GSM. The contraction level in machine direction was higher than the cross direction. In the machine direction, the extension contributed much less and there may be other factors like binder film, melt structure, degree of orientation of fibrils, etc., influencing the Poisson's ratio. In SMS fabrics, the Poisson's ratio increased as the gauge length increased at both the directions irrespective of GSM. Contraction % was more pronounced in the case of shorter widths & the Poisson's ratio increased as the width decreased.

An in-house project has been carried out to characterize tea bags for their thickness, wettability, surface topography, pore size, porosity and permeance towards understanding their influence on infusion kinetics. The 100% cellulose filter paper tea bags of some brands exhibited slight cytotoxicity while the non woven material & PLA (in most tea bags) exhibited severe cytotoxicity and tea bags of nylon and PP string showed mild to moderate cytotoxicity. The absence of Epichlorohydrin in all the tea bags was established using GCMS. Evaluation of the biodegradability of the cotton tea bags is currently in progress. While PLA tea bag is claimed to be biodegradable, they can be decomposed only using an industrial composting facility.

A project initiated during the year attempts to study micro dust present in different varieties of cotton using MDTA 4 (Micro Dust and Trash Analyser), an instrument recently purchased by SITRA that provides the facility to analyse the trash and dust levels precisely. All major Indian and imported cotton varieties are planned to be evaluated.

Another project was taken up during the year to analyse and compare the thickness and bending measurements of medical apparel using Fabric Touch Tester (FTT) and conventional methods. The findings of the study would help to determine the reliability of such measurements and also in deriving the relationship with the standard methods.

OPERATIONAL STUDIES

The online survey of yarn selling price and raw material cost, conducted by SITRA since April 2013 with an objective of keeping the mills informed about the trend in the movement of count-wise yarn selling price (YSP) and raw material cost (RMC) between months has received good support from the industry. This year due to the COVID pandemic only 10 surveys could be carried out. The findings of this survey report helps the mills to compare their RMC, YSP, net out-put value (NOV) as well as their yarn quality and productivity level with other mills every month. The Market Performance Evaluation Index, formulated by SITRA also helps in tracking the movement of commercial efficiency (Net out-put value i.e. yarn selling price – clean raw material cost) based on 12 popular cotton counts ranging from 30s to 100s.

ENERGY CONSERVATION

A new project has been initiated to study the influence of compact spinning system on specific energy/ power consumption of modern and conventional ring spinning machines. Some preliminary data was collected on compact suction pressure in cm WC and the corresponding compact system motor load in kW measured in different makes and models of fibre compacting systems in different mills and the analyses of the same is currently on.

CHEMICAL PROCESSING

Under a study sponsored by the Department of Science & Technology (DST) – WOS 'A', Govt. of India, an attempt is being made to replace the non-biodegradable polymer and costly carrier molecules in textile materials (used as encapsulating agents) by eco-friendly and readily available raw materials, thus ensuring customer wellness through eco-friendly means. Preparation of vitamin E nano formulation was carried out by oil in water nano emulsion method using probe sonication. The study of encapsulation efficiency and FE-SEM of nano formulation are in progress. The application of prepared nano formulation on the fabric and evaluation of anti-oxidant activity and vitamin E release from the fabric are currently on.

Identification and standardization of natural dyes, which are of great demand in recent times, are two major issues. The determination of purity, method of extraction and different sources of the dyes are the important factors determining the value of their dyes. There are no testing protocols available for natural dyes in the literature among ISO, DIN, ASTM or other standard methods. Understanding the need for developing easy methods for identification of natural dyes based on simple chemical test and chromatographic methods which would also reveal the purity content and provide chemical information having good repeatability and reliability, SITRA took up the work to use the methods available namely Kit method (Preliminary test); Chromatographic tests which include Thin Layer Chromatography (TLC) (Mandatory test); High Performance Thin Layer Chromatography (optional test) and High Performance Liquid Chromatography (optional test) and Spectroscopy tests which include UV-Visible Spectroscopy (optional test), FT-IR Spectroscopy (optional test) and NMR Spectroscopy (optional test) to characterize indigo dye, fruit extract of terminalia arjuna and thespesia populnea. The extracted dyes were analyzed for phytochemical composition, such as total phenol, tannin and flavonoids. The phytochemical analysis of dye extract was carried out using FT-IR and GC-MS. The interaction between the colour component, mordant and fabric was studied. Based on the cost and efficiency of results, spot test, TLC and HPLC analysis were chosen for the identification of natural and synthetic dye from the dye extract.

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-treatment 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 by SITRA has resulted in darker and even shades with better fastness properties.

Based on the success of Phase I trials, which was done using the chemicals available commercially, a new cationising agent was synthesized using different raw materials and the characterization study was performed. Dyeing trials were carried out at an industry and analysis of drain characteristics was performed. A single bath scouring, bleaching and cationisation procedure was developed.

In Phase III, a 120 L reactor vessel for the synthesis of cationizer was fabricated in collaboration with the Industry partner (MAK India Limited, Coimbatore) based on the reliable outcome of the laboratory salt free dyeing trials. 48.5 L of final product in solution form was obtained from the bulk scale synthesis. The salt free dyeing trials using the bulk scale synthesized cationizer and laboratory synthesized cationizer were performed and the results were compared.

In Phase IV, a 1000 L capacity reactor vessel was fabricated in collaboration with the Industry partner. Three batches of bulk scale synthesis were performed to produce 720 kg of the new cationising chemical which was named as Go GreenSFD (GGS), in solution form to perform bulk scale dyeing at Tirupur and Erode dyeing units for challenging shades also. Further bulk scale dyeing process at various Tirupur and Erode dyeing industries are in progress.

MEDICAL TEXTILES

There is an urgent need to replace the existing non-degradable materials used in cosmetics and personal care products with biodegradable, sustainable materials with lesser environmental footprint. Hence a project was conceived to formulate and develop bio-based, biodegradable and biocompatible materials to deliver skin-contact products for the protective clothing, cosmetic and biomedical industries. The products used as models were a facemask, a facial sheet mask and a wound dressing. Based on multiple trials, cellulose producing bacteria from environmental sample was isolated, identified and purified. Cellulose from the isolates was done in bulk scale and these bacterial cellulose were characterised. The herbs with antimicrobial and antioxidant properties were screened and herbs extracted.

Personal protective equipment (PPE) such as face mask, coverall, gloves, shoe cover and goggles have been the first protective means that can prevent the spread of the (SARS-CoV-2) virus. Though the available disposable coverall products are cheaper and lighter in weight, they offer least comfort to the wearer and may be less effective against SARS-CoV-2 viruses. Hence, under a project sponsored by the Board of Research in Nuclear Sciences (BRNS), GoI, a study was conceived to develop a biocidal, breathable, reusable and oxo-biodegradable coverall using affordable raw materials to minimize the disease transmission and to combat COVID-19.

Nano particles, less than 100nm, were characterized by FE-SEM, FT-IR and XRD analysis. PCM (PEG 1500) was analyzed through DSC to evaluate their thermal properties such as melting range and heat storage capacity. The nanoparticles were evaluated for their antibacterial activity using Escherichia coli ATCC 25922 as test organism and for antiviral activity using Bacteriophage MS2 ATCC15597-B1 as test organism. The nanoparticles were impregnated on the textile substrate as per the method described below and studied for their antibacterial and antiviral activity in accordance to ASTM E 2149 and SITRA's in house method using two schemes. Under scheme 1, impregnation was tried at fibre stage and in scheme 2 the nanoparticles were impregnated at the fabric stage. The finished fibers as well as fabrics showed 99.99% antibacterial activity against Escherichia coli ATCC 25922. With regards to antiviral activity against Bacteriophage MS2 ATCC 15597-B1, it was 99.9% for both fibres and fabrics. The nanoparticles incorporated fabric was submitted to ICP-MS to evaluate its concentration on the fabric, leaching concentration and the durability of nanoparticles on the fabric. PEG 1500 was applied on the fabric using cross linking agent to improve the comfort properties and submitted to evaluate total hand value (Q_{max}) by FTT (Fabric Touch Tester). The oxidizing agent was applied on the fabric and submitted for soil burial test to evaluate the degradability.

With no comprehensive comfort index available for textile fabrics that can help users to understand the comfort properties of fabrics, SITRA, under a project sponsored by the Ministry of Textiles, GoI, took up a research work to develop a comfort index for some commercially available products by combining the test results from sophisticated instruments available at SITRA for the measurement of comfort properties. Clothing comfort is classified into three broad categories a) Aesthetic comfort b) Thermo-Physiological comfort and c) Tactile comfort/Sensorial comfort. Aesthetic comfort is the subjective perception of clothing by visual sensation, which is influenced by color, style, garment fitting, fashion compatibility, fabric construction and finish. Thermo physiological comfort is defined by heat, water vapour and air transfer through the clothing system in order to maintain the thermal equilibrium between environment and human body. The tactile comfort is related to mechanical interaction between the clothing material and human body/ skin.

Seven interlock double-jersey plaited fabrics and three single jersey fabrics of different profiled cross-sections in the non-skin contact filament and circular cross-sectional in the skin contact filament were evaluated. The Comfort Properties like Water Vapour Resistance(WVR), Thermal Resistance(TR), Air Permeability(AP), Moisture Vapour Transmission rate(MVTR), Liquid Moisture Management property and Total Hand value were assessed with insruments available with SITRA to arrive at a composite Comfort Index. Desirability function was worked out to have the subjective responses of subjects on aesthetic comfort.

Though electrospinning is a well-established and versatile technique, its utilization in industry is limited by the low production rate. Conventional single needle electrospinning system produces only 0.01- 0.1 grams of nanofibers per hour. In order to overcome this limitation, a project was undertaken, sponsored by National Technical Textile Mission, Ministry of Textiles, to develop a needleless high throughput electrospinning set up. In the process of the development, it is hoped to optimize nanofiber production with respect to polymer feeding arrangement and also explore the possibility of developing hybrid composite nanofiber coating on a single substrate as well as at a higher production rate.

An in-house project has been attempted to study the effect of antimicrobial coated hygiene products such as sanitary napkin on the flora of vagina and skin. Though antimicrobial textiles products have good market potential as they combat against microbial infection and assist to save the patients from pathogens, their usage in feminine hygiene products such as sanitary napkin, tampons, wipes, diaper, etc., needs to be studied carefully since some of these products unlike health care products are used in skin contact areas like the vaginal canal which is rich in vascular network and produces mucus which can absorb fluids at a higher rate than skin. Hence, there is a possibility of these products entering into the circulatory system without metabolizing them and putting the user at a greater risk of potential chemical exposures.

The effect of antimicrobial compound on the behaviour of micro-organism isolated from skin and vaginal flora for a specified contact period was studied. Based on the contact time of flora with the sanitary napkin, the microbial populations were grouped as tolerance and persistence cells.

CONSULTANCY SERVICES

It is gratifying to note that the requests for consultancy services, inspite of the pandemic, was decent during the year. The year witnessed 112 consultancy assignments being attended to which were utilized by as many of 13 member mills and 99 non-member units .

TESTING AND CALIBRATION SERVICES

The physical, chemical and biological laboratories have been accredited by NABL for ISO/IEC17025 for the various fibre, yarn and fabric samples tested for their physical and chemical properties. Several mills are seeking SITRA's accredited test reports for export purposes. The year witnessed 1,75,606 tests of fibre, yarn, fabric and PPEs being carried out for their physical, chemical or biological properties. SITRA's physical and chemical testing laboratories which are functioning in two shifts for the past 5 years aim to provide test results to the mills on a fast track. The introduction of the dual shift system has helped in hastening the testing process by reducing the turnaround time to process a request. In 2018, SITRA introduced the "Rapid testing facility" to mills for speedy testing of samples which ensures quick conditioning of samples and preparation of pre-opened cotton fibres for High Volume cotton testing.

A total of 4808 calibration certificates, for calibration of quality control instruments were issued during the year, for the 172 mills which utilised these services. Testing the quality of spinning and weaving accessories/ spares in order to select the right quality is another service being offered by SITRA and 822 samples covering various accessories like paper cones, worm & worm gear wheel, cots, partition pad, spinning rings, spindles, ring travellers and carton boxes received from 217 units were tested.

TRAINING

Eleven different training programmes were offered by SITRA during the year. This included 5 functional programmes, 1 in-house programme, 4 webinars, 16 multi-specialisation programmes in medical textiles, wherein a total of 408 persons were trained. Under operatives training, 256 operatives were trained during the year on right methods of working in textile mills for effective performance.

SERVICES TO DECENTRALISED SECTOR

The services of the 7 Powerloom Service Centres (PSC) in Tamil Nadu, managed by SITRA, have been extensively used by the powerloom sector. A total of 59,295 samples comprising of yarn and fabrics have been tested and 166 persons were trained in the area of loom maintenance, operation of shuttleless looms, calculation of fabric production, etc. The PSCs have attended to 5,424 liaison visits and also inspected 23,049 looms during the year. A total of 32 consultancy assignments were carried out and 118 designs were created during the year.

MOU SIGNED

During the year, Memorandums of Understanding were signed with Precot Ltd., for offering SITRA's expertise in the textile field and more specifically for medical products.

PATENT GRANTED

A method for treating effluent, India Patent No. 355986 granted on 18.01.2021.

PUBLICATIONS

SITRA brought out during the year, 13 publications which included 2 research / inter-mill study reports, 10 online reports, 1 Etech letter (SITRA news publication) (Annexure II).

SITRA scientists published 4 research papers in technical journals, contributed 2 chapters to edited publications, presented 2 papers in conferences and seminars and gave 9 lectures (Annexure V).

ORGANISATION

MEMBERSHIP

In spite of the general pandemic prevailing in the society leading to overall economic slackness in the textile industry, 4 mills, comprising of 3 full members and 1 associate member enrolled newly as members during the year. Three mills opted to resign from the membership due to poor operating profits. The total membership of SITRA during the year was 146, comprising of 186 units (Table 1).

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

Full Membership:

1. Sri Selvabathi Mills Pvt. Ltd, Coimbatore.
2. Sri Sundhareswara Mills, Pollachi.
3. Shri Siddhivinayaga Tex India Pvt. Ltd., Dindigul

Associate Membership:

1. JP Modatex LLP, Silvasa.

SITRA's services are also utilised by 37 small mills under the Technical Support Scheme. In all, 223 units had access to SITRA's services, apart from many units in the decentralised sector which utilised the services offered by 7 Powerloom Service Centres, two Textile Service Centres and 4 CAD Centres.

FINANCE

SITRA managed its finances commendably during the year ending it with a surplus of income. The total recurring expenditure of SITRA during the year after depreciation and before appropriation from reserves was Rs 12.79 crores. The total income, including the grants from the Ministry of Textiles, Govt. of India was Rs 18.74 crores.

SPONSORED PROJECTS

During the year under review, SITRA was involved in 8 sponsored research projects, 3 of which were sponsored by the Ministry of Textiles (MoT), Government of India and rest of the projects by agencies such DST, KVIC, DRDO and BRNS.

Work relating to the following projects, sponsored by different agencies, was completed during the year

1. Development of Eco - Clothing by Greener Reduction Process of Natural Indigo Dye, sponsored by the Ministry of Textiles, Govt. of India.
2. Kovai kora cotton sarees, sponsored by Department of Handlooms and Textiles, Govt of Tamil Nadu.
3. Medical Textile Products identified by INMAS for wound healing and radio protective equipment based on textiles, sponsored by the Defence Research and Development Organisation (DRDO)

The following project, sponsored by MoT is progressing well.

1. Development of total comfort index paradigm for textile structures

Work relating to the following projects, sponsored by different agencies, are also progressing well :

1. Antioxidant cosmetotextiles : Durable nano encapsulated vitamin E finishes on textile fabrics and its controlled release study (sponsored by DST).

Table 1 Region-wise membership

Region	Spinning mills	Composite mills	Fibre manufacturers, Machinery manufacturers and others	Total
SITRA zone	114	4	5	123
Other States	18	1	2	21
Overseas	1	1	-	2
Total members	133	6	7	146
Total units	161	18	7	186

2. Field dissemination of technology of high productivity hand operated charka (sponsored by KVIC)

During the year, SITRA also received funding for the following 2 projects, 1 under the National Technical Textiles Mission (NTTM) of the Ministry of Textiles, GoI and the other under the Board of Research in Nuclear Sciences (BRNS).

1. Design and Development of facile high throughput needleless electrospinning set-up (NTTM)

2. Development of breathable, reusable and oxo-biodegradable coverall using biocidal polyester (BRNS)

Work on both the above projects has been initiated.

MACHINERY AND EQUIPMENT

During the year, SITRA made a fairly large investment of Rs. 1.3 crores on state-of-art machinery and equipment, apart from other infrastructural requirements. Some of the important machinery and equipment installed during the year include an Ion Chromatograph (IC) instrument, 100 KVA Solar power system, Synthetic Blood Penetration Resistance tester(SBPRT), Viral Resistance tester, Automatic Colony counter, Differential Pressure Tester, Twist tester, CSP system and Eaton 80 KVA UPS.

SETTING UP A TESTING FACILITY AT SISPA

The South India Spinners Association (SISPA), Coimbatore had requested SITRA to setup a testing facility for the benefit of their member units. SISPA wanted such a facility to be an exclusive one with the instruments being housed in their association building premise. Both associations have signed a Memorandum of Agreement outlining the terms under which the arrangement would work. Accordingly, SISPA has provided all infrastructure facilities required for the laboratory. The personnel and testing equipment would be taken care of by SITRA. SITRA is offering the testing to the SISPA members at package concessional charges. The inauguration of the facility was done by Shri J. Thulasidharan, Managing Director, The Rajratna Mills Ltd. Coimbatore on 4th March 2021 at SISPA's premises.

STAFF

The staff strength of SITRA practically remained the same as last year at 90. The number at the PSCs also remained unchanged at 29.

CONVERSION OF FIBRE TO YARN

COTTON VARIETIES AND ITS CONVOLUTIONS IN CORRELATION WITH FIBRE LENGTH, FINENESS AND MATURITY

Cotton fibre in a mature unopened boll is fully swollen, round tubes free of convolutions. As soon as the ball opens, the water content in the fibre construction begins to dry and the fibres shrink along their length as well as cross-sectionally until they collapse into the typical flat-ribbon shape. As the wall collapses, the cotton fibre starts twisting and the 'convolution' occurs, much like a rubber tube evacuated by suction. The irreversible change that occurs when the cell boll opens & dries, the collapsing nature of cell wall with respect to its content and the variation in the cross-section formed is called "convolution".

This study was carried out to study the impact of convolutions in cotton on fibre length, fineness and maturity.

Materials and Methods

Binocular optical microscope N-300 M (Lawrence & Mayo) with SCOPEIMAGE 9.0 imaging software was used in visualizing the cotton fibre convolutions. The microscope specifications are given below in Table 2.

Table 2 Specifications of the Microscope.

MICROSCOPE N - 300M	
Achromatic objectives	4X 10X 40X 100X
Eyepiece	WF10 X / 18X
Eyepiece head	Binocular head
Stage	Double layer mechanical stage 140x140mm /75x50mm
Light source	Sliding - in centerable condenser NA1.25
Illumination	S-LED, brightness adjustable/Halogen lamp 6V/20W

Fiber preparation and covolutions measurement:

Single fiber was mounted on a microscope glass slide in a relaxed state (without any tension, because, pulling the cotton fiber may change the shape of convolutions) to capture a longitudinal image of the cotton fiber in parallel fashion. Images were captured in video format for convolution measurements for the entire length of the fibre, the number of convolutions along the fiber in the field of view of microscope, scanned across fibre length, was counted. After capturing the images, all samples were sent for HVI analysis for quality parameters and maturity co-efficient by NaOH method. Figure 1 shows the image of the microscope with Scope Image software.

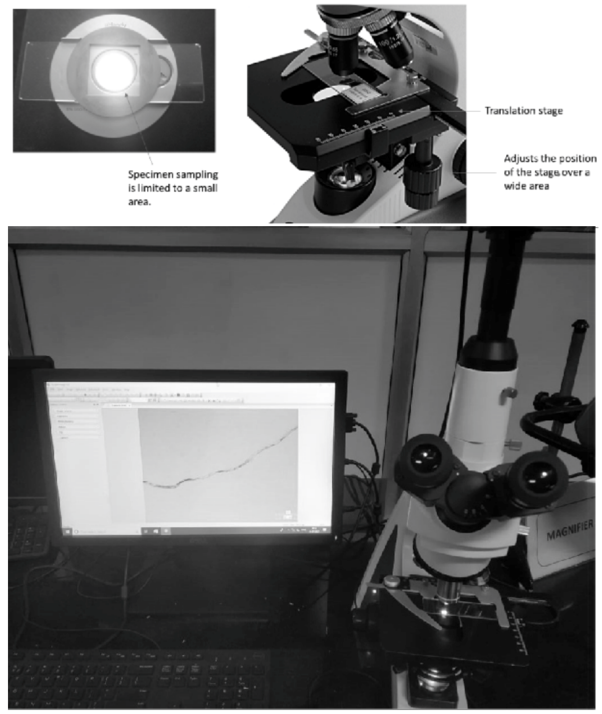


Figure 1 N-300M Microscope with ScopeImage 9.0 Professional Imaging software

Both imported cotton and Indian cotton varities were taken for evaluation. For each variety, 30 fibre samples were taken for measurement of fibre length and the total number of convolutions were converted to convolutions per unit length (per inch). The findings correlates with the findings given in the paper by flint, E. (2008) The structure and development of the cotton fibre. Biological Reviews. 25. 414 - 434. The paper, quotes that the number of convolutions may be as high as 400 per fibre and even coarse Indian cotton fibres have over 200 convolutions per fibre (Clegg & Harland,1924)

Results and Discussion

Both imported cotton and Indian cotton varieties were measured for various fibre properties. The 2.5% span length (mm) and micronaire were measured using HVI, maturity co-efficient by NaOH method and convolution per unit length using the microscope. The results are given in Table 3. It is observed that the imported cottons have lower convolutions per unit length compared to the Indian cotton varieties.

Fibre properties vs Fibre convolution

No significant relationship was observed between the fibre properties namely 2.5 % span length, micronaire and maturity co-efficient. However, there is an increasing trend noticed in convolutions with increase in fibre length and decrease in convolutions as the fibre fineness becomes coarser. No relatiohship was established in the case of maturity Vs convolutions. The trend graphs of Indian cotton as well as imported cotton

The number of convolutions is not distributed equally along the fibre length. It is seen that there is no regularity in the occurrence of convolutions in cotton. Cotton varieties and their convolution images (40 X magnification) are given in Table 2.

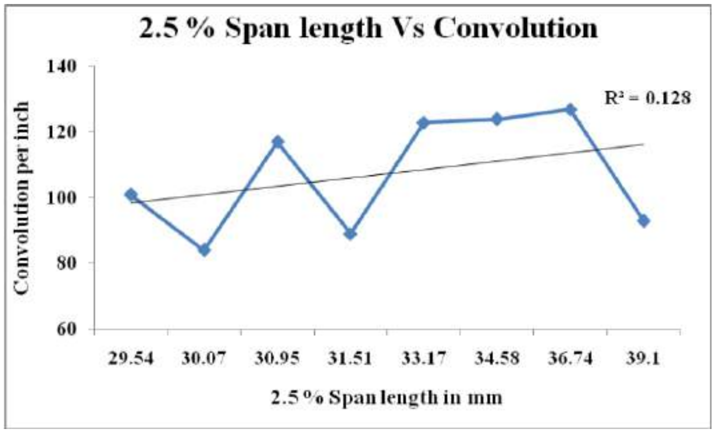


Figure 2(a)

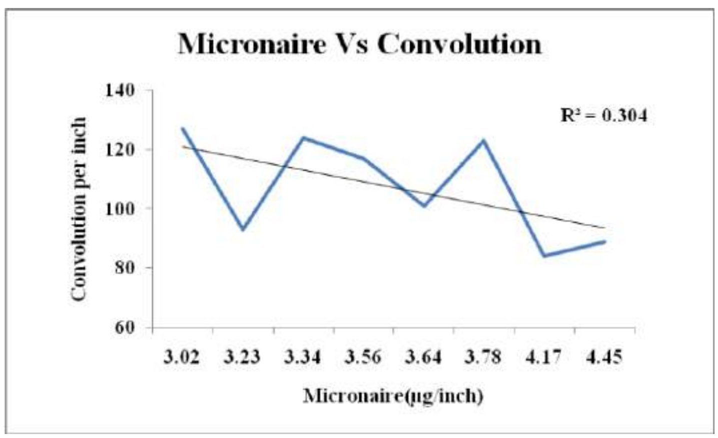


Figure 2(b)

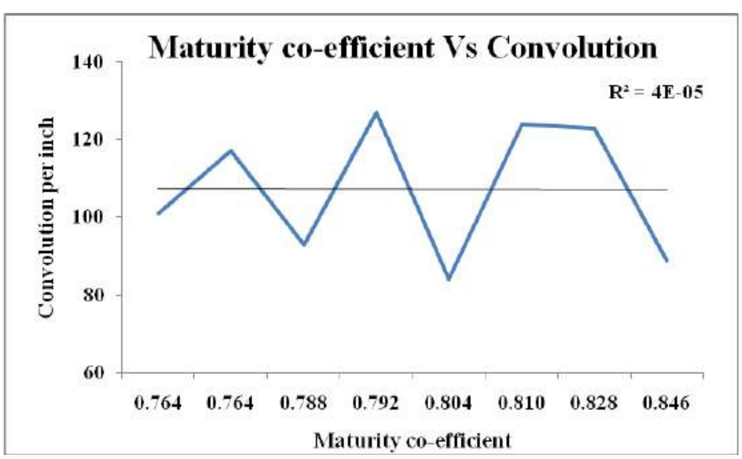


Figure 2(c)

Table 3 Fibre properties and convolutions in imported cotton

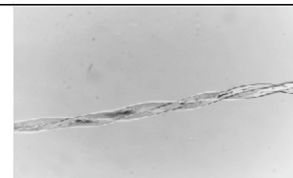
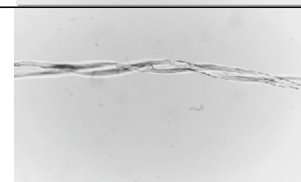
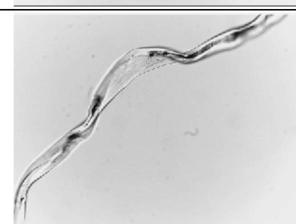
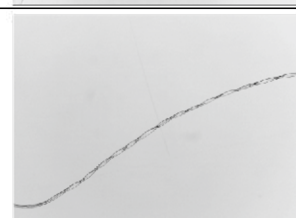
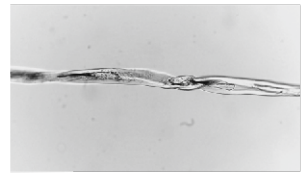
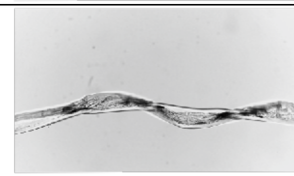
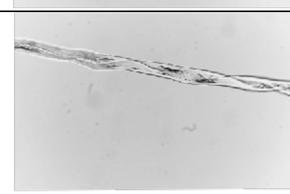
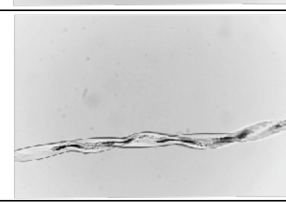
Cotton variety	2.5% SL (mm)	Micronaire (µg/inch)	Maturity co-efficient	Convolution per inch	Microscope image
Imported cotton					
GIZA-94	34.12	3.79	0.84	78	
SUPIMA	37.44	3.96	0.862	80	
ACALA	31.78	4.00	0.842	81	
US-EMOTS	32.41	4.7	0.844	93	
Indian cotton					
MECH	30.07	4.17	0.804	84	
S-6	31.51	4.45	0.846	89	
SUVIN	39.10	3.23	0.788	93	

Table 3 (Contd..)

Cotton variety	2.5% SL (mm)	Micronaire (µg/inch)	Maturity co-efficient	Convolution per inch	Microscope image
Indian cotton					
MCU-5	29.54	3.64	0.764	101	
BUNNY	30.95	3.56	0.764	117	
SURABI	33.17	3.78	0.828	123	
DCH-32	34.58	3.34	0.810	124	
DCH	36.74	3.02	0.792	127	

Further work planned to be carried out

- Cotton fibre convolutions per unit length and its impact on fibre processing and yarn quality needs to be studied.
- Fibre frictional property like cohesive force on sliver and roving, and its impact on tensile property of the yarns to be analyzed.
- Variations in cotton convolutions, pick-wise, need to be studied

MICRO DUST EVALUATION OF DIFFERENT VARIETIES OF COTTON USING MDTA 4

Testing of natural fibres is undertaken to determine the fibre quality to understand the suitability of fibres for particular end use. Natural fibres usually contain non-fibre contaminants generated in production or left over from the extraction processes, e.g., plant debris such as stem bits, leaf bits, seedcoats, dust, soil and foreign matter. Such contaminants are important when determining fibre yield, but can be of more fundamental importance when they limit the usage of fibres in target applications.

The determination of lint and trash content in raw cotton is important, since the presence of trash directly influences the net quantity of cleaned cotton, yarn realization and also to a certain extent quality of the yarn that can be manufactured from a given cotton. The evaluation of trash level in cotton accurately will help a spinner to decide about the cotton lot to be purchased for better realization, quality of the product and to set the process parameters in fibre preparation. Cotton processing machines not only remove trash and foreign matter, but also considerable amount of fibres. Hence, evaluation of categorized trash and dust level to assess the fibre loss is essential.

Most of the commercially available trash evaluation equipment have limited facility to separate the different types of trash and dust. The separation of trash in the above mentioned equipment is also associated with the loss of a certain amount of good fibres. Hence, it requires three to five repeated passages for complete separation of trash and lint as per the standard. This can lead to fibre damage as well as chances for trash particles to get broken down into very small particles that are not collected and calculated as invisible loss. Another difficulty is the collection and categorization of the wastes like heavy particles, dust, micro dust and breathable dust separately. Further, it is not possible to determine the sliver trash in an instrument like Shirley trash analyzer. In this scenario, MDTA-4(Micro Dust and Trash Analyser) provides the facility to analyse the trash and dust levels precisely. The encapsulated system enables separation and collection the of trash and dust particles without liberating anything into the atmosphere and hence samples tested in MDTA shows around 0.5% to 1.0 % higher trash compared to Shirley trash analyzer as given in the Table 4.

Table 4 Comparison of trash extracted from MDTA and Shirley trash analyzer

Machine	MDTA-4		Shirley Trash Analyzer	
Variety	**Lint (%)**	**Trash (%)**	**Lint %**	**Trash%**
MECH	97.06	2.74	97.8	1.70
MECH	95.58	4.12	95.5	3.30
MECH	96.52	3.18	96.2	2.50
MECH	96.37	3.38	95.9	2.90
MECH	96.13	3.58	95.4	3.40
Bunny	96.16	3.49	95.9	2.90
Bunny	96.76	2.91	96.6	2.40
Bunny	96.65	3.05	96.5	2.60
S-6	92.70	6.91	92.3	6.00
S-6	92.87	6.54	92.4	6.10
S-6	93.88	5.72	92.8	5.60
S-6	91.78	7.76	91.6	6.90

Micro Dust and Trash Analyser (MDTA-4) along with additional attachments such as Rotor ring and opening work tester makes it is possible to analyse the classification of impurities such as trash, dust, micro dust levels in the raw material as well as sliver. Finally, the opened fibres are collected in a large rotor box which forms a fibre ring. Using this ring, it is possible to produce a small quantity of yarn and quality evaluation on parameters such as U%, imperfections and single yarn strength to estimate the spinnable count range. Further, opening work value will provide information on fibre frictional characteristics of both cotton and synthetic fibres which will be used for process optimization such as beater speeds, carding delivery rates, draft levels and twist levels. The MDTA machine is shown in Figure 3.

Figure 3 MDTA 4

In MDTA 4, different fibre sample forms, such as fibres from the bale, tufts before carding as well as after carding and draw-frame slivers can be tested. The instrument can also be used to analyse the cleaning efficiency of the blowroom and carding machines. During the measurement, a sample of up to 10 grams is mechanically opened down to single fibres by an opening roller. Both cotton and man-made fibres can be tested on MDTA 4.

Working Principle of MDTA 4

The principle of the suction system of MDTA 4 is depicted in Figure 3. There are two suction devices to provide the vacuum.

- Suction 1 provides the vacuum to suck the fibres off the opening roller-Model: OB20 (fibre channel).
- Suction 2 clears the dust and fibre fragments from the fibres (dust channel).

Both vacuum pressures can be monitored with vacuum sensors that are labelled correspondingly in the MDTA 4 software.

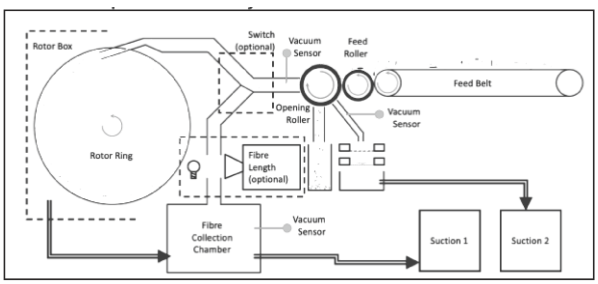


Figure 4 Working principle of MDTA4

The arrangement of different trash and dust separation medium is given below.

(a) Trash tray

Trash particles that are separated from the fibres during the opening process are collected in this tray. The tray is weighed before and after the measurement to determine the amount of separated trash particles.

(b) Fragment tray

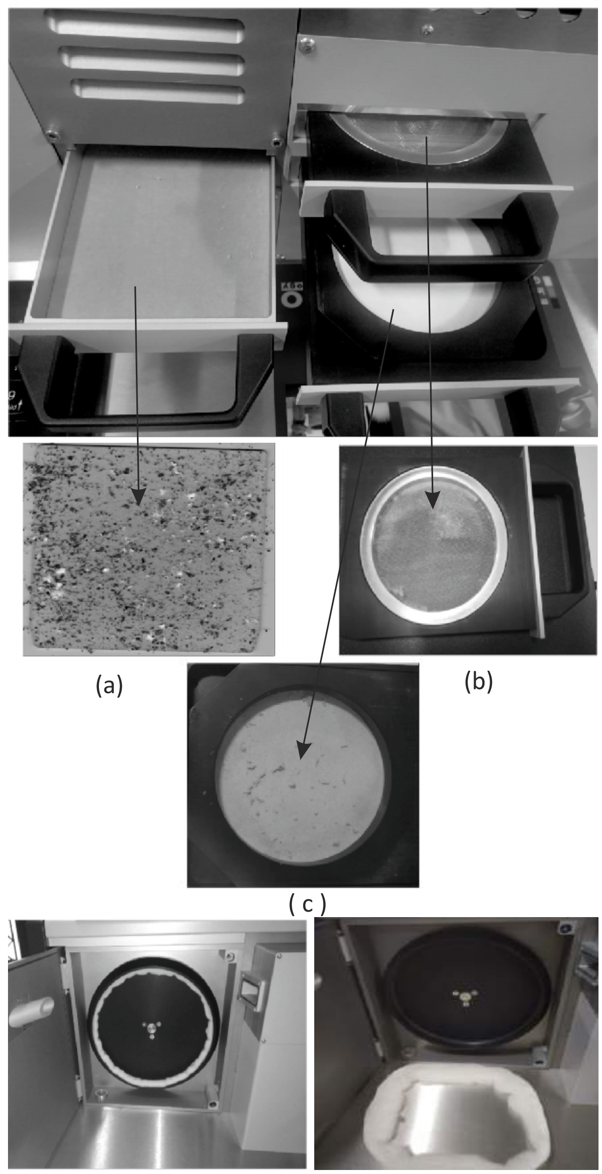
Fibre fragments are collected during the opening process and collected in this tray through suction 2.

(c) Dust tray

Dust particles are collected during the opening process and collected in this tray. Before every test, a new filter should be weighed and inserted. The filter is weighed again after the test to determine the amount of separated dust particles through suction 2.

(d) Rotor / Collection chamber

This rotor or fibre collection chamber is used to collect the fibres in sliver form. The door is locked during the test while the machine is powered on and can only be opened when the machine is not in operation.



(d) Rotor /Fibre collector with fibre/sliver sample

Advantages of MDTA

MDTA-4 gives

1. Accurate quantity of trash, fibre fragments and microdust separately, without any invisible loss during sample testing.

2. The tested material can be collected in sliver form for further analysis.

Proposed experimental plan

Indian cotton and imported cotton varieties were planned to be collected and tested. The proposed sample collection is given in the Table 5.

Process parameter

The process variables of MDTA are as follows ,

1. Feed roller speed - 500 mm/min
2. Opening roller speed (OB 20) - 7000 rpm
3. Rotor speed - 5000 rpm
4. Vaccum dust channel - 2.50 bar
5. Vaccum fibre channel - 2.75 bar

Due to pandemic situation, evaluation has been done for only three Indian cotton varieties, covering two varieties of 29-32 mm length group and one variety of 25-27 mm length group.

Table 5 Proposed experimental plan

Cotton	Length group	Length	No. of variety
Indian	1	25 -27 mm	10
	2	27-29 mm	10
	3	29-32 mm	10
	4	32-36 mm	10
Imported	1	32-36 mm	10
	2	36 mm and above	10

Importance of the analysis

While analyzing in MDTA, it possible to get the micro dust level accurately, which is not available in any other gravimetric evaluation system. This will help to predict the possible invisible loss during the processing of material in the mill apart from moisture loss for the yarn realization calculation.

Result and discussion

The results of Group1 Indian cotton (25-27 mm) and Group3 Indian cottons (29-32 mm) were tested and the results are tabulated in Table 6.

Table 6 Trash and micro dust level

Variety	2.5% SL (mm)	Micronaire (µg/inch)	Maturity co- efficient	Lint (%)	Trash (%)	Fibre fragments (%)	Microdust (%)
Group 1							
S-6	26.81	3.48	0.778	92.70	6.91	0.118	0.268
S-6	26.21	3.52	0.784	92.87	6.54	0.118	0.472
S-6	25.92	3.43	0.796	93.88	5.72	0.126	0.268
S-6	26.20	3.51	0.768	91.78	7.76	0.142	0.320
Group 3							
MECH	30.54	4.89	0.888	97.06	2.74	0.068	0.132
MECH	30.31	3.58	0.832	95.58	4.12	0.093	0.204
MECH	29.94	3.27	0.792	96.52	3.18	0.101	0.200
MECH	30.14	3.63	0.826	96.37	3.38	0.090	0.158
MECH	30.64	3.68	0.832	96.13	3.58	0.095	0.192
MECH	31.84	4.25	0.854	97.17	2.63	0.064	0.132
MECH	31.64	4.40	0.836	96.96	2.77	0.072	0.196
MECH	31.22	4.51	0.842	97.27	2.55	0.056	0.116
MECH	31.00	4.53	0.838	96.78	3.00	0.102	0.125
Bunny	29.42	3.68	0.758	96.64	3.03	0.101	0.232
Bunny	30.32	3.83	0.778	96.46	3.23	0.098	0.208
Bunny	30.26	3.99	0.796	96.83	2.85	0.092	0.228
Bunny	31.61	3.64	0.754	96.16	3.49	0.092	0.252
Bunny	31.99	3.58	0.768	96.76	2.91	0.090	0.234
Bunny	31.93	3.66	0.756	96.65	3.05	0.069	0.232

The tested Sankar-6 samples had a higher trash level of 5.7% to 7.72% and 0.27% to 0.47 % micro dust level compared to MECH and BUNNY cotton varieties.

In MECH variety, samples from different stations showed a wide variation in trash content ranging from 2.6% to 4.1% with micro dust content ranging between 0.13% and 0.20%. Similarly, Bunny variety cotton had 2.8 % to 3.5 % trash with 0.2% to 0.25 % micro dust.

Further work to be carried out

All major Indian and imported cotton varieties are proposed to be evaluated.

A STUDY ON THE EFFECT OF MODIFIED COTS AND TOP ROLLER LOAD ON YARN QUALITY IN RING FRAME

It is well known that in a spinning mill, ring frame is considered as the key machine which is responsible for the final yarn quality and working performance in the downstream process like knitting and weaving. During the conversion of roving in to a final yarn, maximum draft is applied in the ring frames to produce yarns of the required linear density. The combination of draft and top roller loading controls the fibre movement in the drafting zone. There are two types of loading methods for the top rollers in a drafting system, namely pneumatic loading system and spring loading system. In both the systems, the width of the top roller cots is 28 mm. The top roller load is a uniformly distributed load and to a achieve better gripping, 18-20 kg load is applied on the front roller and a total load of 48-54 kg per top arm is being applied in the existing system. In the present generation ring frames, the number of spindles per side is going up to 912 spindles (456 top arms). In this scenario, the overall load applied on the bottom rollers can lead to deformation of bottom rollers, as well as increase in the energy consumed for drafting.

In general, the drafted fibre strand width in ring frame drafting zone varies from 9 mm (finer hank roving bobbin) to 17 mm (coarser hank roving bobbin). But, the ring frame drafting rollers have 28 mm width rubber cots. Further, the width of roving traverse in the conventional ring frame is a maximum of 10 mm and in the case of compact ring frames, the traverse is only upto 4 mm. So, there is no need for a 28 mm wide rubber cot in any case. Hence, preliminary trials were conducted using reduced rubber cot widths and maintaining the same load per unit area in front, middle and back top rollers, thus reducing the top roller load applied on the bottom roller.

Functioning of Pneumatic 3 over 3 drafting system FS 160 P 3-1

The loading support is stamped from the steel sheet and is mounted on a continuous hexagonal section tube behind the rollers (Figure 1). The tube contains a set of rubber hoses connected to a central compressor line. Three top roller holders mounted on two bearing slides are accommodated in the loading support itself. The two bearing slides form a double lever system.

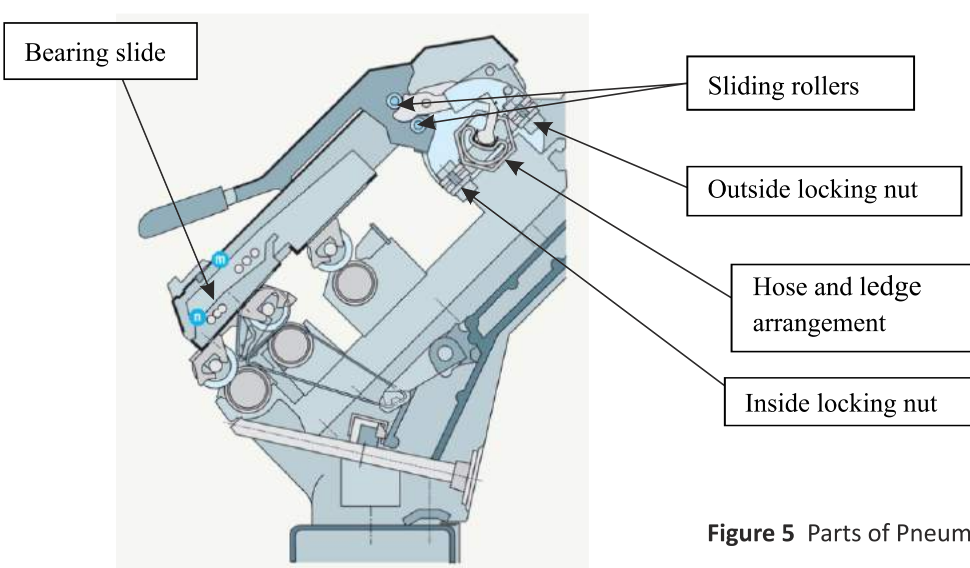


Figure 5 Parts of Pneumatic top arm P 3-1

Depending on where the pin is inserted in one of the three holes as the pivot at 'm', the total pressure coming from the compressed air hose acts through a cam which applies the pressure more strongly to the back roller (or) the two front rollers. Pressure can also be distributed differently between the two front rollers via. a second pin/hole system in the bearing slide of these two rollers at 'n'.

The total pressure on the top rollers is changed by simply adjusting the pressure in the compressed air hose via. a reducing valve at the end of the machine. The trials were carried out on a LMW LR6/S pilot ring frame having P 3-1 pneumatic drafting system with Suessen compact system.

Objectives of the study

- Reducing the raw material cost used for manufacturing synthetic rubber covered rollers, thereby achieving direct savings in the cost of cots replacement.
- Reducing the overall top arm load exerted on the bottom roller, so as to reduce the chances of bottom roller deformation.
- Saving energy due to the reduced drafting load.

Experimental and proposed plan

Trials were carried out as per experimental plan given in Table 7.

This investigation is proposed to reduce the top arm loading and maintain the same load per unit area by reducing the top roller rubber cots width and study its effect on yarn quality. The proposed modification in rubber cots is given in Figure 6.

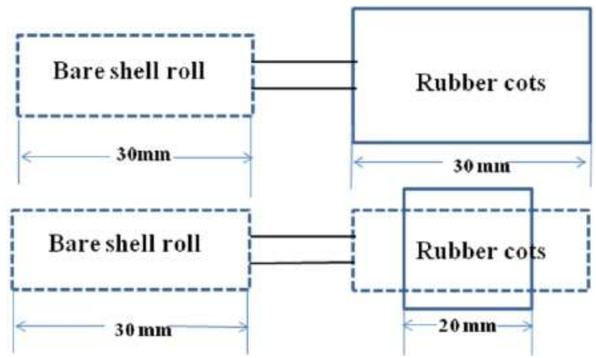


Figure 6 Proposed modification in rubber cots

The experimental plan for top arm loading, cots width and their load per unit area is given in Table 8.

Table 7 Experimental plan

Material	Count (Ne)	Process	Conventional		Compact		No. of trials
			2.5 bar	1.5 bar	2.5 bar	1.5 bar	
Cotton	20 and 40	Carded & Combed	4	4	4	4	16
	80 and 100	Combed	2	2	2	2	8
PC blend (65/35)	20, 40, 60 and 80	Carded	4	4	4	4	16
Polyester	20, 40 and 60	Carded	3	3	-	-	6
Viscose	20, 40, 60 and 80	Carded	4	4	-	-	8
Modal	20, 40, 60 and 80	Carded	4	4	-	-	8
Total number of trials							62

Table 8 Experimental plan

Parameters	Pressure 2.5 (in kg/cm^2)			Pressure 1.5 (in kg/cm^2)		
	Front roller	Middle roller	Back roller	Front roller	Middle roller	Back roller
Load in Kg.	23.55	15.21	22.5	15.9	10.3	14.6
Cots width (mm)	30 mm	30 mm	30 mm	20 mm	20 mm	20 mm
Load in (kg/mm)	0.785	0.507	0.750	0.795	0.515	0.730

Materials and methods

Preparation of yarn samples

The study was carried out in spinning of Ne 20, 30 and 40 yarns, in both combed and conventional carded process. The quality attributes of the cotton used in this study and the process parameters adopted in ring frame are given in Tables 9 &10.

Table 9 Quality attributes of raw material used

S.no	Fiber properties	20, 30 and 40 Ne Combed and Carded
1.	2.5% span length (mm)	29.5
2.	Uniformity ratio (%)	45.6
3.	Bundle fibre strength(g/tex)	23.5
4.	Fibre fineness (µg/inch)	3.9

Results and Discussion

Combed process

Tensile properties

The tensile properties of combed process conventional yarn reveal that there is a marginal increase in yarn CSP and RKM with modified cots for all the counts spun. In addition, there is an improvement in elongation by 0.25% to 0.4 % at a pressure of 1.5 kg/cm^2. All results were found to be statistically significant. The tensile properties of combed conventional yarns are given in the Table 11.

Table 10 Process parameters in Ring frame

Process parameters	Combed and carded conventional		
	20s	30s	40s
Rove hank (Ne)	1.00	1.00	1.00
Total draft	21.04	30.44	39.53
Break draft	1.18	1.18	1.18
Bottom roller setting(mm)	42.5/60	42.5/60	42.5/60
Top roller setting (mm)	51/59	51/59	51/59
Spacer size (mm)	4.0	3.50	3.0
Twist per inch (TPI)	17.74	21.67	25.07
Average spindle Speed (rpm)	17000	18000	18000

Unevenness properties

The evenness properties of combed conventional yarns are given in Table 12. It is observed that in 20s, 30s and 40s combed conventional yarns, there exists a significant difference in the yarn unevenness (U%), where the absolute value witnessed a reduction of 0.4 to 0.5 points.

The imperfections, both in normal and extra-sensitive levels, showed a significant improvement of upto 25% with the modified cots. Similarly, Hairiness index and S3 values also fared better with the modified cots.

Table 11 Tensile properties of combed conventional yarn

Parameter	20s C		30s C		40s C	
	Regular	Modified	Regular	Modified	Regular	Modified
pressure - kg/cm^2	**2.5**	**1.5**	**2.5**	**1.5**	**2.5**	**1.5**
Cots diameter-mm	**30**	**20**	**30**	**20**	**30**	**20**
Count	19.7	19.73	28.77	28.9	39.1	38.11
CV%	1.36	1.23	1.6	1.26	1.2	1.38
Strength	145.15	148.84	90.66	94.21	63.5	66.73
CV%	4.03	2.70	5.08	2.62	4.1	4.5
CSP	2859	2936	2607	2722	2483	2542
Elongation %	5.45	5.75	4.95	5.22	4.21	4.68
Cv%	6.43	8.13	11.33	7.58	8.7	7.16
RKM	18.21	18.72	17.63	17.79	16.88	16.73
Cv%	6.30	5.89	7.08	7.48	11.82	7.63

Table 12 Evenness properties of combed conventional yarns

Count	20s C		30s C		40s C	
Description	**Regular**	**Modified**	**Regular**	**Modified**	**Regular**	**Modified**
Pressure - kg/cm^2	**2.5**	**1.5**	**2.5**	**1.5**	**2.5**	**1.5**
Cots diameter-mm	**30**	**20**	**30**	**20**	**30**	**20**
U %	8.9	8.03	10.22	9.75	10.9	10.42
CVm	11.21	10.13	12.89	12.31	13.78	13.19
Thin -40%	15	3	67	40	117	90
Thick + 35%	159	54	398	283	610	412
Neps +140 %	88	48	286	249	487	380
Total extra sensitive imperfection/km	**262**	**105**	**751**	**572**	**1214**	**882**
Thin - 50%	0	0	1	0	2	1
Thick + 50%	13	8	39	23	**75**	**49**
Neps +200 %	14	12	43	47	104	89
Total normal imperfections/km	**27**	**20**	**83**	**70**	**181**	**139**
H	6.30	5.61	5.94	5.84	4.67	4.54
S3	736.58	638.67	747.17	428.33	1026	618.42

Classimat results

The Classimat results of combed process is given in Table 13. 40s count showed a significant improvement in objectionable, long thick and long thin faults. In 20s count, there was a marginal increase in objectionable and long thick faults. However, the performance of modified cots for 20s need to be studied and optimized through bulk trials.

Carded process

Tensile properties

The tensile properties of carded conventional yarn are given in the Table 14. CSP, RKM and elongation values did not show significant improvement with modified cots in the conventional carded process.

Evenness properties

It was observed that in 20s, 30s and 40s carded conventional yarn, no significant difference is observed in the yarn unevenness (U%), imperfections (both normal and extra-sensitive levels) and hariness index between both regular and modified cots (Table 15). With respect to S3 hariness value in 20s and 30s count, the same was seen to reduce by 50% and 20% respectively. However, in 40s K, an adverse trend was noted in which S3 value increased by two-third.

Classimat results

Classimat result of carded the process, given in Table 16, shows that there was a significant improvement in all objectionable, long thick and long thin faults.

Findings

Significant difference in yarn quality was observed by reducing the top arm load from 2.5 kg/cm^2 to 1.5 kg/cm^2 and maintaining the same load per unit area in the drafting system (around 0.750 kg/mm for front, back rollers and 0.5 kg/mm for middle roller).

Further work proposed

Similar trials need to be conducted and the yarn quality has to be studied for multiple counts in bulk process.

Table 13 Classimat results of combed process

Description	**20s C**	**20s C**	**40s C**	**40s C**
Cots diameter	**Regular**	**Modified**	**Regular**	**Modified**
Arm pressure - kg/cm^2	**2.5**	**1.5**	**2.5**	**1.5**
CLASSIMAT5				
A1	98.8	135.1	888.9	805.5
A2	19.1	17.5	146.5	140.6
A3	4.2	5	21.3	14.4
A4	3.2	1.3	1.9	1.8
B1	27.6	16.3	69.9	62.2
B2	14.9	13.8	29.1	25.2
B3	5.3	3.8	8.7	4.5
B4	0	0	1	3.6
C1	11.7	8.8	24.3	18.9
C2	3.2	1.3	14.6	12.6
C3	1.1	2.5	5.8	1.8
C4	0	2.5	1	0
D1	4.2	7.5	3.9	2.7
D2	4.2	1.3	0	1.8
D3	0	1.3	0	1.8
D4	0	0	0	0
E	8.5	10	6.8	7.2
F	6.4	8.8	13.6	8.1
G	0	0	3.9	0.9
H1	0	0	9.7	3.6
H2	0	0	0	0
I1	0	0	0	0
I2	0	0	0	0
Raw material faults	179.5	200.3	1177.2	1067.7
Objectionable faults	32.9	36.5	64	45.9
Long thick	14.9	18.8	24.3	16.2
Long thin	0	0	9.7	3.6
Total/100km	227.3	255.6	1265.5	1129.8

Table 14 Tensile properties of carded process

Description	**20s K**		**30s K**		**40s k**	
	Regular	**Modified**	**Regular**	**Modified**	**Regular**	**Modified**
pressure - kg/cm^2	**2.5**	**1.5**	**2.5**	**1.5**	**2.5**	**1.5**
Cots dia-mm	**30**	**20**	**30**	**20**	**30**	**20**
Count	19.76	19.9	29.58	29.4	39.3	39.3
CV%	2.35	1.34	2.07	2.4	2.1	2.2
Strength	131.84	131.64	82	86.3	57.7	56.7
CV%	4.65	3.91	4.59	4.61	5	5.8
CSP	2602	2631	2424	2535	2268	2228
UTR						
Elongation %	5.15	5.12	4.65	4.62	4.09	4.42
Cv%	6.45	7.26	10.47	9.57	11.13	8.92
RKM	15.64	15.89	15.7	16.2	14.82	15.16
Cv%	8.39	8.59	8.24	9.56	10.43	10.55

Table 15 Evenness properties of Carded process

Count	20s K		30s K		40s K	
Description	**Regular**	**Modified**	**Regular**	**Modified**	**Regular**	**Modified**
pressure - kg/cm^2	**2.5**	**1.5**	**2.5**	**1.5**	**2.5**	**1.5**
Cots dia-mm	**30**	**20**	**30**	**20**	**30**	**20**
U %	11.25	10.97	13.06	12.98	14.17	13.99
CVm	14.27	13.96	16.71	16.59	18.22	17.98
Thin -40%	119	96	444	387	804	703
Thick + 35%	887	813	1730	1749	2368	2402
Neps +140 %	718	903	2779	2666	3947	3813
Total extra se nsitivity	1724	1812	4953	4802	7119	6918
Thin - 50%	2	1	22	14	42	37
Thick + 50%	143	122	426	420	**758**	**736**
Neps +200 %	117	176	664	653	1169	1056
Total normal	262	299	1112	1087	1969	1829
H	6.18	6.28	5.91	5.24	5.22	5.2
S3	957.17	481	911.67	723.08	242	710

Table 16 Classimat results of Carded process

Description	20s K	20s K	40s K	
Cots dia-mm	**Regular**	**Modified**	**Regular**	**Modified**
Arm pressure - kgs/cm^2	**2.5**	**1.5**	**2.5**	**1.5**
CLASSIMAT 5				
A1	1164.3	1198.2	8283.3	8237.6
A2	152.8	165.4	1508.4	1502
A3	25.1	15.6	76.8	106.9
A4	8.4	2.1	3.2	5
B1	89.4	99.9	1112.5	1059.3
B2	24.2	15.6	62.4	83.9
B3	4.7	6.2	6.4	26
B4	7.5	3.1	3.2	6
C1	16.8	10.4	65.6	59
C2	5.6	6.2	4	8
C3	4.7	2.1	1.6	0
C4	0.9	0	0.8	1
D1	10.2	5.2	6.4	1
D2	4.7	0	1.6	2
D3	0.9	2.1	0.8	0
D4	0	1	0	0
E	20.5	18.7	8.8	5
F	23.3	11.4	35.2	14
G	3.7	0	7.2	0
H1	14	11.4	232.7	168.9
H2	1.9	0	0	0
I1	0	1	0	0
I2	37.3	0	0	0
Raw material faults	1463.3	1500.9	11042.6	10950.8
Objectionable	104.4	62.3	145.6	165.9
Long thick	47.5	30.1	51.2	19
Long thin	53.2	12.4	232.7	168.9
Total/100km	1615.2	1593.3	11239.4	11135.7

STUDIES ON COMBING EFFICIENCY IN MODERN COMBERS

In the process of yarn spinning, the role of comber is to improve the quality of raw material mainly by removing short fibres, with associated removal of trash particles and neps present in it. The quality of combed yarn depends on the type of raw material, amount of noil extracted and selection of process parameters at comber and the comber preparatory. Generally, the quantity of waste to be extracted is fixed arbitrarily by the mills. While fixing the noil level, it is to be borne in mind that the improvement in yarn quality is directly proportional to the quantity of waste extracted. It is, however, not uncommon to find a wide variation in the quantity of waste extracted between mills and there are a number of instances, where the improvement in the yarn quality is not commensurate with the level of waste extracted. Apart from the type of cotton used, poor upkeep of the comber, inadequate maintenance and improper process parameters would lead to a poor performance of the comber and an excessive waste. Considering the above, SITRA in the year 1975, came out with a guideline to judge the combing performance and take necessary process control measures. In line with the changes in the comber technology, the same was then revised in the year 2010. The method of earlier assessment was using the Digital fibro-graph, which measures fiber length based on span length concept.

$$\text{Combing efficiency (\%)}^* = \frac{\left(\begin{array}{c}\text{50\% span length}\\ \text{of comber sliver}\end{array}\right) - \left(\begin{array}{c}\text{50\% span length}\\ \text{comber lap}\end{array}\right)}{\text{50\% span length of comber lap}} \times \frac{100}{\text{Noil\%}}$$

'*'*per 1% noil extraction*

Need for the study

The above formula was used for calculating the combing efficiency using the 50% span length in comber sliver and lap using a Digital fibro-graph, is almost obsolete in the industry. Even though the HVI instrument measures the fibre length in the similar span length concept of Digital fibrograph; with the use of automated fibre sampler, Uster is not recommending HVI for testing well paralleled fibres like comber lap, combed sliver, etc. While the well paralleled fibre is tested using HVI, the results are not accurate, reliable and repeatable due to problems in the method of sample preparation. Because of the above reasons, many times the efficiency values are very low when the combing efficiency is calculated based on the HVI measured 50% span length for the modern combers. Based on those values, it would not be possible to decide on the performance of a comber.

Materials and methods

In order to arrive at a formula that estimates a consistent and repeatable value that forms a measure of combing performance, an in-house project was planned, based on which trials were conducted at mills and samples tested at SITRA.

Formulae derived based on single fibre length data of comber lap, sliver and noils are as follows:

Formula 1

An attempt was made by SITRA in the year 2006 to assess comber performance based on AFIS single fibre test results and a research report, "A methodology to arrive at combing efficiency using single fibre length data" was published. The following formula had been derived that takes into account the overall performance of the combing process.

1.SITRA Combing Index (SCI) =

$$\frac{\Delta L(w) * \Delta SFC(w) * \Delta Nep}{GFC * Noil\%} \quad \text{--- (1)}$$

Where,

ΔL (w) - % improvement in mean length by weight
ΔSFC (w)- % reduction in SFC(w) from lap
ΔNep - % reduction in neps in sliver from lap
GFC - % good fibre content in noil
Noil% - % noil extracted from feed

It was assumed that, under good working conditions, the expected index could be calculated using the following formula.

Under very good M/c working conditions the standard combing index would be	=	$\frac{10 \times 60 \times 70}{20 \times \text{Noil level}}$
	=	2100 / Noil level
where K is 2100	=	(or) K / Noil level

Note: "K"value is calculated based on the fixed values of 10% improvement in mean length by weight, 60% reduction in SFC(w) from lap ,70% reduction in neps in sliver from lap and 20% good fibre content in noils

However in this method, finding the exact amount of good fibre content in noil is difficult. Further the expected combing index using the proposed 'K' value may not appropriate for the performance of present generation machines. Hence, it is necessary to alter the formula with correct inputs.

Formula 2

The following formula is based on the short fibre extraction alone under ideal and actual conditions. The meaning is, theoretically, all short fibres are to be removed by the comber. But, it is practically not so. Hence, the value would be between 0 and 1.

$$\text{Combing index (S)} = \frac{\left[\text{Noil Extracted \%} - \left(\text{SFC (W) in lap} - \text{SFC (W) in sliver}\right)\right]}{\text{Noil extracted \%}} \quad \text{... (2)}$$

Then the output is

towards 0 – Superior
towards 1 – Poor

i.e. lower the value, better is the comber performance. This index only considers the extent of short fibre removal for comber performance evaluation.

Formula 3

Using the available AFIS mean fibre length data of sliver and lap, the following formula was derived to calculate the length improvement index as follows

$$\text{Combing index (L)} = \frac{\left(\text{L (n) of comber sliver}\right) - \left(\text{L(n) of comber lap}\right)}{\text{L (n) of comber lap}} \times \frac{100}{\text{\% of noil extracted}} \quad \text{... (3)}$$

Based on this, if the output is

towards 1 – Superior
towards 0 – Poor

Higher the value, better is the length improvement. This index only considers the fiber length improvement for comber performance evaluation.

Formula 4

Using the available AFIS mean fibre length data and short fibre content of sliver & lap and % noil extracted, another formula was derived to calculate the combing index, as given below.

$$\text{Combing Index (S\&L)} = \frac{\left(\text{L (n) sliver}\right) - \left(\text{L(n) lap}\right)}{\text{L(n) lap}} \times \frac{\left(\text{SFC (n) lap}\right) - \left(\text{SFC (n) Sliver}\right)}{\text{SFC (n) lap}} \times \frac{100}{\text{Noil \%}} \quad \text{... (4)}$$

Based on this, if the output is

towards 1 – Superior
towards 0 – Poor

Higher the value, better is the length improvement. This index considers both the fiber length improvement and the extent of short fibre removal for comber performance evaluation.

Results and Discussion

When the Combing index (SCI) is calculated based on Formula (1), the results show that the index to be between 2 (Poor) to 103 (Superior) with different makes of combers and at various noil levels.

A revised Combing index (S) calculated based on Formula (2)ie., short fibre removal, shows that the combing index to be from 0.15 (Poor) to 0.39 (Superior) between different makes of combers and at various noil levels.

Combing index (L) calculated based on mean length improvement [Formula (3)] showed that index was between 0.43 (Poor) to 1.14 (Superior).

Combing index (S&L) calculated taking into account both mean length improvement as well as the extent of short fibre extracted using Formula (4) showed that the index values were between 0.11 (Poor) to 0.70 (Superior).

Conclusions

When multiple parameters of AFIS length measurement are considered while arriving at the constant 'K' with some basic assumptions as in Formula 1 to calculate the combing performance index (SITRA Combing Index (SCI)), too much variation was observed.

But while using the single parameter of SFC(W) in the formula (Combing Index (S) for comber performance evaluation, the variation in the index was very minimal, thus failing to distinguish poor performing and better performing combers.

While using mean length improvement to evaluate the combing performance, a considerable variation was observed in the index (Combing index (L)).

Hence, to derive a formula to get more reliable results, parameters such as mean fibre length improvement, short fibre reduction and % noil extracted are considered. This formula [Combing index (S&L)] was validated with the data collected from various mills having different make and model combers and trials conducted on the same machines by altering the parameters such as nipping rates and waste%. The combing performance index arrived with this new formula seems to be more appropriate in evaluaiton of the combing performance.

POISSON'S RATIO OF NON-WOVEN SPUN BONDED FABRIC FOR MEDICAL APPAREL

Medical apparels are personnel protective equipment used by medical personnel as well as patients in any medical procedure. With the discontinuance of woven fabric for products like surgical gowns, use of one time use spun bonded material has become prominent.

Besides barrier performance, comfort characteristics play a major role during use. The Poisson's Ratio is one of the fundamental mechanical properties of any structural material like textiles and is investigated on spun bonded fabric for medical apparel. This study becomes essential as it affects the bending, shear and draping behaviour of the fabric. The investigation was carried out on a series of spun bonded nonwoven fabrics differing in aerial density and the number of layers. Physical characteristics of the spun bonded fabrics taken for the study is given in Table 17.

Table 17 Physical characteristics of the spun bonded fabrics studied

Sample code	Direction	Thickness (mm) ISO 9073-2:1996	GSM	Young's Modulus (MPa)	Elongation %
1	MD CD	0.25	35	26.1 13.7	50.20 54.90
2	MD CD	0.31	50	33.0 11.9	54.50 57.32
3	MD CD	0.26	35	31.1 10.1	50.32 65.42
4	MD CD	0.33	50	21.5 8.99	52.41 50.56
5	MD CD	0.23	35	41.5 13.8	41.55 51.10
6	MD CD	0.28	45	35.1 10.1	35.98 48.42
7	MD CD	0.23	35	45.3 17.2	38.11 42.34
8	MD CD	0.26	35	36.2 9.2	56.36 63.64
9	MD CD	0.31	43	25.5 9.06	51.74 56.10
10	MD CD	0.35	50	21.7 10.6	43.40 50.80
11	MD CD	0.38	73	27.9 5.18	38.30 52.80

Poisson's ratio is an indicator of the fabric deformation, and it is influenced by the value of the applied load, loading direction and fabric structure. Results indicate that the Poisson's ratio increases initially and then decreases slightly as the extension is increased in the machine direction.

$$\text{Poisson's Ration} = \frac{\text{Lateral contraction \%}}{\text{Longitudinal extension \%}}$$

The Poisson's ratio is found to be higher with increase in the number of layers of spun bonded fabric assembly for the same GSM. The Poisson's ratios ranged from 0 to 0.728 for the various extension levels that have been considered depending on the direction of action of the tensile force in the machine direction (MD) and cross direction (CD). This was also studied as a function of gauge length and width in both machine and cross directions.

The general trend observed in SMS (Spun bond Meltblown Spunbound) fabrics in this study is that the Poisson's ratio increases as the gauge length is increased at both the directions, irrespective of fabric GSM. Contraction % is more pronounced in the case of shorter widths & the Poisson's ratio increases as the width decreases.

Flexural rigidity and Young's modulus in machine direction is higher than that in the cross direction. Since the elongation values are higher and higher contraction (higher Poisson's ratio) is found in the cross direction, the manufacture of surgical gowns may be patterned accordingly to provide more comfort and stability during weaving.

Results

1. The flexural rigidity in machine direction is higher than in the cross direction for all the spun bonded fabric samples, whereas, the elongation % showed a reverse trend. With multiple layers, the flexural rigidity increases for the same GSM. It was observed that the Poisson's ratio increases initially and then decreases slightly as the extension is increased in machine direction for all fabrics studied.

2. The graph flattens for the cross direction after 15% extension for all the fabrics that were studied. It is inferred that as the number of layers increase for spun bonded fabric, the value of Poisson's ratio also increases when compared with the fabrics of same GSM which in turn can be related to the structural integrity of the component layers. The contraction level in machine direction is higher than in the cross direction (CD). In the machine direction (MD), the extension contributes much lesser and there may be other factors like binder film, melt structure, degree of orientation of fibrils, etc., which influence the Poisson's ratio.

3. Since spun bonded nonwoven fabrics are anisotropic in nature, the Poisson's ratio values

ranged from 0 to 0.728 for the various extension levels considered depending on the direction of action of the tensile stress (MD & CD) in the fabrics evaluated during the study.

4. The general trend observed in SMS fabrics in this study is that the Poisson's ratio increases as the gauge length is increased at both the directions, irrespective of the GSM. Contraction % is more pronounced in the case of shorter widths & Poisson's ratio increases as the width decreases.

5. The correlation between GSM and Poisson's ratio is found to be moderate (0.5-0.7), whereas the correlation between the thickness and Poisson's ratio is lower (0.2-0.4). The regression plot between relative contraction Vs. relative extension reveals the values for CD shows more linearity when compared to MD.

6. The correlation between Young's modulus and flexural rigidity is poor although the trend followed is similar in both machine and cross directions. The classical formula is found to be inapplicable for predicting the Poisson's ratio.

7. For certain applications, due to high Poisson's ratio of the fabric material used, the machine width is over-designed or process conditions are compromised in order to control the width-loss. This problem also extends into finishing operations causing issues of sheet control and overcompensating machine conditions or product dimensions.

8. Since the elongation values are higher and higher contraction (higher Poisson's ratio) is found in cross direction, the manufacture of surgical gown may be patterned accordingly to provide more comfort and stability during its use. With the current COVID 19 pandemic, this study could offer a critical insight into various aspects to be considered in manufacturing coverall/bodysuits for physicians and patients.

A research paper based on the findings of the study has been communicated to JOTI for publication.

CHARACTERISATION OF TEA BAGS & STRINGS USED IN DIP-TEA SACHETS

National Institute for Occupational Safety and Health (NIOSH) labels tea bag sachets as potential carcinogens and have been shown to cause **cancer** in animals, impair fertility and weaken immune function.

Paper tea bags pose an altogether different threat. Many paper bags are treated with a compound called epichlorohydrin, which is used to produce epoxy resins and acts as a pesticide.

Nathalie Tufenkji and her team found that steeping a single silky plastic tea bag (made out of synthetic material) at brewing temperature (95° C) releases approximately 11.6 bn microplastics and 3.1bn nanoplastics (the latter are 150 times smaller than a hair, possibly small enough to permeate human cells) made up of nylon and polyethylene terephthalate (PET) into a single cup of tea.

Tea bags were characterized for thickness, wettability, surface topography, pore size, porosity, and permeance to understand their influence on infusion kinetics of tea bags. Although most of the tea across the world is brewed using tea bags, information regarding the impact of tea bag material parameters on tea bag infusion and brewed tea is slender.

This study was taken up in order to assess the above threats to tea consumers in the Indian scenario by investigating tea bag sachets of common brands that are available in the market. Also, the physical & chemical characterisation of the tea bags and the tea bag strings were studied.

Methodology

Major tea brands available in sachets in the Indian market were identified & their products were collected**.** Investigation included,

- physical characterisation of the string & sachet used
- chemical analysis - specific to migration study, pesticide residues, insecticides (chlorophenols), pH, formaldehyde, APEO, lubricants, etc.,

The study specifically aimed to analyse the advantages & disadvantages of tea bags made of,

- Woven &s Non-woven
- Heat sealable, non-heat sealable & ultrasonically sealed
- Bleached, Oxygen bleached & unbleached
- Chemical treatments – such as Epicholorohydrin, etc.
- Surface coating – such as synthetic starch etc.
- Tea bags of brands A & D were staple free

Investigations done so far

Physical parameters

Table 18 Physical characteristic of tea bags

S.no	Tea bag Sample	Air Permeability ($Cm^3/cm^2/sec$)	Bursting Strength (Kg/cm^2)	GSM (gms/m^2)	Thickness (mm)
1	Brand A	59.7	0.144	16.92	0.089
2	Brand B	126.6	0.200	13.00	0.081
3	Brand C	126.3	0.120	12.41	0.079
4	Brand D	131.1	0.100	13.47	0.080
5	Brand E	130.0	0.154	13.24	0.088

S.no	Tea bag Sample	Count (Ne) (3-ply)	TPI (S-Twist)
1	Brand A	6.73	8.27
2	Brand B	6.58	8.76
3	Brand C	7.54	6.76
4	Brand D	5.69	3.18
5	Brand E	6.55	3.64

S.no	Tea Bag Sample	pH* at 28°C	Formaldehyde content * (upto 16 PPM)
1	Brand A	6.93	ND
2	Brand B	7.13	ND
3	Brand C	7.19	ND
4	Brand D	7.74	ND
5	Brand E	7.76	ND

*pH of RO water used: 7.65; * during extract;*
ND – Not detected

In continuation of this study, and based on the suggestions offered during the 56^{th} RAC meeting last year, the findings of the investigations done are reported.

Findings

Major tea brands available in sachets in the Indian market were identified and their products collected from stores.

- Physical characterisation of the string and sachet used were analysed initially and were found to have average value of 120 ($cm^3/cm^2/sec$) air permeability, 0.154 kg/cm^2 bursting strength, 13.8 $grams/m^2$ and 0.08 thickness.

- The average pore diameter was found to be 41 microns tested using capillary flow porometer.
- The tea bag string was found to have 3 ply yarn of 6's Ne with approximately 3-8 tpi.
- The paper tea bags were made of cellulose and polypropylene, cellulose and polyester and pure cellulose.
- The bonding of tea bags was done thermally in case of cellulose and poly-olefins/polyester blended materials whereas, in case of paper tea bags, it was done by resins.
- The chemical testing carried out shows an absence of free formaldehyde upto 16 ppm.
- The pH was found to range between 6.9 and 7.8 when checked from the extract prepared with tea bags.
- Tea bags were washed and immersed in hot water as the case of tea preparation. The extract was cooled and tested. There was no pH variation in the extract at 28°C. Some of the tea bags had staples for binding the tea bag string.
- The extract of the tea bag samples were tested for their cytotoxicity.
- Samples A and B were made of synthetic materials, whereas samples C,D & E were found to have cellulose material.
- The SEM images showed that there is a coating on the tea bag paper made of cellulose also.
- The Nylon tea bag is more porous than non woven varieties.
- The tea bag material in major brands consists of Non Woven materials made of polypropylene, poly lactic acid and Nylon 6.
- 2 ply filament yarn was found used as tea bag string in which the thread was found heat sealed with the bag.
- Tea bags of Brand C made of 100% cellulose filter paper bag exhibited slight cytotoxicity. Non woven material & PLA exhibited severe cytotoxicity. Nylon, PP String showed mild to moderate cytotoxicity
- Investigation for the presence of epichlorohydrin was done using GCMS. Epichlorohydrin was not present in all the tea bag samples.
- PLA tea bag is claimed to be biodegradable, but they can be decomposed only using an industrial composting facility. Evaluation of the biodegradability of the cotton tea bags is in progress.

ENERGY MANAGEMENT

A STUDY ON THE INFLUENCE OF THE COMPACT SPINNING SYSTEM ON SPECIFIC ENERGY/ POWER CONSUMPTION OF RING FRAMES

The market demand for compact yarns has been significantly increasing in recent years and all the reputed spinning mills have upgraded their existing ring frames for compact spinning capability. During the initial years, the pneumatic compact spinning system is known to increase the overall specific energy consumption(SEC) of ring frames significantly. In order to reduce the energy expenditure, mechanical compact systems have also been tried and are continually being improved. Pneumatic compact system with lower SEC has also been developed by some manufacturers. A study which aims to evaluate the specific energy consumption of the spinning compact systems and its influence on ring frame specific energy consumption in modern, existing ring spinning machines has been taken up.

In ring spinning, various compact systems are used to reduce the spinning triangle and improve the fibre alignment. The fibre compacting, systems give the highest yarn strength and unequaled wearing comfort. Since the protruding fibres are drawn in and are arranged parallel to the yarn axis, the reduction of yarn hairiness in spinning is also one of the major advantages given by the compact systems. In this study, the amount of suction pressure and the corresponding power consumption by the various compact systems has been proposed to be measured under controlled conditions for determining its impact on the SEC of ring frames and overall power comsumption of the mill.

Some preliminary data on compact suction pressure in cm WC and the corresponding compact system motor load in kW measured in different makes and models of fibre compacting systems in different mills are given in Table 19.

Table 19 Compact suction pressure and compact suction motor load in mills

Compact system – Make	Description	Count Range (Ne)	Material	Range of spindles /frame	Range of Compact suction pressure (cmWC) - Measured	Range of compact motor load (kW) - Measured
A (1)	Common duct system (CDS)	18s-95s	Cotton	1200	25-35	4-10
		30s	Synthetic	1200	20-23	4
A (2)	Group drive with multiple fans	25s-120s	Cotton	1008-1200	22-35	5-7
B	Common fan for pneumafil and compact systems	30s-120s	Cotton	1200	7-14	5-6.5*
C	CDS	40s	Cotton	1200	24-30	5-7
D	CDS	25s-40s	Cotton	1008-1200	24-35	5-10 && 10.5
E	Group drive with multiple fans	32s-60s	Cotton	1008-1104	22-30	5.9-9.0
F	No suction fan	34s-40s	Cotton	1200	--	--

OPERATIONAL STUDIES

ONLINE SURVEY OF YARN SELLING PRICE AND RAW MATERIAL COST

SITRA conducts a monthly online survey on RMC and YSP since April 2013 with an objective of keeping the mills informed about the movement of the count-wise yarn selling price (YSP) and the raw material cost (RMC). The findings of this survey report helps the mills to compare their RMC, YSP, net out-put value (NOV) as well as their yarn quality and productivity level with other mills every month. This unique survey covers almost 250 different counts and varieties of yarns in which the following parameters are being covered.

Ex-mill 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% - Imperfections/1000 m - Hairiness Index

The participant mills enter their data on count-wise average RMC, YSP, yarn realisation and production per spindle pertaining to nearly 10 major counts in the web portal "www.rmcysp.sitraonline.org.in" between 1st and 7th of every month. Between 8th and 20th of every month, the entered data is critically scrutinized and analyzed. On 21st of every month, a survey report covering the data of all the participating mills on count-wise YSP and corresponding RMC, NOV, yarn quality, yarn realisation and production per spindle is being uploaded in the above web portal along with data base supported queries. Apart from the above, the trend in the movement of average YSP, RMC and NOV of popular counts is being uploaded every month. The participant mill can access this survey using an user name and password.

Due to the COVID out break, the online survey was deferred for the first two months i.e. April & May 2020. For the year 2020-21, 10 surveys were completed with an overall participation of around 60 mills from different parts of the country.

Market Performance Evaluation Index (MPEI) (June 2020 – March 2021)

SITRA has formulated an index viz. MPEI (Market Performance Evaluation Index) towards tracking the movement of the commercial efficiency (Net out-put value i.e. yarn selling price – clean raw material cost) based on 12 popular cotton counts ranging from 30s to 100s. This index is being estimated from the data provided by the mills in SITRA's monthly online survey on raw material cost and yarn selling price and clearly portrays the trend in the movement of the commercial efficiency between months.

For the year 2020-21, MPEI started with an index point of 77 in June 2020 (Figure 7), which was 5 points lower than the March 2020 index.

In July and August 2020, the MPEI had registered a further lower value of 73 and 71 respectively, which in turn was mainly due to reduction in yarn selling price. In August 2020, yarn selling price index (YSPI) was low at 88 points, whereas the raw material cost index (RMCI) was high at 106 points (Figure 8).

Since most of the mills were running at a lower capacity utilization after resuming from COVID lockdown, the demand for raw cotton had reduced. On the other hand, the demand for yarn had increased. Due to the above, in September and October 2020, the raw material cost (RMCI) reduced by 4 index points and the yarn selling price (YSPI) had increased to 90 and 94 points respectively. This had resulted in an increase in the MPEI and it was found to remain at 90 points in October 2020.

By the end of the third quarter, the MPEI had reached a level almost at-par with the level that prevailed in April 2013 (MPEI: 99). During December 2020, YSPI had increased to 103 points and the RMCI had increased to 108 points.

The last quarter was found to be more in favour of spinning mills. When compared with the month of December 2021, the YSPI had registered an increase of 10 points in January 2021 (YSPI: 113). This had resulted in a 16 point increase in MPEI during January 2021

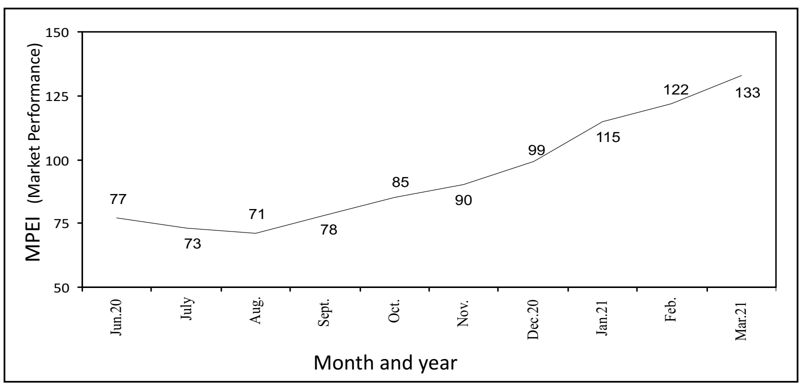


Figure 7 Market Performance Evaluation Index (MPEI)

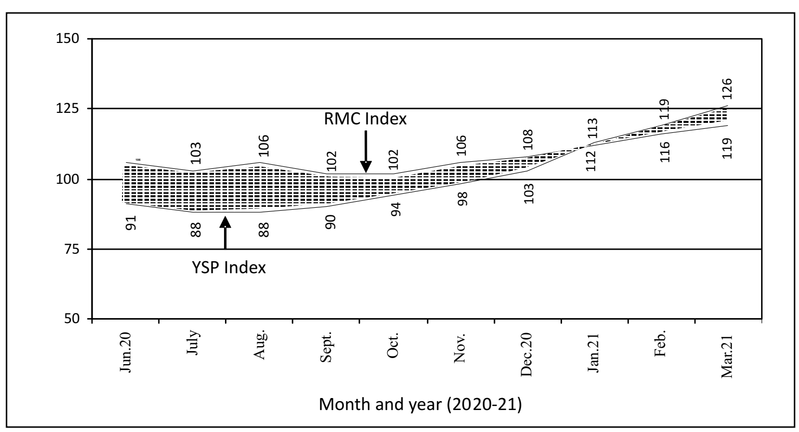


Figure 8 Yarn selling price index (YSPI) and Raw material cost index (RMCI)

(MPEI: 115). In the subsequent months, the yarn selling price had registered a substantial increase and ended with an index point of 126 in March 2021. The raw material cost also witnessed an increase of 4 points in February 2021 (RMCI: 116) and 3 points in March 2021 (RMCI: 119). However, the overall increase in yarn selling price had offset the increase in raw material cost and the MPEI was found to remain high at 133 points in March 2021. In the history of this survey, for the first time, the YSPI exceeded the RMCI.

It is interesting to note that only in the last quarter of the year 2020-21 (January – March 2021), the commercial efficiency was found to excel the level that had prevailed during the inception of the survey (April 2013).

Raw material cost (RMC), yarn selling price (YSP) and net out-put value (NOV) of a few popular counts during the past 7 years (April 2013 – March 2021)

The trend in the movement of RMC, YSP and NOV of a few popular counts during the past 94 months (April 2013 to March 2021) is shown in Figures 9 to 17.

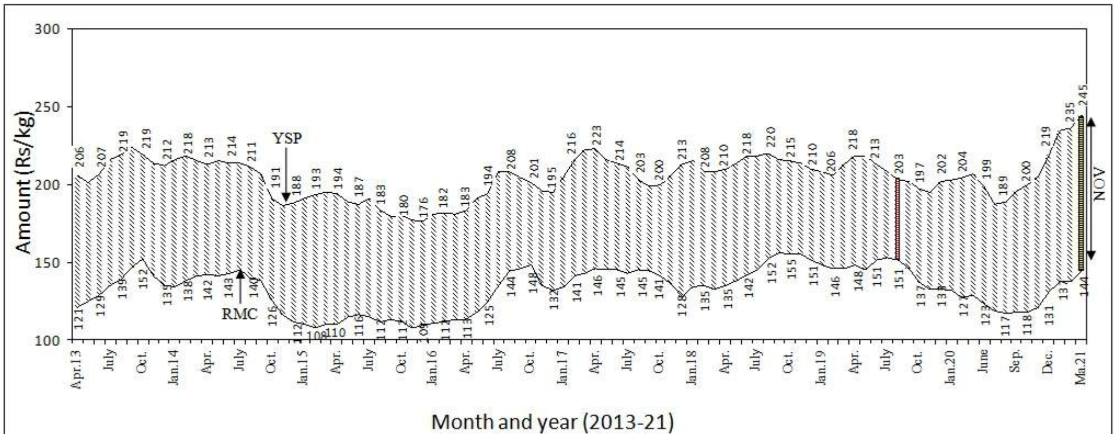


Chart 2 Movement of YSP, RMC and NOV between months (40s K)

Lowest NOV; Highest NOV

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

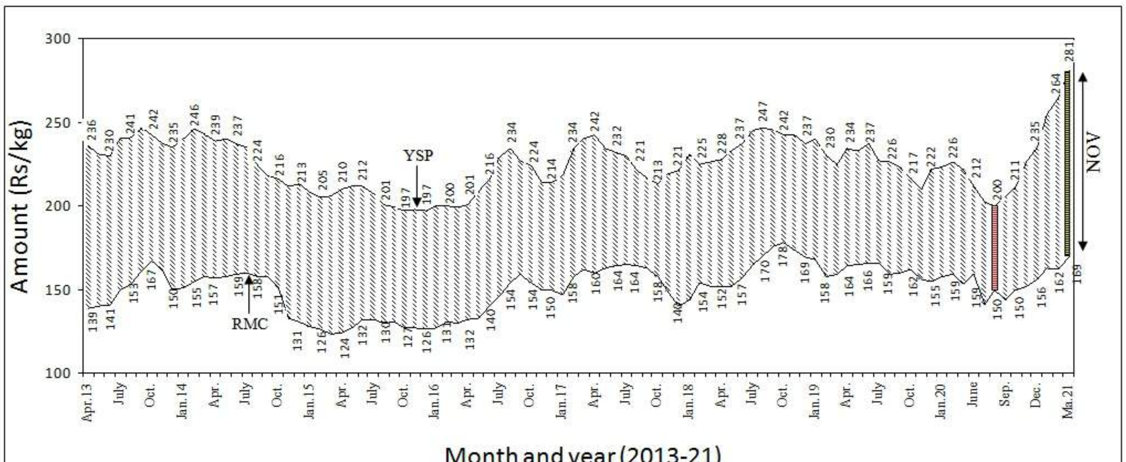


Chart 3 Movement of YSP, RMC and NOV between months (40s C)

Lowest NOV; Highest NOV

Figure 10 Movement of YSP, RMC and NOV between months (40s C)

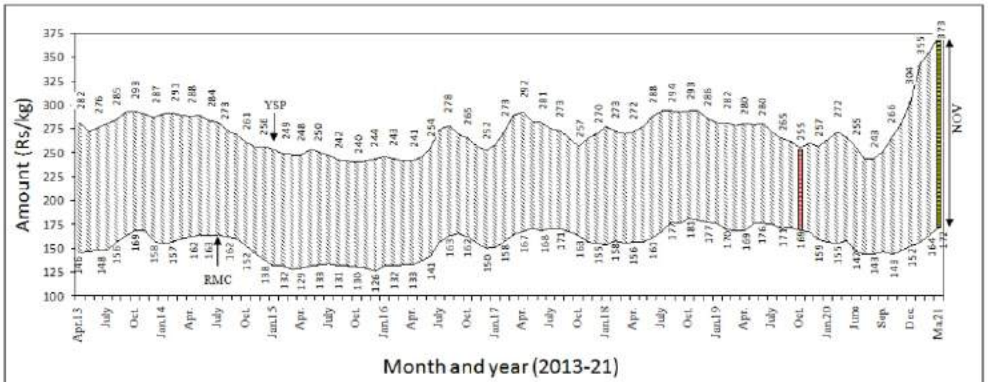


Chart 4 Movement of YSP, RMC and NOV between months (60s C)

Lowest NOV; Highest NOV

Figure 11 Movement of YSP, RMC and NOV between months (60s C)

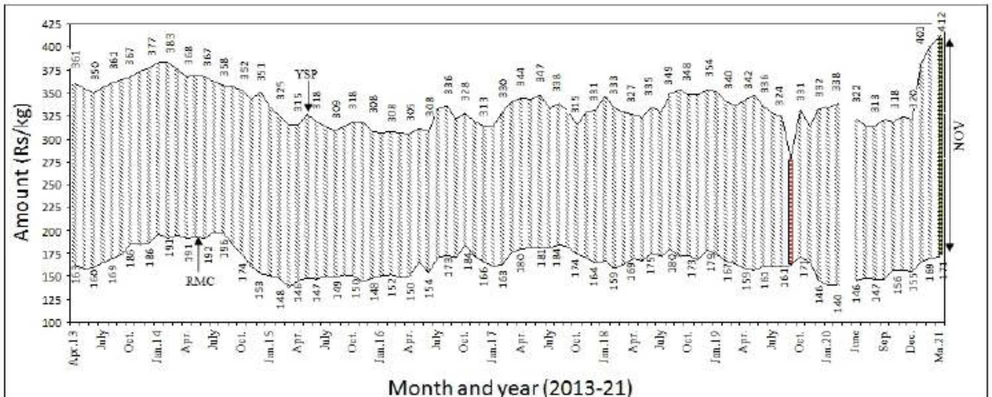


Chart 5 Movement of YSP, RMC and NOV between months (80s C)

Lowest NOV; Highest NOV

Figure 12 Movement of YSP, RMC and NOV between months (80s C)

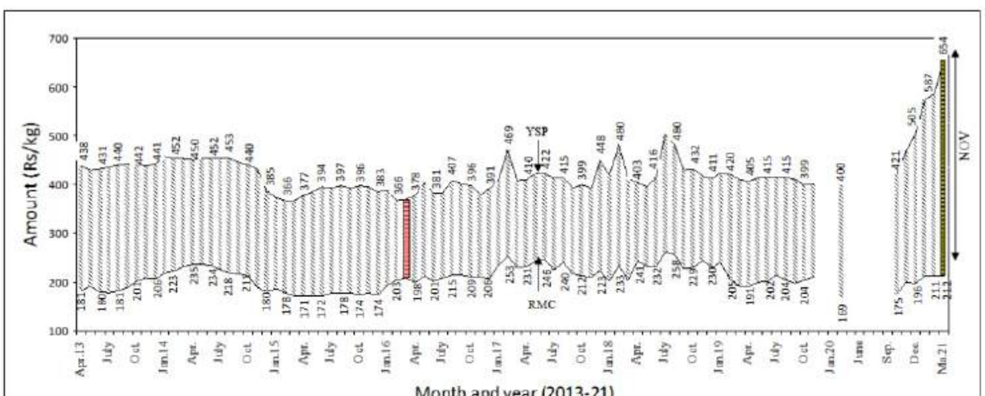


Chart 6 Movement of YSP, RMC and NOV between months (100s C)

Lowest NOV; Highest NOV

Figure 13 Movement of YSP, RMC and NOV between months (100s C)

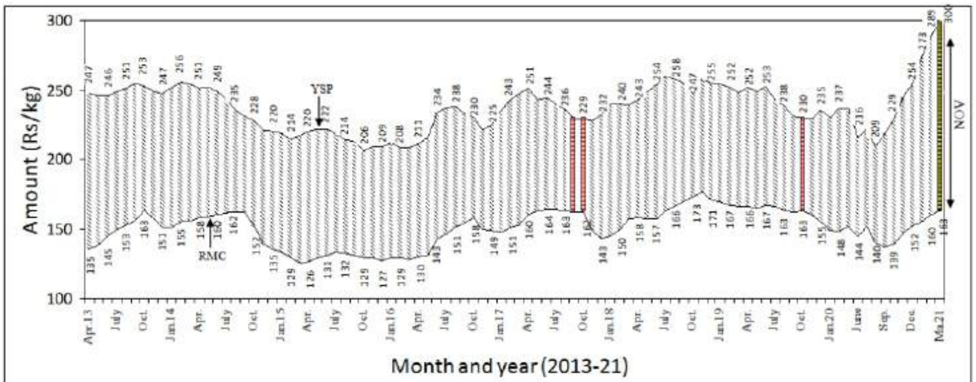


Chart 7 Movement of YSP, RMC and NOV between months
(40s C-Comp.)

Lowest NOV; Highest NOV

Figure 14 Movement of YSP, RMC and NOV between months (40s C-Comp.)

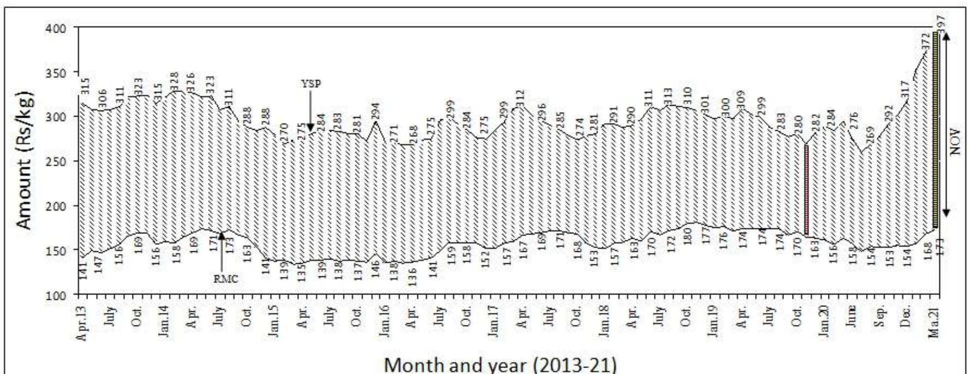


Chart 9 Movement of YSP, RMC and NOV between months
(60s C-Comp.)

Lowest NOV; Highest NOV

Figure 15 Movement of YSP, RMC and NOV between months (60s C-Comp.)

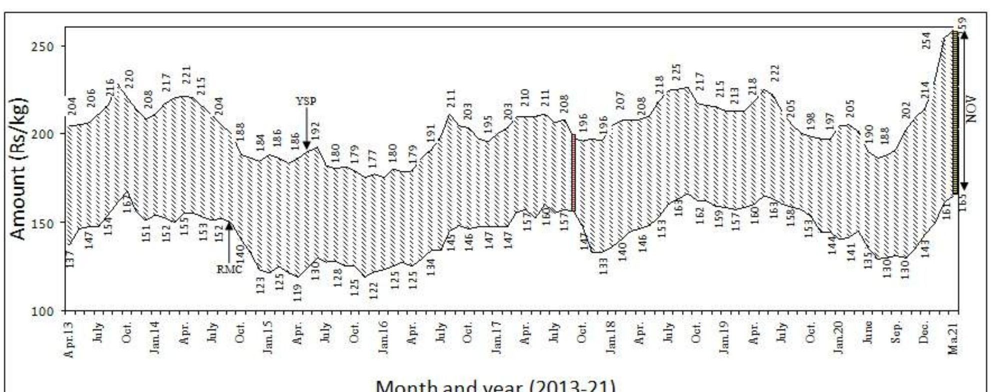


Chart 11 Movement of YSP, RMC and NOV between months
(30s CH)

Lowest NOV; Highest NOV

Figure 16 Movement of YSP, RMC and NOV between months (30s CH)

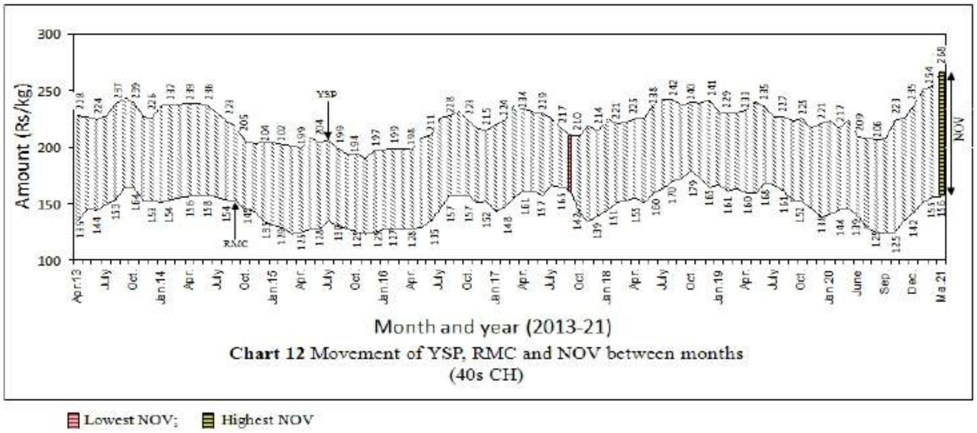


Figure 17 Movement of YSP, RMC and NOV between months (40s CH)

CHEMICAL PROCESSING

ANTIOXIDANT COSMETOTEXTILES: DURABLE NANO-ENCAPSULATED VITAMIN E FINISHES ON TEXTILE FABRICS AND ITS CONTROLLED RELEASE STUDY
Sponsored by Department of Science & Technology (DST) – WOSA, Govt. of India

Now-a-days, the collaboration of various specialists have produced a multitude of innovative applications for textiles especially in the bio-functional and 'intelligent textiles'. Advanced drug delivery systems can be combined with conventional textiles to develop wearable active delivery devices; this new class of materials defined as bio-functional textiles and shows the capability to improve the transdermal administration of active molecules. “Cosmetotextiles” is the emerging term that has been coined to designate textiles with cosmetic properties. Vitamin E, absorbed through all the skin layers to the cell membrane, offers a healthy glow to the skin and speeds up the cell regeneration. Though the oral dosage and topical creams and lotions may be a preferable route for the vitamin E supply, it is associated with the adverse drug reactions in children due to the presence of excipients, such as polyethylene glycol, propylene glycol, or polysorbate 80.

In cosmetic textile fields, micro and nano-encapsulation techniques containing vitamins are being applied in order to improve the safety and durability of functional materials. Nano carriers with increased surface area and lipid carrier ability would result in higher stability and higher drug loading capacity. Nanocapsules containing vitamin E for underwear, towels, T-shirts and bedding, those have direct contact with the skin; the release of vitamin E to the skin will be sustained for a longer period of time. Our approach for the nano encapsulation is through protein-based nanocarriers. Proteins are generally recognized as safe (GRAS), and readily biodegradable, as well as they have non-antigen nature are a great source of nutritional requirement, plentiful sustainable sources and have significant binding capacity.

UV-VIS analysis and HPLC analysis were performed for three different forms of vitamin E. Protein was isolated from its raw material and the total protein content was evaluated by direct (Lowry's method) and indirect methods (Total nitrogen content).

The antioxidant activity of vitamin E was evaluated by TEAC (Trolox Equivalent Antioxidant Capacity) using ABTS radical cation decolorization assay. Free radical scavenging activity of vitamin E (DL-α-tocopherol, D-α-tocopherol and DL-α-tocopheryl acetate) compounds was determined by ABTS radical cation decolorization assay using Trolox as antioxidant standard. $ABTS^{+}$cation radical was produced by the reaction between 7 mM ABTS in water and 2.45 mM potassium persulfate (1:1), stored in a dark at room temperature for 12-16 h before use.

$ABTS^{+}$ solution was then diluted with ethanol to obtain an absorbance of 0.700 at 734 nm. The absorbance of 40 µM sample in diluted $ABTS^{+}$ solution was measured 15 min after the initial mixing. An appropriate solvent blank was run in each assay. All measurements were carried out at least three times. Percentage inhibition of absorbance at 734 nm was calculated using the formula, $ABTS^{+}$ scavenging effect (%) = ((AB–AA)/ AB) ×100 (2), where, AB is absorbance of $ABTS^{+}$ + ethanol; AA is absorbance of $ABTS^{+}$ + sample extract/standard. Trolox was used as standard substance. Calibration curve for Trolox antioxidant activity is shown in Figure 18.

The free radical scavenging activity (%) shown in Table 20 indicates that D-α-tocopherol possess a very good antioxidant activity compared to DL-α-tocopherol and DL-α-tocopheryl acetate. Though DL-α-tocopheryl acetate is a stable derivative of tocopherol, it did not have good antioxidant activity. Hence, the synthetic form of tocopherol (DL-α-tocopherol) was taken for the nano encapsulation studies.

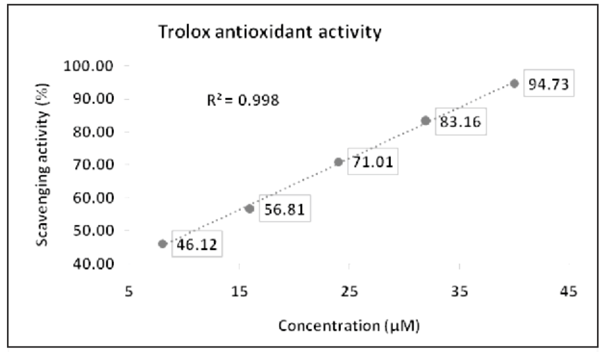


Figure 18 Calibration curve for trolox antioxidant activity

Preparation of vitamin E nano formulation was carried out by oil in water nano emulsion method using probe sonication (Figure 19). The bottom of a high-intensity ultrasonic horn was positioned at the interface of the protein aqueous solution and vegetable oil/vitamin E to prepare the nano formulation. The ratio of aqueous/organic phase (%) and the concentrations of proteins used were optimized to obtain the particle size in the range of 1.58 to 107 nm.

Table 20 Free radical scavenging activity of trolox and vitamin E

Concentration (µM)	Free radical Scavenging activity (%)			
	Trolox	D-α-tocopherol	DL-α-tocop herol	DL-α-tocopheryl acetate
40	94.73	92.24	54.58	5.56
32	83.16	82.28	39.82	3.95
24	71.01	69.84	28.99	2.93
16	56.81	54.32	17.86	1.76
8	46.12	44.51	8.64	0.73

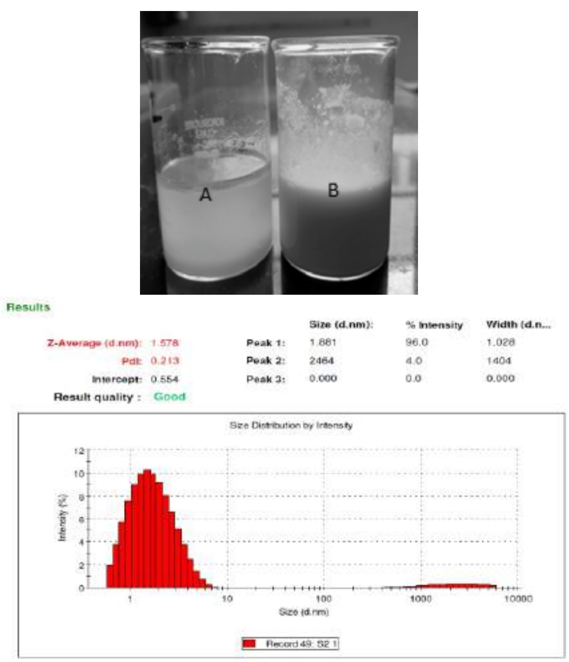
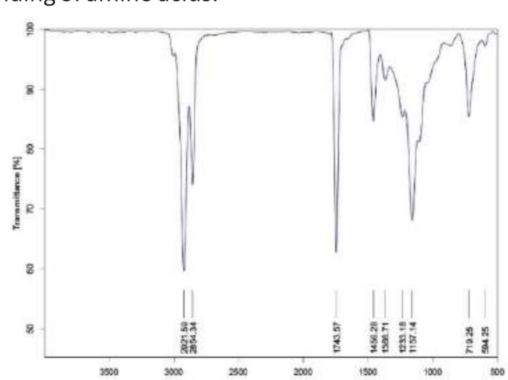


Figure 19 Image of formulation IA) before sonication IB) after sonication II) PSA result

FT-IR analysis was carried out for protein, oil, vitamin E and nano formulation and the results are shown in Figures 21a to 2d. The characteristic peak at 1743 cm^{-1} which corresponds to C=O stretching of oleic acid present in olive oil as shown in figure 21a. Figure 21b represents the FT-IR spectra of protein which indicates the characteristics peaks at 3263 cm^{-1} and 1516 cm^{-1} confirms the presence of –OH stretching and –NH bending corresponds to amino acids. As shown in figure 21c the characteristic peak at 3473 cm^{-1} confirms the presence of –OH stretching peak in DL-α-tocopherol. Figure 2d shows the FT-IR spectra of freeze dried nano formulation. The characteristics peaks at 3283 cm^{-1}, 1744 cm^{-1} and 1536 cm^{-1} confirms the presence of –OH stretching peak, C=O stretching of oleic acid and –NH bending of amino acids.



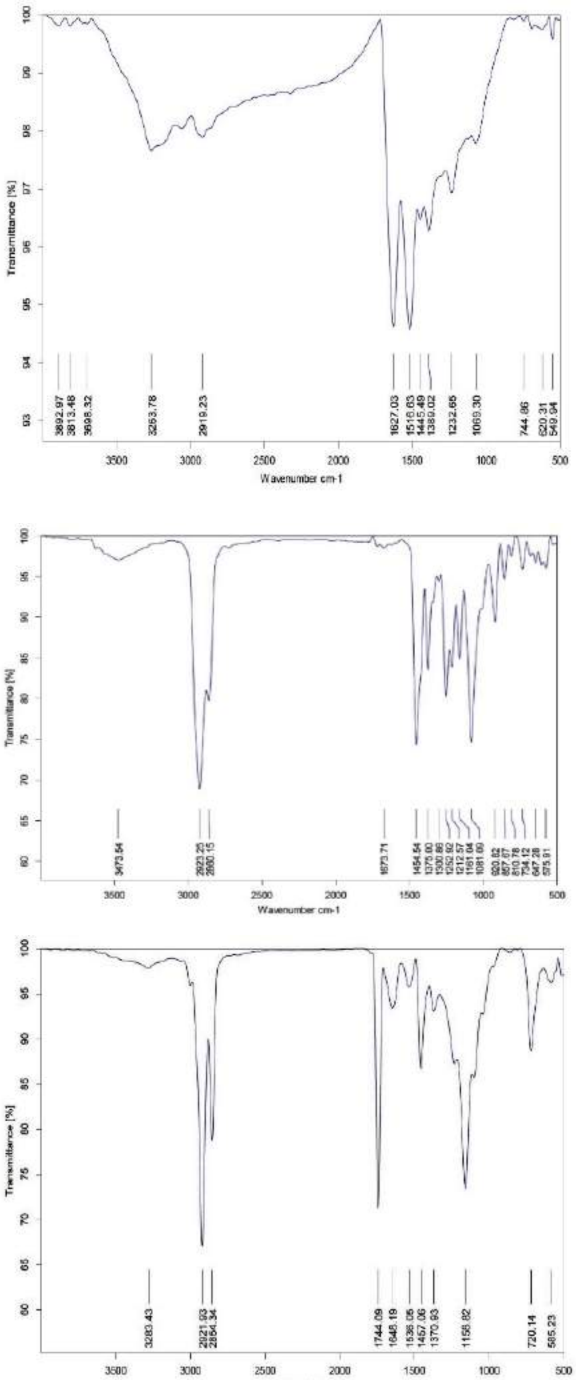


Figure 21 FT-IR spectra of a) Olive oil b) protein c) DL-α-tocopherol d)freeze dried nanoformulation

The study of encapsulation efficiency and FE-SEM of nano formulation is in progress. The application of prepared nanoformulation on the fabric, evaluation of anti-oxidant activity and vitamin E release study of finished fabric will be carried out in future.

CHARACTERIZATION OF NATURAL AND SYNTHETIC INDIGO DYE

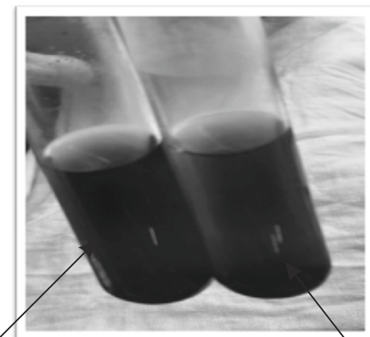
Until the discovery of the first synthetic dye in 1856 by Perkin, natural substances were the only sources for dyes available to mankind for the coloring of textiles. Rapid research studies in synthetic chemistry supported by the industrialization of textile production led to the development of synthetic alternatives to popular natural dyes like Indigo. Accordingly, the first synthetic indigo dye was made by German chemist Adolf von Baeyer in 1878 and first commercially practical synthetic indigo was made in 1897. Most indigo dyes produced today are synthetic, constituting several thousand tons each year.

In recent times the natural indigo dye is gaining importance due to resurgence of natural dyes (ND) in textile industries. Dyes are available from various sources (plant, animal and synthetic); however identification and standardization of natural dye present two major issues. The determination of purity, method of extraction and different sources of the dyes are the important factors of the dyes. There are no testing protocols available and accepted by standard accreditation bodies for the determination of natural indigo dye. Hence, there is a need to develop simple methods for identification of natural dyes based on chemical tests and chromatographic methods, which would also reveal the purity of content and provide chemical information about the dye stuff.

A simple method for the identification of Indigo through color change was explored. The available methods for the identification of natural and synthetic indigo dyes are 1) Kit method 2) High Performance Liquid Chromatography (HPLC) 3) Thin Layer Chromatography (TLC) 4) UV-VIS analysis 4) FT-IR 5) Nuclear Magnetic Resonance (NMR) analysis. Kit test is considered as a preliminary test, TLC is the mandatory test and any one of the optional test (HPLC/UV/FT-IR/NMR) needs to be performed for the identification of natural indigo dye. In continuation to the previous research work, the dye extraction was carried out using a Soxhlet apparatus. Different solvents were used for the extraction of natural and synthetic dyes from the dyed yarn. The extracted dye was characterized by kit method, TLC and HPLC to determine the natural and synthetic indigo dye.

Kit method

Kit method is developed to identify the natural indigo dye using a simple technique. The observable color difference between natural and synthetic indigo dye aids in better characterization (Figure 22). The impurity present in the natural indigo shows purple in the solution and the absence of natural impurity shows blue colour.



Synthetic dye extract **Natural dye extract**

Figure 22 Image of natural and synthetic indigo dye extract

Thin Layer Chromatography (TLC)

The dyed samples were dissolved in a suitable solvent and the dissolved dye samples were spotted in silica coated aluminum sheet and dipped in a mobile phase. The blue spot indicates the color component (Indigotin) present in indigo (Figure 23). The purple spot indicates the presence of natural impurity in natural indigo dye.

Figure 23 TLC of natural and synthetic indigo dye extract

Table 21 Comparison of HPLC results for natural and synthetic indigo dyes

Wavelength (dye)	RT (minutes)	Peak area	Remarks
280 nm (natural indigo dye)	1.434	5.40	The peaks at RT 1.434 & 1.586 indicate natural dye.
	1.586	178.85	
	1.676	115.40	
280 nm (synthetic indigo dye)	1.550	23.45	The peak at RT 1.550 indicates synthetic dye.
	1.662	210.08	
	1.746	114.92	

Table 22 HPLC results for natural and synthetic indigo dye extract from dyed yarn

Wavelength (dye)	RT (minutes)	Peak area	Remarks
280 nm (natural indigo dye extract)	1.020	73.60	The peaks at RT 1.693 indicates natural dye.
	1.693	763.53	
280 nm (synthetic indigo dye extract)	1.080	82.18	The peak at RT 1.720 indicates synthetic dye.
	1.566	84.96	
	1.720	901.84	

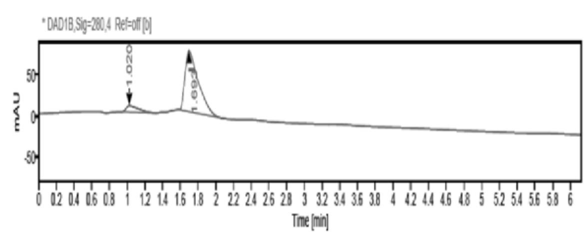


Figure 24 HPLC chromatogram of natural indigo dye extract

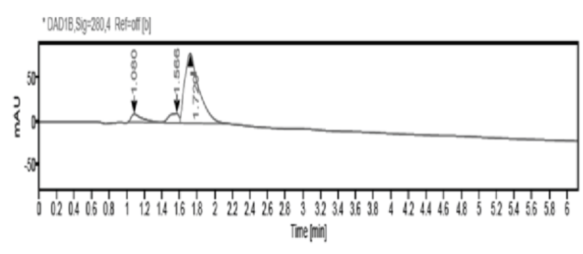


Figure 25 HPLC chromatogram of synthetic indigo dye extract

The dyed samples received from the industry were extracted and characterized through HPLC. The natural and synthetic dye extracts were studied by TLC, kit method and HPLC analysis. TLC was performed for both natural and synthetic dyes and its extracts from dyed yarn (Tables 1 and 2) which confirmed the presence of purple spot corresponding to impurity present in natural dye. HPLC analysis of natural and synthetic dyes was performed for the better identification of dye stuffs (Figures 3 and 4). The shift in the RT and difference in peak area are the major differences between natural and synthetic dye. Based on the cost and efficiency of results, spot test, TLC and HPLC analysis were chosen for the identification of natural and synthetic dyes from the dye extract.

COVERAGE OF DEAD COTTON ON REACTIVE DYED KNIT FABRIC

All cotton bolls may contain at least 5% of immature cotton which is known as thin walled or dead cotton. The presence of dead cotton adversely affects the appearance of dyed/printed fabric and results in a greater value loss. This dead cotton on the fabric is normally visible only after the fabric has been either dyed or printed.

In order to improve the fastness property to various agencies like washing, light, rubbing (dry and wet), perspiration (acid & alkali), etc., the dyer or printer will apply cationic fixing and cationic softener in the final processing of fabric. This treatment not only helps to improve the washing, rubing fastness, and imparts some surface charge (+ve charge) on the dyed/printed fabric and also to the dead cotton, in particular. The surface energy (+ve charge) stored on dead cotton portion is capable of attracting dyes at a faster rate to get coloured and the depth on the dead cotton part is also equivalent to the shade of adjacent area.

There are a few corrective processes and they are

Method 1:

Pad/dry with pigment dye emulsion. Coverage of dead cotton is 100%.

Method 2:

Coverage of dead cotton by redyeing with reactive dyes (Exhaust method).Coverage of dead cotton is 50%.

Method 3:

Coverage of dead cotton by Cold Pad Batch (CPB). The process is in progress.

SALT-FREE DYEING OF COTTON MATERIALS USING A NEWLY SYNTHESIZED CATIONIZING AGENT - PHASE IV (SCALING UP & COMMERCIALIZATION)

Preview of previous work done on this project:

Phase - I:

Cationizing agent was formulated in the laboratory and industry scale salt free dyeing trials were carried out to check the performance. The results were encouraging and the process methodology was found suitable for light, medium and dark shades. The methodology was also found successful in difficult colours such as Turquoise blue, black, etc. When compared to the conventional process, about 70% to 75% reduction was noticed in the overall TDS of the effluent arising out of the salt free dyeing process.

Phase - II:

- Based on the success of Phase I trials, which was done using the chemicals available commercially, a new cationizing agent was synthesized using different raw materials and the characterization study was performed.
- Concentration of the synthesized cationizing agent was optimised for various shades (0.05% – 8% shade).
- Dyeing trials were carried out at the industry level and the analysis of drain characteristics was performed.
- Single bath scouring, bleaching and cationization procedure was developed.

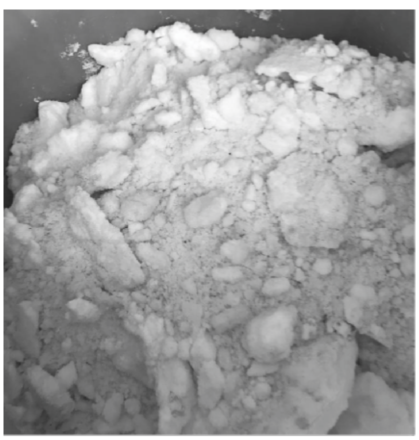
Phase-III:

- Based on the reliable outcome of the laboratory salt free dyeing trials, 120 L reactor vessel for the synthesis of cationizer was fabricated in collaboration with the Industry partner (MAK Controls Limited, Coimabtore).
- 48.5 L of final product in solution form was obtained from the bulk scale synthesis. The salt free dyeing trials using the bulk scale synthesized cationizer and laboratory synthesized cationizer were performed and the results were compared.
- The reactor vessel made of Mild Steel (MS) was found corroded by the starting materials used

and a by product was found formed during the synthesis. The colour of the resultant cationising chemical [Go Green SFD (GGS)] solution was brown because of the rust formed during the reaction. The prepared GGS solution was filtered and used directly for cationization without further purification.

Phase –IV:

- 1000 L capacity reactor vessel was fabricated in collaboration with the Industry partner using corrosion resistance material (Hastelloy C276).
- Three batches of bulk scale synthesis were performed to produce 720 kg of GGS in solution form to perform bulk scale dyeing at Tirupur and Erode dyeing industries.
- The synthesized GGS were used to carry out salt free dyeing process at M/s. Mercury process, Tirupur, for the challenging shades given by the industry.



1000 L capacity MS reactor vessel
Synthesized product

The process sequence for cationization and dyeing are as follows

Pretreatment process sequence (Single bath scouring, cationization & bleaching)

Water + Wetting agent (1g/L) + Imacol CG (1g/L)

↓

Dip the fabric, keep it in cold for 20 min

↓

GGS solution (Based on the % shade), cold for 20 min

↓

Caustic soda (based on % shade), cold for 20 min

↓

70 °C for 1 hr

↓

Peroxide(4 g/L and stabilizer 0.3 g/L)

↓

80 °C for 45 min

↓

Drain, Cold wash, Neutralization, Hot wash and then cold wash

Dyeing process sequence for ME dyes

Water + Dye solution

↓

Dip the pre-treated fabric in dye solution

↓

cold 20 min

↓

60 °C for 20 min

↓

Soda ash (based on % shade)

↓

60 °C for 1 hr

↓

Drain, Cold wash, Neutralization, Hot wash and then cold wash

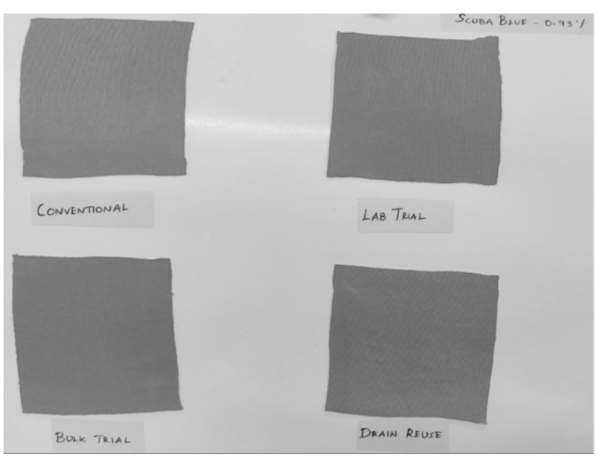
Single bath scouring, cationization and bleaching were performed on the grey fabric and dyed without using salt. The dyed samples were evaluated for their color strength by determining the K/S values, using a Gretag Macbeth 7000 eye (USA) Computer Color Matching System. The comparison for conventionally dyed fabric and salt free dyed fabric were made using ΔE, ΔL*, Δa*,Δb*, Δc* and Δh*.

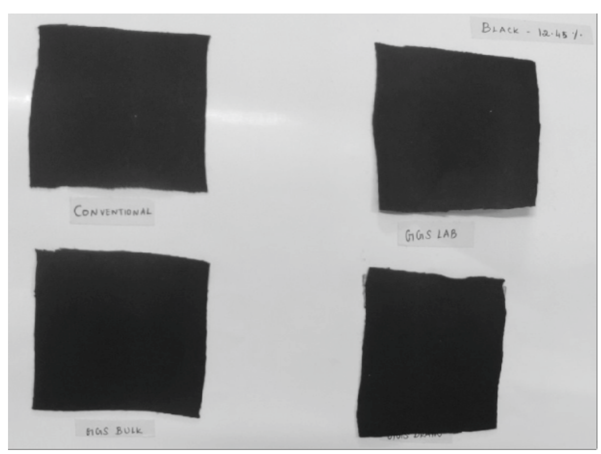
SCUBA BLUE : (Go Green SFD)

SCUBA BLUE : (Go Green SFD)									
Dys T.Blue G 133 - 0.900 % Dys Brill Yell 3GL - 0.015% Dys Blue SAM 02 - 0.0185 % **Total % shade - 0.93%**								**MLR = 1: 9**	
Obs	**Sample**	**Na_2SO_4/ Na_2CO_3**	**ΔE**	**Strength (%)**	**ΔL***	**Δa***	**Δb***	**Δc***	**ΔH***
D65 10 Deg	Conventional	25/12	0	100	0	0	0	0	0
	GGS 12/3 Lab	0/12	**2.49**	**115.13**	-2.46	0.27	-0.24	-0.12	0.34
	GGS 12/3 Bulk	0/12	**2.54**	**122.96**	-1.66	-0.99	-1.65	1.70	0.91
	GGS 10/2 Drain Bulk	0/12	**0.70**	**95.55**	0.08	0.69	0.09	-0.64	0.27

BLACK – 12.45%

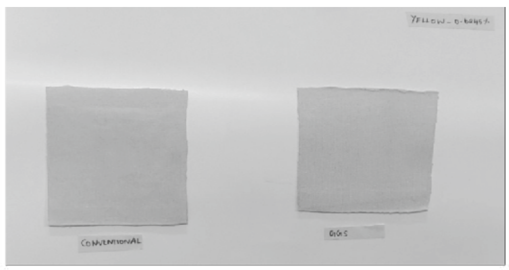
BLACK : (Go Green SFD)									
Nov. Black NN - 11.800 % Nov.Yell S3R - 0.500 % Nov. Ruby S3B - 0.1500 % **Total % shade - 12.45 %**								**MLR = 1: 9**	
Obs	**Sample**	**Na_2SO_4/ Na_2CO_3**	**ΔE**	**Strength (%)**	**ΔL***	**Δa***	**Δb***	**Δc***	**ΔH***
D65 10 Deg	Conventional	60/20	0	100	0	0	0	0	0
	GGS 45/9 Lab	0/20	**0.57**	**101.36**	-0.07	0.20	0.52	-0.23	0.51
	GGS 45/9 Bulk	0/20	**0.35**	**102.49**	-0.26	0.10	0.22	-0.11	0.21
	GGS 36/5 Drain Bulk	0/20	**1.09**	**112.04**	-1.08	0.03	0.12	-0.08	0.09





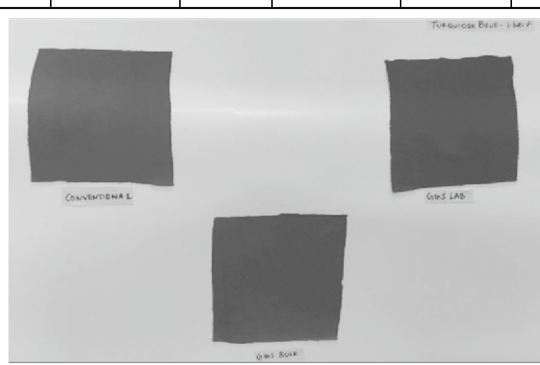
YELLOW – 0.6245%

YELLOW : (Go Green SFD) Bulk Drain									
Spe. Yellow F2GN - 0.450 % Spe.Yell F3R - 0.170 % Megh.Blue BRXM - 0.0045% **Total % shade - 0.6245%**									**MLR = 1: 6**
Obs	**Sample**	**Na_2SO_4/ Na_2CO_3**	**ΔE**	**Strength (%)**	**ΔL***	**Δa***	**Δb***	**Δc***	**ΔH***
D65 10 Deg	Conventional	25/12	0	100	0	0	0	0	0
	GGS 25/12 Lab	0/20	**1.03**	**105.29**	-0.07	0.14	1.01	1.01	-0.17



TURQUOISE BLUE – 1.62%

TURQUOISE BLUE : (Go Green SFD)									
M.ULT.T Blue -1 .040 % M.Blue HEGN - 0.570 % M.Yellow F4G Con - 0.011% **Total % shade - 1.621%**									**MLR = 1: 6**
Obs	**Sample**	**Na_2SO_4/ Na_2CO_3**	**ΔE**	**Strength (%)**	**ΔL***	**Δa***	**Δb***	**Δc***	**ΔH***
D65 10 Deg	Conventional	30/14	0	100	0	0	0	0	0
	GGS 25/12 Lab	0/14	**4.76**	**136.08**	-4.46	1.64	-0.28	-0.74	1.48
M.ULT.T Blue - 0.800% M.Blue HEGN - 0.400 %	GGS 25/5 Bulk Depth -1.2%	0/14	**1.19**	**107.97**	-0.71	0.77	-0.56	-0.01	0.95



Based on the dyeing trials performed on the cationized fabric, the concentration of cationizer and caustic soda required for the pretreatement and salt free dyeing of grey fabric for various shades is optimized.

The optimized concentration of GGS and caustic soda

S. No.	% Shade	GGS (% owf)	Caustic soda (% owf)
1	0.01 to 0.4 %	7	1
2	0.41 to 1%	5	1
3	1.1 to 2%	25	5
4	2.1 to 6% except black	35	7
	> 6 % & Black ≥ 6%	45	7

Colour fastness to washing

COLOUR	Scuba Blue 0.93%	Black 12.45%	Red 6.8532%	Yellow 0.6245%	Turquoise Blue 1.621%
	Mode	Mode	Mode	Mode	Mode
Change in Colour	4	4	4	4	4
Staining on	.	.	.	.	.
Viscose	4-5	4-5	4	4-5	4-5
Acrylic	4-5	4-5	4-5	4-5	4-5
Polyester	4-5	4-5	4-5	4-5	4-5
Nylon	4-5	4-5	4-5	4-5	4-5
Cotton	4	4-5	4	4-5	4
Tri Acetate	4-5	4-5	4-5	4-5	4-5

Colour fastness to rubbing

COLOUR	Dry	Wet
Scuba Blue	4-5	4
Black	4	2
Red	4-5	3-4
Turquoise Blue	4-5	4
Yellow	4-5	4

Colour fastness to light

COLOUR	Light Fading (BW3)
Scuba Blue	4-5
Black	4-5
Red	4-5
Turquoise Blue	4-5
Yellow	4-5

From the above, it can be noted that the reduction in TDS with the saltfree dyeing methodology works out to 30% to 70% when compared to the TDS arising out of the conventional dyeing process.

Standing bath technique:

The presence of chloride in the pre-treatment drain indicates the presence of unutilized cationizer in the drain. Hence, the pretreatment process has been done using the drain solution of single bath scouring, cationization and bleaching process. The above mentioned soft flow dyeing effluent was used directly for the scouring and cationization process and 4 g/L peroxide was used for the bleaching purpose. The pre-treated cotton knitted fabric was dyed using Red RGB dye for 0.05% shade. The comparison for conventionally dyed fabric and standing bath salt free dyed fabric were made using ΔE, ΔL^*, Δa^*, Δb^*, Δc^* and Δh^*.

Drain characteristics:

Parameter	Conventional dyeing using salt		Dyed using Go Green SFD by SITRA				
			Light shade			Medium shade	Dark shade
	2% shade	12% shade	Yellow (0.6245%)	Scuba blue (0.846%)	Turquoise blue (1.621%)	RED (5.15%)	Black (12.45%)
pH	10.11	-	9.26	8.54	10.08	9.98	10.42
TDS (mg/L)	10707	18346	4240	4480	3282	4804	9082
TSS (mg/L)	1795	-	116	142	76	92	50
Electrical conductivity (mS/cm)	9.06	-	4.27	4.89	3.6	5.66	8.52
Chlorides (mg/L)	60.8	-	728	1050	631	900	1450
Sulphates (mg/L)	5755	-	767	313	372	985	899
Sodium (mg/L)	3950	-	1325	1795	815	3940	3440
Total alkalinity (mg/L)	540	-	1276	500	851	740	880
Turbidity (NTU)	32	-	42.43	53	25.84	30.63	19.81
Colour (CU)	1950	-	1181	245	725	9897	23314
COD (mg/L)	-	-	1213	1782	1081	1207	4810
BOD (mg/L)	-	-	236	628	207	353	1143

Progress in a gist:

- 1000 L capacity corrosion resistance vessel was fabricated for the synthesis of new cationising agent.
- The salt free dyeing trials were conducted and the comparison for conventionally dyed fabric and standing bath salt free dyed fabric were made using CCM results.
- All the challenging shades from 0.0125% to 12.5% were achieved with good levelness and dyeing without using salt.
- The trials for single bath scouring, cationisation and bleaching were also achieved using the bulk synthesized cationizer for light shades such as 0.05% with good brightness.
- Standing bath technique was developed for cationization process to further reduce the cost and TDS.
- Bulk scale dyeing process at various Tirupur and Erode dyeing industries is in progress.

MEDICAL TEXTILES

DEVELOPMENT OF MULTIPURPOSE BIODEGRADABLE ANTIMICROBIAL CELLULOSIC SHEET FOR BIOMEDICAL AND PERSONAL CARE

Most skin-contact products used in the cosmetics, personal care and biomedical industries are made from polymers that are neither recyclable nor biodegradable. There is an urgent need to replace the existing non-degradable materials with biodegradable, sustainable and materials with lesser environmental footprint. Bacterial cellulose is bacteria produced biopolymer which possesses several advantages over cellulose of plant and other origins, such as purity, high porosity, higher absorbency, increased air and water permeability. Besides, bacterial cellulose is biocompatible and could be modified to express antimicrobial properties and could be electrospun to elicit multifaceted product applications.

This project aims to formulate and develop bio-based, biodegradable and biocompatible materials to deliver skin-contact products for the protective clothing, cosmetic and biomedical industries. The products used as models are a facemask, a facial sheet mask and a wound dressing.

Facemasks are important components of personal protective equipment for health care workers in hospitals and public civilians during medical environment and pandemic situations. The filtration efficacy of facemasks is very important as they protect the individual from air borne particulates and aerosols from reaching the respiratory system and also prevent inter-individual infection. The surgical face mask is a non-biodegradable medical waste which will be incinerated after use and hence leads to air pollution. But, if it is not incinerated, then it will lead to land and water pollution, since it will not degrade. Electrospun cellulose with antimicrobial properties kept as the inner layer of the mask will not only help to combat the infectious microorganisms, but also will be degradable, thus becoming environment friendly.

The use of natural fibres as biomaterials has numerous advantages including their robustness, degradation and the ability to mimic the extra cellular matrix (ECM) in three dimensions. In this view, electrospun biocellulosic facial sheet mask impregnated with antimicrobial agents offers a good alternative to the existing fossil derived non biodegradable polymers and will be not only beneficial for the skin but will also be biodegradable and will protect the skin, from dermatological infections.

Although several therapeutic approaches are available for the treatment of wound and burns, the search for dressings with healing property still exists in the case of burn wounds for speedy recovery. Bacterial cellulose has many intrinsic characteristics like purity, high porosity, higher absorbency, increased air and water permeability all of which help them to retain moisture, absorb exudates from the injured tissue and accelerate granulation. With inherent features like biocompatibility, non-toxicity, and being non-carcinogenic make it a better option for wound dressing.

Objectives

- To optimize and produce cellulose from bacterial origin.
- To screen and extract herbs with different functionalities for respective products.
- To optimize the parameters for electrospinning of cellulose with herbal nanoparticles.
- To assess the antibacterial, antiviral properties of the electrospun sheet.
- To develop a biodegradable facemask meeting the basic facemask requirements i.e., bacterial filtration efficiency, splash resistance, particulate filtration efficiency, breathability and flammability
- To develop a biodegradable bio-based nanostructured biocompatible electrospun sheet for use in wound dressings.
- To develop and validate a bio-based, bioactive facial sheet mask, in the form of a film impregnated with formulations based on natural compounds.
- Assessing the skin compatibility and biodegradability of the developed textiles using International standard testing methods.

Summary

1. Cellulose producing bacteria from environmental sample were isolated, identified and purified.
2. Mass production of cellulose from the isolates was performed and characterization of bacterial cellulose was done.
3. Screening and extraction of herbs with antimicrobial and antioxidant properties has been completed.

DEVELOPMENT OF BREATHABLE, REUSABLE AND OXO-BIODEGRADABLE COVERALL USING BIOCIDAL POLYESTER

(Sponsored by Board of Research in Nuclear Sciences (BRNS), Government of India

Collaborator: Bhabha Atomic Research Center, Mumbai, Government of India

COVID-19 pandemic continues to spread rapidly around the world and healthcare workers (HCWs) are on the frontline to battle against the severe acute respiratory syndrome coronavirus-2 (SARS-CoV-2). As a preventive measure, the use of personal protective equipment (PPE), such as face mask, coverall, gloves, shoe cover and goggles have been the first protective means that can prevent the spread of the virus. Though the available disposable coverall products are cheaper and lighter in weight, they offer least comfort to the wearer and less effective against SARS-CoV-2 viruses. Hence, the access to effective antiviral PPE for healthcare workers is a key concern. This project is aimed to develop biocidal, breathable, reusable and oxo-biodegradable coverall using affordable raw materials to minimize the disease transmission and also to combat COVID-19.

The key objectives of the project are:

- Physical, chemical and biological characterization of nanoparticles (Nps).
- Development of fiber/fabric having inherent biocidal activities through the impregnation of Nps.
- Improvement of comfort properties.
- Characterization of prototype coverall for its breathability, reusability, oxo-biodegradability and biocidal properties in accordance to National and International standards.
- Technical demonstration of guidelines for the development, manufacturing, usage and disposal of coverall.

Material & Methods

The raw materials such as PET pellets, yarn, fiber, fabric and nanoparticles were procured to carry out the initial trials. 100% Polyester pellets (virgin), fiber (1D; cut length: 32mm), yarn (62s Ne) and fabric (cover factor: 20.5) were procured from the local suppliers. Nanoparticles were sourced from indigenous supplier available in the market. Polyethylene glycol (PEG-1500) and the raw materials used to produce oxidizing chemical were obtained from LOBA Chemical Pvt Ltd. Cobalt stearate (Co: 9 – 10%) was provided by Alfa Aesar. Durability of nanoparticles on the fabric by washing was performed in accordance to AATCC 61 2A test protocol. Quantification of Nps on the fabric and Nps, leeched from the fabric were evaluated by ISO 17294 test method using ICP-MS. To evaluate the biocidal potency of Nps the antibacterial activity (ASTM E2149-13a) and antiviral activity (In-house method) were performed.

Results and Discussion

The procured Nps were characterized by FE-SEM (Figure 1), FT-IR (Figure 26) and XRD analysis. The size of the Nps was less than 100 nm. The procured PCM (PEG 1500) was analyzed through DSC to evaluate its thermal properties such as melting range and heat storage capacity. To improve comfort properties of the polyester coverall, PCM was applied on the fabric.

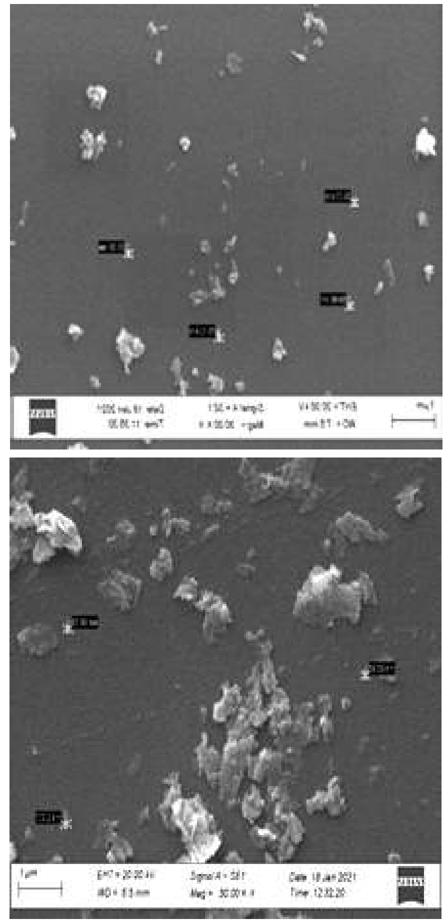


Figure 26 SEM image of Nps (minimum particle size 58.59 nm & 39.06 nm for two different Nps) Mag: 30.0 KX

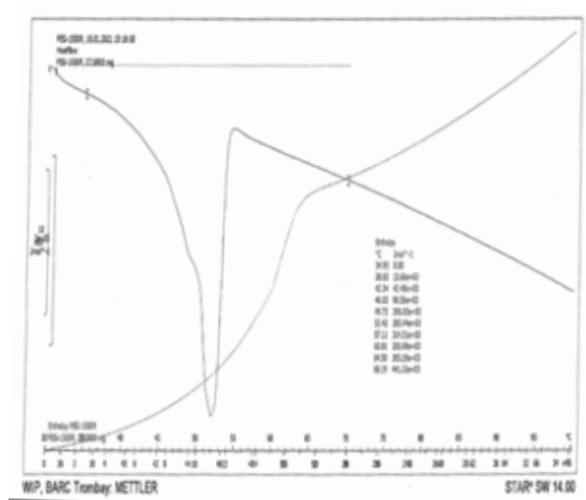


Figure 27 DSC thermogram of PEG 1500 (Tm = 53 ºC ΔH = 285 KJ/mol)

Biocidal activity of Nps

The procured nanoparticles were evaluated for their antibacterial activity using Escherichia coli ATCC 25922 as test organism and for antiviral activity using Bacteriophage MS2 ATCC15597-B1 as test organism. The results are shown in Figure 27, 28 & 29.

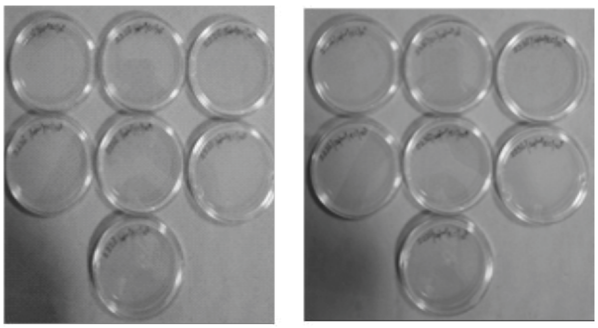


Figure 28 Antibacterial activity of Nps

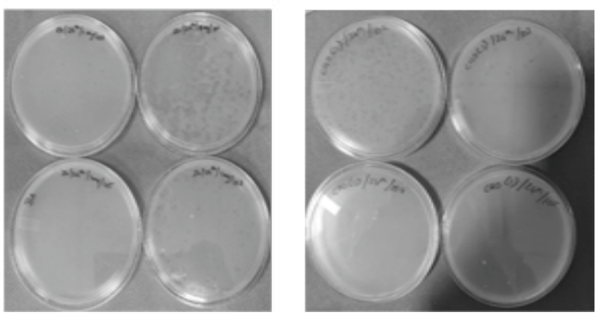


Figure 29. Antiviral activity of Nps

Time and concentration dependent antibacterial /antiviral activity was observed for the test nanoparticles. Further, the nanoparticles were impregnated on the textile substrate as per the method described below and studied for their antibacterial and antiviral activity in accordance to ASTM E 2149 and in house method.

The biocidal activity on polyester fabric was proposed to be incorporated by two different schemes.

Scheme 1: Impregnation of nanoparticles at fiber stage

The physical parameters of the procured fiber are, Denier: 1.0 D, Elongation: 16%, Tenacity: 6.24 g/den. The nanoparticles were applied on the fiber by sonication method and IR exhaustion method. The finished fibers showed 99.99% antibacterial activity against Escherichia coli ATCC 25922 and 99.9% antiviral activity against Bacteriophage MS2 ATCC 15597-B1.

Scheme 2: Impregnation of nanoparticles at fabric stage

Partially hydrolyzed fabric was dipped into the nano formulation containing nanoparticles, cross linking agent and a catalyst in a 2 dip and 2 nip padding mangle at 2 bar pressure and 20 RPM speed. The finished fabric was evaluated for its antibacterial and antiviral activity according to international standards. The antibacterial activity of finished fabric is 99.99% for 4h and 24 h against Escherichia coli ATCC 25922 and antiviral activity is 99.9% against Bacteriophage MS2 ATCC 15597-B1 for 24h. The nanoparticles incorporated fabric was submitted to ICP-MS to evaluate its concentration on the fabric, leaching concentration and the durability of nanoparticles on the fabric. The PEG 1500 was applied on the fabric using cross linking agent to improve the comfort properties and submitted to evaluate total hand value (Q_{max}) by FTT (Fabric Touch Tester). The oxidizing agent was applied on the fabric and submitted for soil burial test to evaluate the degradability.

DEVELOPMENT OF COMFORT INDEX PARADIGM ON TEXTILE STRUCTURES (Sponsored by Ministry of Textiles, Government of India)

With increased requirement of garment comfort, studies have focused on comfort properties of fabrics. Scientific design and development of surgical gown, sportswear with wearing and functional comfort and bed linens with skin sensory comfort enhance not only the well-being and health of the real user, but also their performance and records their achievement.

Clothing comfort is classified into three broad categories a) Aesthetic comfort b) Thermo-physiological comfort and c) Tactile comfort/Sensorial comfort. Aesthetic comfort is the subjective perception of clothing by visual sensation, which is influenced by color, style, garment fitting, fashion compatibility, fabric construction and finish. Thermo physiological comfort is defined by heat, water vapour and air transfer through the clothing system in order to maintain the thermal equilibrium between environment and human body. The tactile comfort is related to mechanical interaction between the clothing material and human body/ skin.

At present, there is no comprehensive comfort index available for the determination of comfort for fabrics. An index will be useful in selecting the appropriate clothing for wearer with respect to different applications and under different environmental conditions. The research work is to develop a comfort index for textile materials with the instruments available at SITRA for the measurement of the comfort properties which include both thermo-physiological comfort and tactile comfort (Sensorial comfort).

Objective

To develop a comfort Index for the commercially available products

- Surgical Gown
- Sportswear
- Bed linens

Methodology for developing comfort index

- The *desirability function* is a simple process to combine the values of several responses in a simple quantitative measure *(Derringen and suich 1980)*
- *Relative importance (ie. Weightage)* for each individual desirability function can be given to arrive at global desirability function

$$d = (d_1^{w1} \times d_2^{w2} \times d_3^{w3} x.....d_m^{wm})^{1/w}$$

Where, d_i-individual desirability function of the property Y_i w_i- w_i is the weight of the property "Y_i" in the global desirability function "d"

$$W=1/w_1+w_2+w_3....w_m$$

Calculation of Individual Desirability Function (di)

Two types of desirability functions

– Desirability function to m*aximize*
– Desirability function to m*inimize*

Formula to Maximize

$$d_i = \begin{cases} 0 \text{ if } Y_i \leq Y_{min} \\ \left(\frac{Y_i - Y_{min}}{Y_{target} - Y_{min}}\right)^s \text{ if } Y_{min} \leq Y_i \leq Y_{target} \\ 1 \text{ if } Y_i \geq Y_{target} \end{cases}$$

Where Y_i-Value of individual desirability function (eg:Air permeability)

Y_{min}-Minimum value

Y_{target}-Required value

Formula to minimize

$$d_i = \begin{cases} 1 \text{ if } Y_i \leq Y_{target} \\ \left(\frac{Y_i - Y_{max}}{Y_{target} - Y_{max}}\right)^t \text{ if } Y_{target} \leq Y_i \leq Y_{max} \\ 0 \text{ if } Y_i \geq Y_{max} \end{cases}$$

Where Y_i-Value of individual desirability functions (eg: Thermal resistance)

Y_{max}-Maximum value

Y_{target}-Required value

= Customer requirement degree

Weightage (w) and customer requirement degree (t)

$$\text{customer requirement degree}(t) = \frac{\text{Average Recorded value}}{\text{Average scale level}}$$

$$\textit{Average recorded value} = \frac{\sum \textit{Occurence X Recorded value}}{\textit{Response number}}$$

Response number = Number of subjects

Occurrence = the number of time a property being repeated for that particular rank

Recorded value = the ranks (eg: 1, 2, 3...)

$$\textit{Weight}(wi) = \frac{\textit{Average recorded values}}{10}$$

Sports Textile

Table 23 shows the parameters tested for comfort properties of sports textile fabric.

Table 23 Instruments for measuring Thermo-physiological comfort

Comfort Properties	Instruments available
Water Vapour Resistance (WVR)	Sweating Guarded Hot Plate Tester
Air permeability (AP)	Air permeability tester
Drying Time (DT)	WRA Inhouse method
Liquid moisture transport property	Moisture Management Tester (MMT)

In the instrument for measuring tactile comfort-Fabric Touch Tester (FTT), the following were determind

<table>
<tr><td>Primary sensory indices</td><td>Index</td></tr>
<tr><td>Smoothness</td><td rowspan="3">Total hand/touch value</td></tr>
<tr><td>Softness</td></tr>
<tr><td>Warmness</td></tr>
</table>

Seven fabrics with interlock double-jersey plaited and three single jersey fabrics of different profiled cross-sectional in the non-skin contact filament and circular cross-sectional in the skin contact filament were evaluated for sportswear application. All the fabrics were made-up of synthetic filament yarn. The knitting parameters for selected fabric is given in Table 24.

Table 24 Knitting parameters of sports textile the fabric

<table>
<tr><td rowspan="2">Sample ID</td><td colspan="2">Denier/No of filament</td><td rowspan="2">Gauge</td><td rowspan="2">Knit type</td><td rowspan="2">GSM</td><td rowspan="2">Stitch</td></tr>
<tr><td>Skin Contact</td><td>Non-Skin Contact</td></tr>
<tr><td>S1</td><td>75/108 SD</td><td>75d/72f</td><td>30</td><td>DJ</td><td rowspan="5">150</td><td rowspan="5">28</td></tr>
<tr><td>S2</td><td>75/108 SD</td><td>75d/72f</td><td>30</td><td>DJ</td></tr>
<tr><td>S3</td><td>75/108 SD</td><td>75d/72f -W CS</td><td>30</td><td>DJ</td></tr>
<tr><td>S4</td><td>75/108 SD</td><td>75d/72f</td><td>30</td><td>DJ</td></tr>
<tr><td>S5</td><td>75/108 SD</td><td>75d/72f</td><td>30</td><td>DJ</td></tr>
<tr><td>S6</td><td>81d/72f/2 Ply FD</td><td>50d/72f</td><td>28</td><td>SJ</td><td rowspan="2">170</td><td>26</td></tr>
<tr><td>S7</td><td>75/144 SD</td><td>100d/144f</td><td>30</td><td>DJ</td><td rowspan="2">30</td></tr>
<tr><td>S8</td><td>80d/72f/2ply</td><td>30d</td><td>28</td><td>SJ</td><td>240</td></tr>
<tr><td>S9</td><td>75d/108 SD</td><td>20d</td><td>36</td><td>SJ</td><td>150</td><td>28</td></tr>
<tr><td>S10</td><td>50d/36f</td><td>75d/72f</td><td>32</td><td>DJ</td><td>140</td><td>36</td></tr>
</table>

DJ-Double jersey, SJ-Single jersey, CS-Crossection, SD-Semi dull, FD-Full Dull

Among the above samples tested, 4 fabrics were chosen based on the test data and availability of raw material for making into garment for subjective analysis. The test data pertaining to the chosen samples are given in Table 25.

Weightage and customer requirement degree calculation:

Professional and regular indoor badminton players were asked to give ranking of the parameters based on their requirement. Further, the relative importance and weightage factor were calculated and the same are given in Table 26.

Table 26 Relative importance and weightage factor for various fabric comfort properties required for players

Parameter	Relative importance(ri)	Weightage(w)
Warmness	1.109	0.444
Smooth	1.266	0.506
Softness	1.234	0.494
WVR	0.453	0.181
AP	0.750	0.300
DR	0.984	0.394
MMT	0.984	0.394

Table 25 Comfort properties of the selected samples

Sample No	Smoothness	Softness	Warmness	Bending Average Rigidity (gf*mm/rad)	MMT	AP (cm3/cm2/sec)	Water vapour resistance (m2 pa/W)	Drying Rate (%/min)
S2	0.63	0.56	0.40	83.13	0.761	210	1.9635	0.24
S5	0.61	0.51	0.38	86.16	0.724	164	2.0195	0.3
S7	0.66	0.49	0.39	87.66	0.831	132	1.9536	0.22
S8	0.68	0.51	0.32	131.87	0.697	123	1.8936	0.24

Table 27 Calculated global desirability function relevant to selected fabric samples

Sample No.	Smoothness	Softness	Warmness	BAR	MMT	AP	Water vapour resistance (m2 pa/W)	Drying Rate (%/min)	GDF
S2	0.29	0.88	0.080	0.969	0.47	0.955	0.472	0.270	0.034
S5	0.18	0.39	0.271	0.912	0.25	0.464	0.198	0.934	0.019
S7	0.69	0.10	0.232	0.883	0.90	0.122	0.521	0.049	0.006
S8	0.86	0.37	0.937	0.050	0.09	0.026	0.815	0.270	0.003

GDF-Global Desirability Function ie Comfort Index

This relative importance and weightage factor was used in calculating the individual desirability and global desirability function (comfort index) as per the equation discussed previously. Table 27 shows that global desirability function derived from both the weightage factor and test results obtained from the fabric touch test, air permeability test and moisture management test.

Surgical gown

Based on the literature survey, the parameters relevant to evaluate the surgical gown are given in Table 28.

Table 28 Comfort properties relevant to surgical gown

Comfort properties	Instruments available
Water Vapour Resistance(WVR)	Sweating Guarded Hot Plate Tester
Thermal Resistance(TR)	
Air permeability(AP)	Air permeability tester
Moisture Vapour Transmission rate(MVTR)	Sweating Guarded Hot Plate Tester
Total Hand value	Fabric Touch Tester(FTT)

Table 29 Test results relevant to the comfort properties of the various surgical gowns

Sample ID	WVR	TR	AP	MVTR	Total hand value
S1	3.1616	0.0107	26.1	1717.80	0.48
S2	3.5965	0.1011	19.5	2121.85	0.48
S3	2.9536	0.0913	32.6	1826.77	0.59

WVR-Water vapour resistance, TR-Thermal Resistance, AP-Air permeability, MVTR-Moisture vapour transmission rate

Three commercially available AAMI level-3 surgical gown samples were procured from the manufacturers to test the comfort characteristics of the surgical gown. The test results pertaining to the comfort properties of the various surgical gowns selected for this study are given in Table 29.

From the above table, it is clear that the sample ID S2 has better MVTR than other samples. However, S2 has lower air permeability property than other samples. Based on the overall results, sample S3 provides better comfort as compared with other samples.

Bed Lenin

Comfort parameters tested for bedlinen fabric selected for this study is given in Table 30.

Table 30 Comfort parameters tested for bed linen fabric

Comfort Properties	Instruments available
Water Vapour Resistance(WVR)	Sweating Guarded Hot Plate Tester
Thermal Resistance(TR)	
Air permeability(AP)	Air permeability tester
Moisture Vapour Transmission rate(MVTR)	Sweating Guarded Hot Plate Tester
Liquid Moisture Management property	Moisture Management Test(MMT)
Total Hand value	Fabric Touch Tester(FTT)

In this study, bed linen manufactured by a leading and popularly used brand in the bed linen market was examined. Each bed linen product was characterized under the same test conditions. The fabric properties of the selected hotel bed linens for this study are given in Table 31.

Table 31 Fabric details of the bed linen fabrics

Fabric Code	EPI	PPI	Ply	TC	Warp Count	Weft Count	Res. Weft Count	Mass per unit area	Wrinkle Free Finish
A	220	95	3	505	80	120	40.0	113	Yes
B	230	89	3	497	80	120	40.0	114	No
C	227	88	3	491	80	100	33.3	124	Yes
D	228	67	4	496	80	100	25.0	129	Yes
E	226	53	5	491	80	80	16.0	142	No
F	228	50	5	478	80	100	20	124	No

Test results relevant to comfort properties of the hotel bed linen samples are tabulated in table 32.

Table 32 Test results of the hotel bed linen samples

Sample ID	OMMC	Total Hand Value	MVTR	Air Permeability	Thermal Resistance	Water Vapour Resistance
A	0.8051	0.53	1666.14	7.02	0.0928	1.8209
B	0.6953	0.52	1606.30	4.88	0.0858	1.9123
C	0.8182	0.57	1528.13	4.98	0.0903	1.8035
D	0.7011	0.53	1685.04	10.9	0.0873	1.8325
E	0.6474	0.52	1717.17	34.4	0.0891	1.8436
F	0.7779	0.49	1779.53	30.4	0.0877	1.9081

From the above table, it is observed that the coarser the yarn count in weft, higher the air permeability. This is because coarser count yarns create longer pore size than the finer count yarns. However, no significant difference was noticed in test results for water vapour resistance, total hand value, as well as thermal resistance.

Work in progresss

Sports Textile

Real-time subjective wear trials are still being conducted in indoor badminton courts with the remaining professional players to get the comfort rating. The players are asked to give comfort rating of the fabric before and after playing for one hour.

Apart from carrying out the comfort trial in sports activities, it is also planned to conduct subjective wear trial with different RH and temperature in a controlled environmental condition. Selected healthy subjects will be asked to run in a treadmill at different speeds for a predetermined time in order to give the comfort rating of the garment used.

Surgical gown

Three varieties of samples have been given to surgeons in a reputed multispecialty hospital in Coimbatore to get the comfort rating. The hospital management has agreed to perform the subjective analysis in operation theatres also.

Bed linen

Three hotels were selected for subjective trials of bed linen. They were asked to perform the subjective analysis using the selected hotel bed linens. After receipt of required number of samples, the results would be reported.

DESIGN AND DEVELOPMENT OF FACILE HIGH THROUGHPUT NEEDLE-LESS ELECTROSPINNING SET UP

(Funded by National Technical Textile Mission – Ministry of Textiles)

Electrospinning is a widely used spinning technique which utilizes electrical forces to produce polymeric nano fibers. Owing to the salient features of nanofibers such as high surface area to volume ratio, smaller pore size with high porosity, strong mechanical property, malleability, and biomimetic nature of ECM, nano fibres are used in various applications such as nanocatalysis, tissue engineering scaffolds, protective clothing, filtration, optical, electronics, healthcare, defense and security and environmental engineering. Though electrospinning is a well-established and versatile technique, its utilization in industry is limited by low production rate. Conventional single needle electrospinning system produces 0.01- 0.1 grams of nanofibers per hour. In order to overcome this limitation, researchers have engrossed their interest towards scaling up of electrospun nanofibers. Multiple needle electrospinning and needle less electrospinning are the two major approaches used at present. The use of multiple needle electrospinning in industry is very limited due to its intrinsic problems including mutual interference of electric field and clogging of needles with polymer solution. Hence, developing needleless electrospinning for scaling up of nanofibers has gained a momentum in the recent past. Numerous trials for needleless electrospinning including rotating disc, rotating balls, rotating spiral coils as spinneret and non – rotating bowl shaped spinneret, metallic slit spinneret and pyramid – shaped spinneret have been attempted so far. Till date, developing electrospinning with continuous jet stability, high throughput and nanofibers with precisely controlled diameter remains a challenge. Keeping the above-mentioned facts in mind, the present project proposal is aimed to develop a needless high throughput electrospinning set up.

Objectives

(I) To design and develop a conductive conveyer system with different pattern engraved surface for holding continuous polymer feeding

(ii) To optimize nanofiber production with respect to polymer feeding arrangement

(iii) To explore the possibility of developing hybrid nanofibers on single substrate, as well as, single polymer with high production rate.

Advantages

The major advantage of the proposed set up is high productivity, versatility (applicable for both solvent as well as melt spinning), hybrid nanofibrous coating on single substrate and easier setup construction.

Outcomes of the project

- ✓ Pilot scale high throughput needleless electrospinning set up
- ✓ Industrial scale high throughput needleless electrospinning set up
- ✓ Capability to manufacture hybrid composite nanofibers coated textile substrates
- ✓ The proposed technology will align with "Make in India" concept.

Work Plan

Phase I

- Proof of concept development
  - Conductive metallic different patterns engraved polymer holding plates development
- Exploring various polymers

Phase II

- Development of pilot scale nano fiber production set up
- Design and development of a conductive conveyer system for holding polymer feeding and polymer delivery system
- 0.3 meters will be fabricated at this stage
- Nanofiber production rate per unit area with respect to time will be optimized to achieve high production rate

Phase III

- Fabrication of industrial scale Nanofiber production set up
- Commercial scale set up of about 1.5 Meters will be fabricated at this stage.
- Possibility of developing hybrid nanofiber composite using different biopolymers
- Patent and commercialization

EFFECT OF ANTIMICROBIAL COATED MEDICAL TEXTILES ON THE VAGINAL / SKIN FLORA

Antimicrobial substances are originally used in textiles to prevent rotting. Now-a-days, with raising concerns on the hygiene and with active lifestyles, the application of antimicrobial agents is extended to textiles that are used in outdoor, health care, hygiene, sport and leisure. In the case of health care sector, the antimicrobials are generally used as liquid to remove/eliminate infection causing pathogens in skin antisepsis and disinfection. Recently, antimicrobial coated fabric are being used to develop curtains, wound dressings, surgical gowns, drapes, sutures, hernia mesh, etc., in health care sectors. Though these materials have good market potential as they combat against microbial infection and assist save the patients from pathogens, its usage in feminine hygiene products such as sanitary napkin, tampons, wipes, diaper, etc., need to be studied carefully before the development, since some of these products unlike health care products, are having contact with the vaginal canal which is rich in vascular network and produces mucus. As a mucus membrane, the vagina secretes and absorbs fluids at a higher rate than skin and also protects against and washes away harmful microorganisms. Hence, these products if functionalized with antimicrobial compounds or deodorizer, will rapidly get absorbed by the mucous membrane and enter into the circulatory system without metabolizing it and putting the user at greater risk of potential chemical exposures. Moreover, the absorbed chemicals disturb the normal flora of the vagina. But, so far there are limited studies to prove the hazards associated with the usage of antimicrobial /deodorizer coated hygiene products at national as well as international level. Hence, in the present study, an attempt has been made to study the effect of antimicrobial coated hygiene products such as sanitary napkins on the flora of vagina and skin.

Plan of work

a. Procurement of antimicrobial incorporated hygiene care products

b. Screening of antimicrobial activity of hygiene care products

c. Isolation of skin and vaginal flora from the end users

d. Studying the effect of antimicrobial compound on the behaviour of microorganism isolated from skin and vaginal flora for a specified contact period.

e. Culturing and grouping of tolerance and persistence cells.

Work done so far

- Sanitary napkins impregnated with anionic chips were procured for the study.
- Selected brand of sanitary napkin showed bactericidal activity against vaginal as well as skin flora.
- Based on the contact time of flora with the sanitary napkin, the microbial populations are grouped as tolerance and persistence cells.

SERVICES TO MILLS

Besides R&D work, SITRA has been offering technical and consultancy services which are well received by its member mills as well as non-members. Recent years have witnessed a marked increase in the utilisation of many of the services, primarily testing and training, by the non-members as well. The services availed by the mills during 2020 -21 are presented in Table 33. The onset of COVID-19 during the first quarter of the year had its impact, resulting in significant reduction in utlisation of most services during that period. However, there was significant surge in the requests received for testing of PPEs during that period.

Table 33 SITRA's services availed by textile mills during 2020 - 21

Type of service	Member units	Non members
Fibre, yarn and fabric testing (including PPE)	134	3605
Consultancy services	13	86
Online surveys	28	35
Training: Executives, supervisors and operatives	35	115
Accessories testing & instrument calibration	44	262

Testing of fibres, yarns and fabrics continued to be the most sought-after service this year as well, with as many as 134 member mills, representing 66% of SITRA's membership, sending their samples for analyses (Table 34). Apart from the member units, as many as 3605 non-member units, also utilised this service. Most of these included units which sent their PPE samples for testing from all over the country. The number of samples received during the year, including PPE samples was 73190 (Table 34).

SITRA's physical testing laboratories carry out several special tests which include evaluation of the performance characteristics of non-textile and special application materials. The samples evaluated include; laminated cloth, nonwoven fabrics treated with natural extracts, needle punched nonwoven fabrics, Nylon filament yarn, Surgical face mask, Polyethylene water proof membrane, Polypropylene/Nylon netting, Resin coated glass fabric, PPE nonwoven fabrics, gauze cloth, anti-microbial water repellent fabric, Natural bast and seed fibres, sugar cane bagasse, Polymer bio-films, Weak spot analysis in spun yarns using Uster Tensojet4, Pilling grade of different fabrics.

With its continuous commitment to mills of ensuring speedy testing of test samples, without in anyway compromising on the test standards which insist on preconditioning of samples, SITRA established during the year, the "Rapid Conditioning System" to condition and prepare the pre-opened cotton fibres quickly for High Volume cotton testing. This system ensures that samples received from mills can be quickly pre-conditioned and sent for testing. Mills desirous of receiving quick test reports for their fibre samples can now opt for new service, "Rapid testing facility" by SITRA.

In April 2013, SITRA initiated the monthly online survey of raw material cost and yarn selling price which provides data to participant mills on their position vis-a-vis other participants on a monthly basis. Every year,

Table 34 Testing services offered by SITRA during 2020 - 21

Material	Commercial		Project and Others	
	Samples	Tests	Samples	Tests
Fibres	31107	99294	193	791
Yarns	10727	27884	595	1154
Fabrics	5396	9346	33	52
Chemical testing	8584	14851	244	836
CoE tests	17376	21191	126	207
Total	73190	172566	1191	3040

this service has been receiving good response from the mills and during 2020-21, due to the COVID pandemic only 10 surveys could be conducted. Sixty three mills participated in the surveys conducted during each month.

The training programmes offered for the managerial, supervisory and operative personnel were utilised by 35 (around 23%) of the member units, while 115 non-member units also availed this service. Most of the programmes during the year were conducted through virtual mode. Further details regarding the training programmes are given in the section under 'Training and development programmes" and labour training.

Quite obviously, on account of the Covid situation, only a few mills utilised the consultancy services offered by SITRA during the year, relating to various operational and other technical/techno-economic issues. While 13 (6%) member units utilised the services, 86 non-member mills also sought this service. Some of the important assignments that were handled by SITRA during the year, are listed below.

- Energy Audit
- Yarn realisation study
- Machinery valuation
- Quality audit
- Assessment of laboratories for compliance to ISO/IEC 1705:2017
- Water consumption audits
- Work and Performance Study in weaving
- Performance audit

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

COMPUTER AIDED TEXTILE DESIGN CENTRES

Established in the year 1995, and with addition of 3 more centres, as a part of the PSCs, there are currently 4 centres 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 35 depicts the various services of these centres that were utilised by the decentralised weaving sector.

Table 35 Services offered by the CAD centres during 2020 - 21

S.No.	Type of service	No. of services
1.	Designs development /graph printouts	330
2.	Training programmes (persons trained)	1 (14)

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 observe 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 centres 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 workers engaged in weaving, twisting, warping and sizing units. The year witnessed the different centres testing the face masks that were meant for distribution by the Govt. of Tamil Nadu under the public distribution system. More than 35000 such samples were tested.

The various services rendered by these powerloom service centres are given in Table 36.

Table 36 Services rendered by the powerloom service centres (2020 - 21)

S. No.	Type of service	No. of services
1.	Consultations	32
2.	New designs development	118
3.	Yarn / cloth / chemical samples testing	59,295
4.	Training programmes (persons trained)	9 (166)
5.	Liaison / request visits	5,424
6.	Number of looms inspected	23,049
7.	Number of special works	12*

** 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 2020 -21.

- Ø Testing of various quality parameters of knitted fabrics and garments
- Ø Fabric faults, cause and remedial measures
- Ø Consultancy services
- Ø Conducting training programmes
- Ø Preparing technical feasibility reports
- Ø 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 37.

Table 37 Services offered by the knitting division (2020 - 21)

S. No	Type of Service	No. of services
1	Testing	2746
2	Samples knitting on FAK machine	670
3	Knitting performance of yarn	138
4	Other testing services	171
5	Fabric observation	684
6	Defect Analysis	1083
7	Consultancy	70

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 analysis

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 be 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, 2,746 samples were tested for various parameters such as shrinkage and spirality(14),yarn count (31), weight per unit area (29), Loop length (21), compression pressure measurement (6) and others (70).

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.
- 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 & Supervisory development programmes
- Training programme on fabric quality inspection and cloth analysis

The major activities of the division during the year include 5 technical consultancy assignments, 9 sample weaving, 4 fabric development and conducting a training programme wherein 24 persons were trained.

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 **17025:2017** 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 no. of parameters in the scope of accreditation by more than 67 % 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. Water testing to test drinking water, construction water, bore-well water, surface/river/ground water, water from purifiers, water from treatment plants, sewage water, effluent water, industrial water, etc. have also received NABL Accreditation in the year 2020. 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 pre-requisite testing was done on fibre, yarn, fabric and garment samples for different mills/exporters to meet regulations for OEKO TEX certification.

The water lab has now facilities required to test most of the testing requirements of,

- Ø Potable drinking water as per IS 10500: 2012
- Ø Packaged drinking water as per IS 14543: 2016
- Ø Water for textile industry as per IS 201:1992
- Ø Laboratory grade water as per ISO 3696
- Ø Packaged Natural Mineral Water as per IS 13428, etc.

Analytical Chemistry Laboratory

The lab is equipped with state-of the art instruments to test the harmful substances in the textile, residues in water, etc. The following are the major instruments available with the laboratory:

- Ø High Performance Liquid Chromatograph (HPLC – DAD / FLD)
- Ø Liquid Chromatograph with Mass Spectrometer Triple Quadrapole (LC-MS/MS)
- Ø Gas Chromatography with Mass Spectrometer (GC-MS)
- Ø High Performance Thin Layer Chromatograph (HPTLC)
- Ø Fourier Transform Infra Red Spectrometer (FTIR)
- Ø Inductively Coupled Plasma Mass Spectrometer (ICP-MS)
- Ø Gas Chromatograph mass spectrometer – Triple Quadrapole (GC-MS/MS)
- Ø Ion chromatograph (IC)

Further, the lab is equipped with state-of-the art instruments viz., UV-Vis spectrometer, Atomic Absorption Spectrometer (AAS), 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, ASTM, IS, ISO, BS EN ISO, DIN, APHA, OECD, EN, etc.

Recent addition of Ion Chromatograph (IC)

During the year 2020-21, the lab had procured a new Ion chromatograph instrument (made in Switzerland) from Metrohm India Limited. With this, the lab is now equipped to test the entire range of anions in water and effluent samples. This instrument is particularly added to analyse the presence of Bromates and Bromides in drinking water, packaged drinking water, etc. It is heartening to note that SITRA now has the entire range of facilities to test packaged drinking water as per IS 14543 and is planning to get BIS recognition for its water testing lab as well.

SITRA's textile chemistry department with skilled manpower and expertise, had offered consultancy services to processing mills on various areas such as water consumption audits, technical troubleshooting, process optimization, technical feasibility study, dyeing with natural dyes, etc. During the year, the department had offered a wide range of consultancy services to textile mills, Government bodies and chemical suppliers. The details are figured in Annexure IV.

Textile Processing industries are the largest water consumer in India. The actual consumption of water and the process time can be identified by the industries through the water consumption audits. It leads to optimization of the sequence of processes and parameters. SITRA had audited about 92 dyeing units in 2020-21. The audit report helps the mills in applying for increasing the production capacity and increasing the consent quantity to TNPCB.

Staff of SITRA are also empanelled as the assessor by NABL to carry out the assessment of laboratories as per ISO / IEC 17025:2017. During the year, 2 assessments were conducted.

The department conducts training programmes on various aspects of testing, quality control, general analysis, instrumental analysis to mill technicians, international participants, students, research scholars, etc. During the year 2020-21, in spite of the COVID pandemic resulting in loss of many days, the department conducted 3 different training programmes and a total of 8 persons were trained.

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 had 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 turnaround 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 accommodate more instruments. With additional 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 tests carried out by the centre during the year was 2877 (including 1747 face mask samples from Govt. of Tamilnadu), which is about 108 samples over the previous year's (2769) tests. However, the number of samples transferred to SITRA reduced significantly to 905 during the year, compared to 1510 during the previous year, which is mainly attributed to the restrictions imposed due to COVID 19 Pandemic.

SITRA TEXTILE TESTING AND SERVICE CENTRE-CHENNIMALAI

In order to cater for the requirements of the handloom and powerloom weavers, textile processing units in SIPCOT, Perundurai and Erode, etc., in the region, SITRA has established a Testing and Service Centre at Chennimalai. Samples collected at the centre are brought to SITRA on the same day. In many cases, results are reported to the customers within 24 hours. The Centre carries out testing of Yarn CSP, fabric analysis for design, identification of fibre, blend analysis, etc. The number of tests carried out by the centre during the year was 3564, which is more than twice that of the previous year (1053 tests). The sudden increase in the no. of samples tested is attributed to the inflow of Facemask samples (about 2925 nos.) pertaining to Free distribution scheme of the Government of Tamilnadu.

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, standards formulation, incubation services, information resources, research and development, technical consultancy and Detailed Project Reports for new ventures. It has technical collaboration with various reputed institutes in India and abroad.

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. SITRA was involved in the testing of PPE during 2020 to assist the Goverment of India and the manufacturers with the selection of right fabric for the development of PPE to combat COVID 19. SITRA was the only lab approved by Ministry of Textiles, Govt. of India for testing and certification of PPE samples. Subsequently, SITRA also carried out third party testing activity for HLL, the agency approved by the Government to procure PPE kits for government agencies. SITRA is now a laboratory empanelled by BIS to test various PPE samples. During the year, the division tested 17376 samples involving 21191 tests.

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 liner 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 also offered consultancies on 9 different assignments for varying customers.

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 391 persons under 11 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.

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, ISO, EN 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 anti-bacterial 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 2020-21, a total of 2842 samples were tested by the microbiology laboratory and 506 samples by the biotech laboratory.

TEXTILE ACCESSORIES TESTING

SITRA offers testing services 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 822 samples from 217 units covering various accessories like Carton Boxes, Paper Cones, Rings & Travellers, Tubes, Paper Cores and Kraft Papers, etc., were tested during the year under review which is marginally lower than the numbers compared to the previous year.

SITRA CALIBRATION COTTONS

SITRA has been involved in supplying calibration cottons to help mills in calibrating their High Volume Testing equipments. Currently available cottons include LL5 (Long), SL5 (Short), LM4 (Low Mic) & HM4 (High Mic). During the year, SITRA calibration cottons were revalidated by means of an Inter Laboratory Comparison (ILC) exercise which had received a good response with 65 mills participating. The currently available calibration cotton has validity up to December 2022.

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 172 spinning, weaving and knitting units availed the service of SITRA to receive calibration certificates for 4808 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.

TRAINING SERVICES

1. STAFF TRAINING

Training of technical and managerial personnel from mills, apart from operatives, is an important activity of SITRA. Over the years, many mill technicians have been trained on various managerial and functional aspects of textiles. During the year 2020-21, 11 different training programmes were organised which included 5 functional programmes, 1 in-house and 4 Virtual trainings. The details of the various programmes are given in Table 38.

A. Functional Programmes

Management Orientation Training

At the request of M/s. Sri Mahasakthi Mills, Chittoor, SITRA conducted a fourteen days orientation training programme for their executives towards the present scenario, process control in spinning, weaving, processing and knitting, yarn number, production and productivity, yarn realization and waste control, type of yarn faults, on-line quality control and monitoring practices in spinning mills, cost optimization and control in spinning mills, textile chemical processing, defect analysis, etc. Two executives of the company attended the programme which was held during 4 – 21 September, 2020.

Orientation training programme for cotton cluster

Sailu Cotton Processing Cluster, Maharashtra, under the Scheme of Maharashtra State Industries Cluster Development Program (MSICDP) sought SITRA’s services for a one day exposure session with class room interactions and visit to our laboratories, The programme focused on topics like quality evaluations of cotton and areas of quality improvement in cotton

Table 38 SITRA's Training and development programmes 2020-21

S. no.	Name of the programme	Duration (in days)	Number of		
			A	B	C
	Functional Programmes				
1	Management Orientation training for M/s. Sri Mahasakthi Mills	14	1	1	3
2.	Training Programme for Sailu Cotton Processing Cluster, Dist.Parbhani	2	1	1	12
3.	Training Programme on Textile testing for Executivesr M/s. Tamilnadu handloom weavers society	3	1	1	6
4.	Training programme on Industrial Energy Auditing for students of Tamil Nadu Agricultural University (TNAU), Coimbatore	2	1	1	42
5.	Training programme on Quality Control for M/s.Coimbatore Polytex Ltd, Arasur	2	1	2	8
	In-house programmes				
6.	Training programme on Fabric Inspection at M/s. Komalapuram spg mill	2	1	1	20
	Webinars				
7.	Webinar on "Changing over to HVI mode of testing in cotton fiber evaluation on high volume equipment	1	1	37	44
8.	Virtual Training Programme on "Knowledge of competing fibres" For M/s. Grasim Industries Ltd	10	1	1	20
9.	Webinar on " Interpretation and Analysis of Spectrogram"	1	1	9	11
10.	Webinar on Yarn Quality analysis and critical evaluation of Deviation Rate (DR %) & Weak Spot Analysis	1	1	12	17
11.	Training programmes in medical textiles	1-10	11	14	391
	Total	-	**21**	**80**	**574**

Note : A - Batches B - Orgnisations C - Participants processing with emphasis from ginning to the yarn conversion process. Ten participants attended the programme.

Training programme on textile testing

At the request from Tamil Nadu handloom weavers society, Chennai, SITRA conducted a training programme for their managers towards sensitising them on topics like count, strength, rubbing wastness, colour fastness and light fastness, etc. Six executives attended the three day training programme.

Training programme on industrial energy auditing for students of Tamil Nadu Agricultural University (TNAU), Coimbatore

Under request from the Energy and Environmental Engineering department of Tamil Nadu Agricultural University (TNAU), Coimbatore, SITRA conducted a two-days training programme on Industrial Energy Auditing for the students undergoing their final year B.Tech course. Concepts of energy auditing in various industries, energy savings in primary and ancillary machinery, specific energy consumption for industries were some of the topics that were covered during the two days programme that was held on 19th and 20th March 2021.

Training programme on fibre testing

At the request from M/s Coimbatore Polytex Ltd, Arasur, Coimbatore, SITRA conducted one day training programme which covered the crucial aspects involved in fibre testing using the PREMIER Art3 equipment. Eight QC personnel of the mill attended the programme that was held during 27th to 29th October, 2020.

B. *IN-HOUSE PROGRAMME*

Training programme for fabric inspection

At the request of M/s. Komalapuram Spg & Wvg Mills, Alleppey, Kerala, SITRA conducted a two day training programme for their operatives towards the weaving process, 4 point system, 10 point system and defect analysis etc. Twenty participants attended the programme.

C. WEBINARS

Webinar on changing over to HVI mode of Testing in Cotton Fiber Evaluation

SITRA organised a Webinar on "Changing over to HVI mode of testing in cotton fibre evaluation on HVI" with the intention to highlight to quality control technicians of spinning mills the key aspects in switching to the HVI mode of testing. The technical session was handled by Mr.Murali Ganesh, Product Support Manager, USTER Technologies, India on 25th November 2020 and was attended by 44 technicians representing 34 mills.

Virtual training programme on knowledge on competing fibres

At the request of M/s. Grasim Industries Ltd, Mumbai, SITRA conducted digital learning on knowledge on competing fibres through online for 10 half-a-day training programme for their service engineers towards sensitizing them on vrious topics like Global consumption figures of various fibres, Classification of fibres – natural vs man-made, man-made – synthetic vs cellulose based, within natural – plant based vs animal based, basic properties of various fibres and how it ties up with end usage, applications and what properties enable the applications. relative strengths and weaknesses of the fibres, fibre microstructure and how it affects their properties, high performance fibres like Aramid, ultra-high MW PE, etc. Twenty service engineers of the company attended the programme held during January 2021.

Webinar on “interpretation and analysis of spectrogram"

Spectrogram is a graphical expression of the results of mass variation in sliver, roving or yarn. The periodic faults in these textiles material can be better understood using the spectrogram as it represents the mass variation. It is essential for technicians to have the necessary skills to effectively analyze the spectrogram towards ensuring seamless production of quality by the mill. SITRA organised a 4-day Webinar on ”Interpretation and analysis of spectrogram with the above objectives wherein 11 participants took part.

Webinar on yarn quality analysis and critical evaluation of deviation rate (DR%) and weak spot analysis

The webinar on "Yarn Quality analysis and Critical Evaluation of Deviation rate and weak spot analysis" . focused on DR as well as other expressions developed by SITRA for predicting yarn quality from fiber properties both for conventional fiber testing instruments and also for those measured by HVI test system. Seventeen participants attended the three-day webinar.

2. LABOUR TRAINING

SITRA has been regularly conducting training programmes for the textile mill workers for the past 40 years. Considering the seriousness of the COVID-19 pandemic, SITRA was forced to suspend many batches of training resulting in reduced training activity during the year. The year witnessed 246 shop floor workers being trained. Training programmes were organized for operatives at mills' premises in the regional languages in 16 batches (Table 39).

Pre-employment and retraining programmes

Two out-station and five local mills availed SITRA's training services for their workers. 234 operatives in spinning, autoconer and reeling departments were trained in 13 batches. The training programmes were conducted in Tamil and Malayalam.

Online Assessment of Trainers/Assessors

The Textile Sector Skill Council (TSC) under the National Skill Development Council (NSDC) has recognized and certified training personnel of SITRA as Master Trainers eligible to conduct TOTs for trainers who train persons in textile mills for various job roles. Master trainers are also eligible to conduct assessment of the trainers. Post-COVID-19, TSC has created protocols and guidelines for carrying out online assessment of trainer on both domain and other skills. Under request from TSC, SITRA conducted online assessments for 6 trainers on the job roles of ring frame tenter and autoconer tenter.

At the request from Textile skill sector council, New Delhi, SITRA conducted the online assessment of 6 assessors/TOT trainers for job roles in ringframe, autoconer and knitting during the COVID period .

Table 39 Training programmes offered for shop floor workers in 2020-21

S. no.	Type of programme	Number of		
		Mills	Batches	Partici-pants
1	Operatives training	7	13	234
2	ToT Trainer Assessment	4	2	6
3	NBCFDC Scheme	2	1	16
	Total	13	16	256

Table 40 Break-up of operatives training programmes for spinning mills (2020-21)

S. no.	Tenting jobs	Number of		
		Mills	Batches	Partici-pants
1	Ring frames	4	8	164
2	Autoconer	2	4	55
3	Reeling	1	1	15
	Total	7	13	234

Training under National Backward Classes Finance Development corporation(NBCFDC)

The National Backward Classes Finance & Development Corporation (NBCFDC), under the Ministry of Social Justice and Empowerment, Government of India aims to improve and develop the economic activities for the members of Backward Classes living below the poverty line by offering assistance to institutions by leveraging their strength to enhance the skill of individuals under different job roles in various sectors.

Under the scheme, SITRA trained 16 operatives from 2 mills for a period of 38 days in tenting jobs in the Autoconer department. The programmes were conducted in Tamil.

1. ANCILLARY SERVICS FOR TEXTILE MILL OPERATIVE

a. Aptitude tests for selection of operatives

Since the jobs in textile mills are mostly semi-skilled, repetitive and monotonous, it is of utmost importance to select only those individuals who possess 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 2020-21, 10 aptitude test kits were purchased by the textile mills.

b. Multimedia DVDs on work methods

SITRA had earlier come out with a CD, for the benefit of spinning mill operatives, providing the work methods for spinning mill operatives. Modernisation has brought in many new machinery in the industry and it was pertinent that SITRA come out with a revised version in line with the times. Hence, a new version of multimedia training materials, in DVD format, was released by SITRA some years back. 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, flyframe, ring spinning, open end spinning, manual cone winding, auto cone winding, ring doubling, two for one twisting and reeling.

During the year 2020-21, 6 DVDs were purchased by the textile mills.

MOU SIGNED

During the year, Memorandums of Understanding were signed with Precot Ltd., for offering SITRA's expertise in the textile field and more specifically for medical products, to carry out a project involving development of undercast pads,

PATENT GRANTED

A method for treating effluent, India Patent No. 355986 granted on 18.01.2021.

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, more than 2400 visitors, which included technicians, students and outside specialists visited SITRA library for utilising its rich collection of books and journals. Forty one publications have been added to the existing bank of more than 27,300 books on various technical subjects, apart from textiles and management. SITRA has also been receiving 117 Journals on varied aspects on textiles and allied disciplines.

Publications

SITRA brought out during the year, 13 publications which included 2 research / inter-mill study reports, 10 online reports, 1 Etech letter (SITRA news publication) (Annexure II).

SITRA scientists published 4 research papers in technical journals, contributed 2 chapters to edited publications, presented 2 papers in conferences and seminars and gave 9 lectures (Annexure V).

ANNEXURE I

THE STAFF

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

SPINNING
Assistant Director and Head of Division:
(Addl. incharge of Weaving & Knitting division)
Mr.D.Jayaraman, M.Tech.

Senior Scientific Officers:
Mr. R.Soundararajan, B.E.
Mr. S.Balamurugan, M.Tech.

Scientific Officers:
Mr. M.K.Vittopa, M.Tech., A.M.I.E.
Mr. V.Vijayajothi, M.Tech.

WEAVING AND KNITTING
Senior Scientific Officer:
Mr. S.Sounderraj, M.Tech.

Scientific Officer:
Ms.C.Vanithamani, B.Tech.

LIAISON AND CONSULTATION
Principal Scientific Officer & Head of Division:
Mr. J.Sreenivasan, M.Tech.

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

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

TEXTILE PHYSICS
Principal Scientific Officer & Head of Division:
Dr.R.Pasupathy, M.Tech., M.B.A., A.M.I.E, Ph.D

Scientific Officer:
Mr. M.Kumaran, M.Tech.

TEXTILE CHEMISTRY
Principal Scientific Officer & Head of Division :
(Addl. incharge of CoE- Medical Textiles division)
Mr. S.Sivakumar, M.Tech., D.T.P

Scientific Officer:
Ms.S.Kowsalya, M.Tech.

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

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

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

TRAINING
Scientific Officer:
Mr.K.V.Vaidhyanathan, B.Tech.

CENTRE OF EXCELLENCE FOR MEDICAL TEXTILES
Senior Scientific Officers:
Dr. E.Santhini, M.Sc., M.Phil., Ph.D.
Dr. R.Radhai, M.Sc., M.Phil., Ph.D.

Scientific Officers:
Mr. D.Veerasubramanian, M.Tech.
Mr. K.R.Muthukumar, M.Tech.

ADMINISTRATION
Principal Scientific Officer & Administrative Officer :
(Addl. incharge of Training division)
Dr.K.Sajjan Rao, M.Sc., Ph.D.

Principal Officer & Head - Finance and Cost Accounts:
Ms.K.Vadivazhaki, B.Com., A.C.A.

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

Senior Officer - Stores:
Mr. M.Babu, B.E.

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

Officer - Accounts:
Ms. K.Prabha, M.Com., PGDCA

ANNEXURE I (Contd..)

THE STAFF

Total staff strength as on 31st March 2021

Officers	*:....................32*
Scientific/Technical assistants	*:....................29*
Administrative staff	*:....................12*
Skilled/Semi skilled & maintenance services	*:....................13*
Technical assistants on contract	*:......................4*
Total	***:.....................90***

Powerloom service centres (Govt. sponsored)

Officers	*:......................2*
Scientific/Technical assistants	*:....................25*
Skilled/Semi skilled	*:......................2*
Total..:	***...................29***

ANNEXURE II

SITRA PUBLICATIONS DURING 2020 - 2021

1. Focus:

Evaluation of seldom occuring yarn faults - Classimat analysis - *R.Pasupathy, D.Jayaraman and G.Nagaraj.*

Remedies for common problems expected in a spinning mill after lockdown period - *D.Jayaraman and J.Sreenivasan.*

How spinning mills have performed commercially during the period 2013 to 2021 - An analysis - *J.Sreenivasan.*

2. SITRA eTech letter:

1 issue

3. Other Publications:

Annual report 2019-20

10 Online Technical Reports

ANNEXURE III

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 IV

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 2020-21 were:

Water consumption audits (92), Energy Audits (8), Compressor air flow Analysis (3), Compressor Study (4) CT testing(43), Fabrication of viscosity Cup (26), Sample Weaving – Product Development (20), Monthly inter-mill survey (6), Fabric development work (4) Assessment of laboratories for NABL accreditation purpose (2), Machinery health audit to mills through mobile App (3), Machiney audit (2) Technical consultancy in weaving (2), study on fixing of inlet quality standards for the CETPs in Tamil Nadu (1), Process optimisation and trouble shooting for textile chemical units (10).

Apart from the above, the following studies were also undertaken:

Work assignment study, Air consumption on weaving machines, DPR (Detailed Project Report) for starting a new dyeing units, Technology transfer of the outcome of a research project, Internal audit of other laboratories, Humidification Plant study, Air Audit, Water consumption audits, Study on fixing of Inlet Quality standards for the CETP's in Tamilnadu, Development of undercast pads with improved frictional properties similar to that of competitors under cast pads, Development of a process methodology for reuse of ginning cotton waste in hygiene core layer, Study of Identifying the usage of mixed salt for dyeing, Study of Identifying the usage of brine solution for dyeing, Study of Identifying the usage of mixed salt for dyeing, Natural Dyeing of cotton lining materials, Technical study - Salt free dyeing, Trouble shooting of ETP operation, Work Assignment study, Process optimization in dyeing.

ANNEXURE V

PAPERS PUBLISHED IN JOURNALS AND PAPERS PRESENTED IN CONFERENCES

PAPERS PUBLISHED IN JOURNALS

Mark David Samraj.S, Selvaraj Dinesh Kirupha, Elango Santhini & Ketankumar Vadodaria	Fabrication of Nanofibrous membrane using Stingless bee honey and Curcumin for wound healing applications.	Journal of Drug Delivery Science and Technology. Available online 7 December 2020, 102271. IF: 2.734
Vadodaria, K, Sureshram, T, Santhini, E & , Kulkarni, A	Design and fabrication of an instrument to evaluate characteristics of fluid handling capacity of wound care dressings.	IJFTR, 45(2), 2020, 169-176. IF : 0.449
Ramaswamy Rajendran, Mariappan Abirami, Elango Santhini, Selvaraj Dinesh Kirupha & Ketankumar Vadodaria	Evaluation of bioactive properties of alternanthera sessilis extract and development of sodium alginate - Alternanthera sessilis membrane for wound management.	Journal of Polymer Engineering, 40(6), 2020.
Amutha K, Grace Annapoorani S, Sakthivel P, & Sudhapriya, N	Eco-friendly dyeing of textiles with natural dyes extracted from commercial food processing waste materials	Journal of Natural fibers, Under review, Manuscript ID: WJNF-2021-0170. Accepted for publication. Impact Factor: 5.323.

CONTRIBUTION AS A BOOK CHAPTER

L. Amalorpava Mary Santhini Elango	Interferon Therapy for Hypertrophic Scars and Keloids	Intechopen, 2021; DOI: 10.5772/intechopen.96789.
Santhini O.E. Kirupha S.D.	(2020) Nanomaterials and Ethical Issues	Khan F. (eds) Applications of Nanomaterials in Human Health. Springer, Singapore.

PAPERS PRESENTED IN SEMINARS /CONFERENCES

N. Sudhapriya & S. Sivakumar	"Nano encapsulation of vitamin E using readily available starting materials"	World Nano Congress on Advanced Science & Technology (WNCST-2021) organized by Centre for Nanotechnology Research (CNR) between March 8-13, 202, Vellore Institute of Technology, Vellore.

LECTURES DELIVERED

S. Sivakumar	Medical Textiles	Webinar organized by Ministry of MSME, August 2020.
	Emerging Opportunities in Medical Textiles	Online conference "Exploring the Expectations and Executions in Scientific Research – EEESR 2020" organized by Mother Teresa Women's University, Kodaikanal.
	"PPE manufacturing and quality evaluation"	Webinar tiltled "A Technical Master Class Personal Protective Equipment" organized by Apparel Training and Design Centre, Bengaluru.

ANNEXURE V (Contd.)

PAPERS PUBLISHED IN JOURNALS AND PAPERS PRESENTED IN CONFERENCES

Lectures delivered (Contd...)

S. Sivakumar & E.Santhini	"Characterization of Personal Protective Equipment"	One-week online short term course on "Characterization Techniques in Textiles and polymers" sponsored by TEQIP, New Delhi and organized by the Department of Textile Technology, Dr B R Ambedkar National Institute of Technology Jalandhar, 15th to 19th Dec, 2020.
S. Sivakumar & E.Santhini	"Characterization of Personal Protective Equipment for Healthcare Applications"	One-week online short term training Programme (STTP) on "Impact of Polyphenols in Enzymen Inhibition and Formulation of the Healthcare Apparels" sponsored by AICTE, New Delhi and organized by the Department of Biotechnology, Jointly with Department of Textiles and Fashion Technology, Kumaraguru College of Technology, Coimbatore, 16th Oct, 2020.
E.Santhini	"Biological Characterization of Medical Textiles"	Webinar organized by the Department of Microbiology, Dwaraka Doss Goverdhan Doss Vaishnav College, Chennai, 15th June, 2021.
	"Basics in Microbiology and Microbial Cellulose"	Students of M. Des. Textile Design, National Institute of Design, Ahmedabad through video conferencing mode, 15th June, 2021
	"Recent Developments in Medical Textiles" "Test methods, Instruments used, National & International Standards of Medical Textile Products - Biological characterization &Rrequirements"	5-day online certificate course on "Medical Textiles" organized by Indian Technical Textiles Association, Mumbai, between 24th and 28th May, 2021.

ANNEXURE VI

MEMBERS OF COUNCIL OF ADMINISTRATION

Elected members

1. Mr.Sanjay Jayavarthanavelu, Chairman & MD, Lakshmi Machine Works Ltd., Coimbatore (Chairman)
2. Mr.E.Sathyanarayana, Managing Director, Sree Sathyanarayana Spinning Mills Ltd., Tanuku (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, Managing Director, Sri Venkatalakshmi Spinners (P) Ltd., Udumalpet.
6. Mr. Prashanth Chandran, Managing Director, Precot Ltd., Coimbatore.
7. Dr. K.V.Srinivasan, Managing Director, Premier Mills Pvt. Ltd., Coimbatore.
8. Dr. S.K. Sundararaman, Executive Director, Siva Texyarn Ltd., Coimbatore
9.. Mr. Thyagu Valliappa, Executive Director, Sree Valliappa Textiles, Ltd, Bangaluru
10. Mr. J.Thulasidharan, Managing Director, The Rajaratna Mills 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. T.V.Sreekumar, Director, The Bombay Textile Research Association, Mumbai.
15. Dr. Arindam Basu, Director General, Northern India Textile Research Association, Ghaziabad.
16. Shri Pragnesh Shah, 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.

Representative of the Government of Tamil Nadu

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

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

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

Representative of the Southern India Mills' Association

22. Chairman, The Southern India Mills' Association, Coimbatore.

Special invitees

1. The Chairman, Confederation of Indian Textile Industry, New Delhi.
2. The Director, Central Leather Research Institute, Chennai (CSIR representative).
3. Mr. Divyar S. Nagarajan, President, Dyers Association of Tirupur.
4. Mr. Raja M. Shanmugam, President, Tirupur Exporters Association, Tirupur.
5. Mr. Suresh Manoharan, Executive Director, Best Color Solutions (I) Pvt. Ltd., Tirupur.
6. Sri Harish Kapil Kumar, Technical Director, Sri Kumaran Mills Pvt. Ltd.
7. Mr. Rohit Rajendran, Executive Director, Premier Spg&WvgMills Ltd.

ANNEXURE VII

MEMBERS OF SUB-COMMITTEES

(A) Finance and machinery sub-committee

Shri Sanjay Jayavarthanavelu	Lakshmi Machine Works Ltd., Coimbatore.
Shri E.Sathyanarayana	Sree Satyanarayana Spinning Mills Ltd, Tanuku.
Dr. K.V.Srinivasan	Premier Mills Pvt. Ltd., Coimbatore.
Dr. Prakash Vasudevan	Director, SITRA, Coimbatore.

(B) Staff and awards sub-committee

Shri Sanjay Jayavarthanavelu	Lakshmi Machine Works Ltd., Coimbatore.
Dr. K.V.Srinivasan	Premier Mills Pvt. Ltd., Coimbatore.
Shri J.Thulasidaran	The Rajaratna Mills Ltd., Palani.
Dr. Prakash Vasudevan	Director, SITRA, Coimbatore

ANNEXURE VIII

MEMBERS OF RESEARCH ADVISORY COMMITTEE

Members

1. Mr. Sanjay Jayavarthanavelu, Chairman cum Managing Director, Lakshmi Machine Works Limited, Coimbatore (Chairman)
2. Dr. Prakash Vasudevan, SITRA, Coimbatore (Director)
3. Dr. T.V.Sreekumar, Director, The Bombay Textile Research Association, Mumbai.
4. Dr. Arindam Basu, Director General, Northern India Textile Research Association, Ghaziabad.
5. Dr. Pragnesh Shah, Director, The Ahmedabad Textile Industry's Research Association, Ahmedabad.
6. Shri. S. Dinakaran, Joint Managing Director, Sambandam Spinning Mills Ltd., Salem.
7. Shri. Gopinath Bala, Technical Director, Sri Venkatalakshmi Spinners Pvt. Ltd., Udumalpet.
8. Shri. M.Muthupalaniappa, Vice President (Technical), representing Mr. T.Kannan, Thiagarajar Mills Ltd., Madurai.
9. Shri.Prashanth Chandran, Joint Managing Director, Precot Ltd, Coimbatore.
10. Dr. K.V.Srinivasan, Premier Mills Private Limited, Coimbatore.
11. The Chairman & Managing Director, National Textile Corporation Ltd., New Delhi.
12. The Chairman, The Southern India Mills Association, Coimbatore.
13. The Commissioner of Handlooms and Textiles, Govt. of Tamil Nadu, Chennai.
14. The Director, Central Leather Research Institute, Chennai.

Invitees

1. Dr.Anbu Kulandainathan, CSIR-Central Electrochemical Research Institute, Karaikudi.
2. Dr.J.Angayarkanni, Head, Dept, of Microbiology,Bharathiar University, Coimbatore
3. Shri K.Balasanthanam, MD, Kongoor Textile Process, Tirupur.
4. Christopher Karunakarn, GM, Knitwell India, Tirupur
5. Dr. V.R.Giridev, Professor and Head, Dept. of Textile Technology, AC College of Technology, Anna University, Chennai.
6. Shri. R. Krishna Kumar, Managing Director, M/s. Cologenesis Healthcare Pvt. Ltd., Salem.
7. Shri Kanthimanthinathan, President, Rajapalayam mills Limited, Rajapalayam.
8. Dr.N.N. Mahapathra, Business Head(Dyes), Shree PushkarCehmicals & Fertilizers Ltd., Mumbai.
9. Dr. Peer Mohammed, Vice Chancellor, Crescent Institute of Sciences & Technology (Deemed to be University), Chennai.
10. Dr.R.Rajendran, Associate Professor, Dept. of Microbiology, PSG College of Arts & Science, Coimbatore.
11. Dr.M.Senthil Kumar, Associate Professor, PSG College of Technology, Coimbatore
12. Mr.S.Shyamsundar, Head - Technical, Precot Limited
13. Mr.Joga Rao, President (Operations), Sree Satyanarayana Spinning Mills (P) Ltd., Tanuku
14. Shri.Sri Hari Prasad, MD, Kadri Wovens, Unit of Kadri Mills, Perundurai.
15. Dr.J.Srinivasan, Professor, Dept of Fashion Technology, Kumaraguru College of Technology, Coimbatore.
16. Dr.Shanmugavasan, MD, KOB Medical Textiles, Palladam
17. Dr.V.Subramaniam, Director, Dept. of Textile Technology, Jaya Engineering College, Chennai.
18. Dr.Umamaheswari. K, Associate Dean, School of Chemical & Biotechnology, SASTRA.
19. Dr. V.Vijaya Padma, Prof and Head, Department of Biotechnology, Bharathiar University, Coimbatore.

ANNEXURE IX

COMMITTEES IN WHICH SITRA STAFF REPRESENTED

Chairman, Hosiery Sectional Committee, TXD10, Bureau of Indian Standards, New Delhi.

Chairman, Medical Textiles Committee TxD36, 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 constituted by India ITME Society, Mumbai..

Member, TX 0I & TX 05 Committees, Bureau of Indian Standards, New Delhi.

Expert member, Board of Studies (BoS) in Textile Technology, Bannari Amman Institute of Technology (Autonomous), Sathyamangalam.

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 and member of Advisory committee for strategic planning and Co-Chairman of technical Committee, 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.

Supervisor, Ph.D & M.Phil. Programmes (Textile Technology), Anna University, Chennai.

Member, Board of Studies (BoS) in Textile Technology (TT) Karpagam University, Coimbatore.

Member, Confederation of Indian Industries (CII), Coimbatore zone.

Member, Board of Governors, 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 Psychology, Bharathiar University, Coimbatore; PSG College of Arts & Science, Coimbatore; Govt. Arts College, Coimbatore; Sri Krishna College of Arts & Science

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.

BIS TXD 07 Committee for Textile chemicals and dyestuffs

Member of the Syllabus Sub Committee for Faculty of technology – Master of technology (Textile Chemistry) for Anna University, Chennai.

DST SEED Project advisory committee for Kumaraguru College of Technology, Coimbatore

Technical committee for tender and purchase of Yarn syeing and stenter machinery for Tamilnadu Co-operative Textile Processing Mils, Erode

Technical committee for establishing a new processing unit at Nadukani Kannur by Department of Handlooms and Textiles, Kerala.

ANNEXURE X

SITRA MEMBER MILLS

Full Members

1 Acsen Tex P. Ltd
2 Adwaith Textiles Limited
3 Amaravathi Spinning Mills
4 Amarjothi Spg. Mills Ltd.
5 Anna Co-op. Spg. Mills Ltd
6 Annamalaiar Mills Private Ltd
7 B K S Textiles Private Limited
8 B R T Spinnerrs Limited
9 Best Cotton Mills (P) Ltd
10 Cardwell Spinning Mills Limited
11 Chenniappa Yarn Spinners (P) Ltd
12 Chida Spg. Mills (P) Ltd
13 Coimbatore Polytex Private Ltd
14 D B V Cotton Mills (P) Ltd
15 Eastman Spinning Mills (P) Ltd
16 Emperor Textiles (P) Ltd
17 Ennar Spinning Mills (P) Ltd
18 G T N Industries Ltd
19 Gopalakrishna Textile Mills Pvt. Ltd
20 Harshini Textiles Ltd
21 Hindustan Cotton Spinning Mills
22 Jai Sakthi Mills
23 Jay Textiles -Unit II (Super Sales India Ltd.)
24 Jayalakshmi Textiles Private Limited
25 Jayavarma Textiles (P) Ltd - Unit 2
26 JVS Exports
27 K K P Spinning Mills Ltd
28 Kallam Textiles Ltd
29 Kaveri Yarns and Fabrics Ltd
30 Kayaar Exports Private Limited
31 Kesharinandan knit fabrics P Ltd
32 L S Mills Ltd
33 Lakshmi Machine Works Ltd
34 Madura Coats Private Limited (4)
35 MAG Solvics (P) Ltd
36 Mallur Siddeswara Spg. Mills Pvt. Ltd
37 Maris Spinners Ltd
38 Marudhamalai Sri Dhandapani Spinning Mills
39 Narasu's Spg. Mills
40 National Textile Corporation (TN&P) Ltd (16)
41 Prabath Spinner India (P) Ltd
42 Prachidhi Spinners Pvt. Ltd
43 Precot Ltd (6)
44 Premier Mills Private Ltd
45 Premier Spg. & Wvg. Mills Ltd
46 S C M Textile Spinners
47 S P Spinning Mills Ltd
48 S.A. Aanandan Spinning Mills (P) Ltd
49 S.P Apparels - Spinning Unit
50 Sahana Textiles
51 Salona Cotspin Limited
52 Sangeeth Textiles Ltd
53 Saravana Polythreads (P) Ltd
54 Sarmangal Synthetics Limited
55 Saudagar Enterprise
56 Saurer Textiles Solution
57 Selvaraja Mills Pvt. Ltd
58 Senthilkumar Textile Mills Private Limited
59 Seyadu Spinning mills
60 Shanmugappriya Textiles Ltd
61 Shiva Mills Limited
62 Shri Cheran Synthetics India Ltd
63 Shri Govindaraja Mills Ltd,- B Unit
64 Shri Ramalinga Mills Ltd
65 Shri Santhosh Meenakshi Textiles Private Limited
66 Shri Siddhivinayaga Tex India Pvt Ltd
67 Soundararaja Mills Ltd
68 Southern Spinners and Processors Limited
69 Sowmiya Textiles Private Ltd
70 Sree Ayyanar Spg. & Wvg. Mills Ltd- Unit (2)
71 Sree Narasimha Textiles (P) Ltd
72 Sree Satyanarayana Spg. Mills Ltd
73 SRG Apparels Ltd
74 Sri Gomathy Mills Private Limited
75 Sri Kannapiran Mills Ltd.
76 Sri Kannattal Mills P. Ltd
77 Sri Karthikeya Spg. & Wvg. Mills Ltd
78 Sri Kumaraguru Mills Ltd
79 Sri Kumaran Mills Private Limited
80 Sri Lakshmi Saraswathi Textiles (Arni) Ltd (2)
81 Sri Mahasakthi Mills Ltd
82 Sri Muni Pachaiyappan Textiles (P) Ltd
83 Sri Nachammai Cotton Mills Ltd
84 Sri Ramakrishna Mills (CBE) Ltd
85 Sri Ranga Textiles (P) Ltd
86 Sri Selvabathi Mills Pvt Ltd
87 Sri Sundhareswara Mills
88 Sri Shanmugavel Mills Pvt. Ltd
89 Sri Sharadhambika Spintex P.Ltd
90 Sri Sivajothi Spg Mills P Ltd
91 Sri Varadaraja Textiles Ltd
92 Sri Vasudeva Textiles Limited Unit II
93 Sri Venkatalakshmi Spinners (P)Ltd
94 Sri Vignesh Yarns (P) Limited
95 Super Spg. Mills Ltd.
96 T T Limited-(Unit Tirupathi Spinning Mills)
97 The Banhatti Co-op. Spg. Mills Ltd
98 The Bharathi Co-op. Spg. Mills Ltd
99 The Kadri Mills (CBE) Ltd (8)
100 The Lakshmi Mills Co.Ltd (3)
101 The Palani Andavar Mills Ltd
102 The Puducherry Co-op. Spg. Mills Ltd
103 The Pudukkottai District Co-op Spg Mills Ltd
104 The Rajaratna Mills Ltd (2)
105 The Ramanathapuram District Co-operative Spg Mills
106 The Southern Textile Ltd
107 The Tamilnadu Handloom Weavers' Co-op.Society Ltd
108 The Tamilnadu Textile Corporation Ltd
109 Tirupur Textiles Private Ltd (3)
110 Umayal Spinners (P) Ltd
111 Veejay Lakshmi Engineering Works Ltd
112 Veejay Syntex Pvt. Ltd
113 Vijay Velavan Spinning Mills (P) Ltd
114 Vishnu Lakshmi Mills (P) Ltd
115 Viswabharathi Textiles Ltd

Associate Members

1 Br.Sheshrao Wankhede Shetkari Sahakari Soot Girni Ltd
2 Eurotex Industries & Exports Ltd.
3 Ginni Filaments Ltd
4 Gloster Jute Mills Ltd
5 Gujarat Heavy Chemicals Ltd. Unit : Sree Meenakshi Mills (2)
6 JP Modatex LLP

Note: Figures in brackets indicate number of units

ANNEXURE XI (Condt..)

SITRA MEMBER MILLS

7 Kangwal Textile Company Limited
8 Loyal Textile Mills Ltd.
9 Maharaja Shree Umaid Mlls Ltd
10 Nagammal Mills Ltd
11 Nagreeka Exports Ltd
12 P B M Polytex Ltd (2)
13 Pee Vee Textiles Limited
14 Pratibha Syntex Limited
15 PT. Indo Liberty Textiles
16 Rajapalayam Mills Ltd
17 Reliance Industries Ltd
18 Rieter India (P) Ltd
19 RSB Cottex
20 Sambandam Spg Mills Ltd
21 Shetkari Sahakari Soot Girni Ltd
22 Siddhi Industries Limited
23 Sree Valliappa Textiles Ltd
24 Sri Jayajothi & Co Ltd
25 Sudiva Spinners Private Limited
26 Sumicot Limited
27 The Suguna Mills Pvt. Ltd
28 Thiagarajar Mills Ltd (2)
29 Vardhaman Yarns & Threads Limited
30 Vippy Spinpro Ltd
31 Voltas Ltd

TSC Members

1 A.R.Appasamy
2 Aarthi-A1-Traders
3 Anishkumar Spinning Mill
4 Anithaa Weaving Mill (P) Ltd.,
5 Dhanalakshmi Textiles
6 Eluru Jute Mill
7 Golden Fashion (India) (P) Ltd
8 Guardian Health Management Pvt Ltd
9 Hanrid Exim LLP
10 J.G. Hosiery Pvt Ltd.
11 Jacquard Fabrics (India) Pvt.Ltd.,
12 Jayanthi Textile Products
13 K G Denim Ltd
14 Kanakalakshmi Mills (P) Ltd
15 Kikani Exports Pvt.Ltd
16 Lakshmi Saraswathi Textiles
17 Lakshmi Spinners
18 Muthu Spinning Mills Private Ltd
19 Nilgiri Textiles (P) Ltd
20 Prathishta Weaving and Knitting Co.Ltd
21 Ramakrishnaa Processing Mills
22 Renaissance Incorporations
23 Rimtex Engineering Pvt. Ltd
24 S.N.N. Textiles Private Limited
25 Sellammal Spinners (P) Ltd
26 Shree M.T.K. Textiles Private Limited
27 Sre Venkatachalapathy Textiles
28 Sreedhara Textiles Private Limited
29 Sri Amman Textiles..,
30 Sri Choleeswarar Spg. Mills,
31 Sri Jagannatha Spinners Pvt. Ltd
32 Sri Palani Andavar Textiles
33 Stalwart Sourcing Solutions
34 Techno Electronics and Instruments
35 V.Thangavel and Sons Private Limited
36 Veejay Terry Products Ltd
37 Veen Farm and Field Agro Products Pvt Ltd

FINANCIAL STATEMENTS
AS ON
31st MARCH 2021

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 Audit of Financial Statements

Opinion

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, 2021 and the Statement of Income and Expenditure for the year then ended, and notes to the financial statements, including a summary of significant accounting policies.

2. In our opinion and to the best of our information and according to the explanations given to us the aforesaid financial statements give a true and fair view of the financial position of the Association as at March 31, 2021 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, 2021; and

   (b) in the case of the Income and Expenditure Account, of the Excess of Income over Expenditure for the year ended on that date.

Basis for Opinion

3. We conducted our audit in accordance with the Standards on Auditing (SAs) issued by ICAI. Our responsibilities under those standards are further described in the Auditor's responsibilities for the Audit of the Financial Statements section of our report. We are independent of the Association in accordance with the Code of Ethics issued by ICAI and we have fulfilled our other ethical responsibilities in accordance with the Code of Ethics. We believe that the audit evidence we have obtained is sufficient and appropriate to provide a basis for our opinion.

Responsibilities of Management and Those Charged with Governance for the Financial Statements

4. Management of the Association is responsible for the preparation of these financial statements that give a true and fair view of the state of affairs and results of operations of the Association in accordance with the accounting principles generally accepted in India. 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.

5. In preparing the financial statements, management is responsible for assessing the Association's ability to continue as a going concern, disclosing, as applicable, matters related to going concern and using the going concern basis of accounting unless management either intends to liquidate the Association or to cease operations, or has no realistic alternative but to do so.

6. Those charged with governance are responsible for overseeing the Association's financial reporting process.

Auditor's Responsibilities for the Audit of the Financial Statements

7. Our objectives are to obtain reasonable assurance about whether the financial statements as a whole are free from material misstatement, whether due to fraud or error, and to issue an auditor's report that includes our opinion. Reasonable assurance is a high level of assurance but is not a guarantee that an audit conducted in accordance with SAs will always detect a material misstatement when it exists. Misstatements can arise from fraud or error and are considered material if, individually or in the aggregate, they could reasonably be expected to influence the economic decisions of users taken on the basis of these financial statements.

8. As part of an audit in accordance with SAs, we exercise professional judgment and maintain professional skepticism throughout the audit. We also:

   (a) Identify and assess the risks of material misstatement of the financial statements, whether due to fraud or error, design and perform audit procedures responsive to those risks, and obtain audit evidence that is sufficient and appropriate to provide a basis for our opinion. The risk of not detecting a material misstatement resulting from fraud is higher than for one resulting from error, as fraud may involve collusion, forgery, intentional omissions, misrepresentations, or the override of internal control.

   (b) Obtain an understanding of internal control relevant to the audit 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 Association's internal control.

   (c) Evaluate the appropriateness of accounting policies used and the reasonableness of accounting estimates and related disclosures made by management.

   (d) Conclude on the appropriateness of management's use of the going concern basis of accounting and, based on the audit evidence obtained, whether a material uncertainty exists related to events or conditions that may cast significant doubt on the Association's ability to continue as a going concern. If we conclude that a material uncertainty exists, we are required to draw attention in our auditor's report to the related disclosures in the financial statements or, if such disclosures are inadequate, to modify our opinion. Our conclusions are based on the audit evidence obtained up to the date of our auditor's report.

9. We communicate with those charged with governance regarding, among other matters, the planned scope and timing of the audit and significant audit findings, including any significant deficiencies in internal control that we identify during our audit.

Report on Other Requirements

10. Further, 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) In our opinion, proper books of account have been kept by the Association so far as appears from our examination of those books.

   (c) The Balance Sheet and Statement of Income and Expenditure dealt with by this Report are in agreement with the books of account.

For P N Raghavendra Rao & Co.,
Chartered Accountants
Firm Registration Number: 003328S
Sd\- Pon Arul Paraneedharan
Partner
Membership Number: 212860
UDIN: 21212860AAAAFX8059

Coimbatore
August 25, 2021

THE SOUTH INDIA TEXTILE RESEARCH ASSOCIATION

BALANCE SHEET AS AT 31ST MARCH 2021

Amount in "Rs."

Particulars	Schedule No.	2020-21	2019-20
LIABILITIES			
Corpus/Capital Fund	1	2,87,92,408	2,82,73,102
Capital Grant from Ministry	2	39,76,85,194	39,66,96,265
Reserves and Surplus	3	73,88,24,937	64,12,09,327
Current Liabilities and Provisions	4	2,88,52,024	3,19,07,014
TOTAL (A)		**1,19,41,54,563**	**1,09,80,85,708**
ASSETS			
Fixed Assets - Net Block	5 & 6	57,35,60,466	56,74,89,374
Investments	7	52,74,94,341	40,88,74,332
Sponsored Projects - Grant Receivable	8	1,63,01,493	2,14,07,108
Current Assets, loans, Advances etc	9	7,67,98,263	10,03,14,894
TOTAL (B)		**1,19,41,54,563**	**1,09,80,85,708**

"Vide our report of even date"

For P.N.Raghavendra Rao & Co.,
Chartered Accountants
Firm Registration No:003328S
(Sd/-) Pon Arul Paraneedharan
Partner
M.No:212860

Place : Coimbatore
DATE: 25-08-2021

(Sd/-) Sanjay Jayavarthanavelu (Chairman)
(Sd/-) E Sathyanarayana (Vice Chairman)
(Sd/-) Prakash Vasudevan (Director)

THE SOUTH INDIA TEXTILE RESEARCH ASSOCIATION
INCOME AND EXPENDITURE ACCOUNT FOR THE YEAR ENDED 31ST MARCH 2021

Amount in "Rs."

Particulars	Schedule No.	2020-21	2019-20
INCOME			
Income from Services	10	15,50,17,034	9,36,87,982
Membership/Ministry Contribution	11	1,78,98,843	1,73,10,625
Sponsored Projects - Overhead Recoveries	12	5,37,481	7,67,186
Interest Income	13	54,63,075	30,48,536
Other Income	14	82,92,911	84,82,906
Changes in Inventories	15	1,52,150	10,24,671
TOTAL (A)		**18,73,61,494**	**12,43,21,906**
EXPENDITURE			
Establishment Expenses	16	8,50,30,949	8,32,26,674
Administrative Expenses	17	1,67,05,223	1,97,18,044
Repairs and Maintenance	18	91,91,284	75,71,491
Stores Consumed	19	56,53,202	47,21,958
Finance Charges	20	26,977	25,508
Sponsored Projects - SITRA Contribution	21	15,02,230	5,36,599
Depreciation	22	97,81,602	89,41,223
TOTAL (B)		**12,78,91,467**	**12,47,41,497**
Balance being excess of Income over Expenditure for the year		5,94,70,027	(4,19,591)
Appropriated from Research & Development Reserve		1,28,084	2,20,296
Appropriated from Infrastructure Dev. & Maintenance Reserve		15,00,619	18,83,400
Appropriated from Staff Benefit Reserve (Payment of Terminal Benefits & Exgratia)		33,50,083	29,53,923
Paid from Sitra Employee Gratuity Scheme		26,20,487	19,17,407
Appropriated from Depreciation Reserve		20,98,479	8,00,859
Balance Surplus		**6,91,67,779**	**73,56,294**
Transfer to Staff Benefit Reserve		65,00,000	45,00,000
Transfer to Research & Development Reserve		1,50,00,000	-
Transfer to Depreciation Reserve Fund		2,40,00,000	-
Transfer to Infrastructure Devel. & Maintenance Reserve		1,50,00,000	25,00,000
Transfer to General Reserve		**86,67,779**	**3,56,294**

"Vide our report of even date"
For P.N.Raghavendra Rao & Co.,
Chartered Accountants
Firm Registration No:003328S
(Sd/-) Pon Arul Paraneedharan
Partner
M.No:212860

Place : Coimbatore
DATE: 25-08-2021

(Sd/-) Sanjay Jayavarthanavelu (Chairman)
(Sd/-) E Sathyanarayana (Vice Chairman)
(Sd/-) Prakash Vasudevan (Director)

THE SOUTH INDIA TEXTILE RESEARCH ASSOCIATION

Schedules to Balance Sheet for the year ended 31.03.2021

Amount in "Rs."

Schedules	2020-21	2019-20
Sch - 1		
Corpus/Capital Fund		
Contribution from Member Mills	2,85,78,448	2,82,67,868
Add: Received during the year	2,13,960	3,10,580
	2,87,92,408	2,85,78,448
Less: Profit / (Loss) on Disposal of Assets	-	(3,05,346)
Total	**2,87,92,408**	**2,82,73,102**
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
MOT/DST/DRDO/Others	12,03,09,015	11,56,54,538
Ministry of Textiles - Sponsored CAD Centre	48,82,780	48,82,780
Ministry of Textiles - Centre of Excellence - Meditech	21,01,80,267	21,38,45,815
MOT/Office of the Textile Commissioner - PLSC	5,87,89,828	5,87,89,828
Total	**39,76,85,194**	**39,66,96,265**
Sch - 3		
Reserves & Surplus		
General Reserve	27,39,66,455	24,67,39,317
Asset Stabilisation Reserve	1,91,64,676	3,18,96,843
Research and Development Reserve	12,72,09,344	10,43,73,738
Infrastructure Development and Maintenance Reserve	8,47,65,309	6,65,13,697
Staff Benefit Reserve - SITRA	3,95,90,313	3,46,50,407
Staff Benefit Reserve - PLSC	65,85,816	1,90,84,951
Depreciation Reserve Invt.Interest	17,98,97,361	13,79,50,375
PLSC/CAD Centre Reserve	76,45,664	(60,00,817)
Less: Transferred to Sitra General Reserve	-	60,00,817
Total	**73,88,24,937**	**64,12,09,327**
Sch - 4		
Current Liabilities & Provisions		
Current Liabilities		
Unspent grant		
Unspent grant - SITRA	19,96,538	23,66,072
Unspent grant - COE	1,42,179	4,25,365
Advance from Debtors	1,10,09,843	76,72,235
Creditors for Purchases & Capital Goods	15,56,436	1,45,27,621
Creditors for Expenses	39,41,505	19,83,016
Total (A)	**1,86,46,501**	**2,69,74,309**
Provisions		
Provision for Expenses -SITRA	47,97,737	34,77,693
Provision for Expenses - COE	43,54,786	10,92,796
Provision for Expenses - PLSC	10,53,000	3,62,216
Total (B)	**1,02,05,523**	**49,32,705**
Total (A + B)	**2,88,52,024**	**3,19,07,014**

THE SOUTH INDIA TEXTILE RESEARCH ASSOCIATION

Schedules to Balance Sheet for the year ended 31.03.2021

Amount in "Rs."

Schedules	2020-21	2019-20
Fixed Assets		
Sch - 5		
Gross Assets		
Lands	7,83,712	7,83,712
Building - SITRA	3,87,24,225	3,70,33,494
Building - COE	8,51,76,526	8,51,76,526
Building - WIP	-	9,24,480
Plant and Machinery	18,23,98,614	17,01,59,613
Furniture & Fittings	80,70,032	80,48,192
Computer & Accessories	1,23,76,100	1,10,07,493
Library	33,38,826	32,47,521
Vehicle	15,69,606	14,89,840
Total	**33,24,37,641**	**31,78,70,871**
Sch - 6		
Fixed Assets under Sponsored Projects		
The South India Textile Research Association	7,38,99,162	7,31,53,124
Integrated Skill Development Scheme	2,42,91,138	2,42,91,138
Centre of Excellence - Meditech	22,73,07,341	22,70,02,901
Powerloom Service Centre	5,96,40,203	5,94,10,975
Total	**38,51,37,844**	**38,38,58,138**
Total Gross Block	**71,75,75,485**	**70,17,29,009**
Accumulated Depreciation		
Depreciation Reserve - Building	1,93,11,879	1,94,76,588
Depreciation Reserve - Computer & Accessories	37,17,151	34,22,838
Depreciation Reserve - Furniture And Fixtures	35,21,442	29,59,963
Depreciation Reserve - Plant & Machinery	10,88,41,140	10,06,97,666
Depreciation Reserve - Vehicles	6,42,011	5,77,160
Depreciation Reserve - Library	14,97,077	12,15,173
Depreciation Reserve - ISDS	64,84,319	58,90,247
Total	**14,40,15,019**	**13,42,39,635**
Net Block	**57,35,60,466**	**56,74,89,374**
Sch - 7		
Investments		
Depreciation Reserve Investment - SITRA	23,78,39,625	20,44,22,767
Research and Development Reserve Investment	9,84,28,011	7,86,82,491
Infrastructure Development & Maintenance Reserve Investment	7,28,66,789	5,81,23,267
Staff Benefit Reserve Investment - SITRA	1,93,33,536	1,53,23,787
Staff Benefit Reserve Investment - PLSC	30,63,160	66,87,896
General Reserve Investment - SITRA	8,83,15,607	3,97,31,882
General Reserve Investment - PLSC	76,47,613	59,02,242
Total	**52,74,94,341**	**40,88,74,332**
Sch -8		
Sponsored Projects - Grant Receivable		
As per Schedule	1,63,01,493	2,14,07,108
Total	**1,63,01,493**	**2,14,07,108**

THE SOUTH INDIA TEXTILE RESEARCH ASSOCIATION

Schedules to Balance Sheet for the year ended 31.03.2021

Amount in "Rs."

Schedules	2020-21	2019-20
Sch - 9		
Current Assets, loans, Advances etc		
Sundry Debtors		
Sundry Debtors	78,04,305	76,09,043
Total	**78,04,305**	**76,09,043**
Inventories		
Raw Materials	14,40,480	9,41,643
Finished Goods	11,76,821	10,24,671
Total	**26,17,301**	**19,66,314**
Cash & Bank Balances		
Cash on Hand	90,768	58,091
Cash at Bank	43,01,243	59,70,152
Cash at Bank Sponsored Project	30,49,820	28,65,696
Total	**74,41,831**	**88,93,939**
Loans & Advances		
Deposits - Others	38,57,660	36,73,265
Interest Receivable	3,26,45,197	5,26,64,084
Advances for Purchases and Others	83,62,080	91,02,867
Prepaid Expenses	13,26,140	12,49,759
Balance with revenue authorities (GST)	28,36,649	27,42,696
Tax Deducted at Source	99,07,100	1,24,12,927
Total	**5,89,34,827**	**8,18,45,598**
Grand Total	**7,67,98,263**	**10,03,14,894**

THE SOUTH INDIA TEXTILE RESEARCH ASSOCIATION

Schedules to Income and Expenditure Account for the year ended 31.03.2021

Amount in "Rs"

Schedules	2020-21	2019-20
Sch - 10		
Income from Services		
Testing and Investigation Fee	15,37,50,003	8,91,96,910
HRD Education Receipts	10,29,961	35,78,708
Publication Income	2,37,070	9,12,364
Total	**15,50,17,034**	**9,36,87,982**
Sch - 11		
Membership/Ministry Contribution		
From Ministry of Textiles	1,20,00,000	1,10,00,000
From Membership Contribution	56,00,063	60,37,713
From Technical Service Card Membership Fees	2,98,780	2,72,912
Total	**1,78,98,843**	**1,73,10,625**
Sch - 12		
Sponsored Projects - Overhead Recoveries	5,37,481	7,67,186
Total	**5,37,481**	**7,67,186**
Sch - 13		
Interest Income		
Interest Income from Investment and Advances	54,63,075	30,48,536
Total	**54,63,075**	**30,48,536**
Sch - 14		
Other Income		
Rent Receipts	11,34,483	27,54,775
Miscellaneous Income	34,09,358	24,05,790
Allocation of Expenses incurred by SITRA for PLSC	8,85,841	10,23,192
Allocation of Expenses incurred by SITRA for COE	28,63,229	22,99,149
Total	**82,92,911**	**84,82,906**
Sch - 15		
Changes in Inventories		
Closing Stock of Finished Goods	11,76,821	10,24,671
Less:Opening Stock of Finished Goods	10,24,671	-
Total	**1,52,150**	**10,24,671**
Sch - 16		
Establishment Expenses		
Salary and Other Allowances	7,74,07,291	7,69,64,399
Payment towards Terminal benefits	33,02,782	25,81,309
Sitra Contributory PF and other Funds	53,03,344	56,74,407
	8,60,13,417	8,52,20,115
Less: a) Allocated to Ministry Sponsored Projects	8,19,503	17,06,291
b) Allocatd to Internal Project from Research & Development Reserve	68,500	2,87,150
c) Allocated to SAMARTH Scheme	94,465	-
Total	**8,50,30,949**	**8,32,26,674**

THE SOUTH INDIA TEXTILE RESEARCH ASSOCIATION
Schedules to Income and Expenditure Account for the year ended 31.03.2021

Amount in "Rs"

Schedules	2020-21	2019-20
Sch - 17		
Administrative Expenses		
Travelling Expenses	12,40,871	15,92,683
Printing & Stationery	7,88,275	9,78,171
Publication Expenses	2,76,927	9,78,743
Postage, Telegrams and Telephone Charges	12,53,756	11,84,910
Journals and Periodicals	7,36,750	2,43,163
Electricity Charges	57,94,895	69,87,686
Less: Solar Energy Consumption	(9,20,393)	-
Insurance	7,47,909	6,71,572
Rent, Rates and Taxes	9,52,745	9,54,392
Advertisement Charges	1,44,827	1,01,024
Training Course Expenses	80,916	5,21,332
Conferences, Seminars and Meetings	54,242	10,84,838
Professional Charges	15,71,554	7,20,987
Office Expenses	5,18,149	4,02,802
Testing expenses	3,03,111	6,06,918
Allocation of Expenses incurred by SITRA for COE	28,63,229	22,99,149
Provision for Doubtful Debts & Bad Debts Written off	2,97,460	3,89,674
Total	**1,67,05,223**	**1,97,18,044**
Sch - 18		
Repairs & Maintenance		
Maintenance of Motor Cars and Vehicles	45,713	42,140
Maintenance of Machinery	64,71,703	48,43,660
Maintenance of Building & Staff Quarters	26,47,379	26,61,767
Maintenance of Furniture and Office Equipments	26,489	23,924
Total	**91,91,284**	**75,71,491**
Sch - 19		
Opening Stock of Rawmaterials	9,41,643	-
Add: Purchase of Consumables	61,52,039	56,63,601
Less: Closing Stock of Rawmaterials	14,40,480	9,41,643
Total	**56,53,202**	**47,21,958**
Sch - 20		
Finance Charges		
Bank Charges and Commission	26,977	25,508
Total	**26,977**	**25,508**
Sch - 21		
Sponsored Projects - SITRA Contribution	15,02,230	5,36,599
Total	**15,02,230**	**5,36,599**

Place : Coimbatore
DATE: 25-08-2021

"Vide our report of even date"
For P.N.Raghavendra Rao & Co.,
Chartered Accountants
Firm Registration No:003328S
(Sd/-) Pon Arul Paraneedharan
Partner
M.No:212860

(Sd/-) Sanjay Jayavarthanavelu (Chairman)
(Sd/-) E Sathyanarayana (Vice Chairman)
(Sd/-) Prakash Vasudevan (Director)

THE SOUTH INDIA TEXTILE RESEARCH ASSOCIATION

Schedules to Balance Sheet for the year 2020 - 2021

DEPRECIATION FOR THE YEAR 2020 - 2021

Schedule 22

Amount in "Rs."

S.No.	Name of the Asset	COST				DEPRECIATION				WDV	
		Value as on 01.04.2020	Additions During 2020-2021	Deletion During 2020-21	Value as on 31.03.2021	Depreciation As on 01.04.2020	Deletion During 2020-21	Depreciation for the year 2020-21	Depreciation As on 31.03.2021	Closing W.D.V As on 31.03.2021	W.D.V As on 31.03.2020
1	Land	7,83,712	-	-	7,83,712	-	-	-	-	7,83,712	7,83,712
2	**Library**										
	Library	31,98,733	73,449	-	32,72,182	12,12,154	-	2,79,148	14,91,302	51,93,539	53,99,237
	ISDS - Library	34,12,659	-	-	34,12,659						
3	**Building**										
	Building	**3,62,92,715**	3,00,000	-	3,65,92,715	1,08,48,628	-	4,35,767	1,12,84,395	2,63,11,497	2,67,34,146
	Building WIP	**3,68,188**	73,685	4,41,873	-						
	ISDS - Building Renovation	10,03,177	-	-	10,03,177						
	Auditorium	5,03,235	13,90,732	-	18,93,967	2,28,148	-	12,868	2,41,016	16,52,951	2,75,087
	Dining Shed WIP	5,56,292	-	5,56,292	-						5,56,292
	Staff Quarters	2,37,543	-	-	2,37,543	1,18,862	-	1,935	1,20,797	1,16,746	1,18,681
	COE Building	8,51,76,526	-	-	8,51,76,526	63,78,190	-	12,87,481	76,65,671	7,75,10,855	7,87,98,336
4	**Furniture**										
	Furniture - Sitra	50,74,491	21,840	-	50,96,331	27,75,087	-	1,60,203	29,35,290	46,10,718	47,95,072
	ISDS - Furniture	24,49,677	-	-	24,49,677						
	Sitra Furniture at PLSC	27,685	-	-	27,685	18,398	-	310	18,708	8,977	9,287
	Furniture & Fixtures - SITRA (COE)	26,17,044	-	-	26,17,044	4,26,844	-	73,153	4,99,997	21,17,047	21,90,200
5	**Machinery**										
	Machinery	15,10,09,940	77,44,384	1,11,765	15,90,57,243	7,97,77,630	6,218	58,86,958	8,56,58,370	11,39,53,549	11,18,22,302
	Machinery WIP	-	4,14,687	-							
	Sponsored Projects - Assets	4,05,54,676	-	-	4,05,54,676						
	Machinery-SISPA	-	3,17,252		3,17,252	-	-	1,822	1,822	3,15,430	-
	Sitra Machinery at PLSC	4,33,949	-	-	4,33,949	2,51,116	-	9,416	2,60,532	1,73,417	1,82,833
	Depreciation Reversal - PLSC	-	-	-	-	1,91,56,113			1,91,56,113	(1,91,56,113)	(1,91,56,113)
	CoE Building Electrical Equipments	1,31,46,233	-	-	1,31,46,233	22,63,255	-	3,63,491	26,26,746	1,05,19,487	1,08,82,978
6	**ISDS Assets**										
	ISDS - Machinery	1,34,70,102	-	-	1,34,70,102	45,40,234	-	4,59,888	50,00,122	84,69,980	89,29,868
	ISDS-PSC-Machinery	36,00,001	-	-	36,00,001	12,40,034	-	1,21,538	13,61,572	22,38,429	23,59,967
	ISDS - Machinery Phase II	3,55,523	-	-	3,55,523	1,09,979	-	12,646	1,22,625	2,32,898	2,45,544
7	**Computer**										
	Computer - Sitra	87,21,103	9,92,978	-	97,14,081	34,22,838	-	2,92,886	37,15,724	59,98,357	52,98,265
	ERP WIP	22,86,390	51,180	-	23,37,570	-	-	-	-	23,37,570	22,86,390
	Computer-SISPA	-	3,24,449		3,24,449	-	-	1,427	1,427	3,23,022	-
8	**Vehicles**										
	Motor Cars	13,78,119	-	-	13,78,119	5,24,713	-	60,336	5,85,049	7,93,070	8,53,406
	Motor Cycles & Scooters	1,11,721	79,766	-	1,91,487	52,447	-	4,514	56,961	1,34,526	59,274

THE SOUTH INDIA TEXTILE RESEARCH ASSOCIATION

Schedules to Balance Sheet for the year 2020 - 2021

DEPRECIATION FOR THE YEAR 2020 - 2021

Schedule 22

Amount in "Rs."

S.No.	Name of the Asset	COST				DEPRECIATION				WDV	
		Value as on 01.04.2020	Additions During 2020-2021	Deletion During 2020-21	Value as on 31.03.2021	Depreciation As on 01.04.2020	Deletion During 2020-21	Depreciation for the year 2020-21	Depreciation As on 31.03.2021	Closing W.D.V As on 31.03.2021	W.D.V As on 31.03.2020
9	**COE Assets**										
	CoE Equipment Electrical General	16,25,754	-	-	16,25,755	2,08,507	-	47,337	2,55,844	13,69,911	14,17,247
	Machinery	39,43,736	38,74,443	-	78,18,179	6,25,029	-	2,56,685	8,81,714	69,36,465	33,18,707
	Furniture & Fixtures	3,28,972	-	-	3,28,972	58,410	-	9,037	67,447	2,61,525	2,70,562
	Library	48,789	17,855	-	66,644	3,019	-	2,756	5,775	60,869	45,770
	Sponsored Projects -Assets										
10	UNDP Jute Project Machinery	1,32,01,739	-	-	1,32,01,739	-	-	-	-	1,32,01,739	1,32,01,739
11	Assets under Sponsored Projects - SITRA	1,93,96,709	7,46,038	-	2,01,42,747	-	-	-	-	2,01,42,747	1,93,96,709
12	Assets under Sponsored Projects - COE	22,70,02,901	3,04,440	-	22,73,07,341	-	-	-	-	22,73,07,341	22,70,02,901
13	Assets under Sponsored Projects - PLSC	5,94,10,975	2,29,229	-	5,96,40,204	-	-	-	-	5,96,40,204	5,94,10,975
	Total	**70,17,29,009**	**1,69,56,408**	**11,09,930**	**71,75,75,485**	**13,42,39,635**	**6,218**	**97,81,602**	**14,40,15,019**	**57,35,60,466**	**56,74,89,374**

THE SOUTH INDIA TEXTILE RESEARCH ASSOCIATION

Schedules to Balance Sheet for the year 2020 -2021

Financial Status of Sponsored Projects : 01/04/2020 - 31/03/2021

Schedule 8 & 21

Amount in "Rs."

Sl. No	Name of Sponsored Project	Opening Balance 2020-21		Receipts			Expenditure as at 31.03.2021 Recurring & Non Recurring			Total Expenditure as at 31/03/2021	Balance as at 31/03/2021 IA / SITRA		Balance as at 31/03/2021 MOT	
		Industry	Ministry	MOT/IA Contribution	Revenue/ Appropriation	Total Receipts	Industry	SITRA	MOT		Unspent	Due	Unspent	Due
1	**Ministry of Textile Sponsored Research Projects**													
a	Development of Special wound care Dressing made of PVA/ chitosan	-	(36,221)	-	16	(36,205)	-	-	-	-	-	-	-	(36,205)
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	-	(13,98,490)	-	1,044	(13,97,446)	-	-	-	-	-	-	-	(13,97,446)
c	Design and fabrication of an instrument to evaluate the characteristics of fluid handling capacity of wound care dressings	-	(15,00,916)	-	405	(15,00,511)	-	-	-	-	-	-	-	(15,00,511)
d	Development of a Heat and Moisture Exchange Filter	-	(14,43,776)	-	984	(14,42,792)	-	-	-	-	-	-	-	(14,42,792)
e	Development of Indigeneous Viral Barrier Fabric	(15,00,000)	(11,55,812)	15,00,000	810	(11,55,002)	-	-	-	-	-	-	-	(11,55,002)
f	Development of an Anterior Cruiate Ligaments (ACL) using Textile Materials	-	(14,61,241)	-	1,035	(14,60,206)	-	-	-	-	-	-	-	(14,60,206)
g	Development of Nanoparticle based transdermal patches of selected cardiovascular drugs	-	(12,98,808)	-	865	(12,97,943)	-	-	-	-	-	-	-	(12,97,943)
h	Polyester Vascular Graft Implant- Process Optimization and Production Scale up	-	(18,23,995)	-	3,657	(18,20,338)	-	-	-	-	-	-	-	(18,20,338)
i	Development of Eco Clothing by greener reduction process of Natural Indigo Dye	1,00,340	(4,06,787)	-	291	(3,06,156)	1,00,340	731	1,11,744	2,12,815	-	-	-	(5,18,240)
		(13,99,660)	**(1,05,26,046)**	**15,00,000**	**9,107**	**(1,04,16,599)**	**1,00,340**	**731**	**1,11,744**	**2,12,815**	-	-	-	**(1,06,28,683)**

THE SOUTH INDIA TEXTILE RESEARCH ASSOCIATION

Schedules to Balance Sheet for the year 2020 -2021

Financial Status of Sponsored Projects : 01/04/2020 - 31/03/2021

Schedule 8 & 21

Amount in "Rs."

Sl.No.	Name of Sponsored Project	Opening Balance 2020-2021	Receipts		Expenditure Recurring		Capital -	Total Expenditure As At 31/03/2021	Refunded/Transfer to Reserve	Balance as at 31/03/2021			
			Funds Received during the year	Revenue / Appropriation	IA	MOT	MOT			IA / SITRA Unspent	IA / SITRA Due	MOT Unspent	MOT Due
1	Ministry sponsored powerloom service centre receipts	-	1,14,00,000		75,96,191	1,14,00,000	-	1,89,96,191	-	-	-	-	-
2	Tamilnadu Skill Development Programme Commissioner of Backward Classes	(1,78,780)	-		-	-	-	-	1,78,780	-	-	-	-
3	Samarth - Scheme for capacity building in Textile Sector	1,98,574	4,48,320	-	-	16,11,120	-	16,11,120	-	-	-	-	(9,64,226)
4	International Training Programme	(50,88,792)	41,47,049	-	-		-	-	9,41,743	-	-	-	-
5	**CoE Projects**												
i	Office of the Textile Commissioner												
	a) Development of Collagen coated hernia	(2,40,000)	-	-	-	-	-	-	-	-	-	-	(2,40,000)
	b) Development of Moppings pads using non woven & Woven structure	(2,40,000)	-	-	-	-	-	-	-	-	-	-	(2,40,000)
ii	Design & Development of an instrument to assess the puncture resistance of surgical material by using sharp edged puncture	(7,64,067)	-	974	-			-		-	-	-	(7,63,093)
iii	Development of nanofibrous membrane for wound healing by controlled release of Indian Honey & Curcumin	(2,00,245)		435	-		-	-	-	-	-		(1,99,810)
iv	Dev of Total Comfort Index paradigm for textile structures	(20,00,063)	-	364	-	9,69,564	-	9,69,564	9,644	-	-	-	(29,78,907)
v	Development of Leukodepletion Filter - Sree Chitra Tirunal Institute	1,33,935	-	6,886	33,495		-	33,495	-	1,07,326	-	-	-
vi	Medical Textile products identified by INMAS for wound healing and radio protective equipment based on textiles - DRDO	2,81,786		8,468	-	2,55,401		2,55,401	-	-	-	34,853	-

THE SOUTH INDIA TEXTILE RESEARCH ASSOCIATION

Schedules to Balance Sheet for the year 2020 -2021

Financial Status of Sponsored Projects : 01/04/2020 - 31/03/2021

Schedule 8 & 21

Amount in "Rs."

Sl.No.	Name of Sponsored Project	Opening Balance 2020-2021	Receipts		Expenditure Recurring		Capital -	Total Expenditure As At 31/03/2021	Refunded/ Transfer to Reserve	Balance as at 31/03/2021			
										IA / SITRA		MOT	
			Funds Received during the year	Revenue / Appropriation	IA	MOT	MOT			Unspent	Due	Unspent	Due
6	**SITRA DST & Inhouse Project**												
i	Durable Non-Fluorinated Functional Textiles using Fumed Silica Sols	(2,46,183)		293			-	-	-	-	-	-	(2,45,890)
ii	Field dissemination of technology of high productivity hand operated charkha developed - KVIC	7,11,567		21,324		2,49,126	-	2,49,126	-	4,83,765	-	-	-
iii	Warp Knitted Sewing Ring Fabric - Sree Chitra Tirunal Institute	2,53,226	-		-	2,53,226	-	2,53,226	-	-	-	-	-
iv	Dev of Cost effective and better fastness dyeing methods for production of Kovai Kora Cotton sarees - Dept of Handlooms & Textiles	(1,157)		273	-	40,000	-	40,000	-	-	-	-	(40,884)
v	Others - Grant												
	a) Coir Board	(9,500)	-	-	-	-	-	-	9,500	-	-	-	-
	b) NSTT Project	(3,79,631)	-	-	-	-	-	-	3,79,631	-	-	-	-
	c) National Accredation Lab	(23,000)	-	-	-	-	-	-	23,000	-	-	-	-
vi	Antioxidant Cosmetoextiles durable non encapsulated Vitamin E Finishes on Textile fabrics and its controlled release study	11,02,365	10,90,000	14,490		10,04,006	2,85,000	12,89,006	14,490	-	-	9,03,359	-
vii	Development of breathable, reusable and oxi-biodegradable coverall using biocidal polyester - BRNS		15,93,700	18,185		5,77,471	4,25,000	10,02,471				6,09,414	
		(66,89,965)	**1,86,79,069**	**71,692**	**76,29,686**	**1,63,59,914**	**7,10,000**	**2,46,99,600**	**15,56,788**	**5,91,091**	**-**	**15,47,626**	**(56,72,810)**

Annexure

THE SOUTH INDIA TEXTILE RESEARCH ASSOCIATION

Centre of Excellence Medical Textiles
Balance Sheet as at 31st March 2021

Amount in "Rs."

31.03.2020	LIABILITIES		31.03.2021	31.03.2020	ASSETS		31.03.2021
Rs.		Rs.	Rs.	Rs.		Rs.	Rs.
	CAPITAL GRANT				**FIXED ASSETS**		
21,35,67,864	Contribution from Ministry-Opening	21,38,45,815		22,70,02,901	- Ministry Grant		22,73,07,341
2,77,951	Additions during the year	2,43,932	21,40,89,747	59,47,251	- Others	98,39,550	
				8,94,965	Less: Accumulated Depreciation	12,10,779	86,28,771
				23,20,55,187			
-	Interest Opening balance	-			**CURRENT ASSETS**		
24,064	Add: Earned during the year	33,106		7,36,651	Sundry Debtors		30,29,241
24,064		33,106		15,100	Loans & Advances		15,100
-	Less: Refund to MoT	9,644		21,47,924	Advances for Purchases & others		28,00,179
24,064	Transfer to Various Grant	23,462	-	27,06,119	Bank Balance		9,52,050
-				-	Branch and Divisions		74,09,013
				6,32,270	Balance with revenue authorities		12,15,547
4,25,365	Unspent Grant		1,42,179	1,49,196	Prepaid Expenses		2,12,270
				10,00,000	Investment		30,24,426
	RESERVES & SURPLUS						
-	Depreciation Reserve	1,84,47,618			**Inventories**		
1,15,96,813	Appropriation for Capital Expenditure	1,54,71,256		9,41,643	Raw Material		14,40,480
5,00,000	Staff Benefit Reserve	20,00,000		10,24,671	Finished Goods		11,76,821
	Research & Development Reserve	1,00,00,000					
	Infrastructure Devel.& Maint Reserve	1,05,00,000					
5,19,040	General Reserve	7,80,377	5,71,99,251		**SITRA - RESERVE ADJUSTMENT**		
				1,07,93,256	Asset Stabilization Reserve	1,46,67,699	
	CURRENT LIABILITIES:			9,78,178	Staff Benefit Fund Reserve	12,20,591	
3,89,39,770	Branch & Divisions	-		1,17,590	SITRA Group Gratuity Scheme	4,98,200	
20,70,526	Advance from Customers	45,01,466		9,56,063	Infrastructure & Main. Reserve	9,56,063	
7,41,028	Creditors for Purchases & Capital Goods	4,38,602		5,52,382	Depreciation Reserve	-	
-	Creditors for Expenses	2,49,200		23,86,776	General Reserve	-	
10,92,796	Provision for Expenses	43,54,786	95,44,054	19,99,628	Research & Development Reserve	19,99,628	1,93,42,181
				49,54,019	Sponsored Projects - Grant Receivable		44,21,810
					INCOME & EXPENDITURE ACCOUNT		
				55,84,500	Opening Balance		-
26,97,31,153	**Total**		**28,09,75,230**	**26,97,31,153**	**Total**		**28,09,75,230**

Place : Coimbatore
Date : 25/08/2021

"Vide our report of even date"
For P.N Raghavendra Rao & Co.,
Chartered Accountants
Firm Registration No:003328S
Partner

(Sd/-) Sanjay Jayavarthanavelu (Chairman)
(Sd/-) E Sathyanarayana (Vice Chairman)
(Sd/-) Prakash Vasudevan (Director)

THE SOUTH INDIA TEXTILE RESEARCH ASSOCIATION

Centre of Excellence Medical Textiles

Annexure

Income & Expenditure Account for the year ended 31st March 2020

31.03.2020 Rs.	EXPENDITURE	Rs.	31.03.2021 Rs.	31.03.2020 Rs.	INCOME	31.03.2021 Rs.
	To Opening Stock of Finished Goods		10,24,671			
94,08,493	Establishment Expenses	1,01,37,060		1,28,21,949	Testing & Investigation Fees	8,96,22,192
	Salary for Lockdown period transfer from SITRA	2,06,32,419				
	Payment towards Terminal benfits	3,98,545		8,22,084	HRD Education Receipts	1,24,826
94,08,493		3,11,68,024				
7,68,491	Less : Allocated to Sponsored Projects	4,63,411		16,50,000	Ministry Contribution	18,00,000
	Transfer to Research & Development Reserve					
2,48,050	(Internal Projects)	-				
83,91,952			3,07,04,613	1,05,000	Sponsored Projects - Overhead Recoveries	66,118
21,762	Training Course Expenses		7,080			
6,31,388	Travelling Expenses		1,18,103	33,823	Interest Income	1,18,684
	Opening stock - Rawmaterials	9,41,643				
20,14,169	Add: Stores Consumed-Raw Material	17,98,701		10,24,671	Closing Stock of Finished Goods	11,76,821
(9,41,643)	Less: Closing Stock of Raw Materials	14,40,480	12,99,864			
4,86,945	Stores Consumed		13,81,863			
62,370	Building Repairs & Maintenance		1,77,068			
7,97,434	Maintenance of Machinery		27,45,696			
54,576	Printing & Stationery		2,37,812			
2,83,032	Office Expenses		2,52,671			
8,16,954	Electriciy Charges		9,18,355			
1,89,796	Insurance		1,49,196			
51,703	Postage & Telephone charges		2,36,399			
59,500	Professional Fees		1,96,560			
3,45,989	Testing Expenses		1,68,558			
22,99,149	Allocation of Expenses incurred by SITRA for COE		28,63,229			
4,33,358	Sponsored Projects - IA Contribution		15,01,499			
3,74,402	Depreciation		3,15,814			
84,691	Excess of Income over Expenditure Income for the year c/o		**4,86,09,590**			
1,64,57,527	**Total**		**9,29,08,641**	**1,64,57,527**	**Total**	**9,29,08,641**

INCOME & EXPENDITURE APPROPRIATION ACCOUNT

	Excess of Income Over Expenditure for the year c/o		**4,92,32,613**	**84,691**	Excess of Income over Expenditure for the year b/f	**4,86,09,590**
5,00,000	Transfer to Staff benefit Reserve	15,00,000		2,57,671	Appropriated from Depreciation Reserve-SITRA	-
	Transfer to Research & Development Reserve	1,00,00,000		-	Paid from Sitra Employee Gratuity scheme Fund-SITRA	3,80,610
	Transfer to Depreciation Reserve Invt.Interest	1,90,00,000		2,16,966	Appropriated from Staff Benefit Reserve-SITRA(Exgratia and Encashment Salary)	2,42,413
	Transfer to Infrastructure & Maintenance Reserve	1,05,00,000				
59,328	Transfer to General Reserve	82,32,613				
5,59,328			**4,92,32,613**	**5,59,328**		**4,92,32,613**

Place : Coimbatore
Date : 25/08/2021

"Vide our report of even date"
For P.N Raghavendra Rao & Co.,
Chartered Accountants
Firm Registration No:003328S
(Sd/-) Pon Arul Paraneedharai
Partner

(Sd/-) Sanjay Jayavarthanavelu (Chairman)
(Sd/-) E Sathyanarayana (Vice Chairman)
(Sd/-) Prakash Vasudevan (Director)

Annexure

THE SOUTH INDIA TEXTILE RESEARCH ASSOCIATION

Ministry of Textiles Sponsored Powerloom Service Centres

BALANCE SHEET AS AT 31st March 2020

Amount in "Rs."

31.03.2020	LIABILITIES		31.03.2021	31.03.2020	ASSETS		31.03.2021
Rs.		Rs.	Rs.	Rs.		Rs.	Rs.
	CONTRIBUTION FROM GOVERNMENT AND GOVERNMENT DEPARTMENTS	5,87,89,828		5,96,83,580	**FIXED ASSETS (AT COST)**		5,99,12,808
5,87,89,828	Add: Interest received from MOT funds	-	5,87,89,828	59,02,242	**Investments**		76,47,613
					ADVANCES AND DEPOSITS		
(78,74,387)	**PLSC/CAD CENTRE - GENERAL RESERVE**		55,42,865	11,63,782	Sundry Deposits	11,63,782	
				1,77,937	Advances for Purchase & Others	95,610	
							12,59,392
	STAFF BENEFIT RESERVE APPROPRIATION FOR TERMINAL BENEFITS						
1,19,85,696	**Opening Balance**	1,23,97,055					
	Less: Excess Provision Reversal	(36,59,314)			**CURRENT ASSETS**		
5,00,000	Add: Transfer of Balance Surplus	25,00,000		24,976	Cash on Hand	46,875	
(88,641)	Less: Staff Terminal Benefit Apportioned for the year	-					
1,23,97,055	Less: Amount transferred to LIC Group Gratuity Scheme	(78,25,525)	34,12,216				
				6,39,020	Cash at Bank	19,23,715	
	PSC RESERVE APPROPRIATION FOR CAPITAL EXPENDITURE						
	Opening Balance	18,73,570					
18,73,570	Add: Current year Utilisation	2,29,229	21,02,799	1,78,780	Grant Receivable	-	
				1,49,488	Sundry Debtors	27,606	
					Branches & Divisions	3,13,981	23,12,177
	CURRENT LIABILITIES						
5,67,324	Creditors for Purchases and Capital Goods	1,96,789					
-	Provision for Expenses	10,53,000					
61,896	Advances Received from Customers	34,493					
21,04,520	Branches and Divisions	-	12,84,282				
6,79,19,806	**Total**		**7,11,31,990**	**6,79,19,806**	**Total**		**7,11,31,990**

Place : Coimbatore
Date : 25.08.2021

"Vide our report of even date"
For P.N.Raghavendra Rao & Co.,
Chartered Accountants
Sd/- (Pon Arul Paraneedharan)
Partner

(Sd/-) Sanjay Jayavarthanavelu (Chairman)
(Sd/-) E Sathyanarayana (Vice Chairman)
(Sd/-) Prakash Vasudevan (Director)

THE SOUTH INDIA TEXTILE RESEARCH ASSOCIATION
Ministry of Textiles Sponsored Powerloom Service Centres

Income & Expenditure Account for the year ended 31st March 2021

Annexure

Amount in "Rs."

31.03.2020	EXPENDITURE		31.03.2021	31.03.2020	INCOME		31.03.2021
Rs.			Rs.	Rs.		Rs.	Rs.
1,20,73,166	Salaries	1,14,89,077		1,14,00,000	Revenue Grant from Ministry		1,14,00,000
-	Less: Samarth Scheme	5,89,881	1,08,99,196				
1,20,73,166							
38,47,069	General office expenses		36,78,296	91,61,396	Income from Services		1,60,43,123
	Rent, Rate & Taxes	33,67,259					
31,74,635	Less: Samarth Scheme	3,17,467	30,49,792				
				1,81,766	Interest on Bank and other deposits		2,19,015
83,105	Spares, store & Consumbles		1,44,066				
9,63,300	AMC/Maintenance of Equipement		12,24,841				
6,01,887	Excess of Income over Expenditure for the year c/o		86,65,947				
2,07,43,162	**Total**		**2,76,62,138**	**2,07,43,162**	**Total**		**2,76,62,138**
				6,01,887	Excess of Income over Expenditure for the year b/f		86,65,947
9,59,097	**Balance Surplus**		86,65,947	88,641	Appropriated from Staff Benefit Reserve - Provision for Terminal Benefits-PLSC		0
5,00,000	Transfer to Staff Benefit Reserve - PLSC		25,00,000	2,68,569	Appropriated from Staff Benefit reserve for payment of Terminal Benefits - SITRA		0
4,59,097	Transfer to PLSC/CAD Centre Reserve		61,65,947				
9,59,097			**86,65,947**	**9,59,097**		**0**	**86,65,947**

"Vide our report of even date"
For P.N.Raghavendra Rao & Co.,
Chartered Accountants
Firm Registration No:003328S
(Sd/- Pon Arul Paraneedharan)
Partner

Place : Coimbatore

Date : 25.08.2021

(Sd/-) Sanjay Jayavarthanavelu (Chairman)
(Sd/-) E Sathyanarayana (Vice Chairman)
(Sd/-) Prakash Vasudevan (Director)