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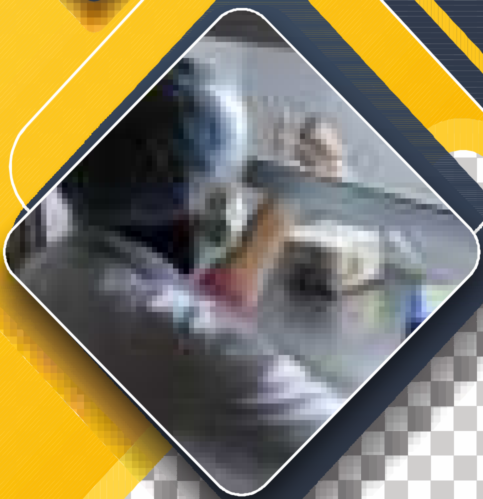

ANNUAL REPORT 2018-19

THE BOMBAY TEXTILE RESEARCH ASSOCIATION

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BTRA Annual Report (2018-2019)

MEMBERS OF THE GOVERNING COUNCIL

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We have great pleasure in presenting the 65th Annual Report of The Bombay Textile Research Association (BTRA). It highlights the R & D and other activities of BTRA and also presents the Audited Statement of Accounts for the year ending 31st March 2019.

1. INTRODUCTION

BTRA has been associated with the textile industries for more than five decades. It has been a great journey for BTRA to develop various products, providing solutions to technical and techno-economic problems regarding- Quality, Machine Production, Machine Maintenance, Manpower Complement, Quality Systems, etc. through shop-floor Investigations in spinning, weaving and chemical processing areas.

BTRA provides services to the textile industries all over India in four main domains- (i) Research and Developmental work for new products/ processes; (ii) Testing (iii) Consultancy and (iv)Training

The resources of BTRA have been, from the very beginning, efficiently deployed in such areas where maximum benefits accrue to the textile industry. R & D activities at BTRA cover applied and basic research, process and product development, new and frontier areas of technology, operational studies to improve and standardize mill working, testing and consultancy services, energy conservation, etc.

The main area of research has been in developing sustainable technologies, focussing on use of Plasma, Electron Beam and Conductive polymer fabrics. These are aimed to produce Technical textiles which have great demand in national and international markets. BTRA has testing laboratories which are accredited by NABL as per ISO 17025. Since we have experts in the areas of weaving and chemical processing, consultancy is provided to mills. BTRA conducts training and development activities regularly in textile manufacturing processes and testing of textiles. It offers need based training programmes, refresher courses, basic courses to executives (from marketing), students, shop-floor technicians/operators and seasoned technocrats. BTRA also conducts training program in weaving, various textile processing methods and Eco management.

BTRA also encourages its scientists to publish in peer review journals and participate in conferences for showcasing the high quality research work. BTRA also has its own publication BTRA Scan where scientists contribute their articles as well. Thus BTRA can be said to have both academic and industrial linkages, benefitting the textile industry. Commercialization of developed technologies is another very important activity at BTRA.

BTRA has been working on many thrust areas and a glimpse of some of the work carried out during the period under review is briefly highlighted as follows.

Overview

- **On-going sponsored projects -** The number of on-going sponsored projects is seven (including one completed project) for the period under review. Details are as follows.

- ✓ In 'Adhesion improvement for coated textiles by atmospheric plasma treatment' project, an adhesion study was carried out on 100% polyester fabric. Effect of plasma treatment parameters vis. treatment time and plasma power on adhesion properties of plasma treated and PU coated polyester fabrics was analysed using T-peel off method. Changes in wettabillity, surface chemical composition, surface morphology, and bulk properties were studied using capillary height measurement, XPS, SEM, tensile and tear strength measurement respectively. Results of T-peel off test showed that with the increase in plasma exposure time there is significant improvement in adhesion strength. Wicking height measurement showed improved wettability of plasma treated samples. XPS results showed the incorporation of carboxyl and ester groups which are mainly responsible for increased hydorphilicity and improved adhesion strength. SEM images of plasma treated fabric samples showed the surface roughness. Tensile and tearing strength of the plasma treated polyester sample remain unchanged without affecting the desired bulk properties.

- ✓ Project on 'Analysis of Eco Management in Indian textile Industry' - The Indian textile industry is one of the largest textile industries in the world. Textile industry has a heavy impact on the environment as the current practices are unsustainable; and companies, environmentalist and consumers are looking at strategies for reducing the textile carbon footprint. This an awareness cum assessment project to minimize environmental issues in small scale industries and medium scale industries. The textiles sector can benefit by making improvements targeting resource efficiency, process improvements, energy efficiency and reduced negative environmental impacts. By employing appropriate technologies, both environmental and economic gains can be achieved. BTRA audited 28 textile processing houses for Eco-management awareness and its implementation in their units. Analysis is being done for ETP, boiler flue gas emissions, noise level, chemical management system and utility / energy conservation practices. Effluent samples (both inlet and outlet) were also collected for their characteristic analysis. Based on the outcome, BTRA organized training in ETP, water recycling & sustainable technology for textile industry technicians.

- ✓ Project on 'Development of electronic servo control drive industrial TFO twister for heavy denier filament yarn' – The drawback of conventional gear drive TFO twisters is high energy consumption, difficulty in maintaining lower twist level in industrial yarns, etc. BTRA, in collaboration with Kristeel Shinwa Industries Ltd fabricated a TFO machine with servo controlled drive that saves power to the extent of 39% as compared to the conventional gear drive machine.

- ✓ Project on 'Development of cotton waste based oil absorbent for oil spill clean-up'-The objective of this project is to develop a super oleophilic and super hydrophobic cotton waste based oil sorbent for oil spill clean-up in land, water surface and under water. Waste cotton generated from blow room, carding, in textile mills was cleaned, pre-treated and processed through carding, needle punching and made to a non woven fabric of about 200 GSM. Utilizing waste material to a sustainable, value added product was the main mile stone of this project work. The non woven fabric was chemically modified by using various techniques. The chemically modified sorbent exhibits bi functional property of super oleophilic and super hydrophobic. Oil absorption property of the sorbent was found to be 25-30 times of the weight of material and contact angle with water was found to be more than 150^{o}. Since cotton is biodegradable as compared to synthetic materials like polypropylene, the material is eco-friendly.

- ✓ Project on 'Nanofibre Application to Enhance the Anticlogging properties of Geotextiles' - If the pore size of geo-filter is larger than the fine soil particle, too many fines could reduce the discharge capacity and increase the filter resistance. The smaller but apparent pore size is needed to prevent clogging. Deposition of thin nanofibrous web with small pore size on geotextile can help to reduce this problem. Electrospinning is an efficient and versatile technique to obtain fibers with very small pores and diameters ranging from several microns to tens of nanometers. In this project, Nylon 6 polymer is selected for the spinning of nanofiber and deposit the same on the surface of spunbonded polypropylene to minimize the pore size and improve the anticlogging properties of geotextle. Required spinning parameters are standardized for Nylon 6 to get the smaller diameter fiber in the needleless electrospinning machine with wire electrodes. Deposition time is also standardized to obtain the required pore size of the nanofiber mat. Nanofiber deposited filter fabric is tested in presence of soil for longer duration. There was no intrusion of fines into the fabric and steady water flow was observed throughout the duration.

- ✓ Project on 'Melt spinning of PVDF/ZnO nanostructure hybrid filament for wearable smart textile' - Among the different types of smart materials, piezoelectric materials are the most widely used due to their fast electromechanical response. Zinc oxide is a piezoelectric material and its high aspect ratio nanostructure shows excellent piezoelectric properties. PVDF (Poly vinylidenefluoride) also shows good piezoelectric property. Under this project, synthesis of ZnO nanorods is done successfully and melt-blended with the PVDF in different percentages. The PVDF/ZnO compounded polymer was melt spun into filaments and drawn to achieve high beta crystals. Fabric is prepared out of those filaments and analysed. The voltage generation was found to be 22% more as compared to PVDF sample.

- ✓ Project on 'Development of Test Method for Analyzing Hexavalent Chromium (Cr+6) Content in Dyes, Pigments and Textile Auxiliaries' - The Objective of this project is to develop a test method for analyzing Cr(VI) content in dyes/pigments/auxiliaries at trace levels. As at present, there is no standard validated test method for analyzing Cr(VI) in dyes. In this R&D project we have successfully developed one test method for estimation of Cr(VI) in water insoluble dyes/pigments and three test methods for water soluble dyes by using chromatographic technique, where Cr(VI) can be very well segregated from interfering dye chromophores. All the developed test methods have been validated as per the international validation protocol. As a part of commercialization, the test methods have been submitted to BIS to formulate a national standard.

- ✓ Under the project 'Studies on performance enhancement of textile effluent treatment plant by electron beam method', simulated industrial effluent samples of desizing, scouring, dyeing and printing processes were prepared separately and allowed to pass through conventional biological treatment and E-beam treatment followed by activated sludge process to check its comparative performance. Efficiency of biodegradation was measured in terms of COD and BOD reduction. The results of the study indicate that, E-beam treatment improves the biodegradability of all kinds of textile wastewater (except printing effluent) for an activated sludge process. Overall E-beam treatment followed by biodegradation process improves the performance of textile wastewater treatment plant. Heavy metals removal from industrial effluent can also be achieved with electron beam irradiation. Related work is included in this report.

❖ Product Development Assistance to the industry

- ✓ In needle-punch nonwoven and hydro-entanglement pilot plants, 17 samples were developed for applications such as thermal insulation, viscose spun lace, etc.
- ✓ In the pilot plant of Technical Textiles Weaving, 29 samples (of 15 m in length) were developed for applications such as tyre cord and filter fabric

❖ Calibration, Technical Services and Training

- ✓ BTRA calibration laboratory received accreditation from NABL as per ISO/IEC 17025:2005 standards for Mass, Balance and Volume. BTRA is ready to provide calibration services to other NABL accredited testing laboratories for Mass, Balance and Volume parameters.

- ✓ BTRA undertakes extensive liaison and consultancy services to solve problems of quality, maintenance, productivity, water / energy conservation, etc., at various levels from time to time. Also, special studies such as vendor selection, valuation of fixed assets, manpower planning, etc. are undertaken for the mills. For the period under review, BTRA provided services in the areas of Accredited partner audits, boiler efficiency audit, Verification of EPI, PPI and Width of fabric on loom and on table, etc.

- ✓ BTRA conducted several training programmes at the mills' premises covering subjects such as Technology Upgradation, Quality Control and Value Addition for chaddar manufacturers, Fabric Inspection, Size Application and Evaluation, Cuprammonium fluidity test and Good Work Practices & Utility Conservation. Also, BTRA imparted training (theory and practical) at the testing laboratories/pilot plants covering subjects such as Technical Textiles (Geotech), Textile Terminology and Processing, Yarn testing and sizing, Sizing and Testing, Mechanical & Chemical Testing and General elements of textiles. Total number of personnel trained; during the period under review were 240.

❖ **Others**

- ✓ Under Centre of Excellence for Geotech, BTRA soil mechanics laboratory has started its testing activity. It undertakes 13 soil classification and other related soil tests for the industry.

In a nutshell, research and development and consultancy activities at BTRA were directed towards innovative product / process or test method development and providing essential database for the industry. In the years ahead, BTRA will strive to make its mark in the areas of technical textiles, utility conservation, plasma and application of nanotechnology.

2. ON-GOING SPONSORED PROJECTS

2.1 Studies on effect of plasma treatment for adhesion improvement of coated technical textiles

Abstract: Effect of plasma treatment on PU coating adhesion with PET fabric was studied. Plasma treatment of polyester fabric was done at various treatment time and plasma power. Adhesion strength of coated fabric was evaluated by T-peel off test. It was observed that plasma treatment time and power were the important parameters to improve the coating adhesion. Surface wettability, surface morphology, chemical composition and bulk properties of plasma treated and untreated fabric was analysed using capillary rise, SEM, AFM, XPS and tensile and tear strength measurement respectively. Results showed that after plasma exposure, wettability of fabric was improved, surface became very rough and surface chemical groups such as C-O, C-OH, O-C=O, COOH were introduced after plasma treatment and desired bulk properties remain unaffected.

2.1.1 INTRODUCTION

Over the past decade, non-thermal plasma processes involving low pressure plasma as well as atmospheric pressure plasma for modification of the surface properties of the polymeric materials has gained lot of importance. Recent development in the plasma treatment of textile materials has revealed that it has an enormous potential as an alternate technology for the textile processing in terms of cost saving, water saving and ecofriendliness.

Polyester is a commonly used polymer in commodity production due to its special chemical properties and physical characteristics. In the methods of making coated products with the use of polyester fibres, serious drawbacks of this polymer are the low surface energy and hydrophobic surface, which result in weak molecular interactions between the coating polymer and polyester. The surface energy of polyester material can be tailored by creating new functional chemical groups on the material surface by using non thermal plasma technology.

In this study, atmospheric pressure plasma was used for the surface modification of 100% polyester fabric for adhesion improvement with PU coatings.

2.1.2 Experimental

2.1. 2.1 Materials and methods

A plain (1X1) woven polyester fabric with an area weight of 100 g/m2 was plasma treated on atmospheric pressure plasma reactor. Optimisation of the plasma process parameters was carried out by varying the plasma power and treatment time. Six different samples were treated with power of A, B, C and treatment time at D, E, F. Helium gas was used for generation of plasma. Plasma treated polyester fabrics was coated with polyurethane (commercial name: TUBICOAT MP SP) with knife over roller coating method using hand coating machine.

2.1.2 Characterization techniques

2.1.3.1 Wicking measurement

The rate of vertical capillary rise on plasma-treated samples was measured using the method described in ISO 9073-6; 2000 (E). Test specimen strips were suspended vertically in the liquid and checked for the increase in the capillary height at predetermined time intervals up to 20 min.

2.1.3.2 Adhesion strength test

The peel bond strength test was employed to measure the adhesion strength of coated fabrics according to the IS 7016 part 5- 2011 test standard with a Tinius olsen, peel bond tester. Five different measurements were performed and average value was considered as bond strength of the coated fabric.

2.1.3.3 Surface morphology by SEM and AFM

Surface topographical modifications in the polyester samples before and after plasma treatment were investigated by scanning electron microscopy (SEM) on JEOL SEM model JSM 5400 (Tokyo, Japan). Atomic force microscope (AFM), Oxford instrument, Asylum MFP 3D model, used to analyse microstructure of the plasma treated samples.

2.1.3.4 Chemical analysis by X-ray photoelectron spectrometry (XPS)

Surface chemical composition of the polyester fabric before and after plasma treatment was analyzed by XPS spectroscopy. XPS studies were performed by using ESCA+, (omicron nanotechnology,
Oxford Instrument Germany) equipped with monochromator Aluminum Source.

2.1.3.5 Mechanical properties

Tensile strength of the untreated and plasma treated samples were carried out on pyramid tensile testing machine (model Tinius olsen H50KL). ASTM D 5035 -2015 standard test method was used. Average of the five test specimens was considered as the tensile strength of the fabric. Elmendorf tear strength was performed as per ASTM –D 1424-2013 standard test method.

2.1.4 Results and Discussion

2.1.4.1 Wicking Measurement:

Plasma treatments are known to impart desired properties depending on gas/ monomer used. In this experiment, helium is used for plasma treatment of polyester fabric. Therefore, change in hydrophilicity is measured using capillary method. The height of capillary rise was recorded for different wicking durations up to 20 mins for plasma treated and untreated fabrics. The value of capillary height recorded for predetermined time for both untreated and plasma treated samples is plotted against the wicking time.

Figure 1 shows the changes in wicking height of the samples treated with plasma under different plasma exposure time. It can be observed that, after plasma treatment, the wicking height of the polyester fabric is increased significantly with increased in plasma treatment duration. From fig. 1 it may be concluded that, Plasma processing of sample AE is optimum to get maximum

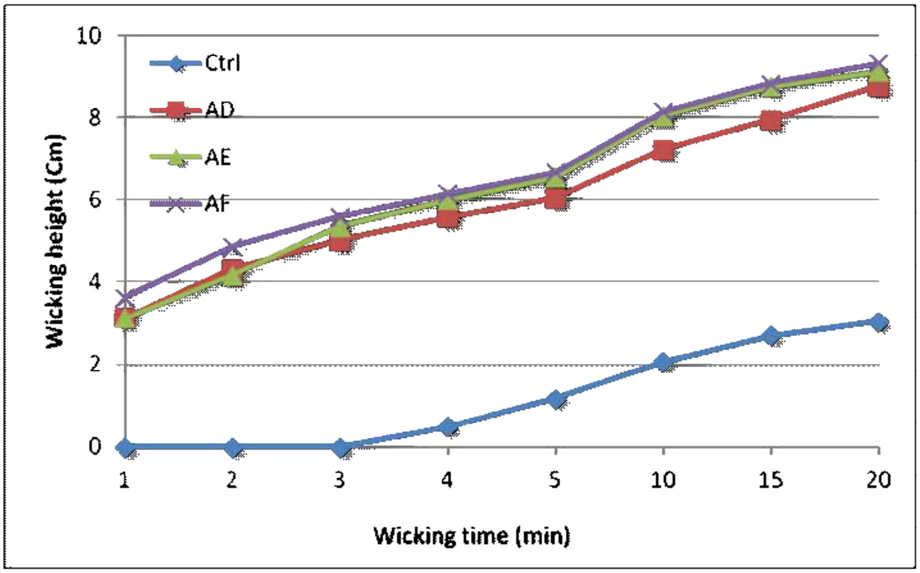


Figure 1 Effect of plasma treatment time on wettability of polyester fabric

wettability. Similarly, plasma power of B was found to be optimum for maximum improvement in wicking height.

2.1.4.2 Adhesion strength

Force acting between two layers of materials to keep them together is called adhesion. Adhesion force between the polyester fabric and PU coating was measured as peel off strength and is given in Fig. 2. The adhesion bond strength of plasma treated coated samples showed 30 -80 % increase compared to the untreated coated sample. Plasma power of A and plasma time of F was found to be optimum to get maximum improvement in adhesion strength. Increase in adhesion strength may be attributed to better wetability of the plasma treated samples. Further, saturation of the plasma species at longer plasma treatment duration and higher power was observed which results in no improvement in adhesion force of the treated fabrics.

2.1.4.3 Surface morphological analysis by SEM and AFM

Morphological changes on the surface after helium plasma treatment can be observed (fig. 3B). The untreated (fig. 3A) polyester has smooth and clean surface, while plasma treated fabric shows rougher surface. It is clear that helium plasma treatment etched the surfaces. Morphological alteration of the polyester surface might lead to improved mechanical adhesion by providing better interlocking due to the roughening effect.

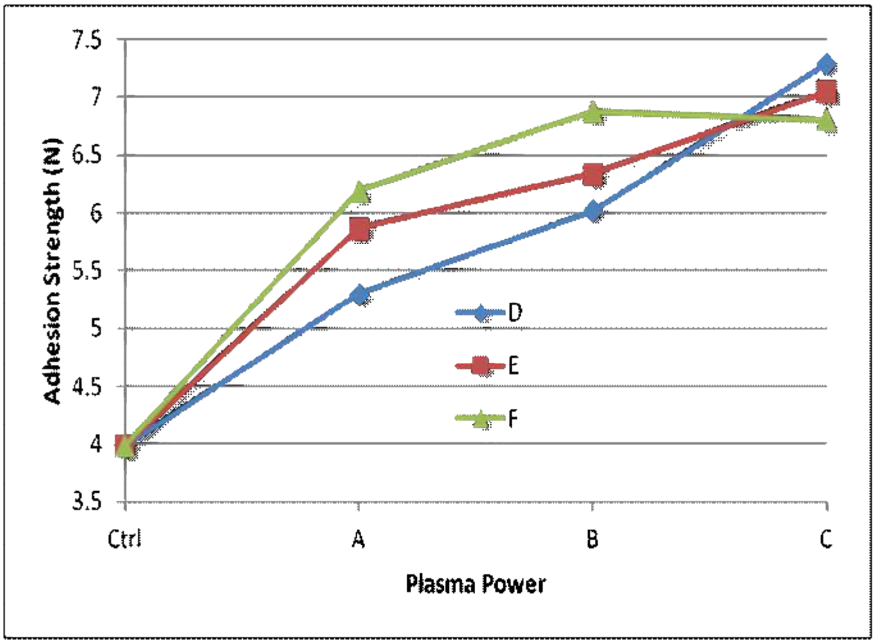


Figure 2. Effect of plasma treatment on the adhesion properties of polyester coated samples

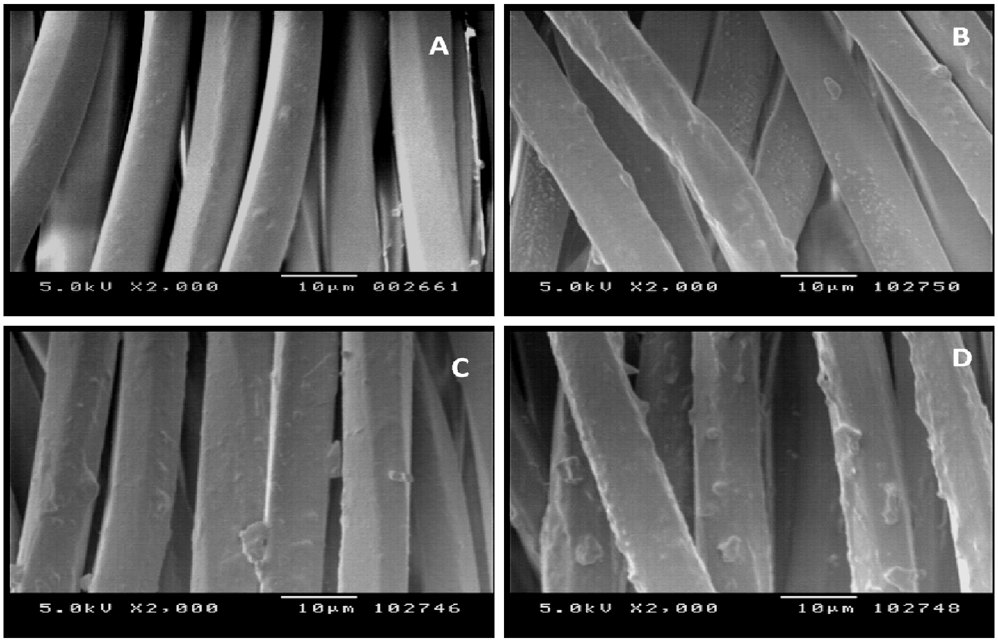


Figure 3 : SEM images A- Untreated, B- Plasma treated, C- Untreated coated surface view after peel off, D- Plasma treated coated surface view after peel off.

Figure 3-C, shows the smooth and clean surface of untreated coated polyester fabric after peel off testing. Smooth surface after removal of coating layer suggests that there is no bonding between the polymer and fabric, hence the coating polymer peels off easily and bond failure is at the interface between adherent and adhesive. On the other image (fig. 3 D) of plasma treated coated sample after peel off shows a considerable amount of PU film is left on the fabric surface. This shows that the failure is within the adhesive.

Surface roughness was quantitatively measured using 3D images of AFM. RMS values for untreated and plasma treated samples are given in table 1 and images are shown in figure 4 A & B. It is clearly observed that the surface become rough after plasma treatment. This rough surface is mainly responsible for improved adhesion by providing mechanical interlocking between adherent and adhesive.

Table 1 : RMS values (in nanometers) of the untreated and plasma treated PET

Sample Name	Root Mean Square (RMS)	Roughness % increase
Untreated PET	5.778	
Plasma Treated PET	24.578	425

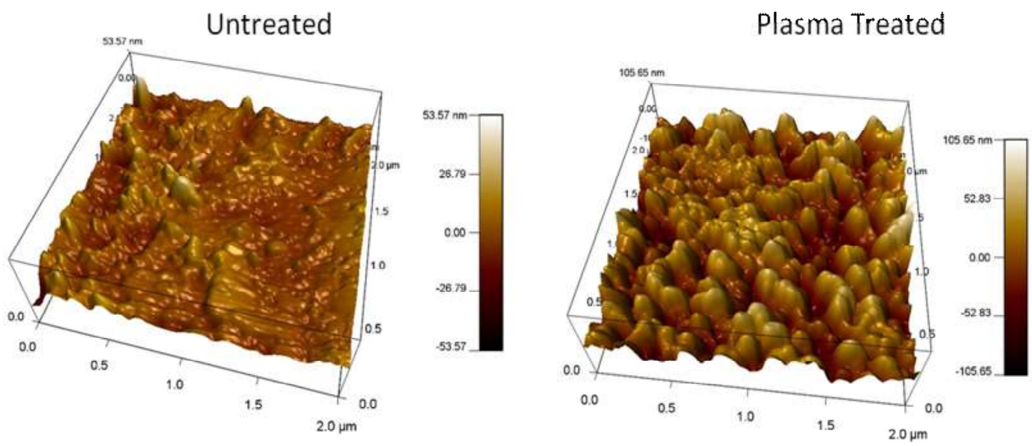


Figure 4 AFM images of untreated and plasma treated PET fabric.

2.1.4.4 Chemical analysis by X-ray photoelectron spectrometry (XPS)

Deconvolution analysis of high resolution C1s spectra of the XPS is carried out using CASAXPS software and atomic concentration of the functional groups on sample surface is given in Table 2.

Table 2 XPS data analysis of high resolution C1s spectra

Sample	Relative area of different chemical bonds (%)		
	C – C and/or CH (285eV)	C–O and/or C–OH (286.5eV)	O–C═O and/or COOH (289eV)
Untreated	80.09	10.75	9.16
Plasma treated	58.51	24.58	16.91

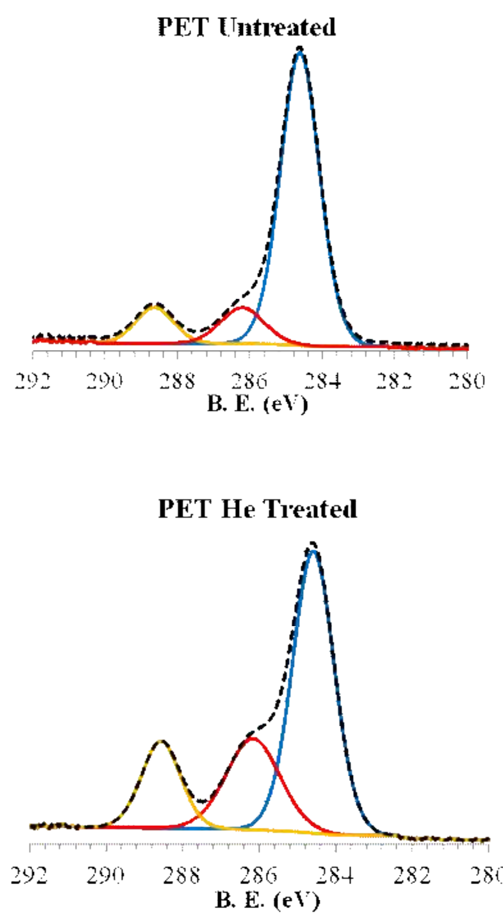


Figure 5 Deconvolution spectra of XPS analysis of untreated and plasma treated PET fabric

Peak of the untreated polyester is composed of three main components: C–C or CH group which corresponds at 285 eV and C–O and O–C═O groups referent at 286.5 eV and 289 eV, respectively. After performing a treatment using helium gas atmospheres it is possible to observe that the peak intensity regarding C–C and CH groups decreased while the peaks intensity referents to carboxyl and ester groups increased compared with the untreated sample. The variation of the relative area is presented in the Table 2 where a reduction in the relative area of C–C and CH group after the treatment with He can be noticed, whilst the relative area of C–O and COO groups increased. These results evidence surface modification in some C–C and CH groups that have been oxidized forming C–O and O–C═O. These increased concentration of C-O and O-C=O are mainly responsible for increased in hydrophilicilty improvement and increased bonding strength.

2.1.4.5 Mechanical properties

The effect of plasma exposure time and discharge power on the tensile properties of polyester fabric was evaluated in warp direction and depicted in Fig. 6. The initial tensile strength of untreated polyester fabric was 19.3 N/mm. After plasma treatment the strength was slightly increased up to 19.8 N/mm. This may be due the surface roughness created after plasma treatment. The rough surface increases the cohesion between fibres and improves the strength. When statistic test ANOVA was applied to check the significance, no significant change in tensile properties was seen as plasma is a surface modification technique and does not affect the bulk properties of the textile materials.

It can be concluded from the Table 2 that plasma treatment does not alter the tearing strength of the polyester fabric as it only modifies the surface at top layer up to few nano meters and bulk properties remain unchanged.

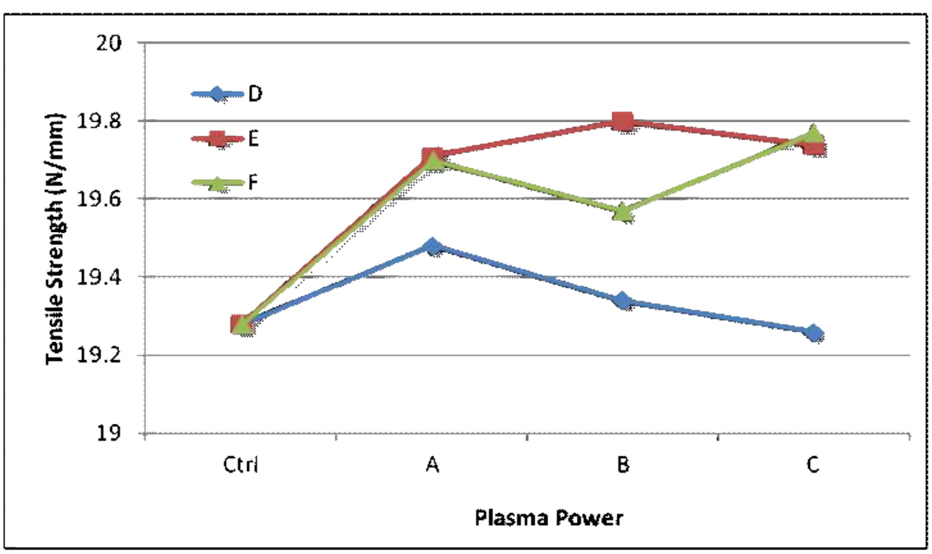


Figure 6 Tensile strength of the polyester fabric, effect of plasma treatment time. Tearing strength of untreated and plasma treated polyester fabric is given in Table 3.

Table 3. Tearing strength (N) of the polyester fabric.

Sample	Plasma treatment time in sec.		
	D	E	F
ctrl	23.99	23.99	23.99
Power A	23.58	22.98	23.14
Power B	23.76	22.26	22.15
Power C	23.1	22.61	22.89

2.1.4.6 Conclusions

Plasma treatment of 100% polyester fabric was carried out at atmospheric pressure plasma using helium gas. Wicking height measurement showed the improved wettability of the plasma treated samples. SEM images of the plasma treated fabric samples showed the surface roughness. Surface roughness was quantitatively measured using AFM. Plasma treated fabric was coated with PU polymer and adhesion force between the fabric and coating was measured by peel bond test. It was observed that with increase in plasma exposure time, there is significant improvement in peel bond strength. XPS results showed the incorporation of the carboxyl and ester groups which were mainly responsible for the increased hydorphilicity and improved adhesion strength. Tensile and tearing strength of the plasma treated polyester samples remain unchanged without affecting the desired bulk properties.

2.2 Analysis of Eco-management in Indian Textile Processing Industry

As we know that the different stages of cotton processes like scouring, bleaching, Mercerizing, dyeing, printing and finishing use hazardous chemicals like dyes, auxiliaries and energy to prepare fabric. These processes and chemicals used which eventually create water ,air pollution and solid waste. To overcome this situation, an awareness and responsibility of the company towards ecosystem is a must. The Bombay Textile Research Association (BTRA) takes this opportunity with the help of the Ministry of Textiles (MOT) through this project to create awareness in small and medium scale industries towards environmental issues.

The project focuses on the following:-

- Analysis of current status of awareness regarding environmental protection in textile Industries.
- To understand chemical management system in textile mills and create awareness about harmful effects of restricted substances on human and aquatic life.
- Encourage textile mills to adopt environmental policy, conduct environmental review and introduce environmental Programme.
- Defining problems faced by industry regarding environmental protection.
- Developing recommendations and to provide best practice guidelines for improvement in the Environment Management System.

2.2.1 Current status

Till the end of March 2019, we audited 28 textile processing houses for eco management awareness and eco-management implementation in their units. Analysis is being done for ETP, boiler flue gas emissions, noise level, chemical management system and utility/energy conservation practices. Also, 12 units were reviewed for the improvement in the eco management system. We have collected effluent samples (both inlet and outlet) for its characteristic analysis. This project will be completed by Sept 2019.

2.2.2 Improvement support given by BTRA Mumbai to the mills

Based on the outcome of the audit in the first round, to improve the awareness and implementation of the Eco-management system of the participated mills, the project team has taken efforts through the following supporting activities,

1. Mill wise process mapping and environmental aspect and impact sheet were prepared and given to the concerned mills. The prioritization of significant environmental aspects was prepared by considering the various factors such as, the severity of impact on the environment, the probability of occurrence, legal and regulatory requirement, risk and nuisance.
2. For the awareness of Eco-management system requirement and implementation, BTRA team provided information related to Environment management system (EMS) to the participating mills. It contains EMS manual preparation template, templates for preparation of environmental procedures and list of records required for EMS.
3. The inlet and outlet effluent samples were collected during the visit and the samples were tested at BTRA laboratory. The test results for the collected samples were shared with the concerned mills so that corrective action could be taken by them.
4. Meanwhile, for the betterment of the Eco-management, conservation of water and energy, we provided information on the best available techniques (BATS) related to the textile processing. These BATS contains the information on Best management practices related to manpower training, maintenance of machines and technical equipment in production, chemical storage, handling, dosing and dispensing, improved knowledge of raw material being used, minimization and optimization of chemicals used.
    - ✓ Water management with the sustainable effluent treatment system
    - ✓ Off-gas management and air pollution reduction
    - ✓ Solid waste management
    - ✓ Energy saving
    - ✓ Utility(steam generation and distribution, electricity, air and water) conservation
    - ✓ Textile Processing techniques for sizing, desizing, singeing,

scouring, bleaching, mercerization, dyeing, printing and finishing.

- ✓ Proper selection of chemicals, dyes and auxiliaries, etc.

2.2.3 Furthermore, a conference was held on 27th April 2018 at BTRA Mumbai on "sustainable Eco-management system in the Textile processing industry". In this program, speakers from well-known textile industries as well as BTRA technical staff were involved in knowledge sharing with industry leaders as well as other technical staff from the mill. The book of papers was published at the time of the conference.

2.2.4 BTRA project team designed and organized the in-depth training program on " ETP, water recycling & sustainable technology" with certification for cleaner production with correct treatments in ETP designed for Environmental officials of the textile mills. The training program inauguration function was held on 20th Aug 2018. The handbooks on ETP, water recycling & sustainable technology and analysis of wastewater & restricted substances were published during this inaugural function.

This in-depth training program for ETP, water recycling & sustainable technology was based on the need and outcome of the studies under this project. One of the objectives of this training program is to develop skills and bring awareness with a focus on water effluent treatments, water recycling activity and final impact of the pollution on the eco-system. It is worth noting that "National Environmental Engineering Research Institute" (NEERI) and "Maharashtra Pollution Control Board" (MPCB) have given full support by authenticating the certification course.

2.3 Development of electronic servo control drive industrial TFO twister for heavy denier filament yarn

2.3.1 Abstract

Two for one twister (TFO) is the machine for plying of both spun yarn and filament yarns. This twister is advantageous for the production of long length knot free yarns and higher productivity. In this invention, TFO twister has been designed with individual drive to traverse, take up and spindle. Drives to the traverse mechanism consist of servo motor control mechanism. Total gear drive mechanism is replaced with simple driving mechanism in the developed machine compared to conventional TFO twister. This machine is able to save up to 40% of power consumption compared to existing gear drive machine. The pot of the machine is suitable to accommodate large package of heavy denier industrial threads. Human Machine Interface (HMI) has been

attached to facilitate the easy operation in the machine.

2.3.2 Introduction

Yarn twisting process enhances the cohesive force among the fibers. This increase in cohesiveness helps to protect the yarn from tension generated during weaving and knitting. The two for one twister (TFO) first introduced in the textile manufacturing process for the filament twisting purpose. Recently two for one twister has gained interest for plying of both spun yarn and filament yarns due to their advantages such as production of long length knot free yarns and higher productivity. A long length knot free yarn facilitates better performance in subsequent processes. This system is suitable for all types of yarns except very fine yarns above 80 s count.

In the TFO, each rotation of the spindle insert one turn of twist in the length of yarn within the spindle, plus another turn of twist in the yarn balloon. As a result, two turns of twist are inserted into the yarn for each rotation of the spindle; hence the name two-for-one twisting. The two-for-one twisting machine currently offers high operational flexibility, working both with controlled and free balloons, extracting the balloon limiter.

In last three decades, many developments have been taken place in TFO twister to improve the performance, productivity and application areas. With the improvements in feed package and spindle zone, TFO twister can also be used to ply synthetic spun yarns and open end yarns. Development in the winding zone is facilitating to build the soft packages for dyeing purpose. Incorporation of the pneumatic threading system is helping to save the operator time. In the conventional TFO twister, all the drives were linked with one motor and gearbox. Machine has been developed with two gear box instead of one to enhance the versatility of the machine. Double gear system facilitates independent driving of the two sides using low power motors. In this system, quick adjustment in parameters is possible. Besides, these, still there is need of market to increase the performance of machine during plying the heavy denier industrial threads. The ply twisting of high denier industrial thread requires pot with large size and high twist multiplier with low power consumption. If the package is big, consequently it requires large capacity motors to drive the spindles.

Driving system of TFO twister plays an important role to enhance the performance and versatility of the machine. Servomotor is one of the latest technologies in the field of driving mechanism. Motors used in automatic control system is called servomotor. Servomotors convert electrical signal in to angular displacement of a shaft. They can operate in a continuous duty or in a step duty based on the construction. Linear relationship between speed and electrical control signal, steady state stability, wide range of speed control, low mechanical and electrical inertia and fast response is possible by the servomotor drive.

In this project, conventional drive arrangement with gear box has been replaced with one servo motor and two induction motors to provide drive separately to traverse, twisting and winding mechanism. Machine has been designed with servo motor drives and large size pot. Servo motor in place of gear box drive consumes low power and bigger size pot accommodates the large size package for uninterrupted running of the machine.

2.3.3 Methods

2.3.3.1 Replacement of single motor gear drive mechanism

In the conventional TFO twister all drive was from single large gear box and vertical shaft. Single motor driven gear box arrangement in the conventional TFO twister consists of (a) cam shaft assembly (b) Vertical shaft assembly (c) Crossing angle gears shown in Figure 1. Consumption of power and lubricant is more in single motor gear box arrangement. This single motor gear drive arrangement was replaced by servomotor and individual induction motor drive. Servomotor was used to drive the traverse mechanism, 3hp induction motor was used to drive take up mechanism and 10hp induction motor was used to drive the spindles. All three motors were synchronised by HMI control.

TFO twister consists of 12 spindle has been designed by replacing the one motor gear drive system. One 10 hp induction motor has been used to drive the spindle by tangential belt driving system. One 3hp induction motor for take up and one servo control motor has been used for traverse system.

In the developed TFO twister, there is arrangement of three individual motor to drive the three different mechanisms. All the motors are synchronised to Human Machine Interface electronic panel. Any changes in the parameter such as revolution per minute, twist per meter and traverse width can be done through the panel, where as in the conventional system, any changes in parameter need to change the pinion in the gearing system.

Spindle speed range in developed machine can be varied between 1000 to

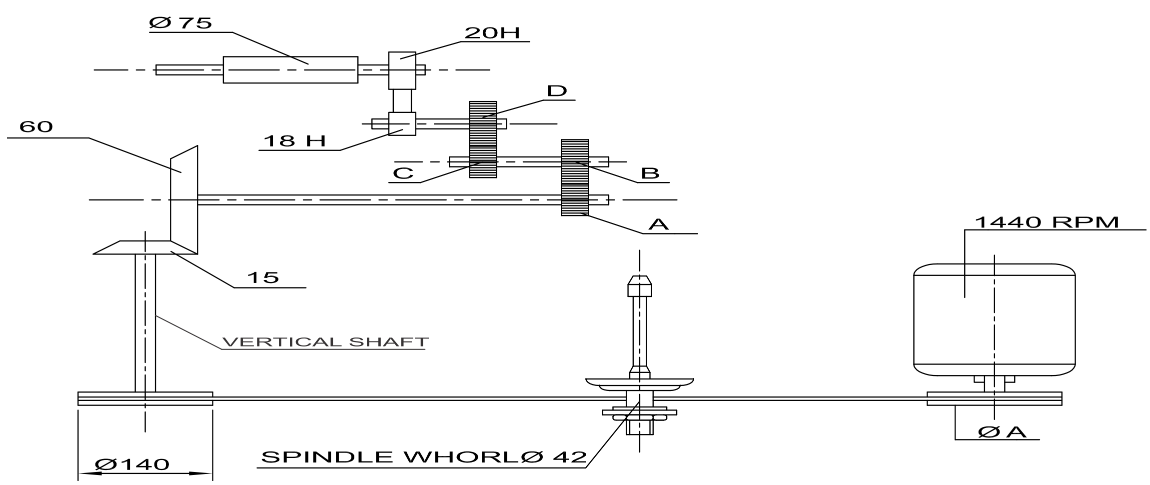


Figure 1. Gear diagram of motion transfer in conventional TFO twister

5000 RPM (Revolution per Minute) without changing any wheel. In the existing machine depends on motor pulley diameter and spindle whorl diameter.

Spindle RPM = Motor RPM × Motor pulley diameter / Spindle whorl diameter
Twist per Meter (TPM) can be changed from 40 to 1000 in developed machine compared to 40 to 700 in existing machine. The changes in parameter can be controlled electronically in developed machine whereas existing machine needs manual setting and wheel change.

2.3.4 Result and discussion

During initial trial, over loading of the machine was observed with 1 kW of servomotor so it was changed to 2 kW. By using 2 kW motor, over loading problem was eliminated but cross winding in the package was observed during package formation. This problem was solved by shifting the motor from one corner of the machine to the middle of the machine and changing the direct drive with suitable gear assembly.
Developed 12 spindle prototype machine and similar 12 spindle conventional machine were operated with full load at different revolution per minute to compare the power consumption and package property. Details about the parameter and current intake by both the machine are given below in Table 1(a), 1(b) and 1(c).

Table 1(a): Input Ampere value at 2000 RPM

Parameters	Conventional Machine	Developed Machine
Spindle speed (RPM)	2042	2000
Twist per meter	80	80
Yarn denier	1000	1000
No. of sections	2	2
No. of spindles	12	12
Input Ampere	2.4	1.8

Table 1(b): Input Ampere value at 2600 RPM

Parameters	Conventional Machine	Developed Machine
Spindle speed (RPM)	2500	2600
Twist per meter	80	80
Denier	1000	1000
No. Of sections	2	2
No. Of spindles	12	12
Input Ampere	3.25	2.5

Table 1(c): Input Ampere value at 3200 RPM

Parameters	Conventional Machine	Developed Machine
Spindle speed (RPM)	3185	3200
Twist per meter	80	80
Denier	1000	1000
No. Of sections	2	2
No. Of spindles	12	12
Input Ampere	4.16	3.25

The average input current in developed servo motor base machine is 2.51A and in conventional machine is 3.27A. Power consumption by the machine isI^2R where I = input current and R = resistance. The power consumption by developed machine is $(3.25)^2R$= 10.56 R Watt and by the conventional machine is $(4.16)^2R$= 17.30 R Watt. Resistance offered by the two machines is similar so power consumption per unit resistance is 10.56 W and 17.3 W by the developed machine and conventional machine respectively. Reduction in power consumption is 6.74 W. This is about 39% reduction in power consumption after using electronic control servo motor. Package holder pot size can be used between 190 to 260 mm.

2.3.5 Conclusion

Two for one twister is successfully developed with electronic control servomotor drive. Single motor gear drive mechanism in conventional machine is replaced by independent drive to take up, spindle and traverse. Traverse mechanism was driven by electronically controlled servomotor. Reduction in power consumption by developed machine was found to be 39%. Maintenance time is less compared to the conventional one due to the absence of gear drive system. Package holder pot size can be increased up to 260mm.Lower twist per meter (TPM) up to 20 is also possible All the process parameter control and display in the machine is possible through human machine interface electronic panel. Performance and efficiency of the developed machine is higher than the conventional single motor gear driven machine due to almost nil stoppage time for changing revolution per minute (RPM), TPM, overfeed etc, while changing the lot.

2.4 Development of cotton waste based oil absorbent for oil spill clean-up

Oil spill cleanup is a global concern due to its environmental and economical impact. Various commercial systems, including synthetic fibres like polypropylene, have been developed to clean up oil spillage. But these synthetic fibre based sorbents pollute environment in another way such as disposal of used oil sorbents, non biodegradable in nature (hence non eco-friendly), etc. Hence, in this R&D project, waste cotton, which is bio-degradable in nature, has been used as oil absorbent after subjected to various modifications.

The cotton waste was cleaned, pre treated and converted to a non woven fabric through a carding and needle punching process. The non woven web was chemically modified. The chemically modified fabric was found to be super oleophilic and super hydrophobic as compared to the commercial polypropylene based sorbents. Oil absorption property, oil recovery and characterization studies were carried out.

Oil absorption property of the sorbent in various oils has been studied. It was found that polypropylene absorbed motor oil in the range of 10-12g/g, where as cotton waste based sorbent absorbed in the range of 20-30 g/g. Absorption of diesel oil in polypropylene was in the range of 5-9 g/g whereas, cotton waste based sorbent was in the range of 9-13 g/g. Cotton waste based sorbent was having good water repellent property too. The water repellent property of the sorbent was established by measuring the contact angle, which was more than 150°. The dynamic water absorption capacity of the sorbent was as low as 0.1g/g. Chemical characterization of the sorbent was carried out using TGA, SEM-EDAX, FTIR. A provisional patent was filed.

Since, the cost of the sorbent was higher in comparison to the commercial polypropylene sorbent, we are making an attempt to commercialise the sorbent with a competitive price.

2.5 Nano-fibre application to enhance the anti-clogging properties of geotextiles

2.5.1 Abstract

Prefabricated vertical drain (PVD) is one kind of geo-filter for the consolidation of soil before the building of structure. This consists of a plastic core with formed flow path grooves on the both sides along its length (which acts as free draining water channel even at large lateral pressure), surrounded by a nonwoven geotextile (filter) that maintains the hydraulic capacity of the grooves and preventing clogging by soil intrusion. If the pore size of filter is larger than the fine soil particle, the soil under lateral pressure clogs the internal water flow paths of PVD. The intrusion of too many fines could reduce the PVD discharge capacity and increase the filter resistance. The pores smaller in size and larger in number are suitable for the filter jacket to prevent clogging and maintain the hydraulic capacity of the grooves. To avoid this problem, thin nanofibrous web with small pore size was laid on spun bonded nonwoven membrane. The laying of nanofiber was carried out using needle less electrospinning system. The electro spinning parameters were optimized to get uniform bead less nanofiber layer with required diameter. The thickness of nanofiber mat was standardized to keep the pore size less than the soil particle size present in the mercy land soil. Anti-clogging property and water permeability of the membrane with nanofiber layer was investigated by continuous use for a long time in presence of soil. Results showed that use of nanofiber membrane rather than only nonwoven membrane, significantly improves anti-clogging property. The presence of soil particles in the membrane pores was checked by the Scanning Electron Microscope (SEM) after use.

2.5.2 Introduction

Geotextiles are permeable textile materials used with sand, soil and rock in various areas of geotechnical structures like roads, river & sea bank protection, canal lining, landfills, airport railways etc. They may be woven, non-woven or knitted as per the requirement for end use applications. Amongst the various functions of geotextiles, filtration is an important function to separate water from soil. This is because of the fact that geotextiles are porous to liquid flow across their manufactured plane and also within their thickness.

Prefabricated vertical drains (PVD) are one kind of geo-filters for the consolidation of soil before the building of structure. This consist of a plastic core with formed flow path grooves on both sides along its length acts as free draining water channel even at large lateral pressure, surrounded by a geotextile (filter) that maintains the hydraulic capacity of the grooves and preventing clogging by soil intrusion. Under lateral soil pressure, the internal water flow paths of PVD get clogged by fine soil particles, if the pore size of filter is larger than the fine soil particle, as too many fines could reduce the PVD discharge capacity and increase the filter resistance. The pores smaller in size and larger in number are suitable for the filter jacket to prevent clogging and maintain the hydraulic capacity of the grooves. Laying of thin nanofibrous web with small pore size on geotextile could reduce this problem.

In this study we have chosen Nylon 6 polymer for the spinning of nanofiber and lay the same on the surface of the spun bonded polypropylene to minimize the pore size and improve the anti-clogging property of geotextle. Properties related to clogging and filtration of prepared PVD has been compared with conventional PVD.

2.5.3 Experimental Methods

The measured amount of solvent was taken in a conical flask and stirred using magnetic stirrer. The polymer was added slowly during stirring to prepare the solution. The needleless electrospinning machine from ELMARCO (NS IS500 U) with wire electrode was used for the nanofiber spinning. Electrospinning parameters were standardised. Morphology of Nylon 6 nanofibers was observed by Scanning Electron Microscope (SEM JEOL JSM 5400) after gold coating. Quantachrome's 3G porometer operating under windows ® the 3G win software was used for the analysis of pore size. Water permeability in presence of soil was measured by using falling water head test instrument designed in the laboratory. In this tester, water was flown through the sample from a constant water head and time was recorded after water head falling down to 5cm. In order to maintain the water head pressure, reading was taken after 5cm only.

2.5.4 Results and discussion

2.5.4.1 Process parameter standardization

Effect of different electrospinning parameters was standardized based on the fiber uniformity and pore size. The nanofiber spun at standardized parameter was uniform in diameter and free form beads. The SEM image of nanofiber at standardized parameters is given in Figure1.

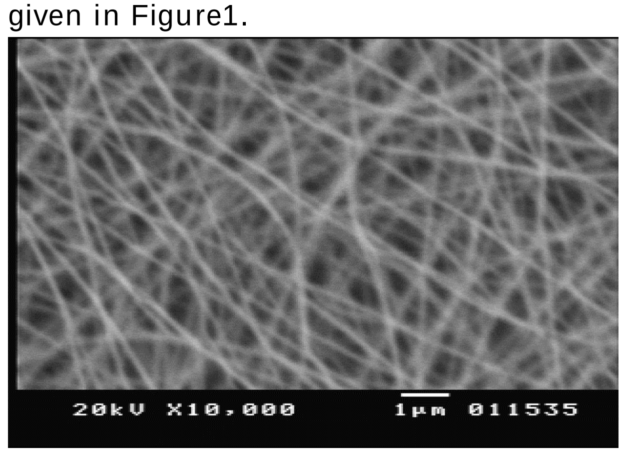


Figure1: SEM image of Nylon6 nanofiber at standardized parameters

2.5.4.2 Soil particle size analysis & pore size optimization

Marshy land soil contains very tiny soil particles; therefore the particle size analysis was very essential to standardize the pore size of nanofiber mat. The marshy land soil was simulated in our laboratory and taken for particle size analysis. Particle size distribution of the soil is given in Figure 2. The minimum size of 0.4 µm and average size of 2.16 µm soil particle was found in the simulated soil sample and volume wise, less than 10% particles were in 0.4 µm size.

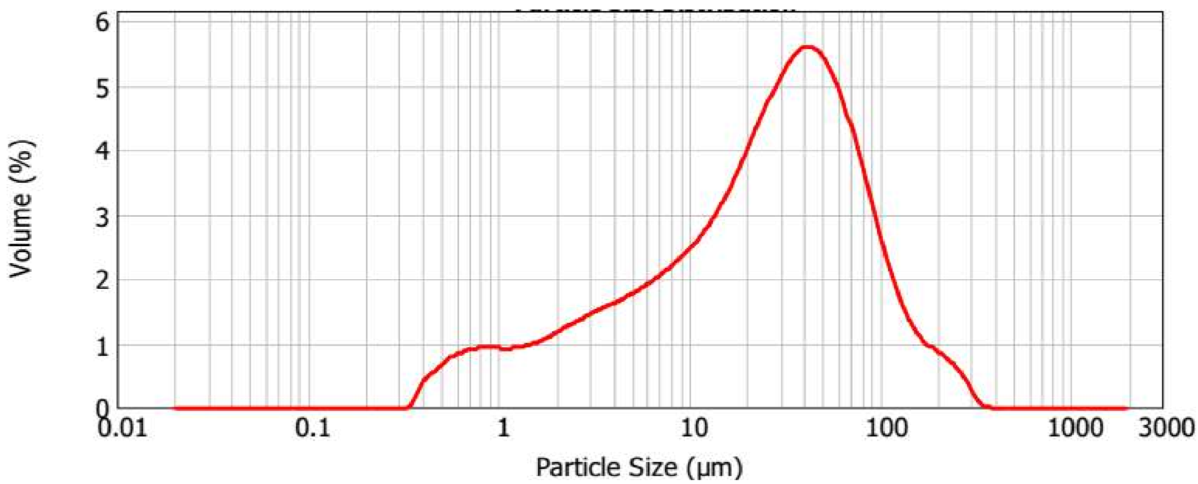


Figure 2: Particle size distribution of mercy land soil

Thickness of the nanofiber mat is inversely proportional to the water permeability so at standardized spinning parameters, thickness of nanofiber mat was standardized by varying the deposition time.

The water permeability of the existing media and nanofiber deposited media was evaluated by falling water head tester in presence of soil particles. Evaluation was done by changing the soil concentration 1 to 4% on the weight of water. At 1 and 2 % soil more water flow was observed in existing media compared to nanofiber deposited media but reverse of this trend was observed at 4% concentration of soil. The initial water flow was found similar for both the media at 3% soil, so this concentration was taken to study the performance of nanofiber deposited media in long term use. In this experiment, both the media was kept continuously in presence of soil for long time and time taken for water head fall to 5cm was recorded continuously. The plot of time taken by water head fall per centimetre corresponding to hour is given in Figure 3. Initially, water head falling time per cm is less in existing nonwoven media compared to nanofiber media but after few hours, it increases and crosses the time taken through the nanofiber deposited media. This is because of low filtration resistance of existing nonwoven media which is increasing after few hours by intrusion of soil particles and clogging of pores. This phenomenon is not happening in the case of nanofiber deposited media.

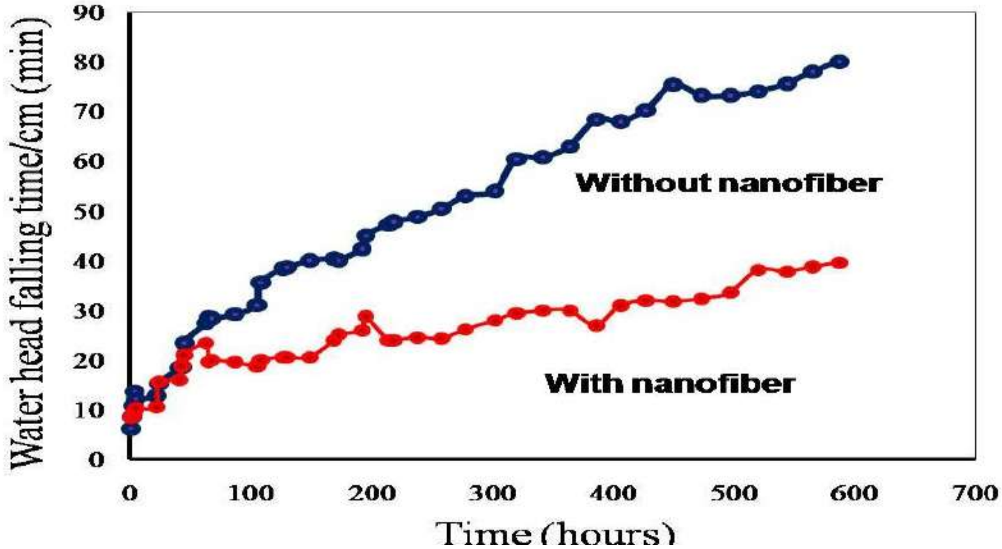


Figure 3: Water head falling time after continuous use in presence of soil

2.5.4.3 Conclusion

The electro spinning parameters are standardized for Nylon 6 in the needle less electrospinning machine with wire electrodes. Deposition time was standardized to obtain the required pore size of the nanofiber mat. The clogging behavior and water permeability of the PVD substrate with nanofiber mat was investigated for long time in presence of soil. Gradually decrease in water permeability was observed in nonwoven media compared to nanofiber deposited media. This increase in time was due to clogging of pores of nonwoven media by fine soil particles. Deposition of nanofiber on the existing nonwoven filter media can be helpful to maintain the water flow through the channel and reduce the consolidation time.

2.6 Melt spinning of PVDF / ZnO nanostructure hybrid filament for wearable smart textile

2.6.1 Abstract

The increase in aspect ratio of nanostructure helps to induce and retain the alignment of polymer chain to fibre axis due to higher degree of interaction with polymer chain along their length. In this study, PVDF/ZnO nanowire hybrid composite filament has been prepared by melt spinning process to increase the piezoelectric property of PVDF, further, to make it suitable for different applications. Standardisation of nanowire loading percentage has been done based on the β phase content in the filament. Significant increase in β phase content and in piezoelectric property was observed in the prepared composite filament compared to the normal PVDF filament. Effect of various spinning parameters such as melt draw ratio, draw ratio, drawing temperature and hydrophobic functionalization of nanowires on the β phase content was investigated. The β phase content has been analysed using the

wide angle X ray diffraction and FTIR spectroscopy.

2.6.2 Introduction

Among the different types of smart materials, piezoelectric materials are the most widely used because of their fast electromechanical response. A classical definition of piezoelectricity is the generation of electrical polarization in a material in response to a mechanical stress. Ceramics are well accepted piezoelectric material but for certain applications polymeric piezoelectric materials are suitable over the ceramic because of their unique properties such as higher piezoelectric stress constant, processing flexibility, toughness, high strength and high impact resistance.

Piezoelectric property in Poly (vinylidenefluoride) PVDF was first observed by Kawaiand PVDF films that had been poled exhibited a very large piezoelectric coefficient. From the structural point of view, it is a semicrystaline and polymorphic material shows at least four crystal phases at different processing condition. Among the four crystal phases, the β phase shows piezo, pyro and ferroelectric characteristic due to the all trans-conformation in orthorhombic unit cell. The most stable α phase of this polymer forms during melt crystallization. This stable α phase can be transformed to β phase by application of mechanical force below the temperature 100°C.The polarisation process further helps to improve the piezoelectric property by increasing uniformity in alignment of dipole moments in the unit cell of β phase. Other than the mechanical stretching, the enhancement in β phase content is also possible by incorporation of nanoparticles in the polymer. Besides these, the increase in aspect ratio of nanostructure also helps to induce and retain the alignment of polymer chain to fibre axis due to higher degree of interaction with polymer chain along their length. Zinc oxide is a piezoelectric material and its high aspect ratio nanostructure shows excellent piezoelectric properties. On the other hand PVDF shows good piezoelectric property so it is expected that, the incorporation of ZnO nanostructure of high aspect ratio in PVDF during melt spinning will help to improve further the pezoelectric properties to higher degree. Therefore, incorporation of ZnO nanostructure of high aspect ratio in PVDF during melt spinning and its contribution to enhance the β phase content, piezoelectric property and mechanical properties of PVDF is explored in this study.

From the application point of view this composite filament can be usedas static pressure sensor, actuator, transducer in medical field and as nanogenerator to harvest the power from the low frequency human body movement.

2.6.3 Results and discussion

2.6.3.1 Synthesis &Characterization of ZnO nanorods

ZnO nanorods were synthesized and characterised using SEM. SEM images of nanorods are shown in Figure 1. Nanorods were polydisperse in nature, average aspect ratio of rod was measured 26. Purity of synthesised nanorods was investigated using wide angle X-ray diffraction technique. A typical XRD pattern of ZnO nanorods is shown in Figure 2. The unit cell of the crystal found to be hexagonal from the appeared peaks. Further, the intensities of peaks are different which indicates that the growth of various planes is anisotropic. In the spectrum no impurity peaks were detected, which indicates that the synthesised nanorods are highly pure.

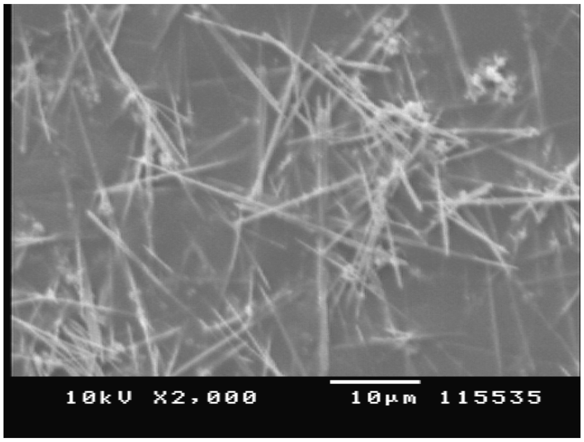


Figure 1: SEM image of synthesized ZnO nanorods

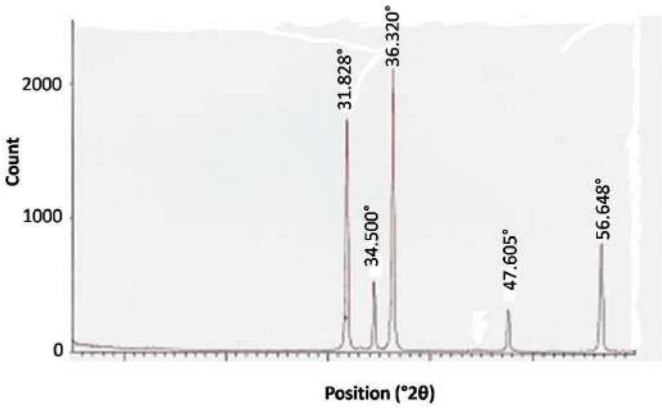


Figure 2: WXRD spectra of ZnO nanorods

2.6.3.2 Compounding of ZnO nanorods with PVDF

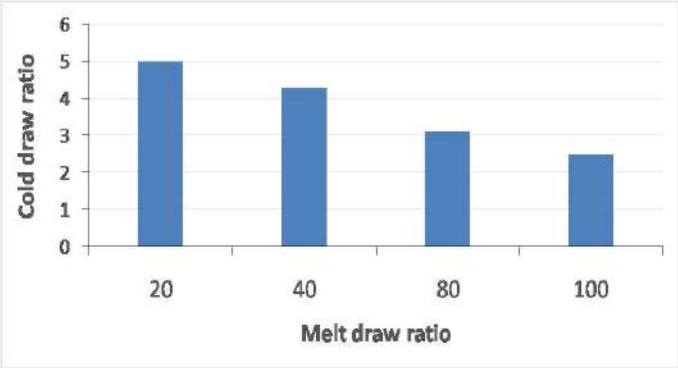
Uniform dispersion of nanorods in the polymer is important for the spinning of good filament with better properties. For the uniform distribution, nanorod at different percentage was melt compounded with polymer.

2.6.3.3 Melt spinning of compounded polymer

Standardization of melt draw ratio

The possible cold draw ratio at different melt draw ratio was checked and bar chart is shown in Figure3.

Figure3: Possible cold draw ratio at different melt draw ratio



Effect of nanorod loading percentage

The PVDF/ZnO composite filaments were prepared with different loading % of nanorods. All the spun filaments were drawn off line with standardized parameters. The % crystallinity of the composite filaments including neat PVDF filament was measured using WXRD technique and overlay of those spectra are shown in Figure 4.There is a significant increase in total crystalline % in nanorod loaded polymer compared to the neat PVDF. The α and β crystal percentage in those filaments before and after cold drawing are given in Figure 5.

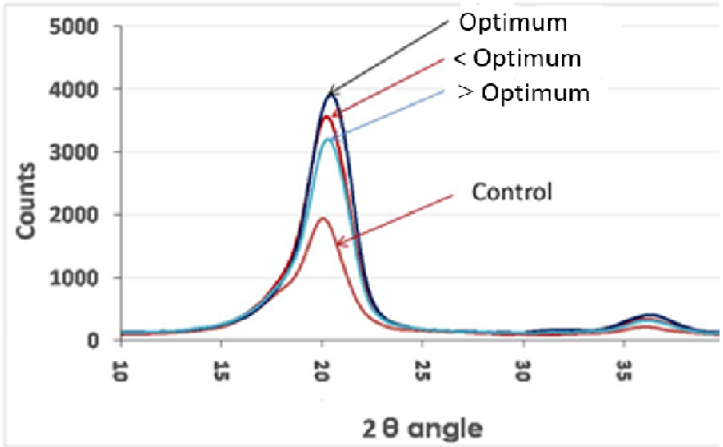


Figure4: WXRD spectra of filaments with different loading percentage

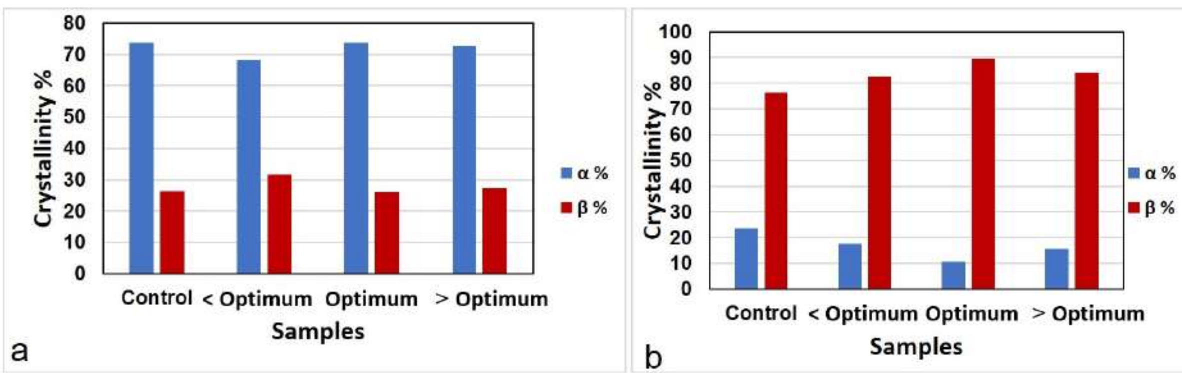


Figure 5: % α & % β crystal content in the filament with nanorods (a) before drawing (b) after drawing

2.6.3.5 Effect of nanorods over nanoparticles

To investigate the advantages of nano rods over nanoparticles, filament was also prepared with same % of ZnO nanoparticles and compared with the ZnO nanorod composite filament. WXRD spectra of those filaments are shown in Figure 6. Total crystalline % was found less in nanoparticle loaded filaments as compared to the nanorod loaded filament. The β crystal % was also found significantly less compared nanorod loaded filaments. To investigate the effect of polarity of the nanostructures on dispersion and crystal development in polymer, both nanoparticles and nanorods were functionalised with nonpolar compound and then melt compounded with polymer. There was and β crystal % in both the cases after the nonpolar functinalisation.

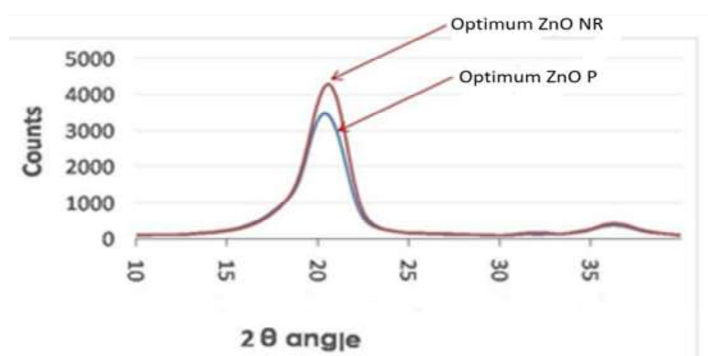


Figure 6. WXRD spectra of composite filaments loaded with ZnO nanoparticles & nanorods

2.6.3.6 Pieezo-electric property evaluation

A small sample was prepared by wrapping multi filament yarn closely over an insulator plate, which is shown in Figure 7. Those filaments were covered with copper plates at both side and connected with conducting wire to collect the signal by digital multimeter. The stress was applied by hand on the prepared sample and generated voltage was recorded from the multimer. Increase in voltage generation about 22% was observed compared to the control PVDF sample and about 10% compared to nanoparticle loaded sample.

Figure 7. Parallel filaments covered with electrodes and insulating tape

2.6.3.7 Conclusion

Synthesis of pure ZnO nanorods was done successfully and meltcompounded with the PVDF in different percentages. The highest cold draw ratio was achieved by spinning at low melt draw ratio. The highest % crystallinity and β crystal formation was found at optimum wt% loading of nanorods. Increase in %crystallinity and % β crystal is more in case of nanorods as compared to nanoparticles due to the increase in interaction area with polymer molecules. Nonpolar functionalization of ZnO nanorods could not help to improve the dispersion in the PVDF during compounding and spinning. The improvement in piezo-electric property in nanorod loaded composite filament was found up to 22% in terms of voltage generation compared to the control PVDF which was up to 10% compared to nanoparticle loaded filament. Further study on evaluation of piezo-electric property is in progress.

2.7 Development of test method for analysing hexavalent chromium content in dyes, pigments and textile auxiliaries

Hexavalent chromium (Cr(VI) is a known mutagenic and carcinogenic substance. Cr(VI) is commonly found in textile dyes, pigments, paints, inks leather products and textile auxiliaries. Due to the high toxicity, most of the government regulations restricted the use of Cr(VI) in consumer products. At present the only test method available to test Cr(VI) is ISO method for leather products which cannot be applied for water soluble dyes due to the high matrix interference of dye chromophore. Hence in this R&D project we have successfully developed one test method for water insoluble dyes /pigments and three test methods for water soluble dyes.

For water insoluble dyes/pigments, after extraction of Cr(VI) in a buffer solution, we could segregate the colouring matter by membrane filter, further Cr(VI) can be derivatized and measured using a spectrophotometer.

For water soluble dyes we could develop three different but technically equivalent test methods to estimate Cr(VI) in trace level. All the in house developed test methods have been validated as per international validation protocol.

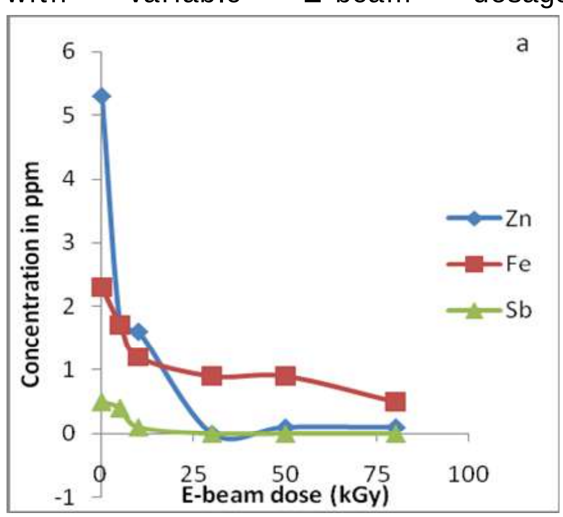
The spike recovery study shows more than 90% recovery of Cr(VI) in water soluble dyes. Inter laboratory study (Round Robin Test) when conducted with seven accredited laboratories shows good reproducibility with a Z score value in the range of -2.0 to +2.0. All the in house developed test methods show good repeatability. As a part of commercialization, a draft of the test method submitted to BIS to formulate a national standard.

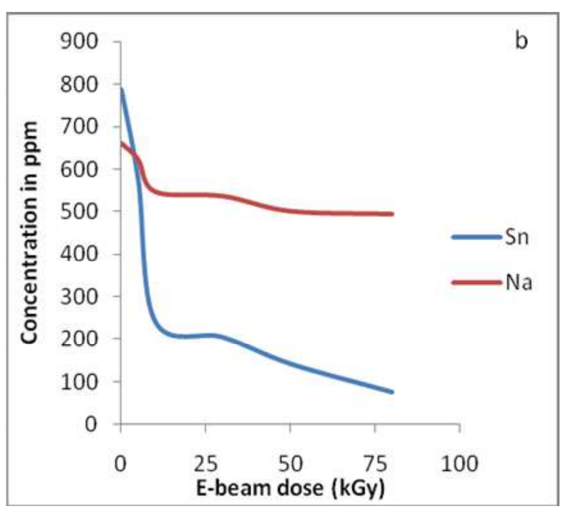
2.8 Studies on performance enhancement of textile effluent treatment plant by electron beam method

Biodegradability improvement and decolorization in textile wastewater with E-beam radiation technology was achieved successfully in our previous work. The present work describes the efficiency of electron beam treatment towards heavy metal removal from textile wastewater.

Different heavy metals are frequently found in industrial effluent due to various activities in textile industries. Their presence can cause serious damage to aquatic environment; hence there is a need to remove them from the effluent before discharging. The electron beam treatment appears to be promising alternative for metal removal in textile effluent. In this work, E-beam treatment was used to remove heavy metals from simulated industrial effluent. This E-beam treatment produces reactive species like hydroxyl radicals through water radiolysis, which reacts with the metallic ions inducing their precipitation. Removal of heavy metals through textile waste water was evaluated through elemental determination.

Simulated industrial effluent was prepared with adding known concentrations. The samples were irradiated at Board of Radiation and Isotope Technology-Bhabha Atomic Research Centre (BRIT-BARC) Vashi with variable E-beam dosages.





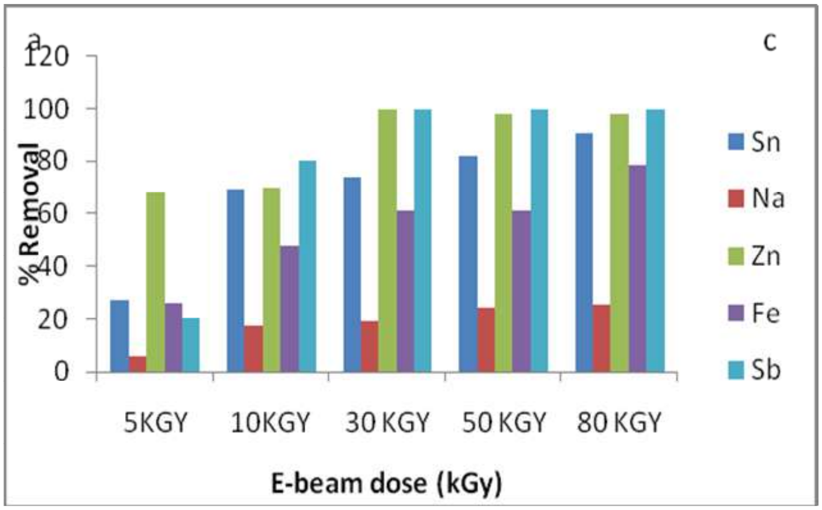
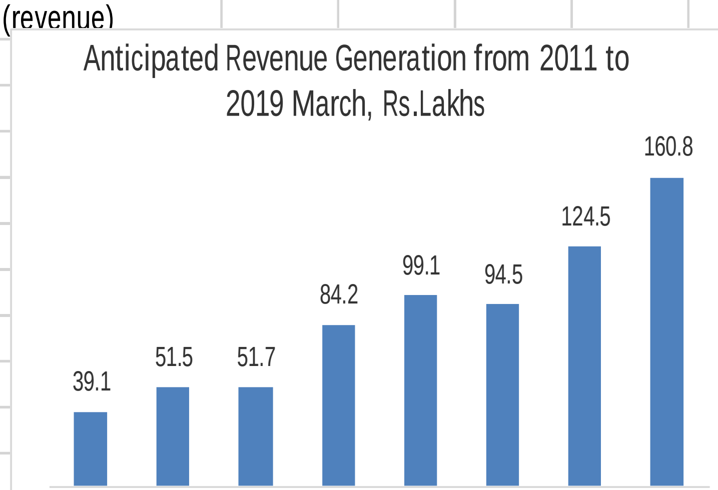


Fig.1(a-c) : Heavy metal removal with Variable E-beam dosages

E-beam treatment on simulated effluent gives100% removal of Zn and Sb with 30kGy dose, more than 80% removal of Sn with 50kGy dose, 60% removal of Fe with 50kGy dose and 20% removal of Na with 20kGy e-beam dose (fig.1a-c). However metal removal level depends strongly on initial sample characteristic i.e. presence of inorganic, organic and biological composition in effluent, as they react at different rate with reactive species (hydroxyl radicals, hydrated electrons and hydrogen atom) formed during radiolysis.

2.9.1 Centre of Excellence for Geotech

Year	Rs In Lakhs (revenue)
2011-12	39.1
2012-13	51.5
2013-14	51.7
2014-15	84.2
2015-16	99.1
2016-17	94.5
2017-18	124.5
2018-19	160.8



BTRA is recognized as a Centre of Excellence for Geotech by the Ministry of Textiles, Government of India. Development (Geotextile) facility and State-of-Art facilities for testing Geotech are set up at BTRA. The new laboratory have all testing facilities for geosynthetic products like Geotextiles, Geomembranes, Geocomposites, Gabions, Geosynthetic Clay Liner, Geogrids, Prefabricated Vertical Drain Geocell, Geomattress, Canalliner etc. Also, BTRA is strengthening its information resources on Geotech by procuring various books and test methods. BTRA is actively working on standardization of specifications of geosynthetic products application wise and test methods.

The Geotech Laboratory at BTRA is accredited by Geosynthetics Institute (GSI), Folsom, Pensylvania, USA under the GAI – LAP Accreditation Programme for 24 tests of geosynthetics products.

It is pertinent to mention that BTRA is the first institute having commercial Lab in India and probably only the third in ASIA to get this coveted accreditation. What this means to the geosynthetics producers and users is that they can get the products tested in BTRA with utmost confidence that the accuracy of the results are as good as any other GAI-LAP accredited laboratories. They can get the tests done in India, thus saving time and money without compromising on the quality of the results.

2.9.1 Soil Mechanics Laboratory

BTRA Soil Mechanics Laboratory has started the following tests for soil classification and other related tests as per Bureau of Indian Standard Test Methods.

Soil classification tests	***Other soil tests***
1) Specific Gravity (IS 2720 Part-3)	**1)** Standard Proctor Compaction Test (IS 2720 Part-7)
2) Particle Size Analysis (dry/wet) (IS 2720 Part-4)	**2)** Modified Proctor Compaction Test (IS 2720 Part-8)
3) Liquid Limit (IS 2720 Part-5)	**3)** Unconfined Compressive Strength (IS 2720 Part-10)
4) Plastic Limit (IS 2720 Part-5)	**4)** Triaxial Shear Test (IS 2720 Part-11)
5) Shrinkage Limit (IS 2720 Part-6)	**5)** Direct Shear Test (IS 2720 Part-13)
6) Natural Moisture Content (IS 2720 Part-9)	**6)** California Bearing Ratio (CBR) Test (IS 2720 Part-16)
7) Differential / Free Swell Index (IS 2720 Part-40)	

BTRA staff attended the following related to Geotech.

2.9.2 Conferences / Meetings Attended

- Attended Expert panel meeting of BIS on Geosynthetics (TX-30), The Office of Indian Technical Textiles Association, Mumbai, 16th April 2018
- Attended meeting related to Curtain Raiser of Technotex 2018, New Delhi, 17th May 2018
- Attended meeting related to Review of Technotex 2018 with secretory MOT, Udyog Bhavan, New Delhi, 21st May 2018
- Attended the meeting of BIS panel expert on Geosynthetic, ITTA, BTRA Mumbai, 11th June 2018
- Attended the meeting (TX-30) usage of Geosynthetic demand & local source, Textile Commissioner Mumbai, 29th & 30th June 2018
- Attended meeting with Shri Arun Kumar, Secretory, MOT, GOI Empower committee for NER state project approval, Udyog Bhavan, 04th July 2018
- Attended BIS expert panel meeting on Geosynthetics,, ITTA, BTRA-Mumbai, 31st July 2018
- Attended meeting of BIS expert panel (8th) on Geosynthetics, TX30, ITTA, Mumbai, 28th August 2018.
- Attended 8th meeting of Expert Panel-Geosynthetics, ITTA Office, BTRA Mumbai, 30th October 2018
- Aattended meeting at National Conclave on Technical Textile and Curtain Raiser for Technotex 2019, Mumbai on 29th January 2019
- Attended meeting of Mandates of Technical Textiles With Jt.Secretary, MOT at Udyog Bhavan, New Delhi on 4th February 2019
- Attended BIS meeting of Tx 30 & Tx 33 at Manak Bhavan, Mumbai on 26th February 2019.

2.9.3 Award/Recognition

Mr. V. K. Patil received 'Resource Person' award from Dept. of Handloom & Textiles, Govt. Of Tamilnadu and Sardar Vallabhbhai Patel International School & Management, Coimbatore on 19th December 2018.

2.9.4 Exhibition Participation

- Technotex India 2018 Exhibition held on 27th June 2018 at Mumbai
- Fibres & Yarns Exhibition during 5th and 7th April, 2018 at World Trade Centre, Mumbai
- Nonwoven Tech Asia 2018 Exhibition during 6th and 8th June, 2018 at NESCO,Goregaon ,Mumbai
- GTTES 2019 Exhibition during 18th to 20th January 2019 at Mumbai.

3. CALIBRATION LABORATORY

BTRA has set up a calibration laboratory to cater to its own needs as well as provide calibration services to other NABL accredited testing laboratories.

Calibration of measuring Instruments having accredited traceability is the requirement of accredited testing laboratories.

BTRA calibration laboratory received NABL accredited laboratory as per 17025:2017 standards for Mass, Volume Balance and Force. BTRA is ready to provide calibration services for Mass, Volume Balance and Force parameters for the following ranges.

Parameter to be calibrated		Range
• Balance	:	1 mg to 5 kg
• Weights	:	1 mg to 5 kg
• Volumetric glassware	:	0.5 ml (500 µl) to 1000 ml
• Force(Tension & compression)	:	1kN to 100 kN

The worth equipment available are Balance, Weight, Force – Standard balance 220 g-1 nos, 3kg-2nos & 5kg-1nos. weights 1 mg to 200 g, E2 class, 1 mg to 200 g F1 class and 500g, 1000g, 2000g,3000g F1 class. We were having the load cells with digital indicators in the range of 200N to 100kN.Total certificates issued for Mass, Volume Balance and Force in the last financial year were 94.

4. ACCREDITED PROFICIENCY TESTING PROVIDER

Testing laboratories play a major role in the evaluation of quality of different products including textiles and geo textiles. The results being reported by the testing laboratories is crucial in deciding the fitness of purpose of a product manufactured. The results should be reliable, repeatable and reproducible. The competence of testing laboratories can be demonstrated by documenting and implementing of a laboratory QMS as stipulated in the international standard ISO/IEC 17025:2017. One of the main critical requirements to be demonstrated by a laboratory as stated in this standard is participation in proficiency testing conducted by a third-party accredited agency.

The organization that conducts proficiency testing is called a Proficiency Testing Provider. The international organization for standardization has stipulated the QMS to be implemented by such an organization in ISO/IEC 17043:2010. NABL has started accreditation of PT Provider in accordance with the standard ISO/IEC 17043:2010 from 2011 onwards. So far, over 35 Proficiency Testing Providers are accredited by NABL for testing/calibration of different products/items.

The five main advantages of participation in PT Scheme are as under

a) Evaluation of performance of laboratory for specific tests /calibrations.
b) Providing additional confidence to customers of the laboratory.
c) Identification of problems in laboratories and initiation of actions for improvement which, for example, may be related to inadequate test or measurement procedures, effectiveness of staff training and supervision, or calibration of equipment.
d) Education of participating laboratories based on the outcomes of such comparisons
e) Validation of uncertainty claims of laboratories.

The deficiencies in the self organized ILC are as under:

a) Impartiality is not maintained as the organizer is also a participant;
b) Robust statistical techniques are not used in the performance evaluation;
c) Confidentiality of the participants is not maintained and consequently, there is a possibility of collusion between the participants and falsification of the results.
d) Number of participants is less in ILC (around 5 or 6 only) and hence the uncertainty in the assigned value is too large and outcome of ILC is not dependable;
e) Homogeneity and stability of the samples distributed is not ensured;
f) Handling, storage and transport of PT items is not satisfactory and consequently. Integrity of the sample is compromised.

The competency of a laboratory to perform testing of any product can be ascertained only through PT participation and not ILC participation.

The above mentioned deficiencies are rectified in proficiency testing conducted in accordance with ISO/IEC 17043:2010. Further, proficiency testing requires **robust statistical methods** to be used for (i) determination assigned value for each measurand or characteristic of the proficiency test item (i.e sample), (ii) determination of evaluation criteria such as Standard Deviation for Proficiency Assessment (**SDPA)**, and (iii) performance evaluation in terms of Z score or Z prime score etc. All these requirements are stipulated in a comprehensive manner in the standard ISO 13528:2018.

In order to meet the proficiency testing requirements of textile testing laboratories, BTRA has documented and implemented the QMS as per ISO/IEC 17043:2010 and secured accreditation by NABL during 2018. This includes most of the conventional mechanical and chemical tests being performed by textile testing laboratories. BTRA had conducted 6 PT programs till date as per ISO/IEC 17043:2010 in chemical/ mechanical testing. Over 50 plus textile testing laboratories from different parts of the country had participated in these PT programs. We had received good response from the laboratories as well as our reports were well accepted by the users.

Now currently we have launched two programs with total 11 tests covering chemical and mechanical parameters.

5. TECHNICAL SERVICES

BTRA has provided extensive liaison and consultancy services to solve problems of quality, maintenance and productivity at various levels for the textile units. The details are given below.

5.1 Overview

✓ Technical investigations carried out	:	76
✓ Technical enquires attended	:	270
✓ Local mill visits made [man-days]	:	109
✓ Outstation mill visits made [man-visits]	:	133

5.2 Type of Assignments Undertaken

- ♣ LIVA Accredited Partner Audits for 43units
- ♣ Boiler Efficiency Audit in a mill
- ♣ Fabric inspection training for a mill
- ♣ Eco management analysis in Indian Textile Industry
- ♣ Weavers training in a mill
- ♣ QC Qualification Pack Preparation
- ♣ Training of Assessors
- ♣ PMKVY participation handbook Preparation
- ♣ NTC mills valuation Work

Product Development Assistance to the industry

- In needle-punch nonwoven and hydro-entanglement pilot plants, 17 samples were developed for various applications such as thermal insulation, viscose spun lace, etc.
- In the pilot plant of Technical Textiles Weaving, 29 samples (of 15 m in length) were developed for various applications such as tyre cord, filter fabric, etc.
- In the Plasma Treatment Machine, twenty metres of fabric were processed for two academic / research institutes

6. TESTING SERVICES

BTRA Test Laboratories had undertaken wide-range of testing activity such as Fibre Properties, Yarn Properties, Fabric Properties, Fabric Defect analysis, Chemical Testing (chemicals & auxiliaries), Eco-parameters Testing, Geotextiles Testing, Soil Testing, Technical Textiles Testing (other than Geotech), Microbiology Testing, Scanning Electron Microscope Studies, Special Testing [Flammability, static charge measurement, FT-IR / DSC / TGA / X-ray / GPC analysis, Melt Spinning trials, etc.] and Material Testing (non-textile items such as water, paint, oil, etc.). Total number of tests conducted for the period under review is 27024 and section wise details are as follows.

6.1 Overview

Test Particulars	Number of Tests
Physical Testing	6604
Chemical Testing and Eco-parameters, Chemicals / Dyes / Auxiliaries Testing and Material Testing ***(non-textile items, water, oil, etc.)***	9746
Fabric Defect Analysis	398
Geotextile Testing	5868
Technical Textiles Testing ***(other than Geotech)***	
Microbiology Testing	707
Scanning Electron Microscope	443
Special Testing ***(Flammability, static charge, FTIR / DSC / TGA / X-ray / GPC studies, Melt spinning trials, etc.)***	3216
Calibration Testing	42
TOTAL TESTS CONDUCTED	**27024**

6.1.1 Proficiency Testing Programs Participation

During the period under review, BTRA Test Laboratories participated in the following proficiency testing programs in order to maintain its laboratory performance at par with national / international laboratories.

- ASTM Proficiency Test Program on 'Woven Fabrics'
- AATCC Proficiency Test Program on 'Fibre Identification & Analysis'
- AATCC Proficiency Test Program on 'Colour Fastness'

6.1.2 New Machinery / Instruments added

- Scanning Electron Microscope (SEM)
- Moisture Density Gauge
- Thickness Tester
- Weighing Balance

6.1.3 New Test Methods Launched

BTRA undertakes the following new test methods as per national and international standards.

- ❖ Oil absorbency test for oil sorbents
- ❖ Cr(VI) in Dyes/pigments
- ❖ Polymer Tests (Thermal Analysis) using Differential Scanning Calorimetry (Perkin Elmer DSC 8000) - Oxidative Induction Time (OIT) / High Pressure OIT
- ❖ Polymer Tests (Morphological / Structural Analysis) using Perkin Elmer Frontier Near Infra Red (NIR) Spectroscopy - IR and NIR analysis for Identification of Polymer/Fibres, Coating type, Changes in functional groups after chemical modification and many more
- ❖ Dilute Solution Viscosity Measurement of Polymers (Inherent / Intrinsic / Relative Viscosities) as per ASTM D1243 / D2857 / D4603 Test Methods
- ❖ Formaldehyde Content in Auxiliaries as per GOTS
- ❖ Allergenic Disperse Dyes
- ❖ Glyoxal Content in Textiles
- ❖ Polycyclic Aromatic Hydrocarbons (PAH)
- ❖ Identification & Quantification of Virgin / Recycled Polyester Fibre
- ❖ Heavy Metal Content in Water using AAS

- Formaldehyde Content in Chemicals and Auxiliaries using HPLC (detection limit - 1 ppm)
- Surface Tension of Liquids and Films using KRVSS Drop Shape Analysis System
- Particle Size Analysis for Dry Powders
- Determining deterioration of visibility due to smoke released on combustion of materials [using Smoke Visibility Tester] as per UIC 564.2 OR Appendix-15 method
- Determination of Toxicity Index [Fume Toxicity Tester] as per N.C.D. 1409 method
- Standard Test Method for Using Seeded-Agar for the Screening Assessment of Antimicrobial Activity In Carpets [ASTM E 2471]
- Standard Test Method for Determining Fungi Resistance of Insulation Materials and Facings [ASTM C 1338]
- Standard Test Methods for Mildew (Fungus) Resistance of Paper and Paperboard [ASTM D 2020 Method A]
- Standard Test Method for Resistance of Emulsion Paints in the Container to Attack by Microorganisms [ASTM D 2574]
- Measurement of antibacterial activity on plastic surfaces [ISO 22196]
- Standard Specification for Retro-reflective Sheeting for Traffic Control [ASTM D 495]
- Weatherability Testing of various products
- Performance Testing of various Chemicals and Auxiliaries used in Textiles (Application and Evaluation)
- Evaluation of Sizing Agents as well as Sizing and Weaving Trials

6.2 Technical Textiles Testing

BTRA carried out in total 5868 tests for geotextiles and for technical textiles (other than Geotech). The following types of testing of technical textiles are undertaken at BTRA.

- FILTER FABRICS – Woven / Nonwoven
- GEOTEXTILES – Woven / Nonwoven
- PVD BAND DRAIN
- GEO-MEMBRANE LINER
- GEO-GRID
- ROPE GABION
- METAL GABION
- NONWOVENS – Wadding, Cover Stock, Face Mask, Interlining, Absorbing/Shoulder Pads, Insulation Pad and Carpets [Nonwoven Type]
- COATED FABRICS
- AUTOMOTIVE TEXTILES
- MEDICAL TEXTILES
- OTHER TECHNICAL TEXTILES - Narrow Fabrics, Conveyor Belts up to 13 mm Thick [Dumbbel Shape], Nylon Ropes up to 12 mm, Composites - Glass Composites / Glass Composites/Mats and Glass Roving / Fabrics

Apart from conducting usual tests such as weight per square metre, weight per linear metre, thickness / density, yarn number, etc., certain unique tests are also undertaken. They are as follows.

✓ **FILTER FABRICS** (Woven and Nonwoven): Tensile Strenth Tear

Resistance (Trapezoid Strength), Grab Strength, Water Permeability, Air Permeability, Pore Size by Porometer, Apparent Opening Size, Bursting Strength, Breaking Strength & Elongation

- ✓ **GEOTEXTILES** (Woven and Nonwoven): Abrasion Resistance, Apparent Opening Size, Bursting Strength, CBR Puncture Strength, Cone Drop Test (Dynamic Puncture Test), Grab Tensile Strength & Elongation, Index Puncture Resistance, Mullen Bursting, Pore Size by Porometer, Seam Strength, Static (CBR)Puncture Strength, Tensile Strength & Elongation ,Tensile Strength (Before & After Exposure UV Xenon Arc), Trapezoid Tear Strength, UV Resistance Exposure to Light, Moisture & Heat in Xenon Arc, Water Permeability, Hydraulic Transmissivity.
- ✓ **PVD BAND DRAIN**: Tensile Strength & Elongation, Water Permeability of Filter, Tensile Strength of Core, Grab Strength & Elongation for PVD Composite, Trapezoid Tear for Filter Component only Discharge capacity.
- ✓ **GEO-MEMBRANE LINER**: Density, Tensile Strength, Tear Strength, Puncture Resistance, Carbon Black Content, Melt Flow Index, ESCR, 2% Secant Modulus of Polyethylene Geomembrane, Stress cracking resistance, OIT (Normal and High pressure)
- ✓ **GEO-CELL:** Seam (weld strength), Density, Tensile Strength, Tear Strength, Puncture Resistance, Carbon Black Content, Melt Flow Index, ESCR, 2% Secant Modulus of Polyethylene Geomembrane, Stress cracking resistance, OIT (Normal and High pressure)
- ✓ **GEO-GRID**: Tensile Strength & Elongation (Single Rib) / Multi Rib, Carbon Black Content, Melt Flow Index, Aperture Size & Number of ribs per meter
- ✓ **ROPE GABION**: Size, Tensile Strength, Identification of material [TGA / DSC], UV Resistance Exposure to Light Moisture & Heat in Xenon Arc, Tensile Strength (Before & After Exposure UV Xenon Arc), Tensile Strength of Rope after Thermal stability.
- ✓ **METAL GABION**: Size, Thickness of Wire and Coating, Tensile Strength of Wire Coating

6.3 NONWOVENS

- ❖ **WADDING:**Compressional Recovery, Air Permeability, Thermal Conductivity
- ❖ **COVER STOCK:** Mass [EDANA], Absorbency [EDANA], Liquid Strike through time [EDANA], Wicking Rate [EDANA], Tensile Strength & Elongation [EDANA]
- ❖ **FACE MASK**: Pore Size
- ❖ **INTERLINING**: Mass per square metre, Thickness [EDANA], Tensile Strength & Elongation, Heat Shrinkage
- ❖ **ABSORBING / SHOULDER PADS**: Mass per square metre [EDANA], Thickness [EDANA], Absorbency [EDANA]
- ❖ **INSULATION PAD**: Mass per square metre [EDANA], Thickness [EDANA], Thermal Conductivity

- ❖ **CARPETS** (Nonwoven Type): Mass per square metre, Thickness, Compressional Recovery, Taber Wear Index [up to 300 cycles], Colour Fastness to Light up to 5 Rating, Dimensional Stability – Heat/ Water, Flammability at 45O, Horizontal Burning Rate, Pill (Camphor / Methanamine) Test, Tuft Withdrawal Strength (Piled Carpets), Static Charge measurement, Surface Resistivity, Volume Resistivity, Antimicrobial Activity, Antimicrobial Activity, Antifungal Activity
- ✓ **COATED FABRICS**: Mass per square metre, Thickness, Tensile Strength & Elongation, Tongue Tear Strength, Single Rib Tear Strength, Bonding Strength Bonded / Coated, Application of Adhesive, Water Vapour Transmission [ASTM E: 96 by Gravi Test Instrument], Identification of Coating by FTIR, Taber up to 300 cycles, Hydrostatic Pressure Heat Test, Removal of Coating, Identification of Fibres, Yarn Count, Threads/Inch, Martindale Abrasion Test – 10,000 rubs, Pliability, Blocking Test, Gelling Test, Flexing Test [Dematia Method], Limiting Oxygen Index, Vertical Flame Test, Horizontal Burning Rate
- ✓ **AUTOMOTIVE TEXTILES**: Mass per square metre, Thickness, Abrasion Resistance: Taber H18 / CS10 [Automotive Std.] up to 300 cycles, Flammability at 45O, Horizontal Burning Rate, Pill (Methanamine) Test, Relaxation Shrinkage, Thermal Shrinkage, Odour Test, Tensile Strength [Automotive Std.], Tear Strength [Automotive Std.], Colour Fastness to Light (up to 6), Colour Fastness to Crocking, Colour Fastness to Shampooing, Colour Fastness to Resistance to Cold -20^{o}C for 2 hours, Pliability, Blocking Test, Gelling Test, Flexing Test [Dematia Method]

6.4 MEDICAL TEXTILES

- ✓ **COTTON WOOL PADS**: Acidity or Alkalinity [Methyl Orange / Phenolphthalein], pH at 26^{o}C, Absorbency Sinking Time, Water Holding Capacity, Water Soluble Substance, Ether Soluble Substance, Sulphated Ash, Fluorescence, Bio burden Test (4 Organisms), Drying Rate [67 + 2% R.H. & 27 + 2^{o}C Temp.]

6.5 OTHER TECHNICAL TEXTILES

- ✓ **NARROW FABRIC**: Seat Belt Strength, Tape / Webbing Strength & Elongation, Hot Water Shrinkage of Webbing, Tensile Strength & Elongation, Belt for Lift
- ✓ **CONVEYOR BELT** upto 13 mm Thick (Dumbbel Shape): Tensile Strength [In-house Method]
- ✓ **NYLON ROPES** upto 12 mm: Tensile Strength, Diameter of Rope, Linear Density

COMPOSITES

- ➔ **Glass Composites**: Flexural Strength, Lap Shear Strength,Tensile Strength
- ➔ **Glass Composites / Mats**: Thermal Conductivity, Mass per square metre, Tensile Strength, Thickness, Density

- **Glass Roving / Fabrics**: Mass per square metre, Yarn Number, Thickness, Density, Breaking Strength & Elongation at Break, pH of Aqueous Extract, Glass Content
- **Carbon Composites:** Flexural Strength, Lap Shear Strength, Tensile Strength
- **Other Composites :** Charpy of Izod impacts.

6.6 Special Testing

Apart from undertaking testing of fibres, yarns and fabrics (for physical as well as chemical properties), numerous special tests (that are most sought after) are conducted at BTRA. The same are widely availed by the industry. BTRA carried out 3216 tests under special testing. The type of tests conducted here as follows.

- ✓ Differential Scanning Calorimetry (DSC) Analysis
- ✓ Thermal Gravimetric Analysis (TGA)
- ✓ Gel Permeation Chromatography for Molecular Weight Distribution
- ✓ X-ray Diffraction Analysis (Mineral analysis / Chart diffraction / Fibre orientation angle / Material identification)
- ✓ FT-IR spectroscopy (Material & Finish identification)
- ✓ Scanning Electron Microscope
  - Longitudinal View of Fibres/Yarns
  - Cross-section View of Fibres/Yarns
  - Micrographs for Powder Sample
- ✓ Static Charge Measurement
  - Total Charge Developed and Half Decay Time [ASTM D:4238]
  - Surface Resistivity [ASTM D:257]
  - Volume Resistivity
- ✓ Melt Spinning Experiments
- ✓ Other special tests undertaken
  - UV Protection Factor [AATCC-183]
  - Surface Tension – drop volume method (or) contact angle method
  - EMI Shielding Effectiveness [ASTM D 4935]
  - Birefringence measurement by Polarising Microscope
  - Particle Size Analysis
  - Contact Angle
  - Total Organic Carbon (TOC) Analyser
  - Refractive Index of Liquids (Abbe's Refractometer)

- ✓ **Flammability Tests**

General Apparel

- Ease of ignition of vertically oriented specimen [BS EN ISO 6940]
- Flame spread properties of vertically oriented specimen [EN ISO 6941 / BS EN 1103]
- UK night wear safety regulation [BS 5438 / BS 5722 Test 1,2 & 3]

Curtain, Drapes and Blinds

- Ignitability of vertically oriented specimen [BS EN 1101]
- Flame spread properties of vertically oriented specimen [BS EN 1102]

Personal Protective Clothing

- Limited flame spread [EN 532 / ISO 15025 / BS 5438: 1976 Tests 1, 2 & 3]
- Limiting Oxygen Index [IS:13501 / ASTM D 2863]

- Vertical Flammability [IS:11871 / BS:3119 / NFPA 1975 / NFPA 2112]
- Horizontal Flammability [IS:15061 / ASTM D:5132 / FMVSS / SUZUKI]
- 45°C Inclined Flammability [16 CFR 1610 / ASTM D:1230 / IS:11871(B)]
- Carpet Flammability [ASTM D:2863 / 16 CFR 1630 / ISO:6925 / BS : 6307]
- Vinyl Coated Fabric Flammability [IS:1259]

Flammability of plastics

- Vertical Burning Test [UL 94 (VO.V1.V2) / ASTM D:3801 / IEC 60695–11–10(B) / ISO:1210(A) / UL 94 (VTM) / ASTM D: 4804 / ISO:9773 (Non Rigid Sample) / UL 94 (5V) / ASTM 5048 / IEC 60695-11-20]
- Horizontal Burning Test (Wing Top Method) [ASTM D:4986 / ISO:3582 / ISO:9772]
- Horizontal Burning Test [UL94HB / ISO:1210(A) / ASTM D:635 / IEC:60695–11–10(A)]
- Determining deterioration of visibility due to smoke released on combustion of materials [using Smoke Visibility Tester] as per UIC 564.2 OR Appendix-15 method
- Determination of Toxicity Index [Fume Toxicity Tester] as per N.C.D. 1409 method

6.7 Eco-parameters Testing

The following types of tests are undertaken at BTRA.

- Formaldehyde Content in Auxiliaries as per GOTS
- Allergenic Disperse Dyes
- Glyoxal Content in Textiles
- Polycyclic Aromatic Hydrocarbons (PAH)
- Identification & Quantification of Virgin / Recycled Polyester Fibre
- Free formaldehyde [ISO:14184 - part 1]
- Release formaldehyde [ISO:14184 - part 2]
- Chlorophenol - PCP / TECP / OPP
- Pesticides - Organo chlorine / Organo phosphorous / Others / Total pesticide residue
- Aryl amines
- Phthalates
- Chlorinated organic carriers
- Poly chlorinated biphenyls
- Hexachloro benzene
- Allergenic disperse dyes
- Organo tin
- Heavy metals
- Oekotex-100 [9 metals]
- Hexavalent chromium
- Spectro photometric evaluation of dyes/optical whitener - Water soluble / Solvent soluble
- Analysis of organic compounds by - GC-FID / GC-MS {NIST library search report}
- Perfumery analysis by GC-MS
- TLC analysis
- HPLC analysis
- Triclosan

... and many more

6.8 Microbiology Testing

Textiles, being an integral part of our every day life, have been involved in search of hygienic functional garments with application of anti-microbial finishes. BTRA carried out 707 tests under microbiology testing. The type of tests conducted at this laboratory is as follows.

- Antifungal activity, assessment on textile materials: Mildew and Rot resistance of Textile materials Test-II – Agar Plate, Chaetomium globosum [AATCC 30 Test 2]
- Antifungal activity, assessment on textile materials: Mildew and Rot resistance of Textile materials Test-III – Agar Plate, Aspergillus niger [AATCC 30 Test 3]
- Antifungal activity, assessment on textiles materials: Mildew and Rot Resistance of Textile materials Test –IV – Humidity Jar, Mixed spore suspension [AATCC 30 Test 4]
- Antibacterial Activity of Fabrics, Detection of: Agar Plate Method [AATCC 90]
- Assessment of Antibacterial Finishes on Textile Materials [AATCC:100]
- Antibacterial Activity of Fabrics, Assessment of Textile Materials – Parallel Streak Method [AATCC:147]
- Antimicrobial Activity Assessment of New Carpets - qualitative antibacterial assessment / quantitative antibacterial assessment / quantitative antifungal assessment. [AATCC 174 – Parts 1 to 3]
- Determination of a population of microorganisms on products [ISO 11737 – Pt I]
- Textile fabrics – Determination of antibacterial activity – Agar Diffusion Plate Test [ISO 20645]
- Textiles – Determination of antibacterial activity of antibacterial finished products [ISO 20743]
- Determination of the Antimicrobial Activity of Immobilized Antimicrobial Agents Under Dynamic Contact Conditions [ASTM E 2149]
- Standard Practice for Determining Resistance of Synthetic Polymeric Materials to Fungi [ASTM G 21]
- Test for antibacterial activity and efficacy on Textile Products [JIS L 1902]
- Antimicrobial products - Test for antimicrobial activity and efficacy for plastics and other antimicrobial coated hard surfaces. (Film Contact Test Method) [JIS Z 2801]
- Microbiological Examination of Water [IS 1622 & IS 5403]
- Methods for testing cotton fabrics for resistance to attack by microorganism by Humidity Chamber Method [IS 1389]
- Evaluation of Bacterial Filtration Efficiency of Medical Textiles [In-house Test Method]
- Aerobic Plate count & Yeast and Mold count [Bacteriological Analytical Manual]
- JIS Z 2801:2000 for Paints / Films

6.9 Other Services

BTRA continued the activity of supplying chemicals / gadgets, repairing / calibrating gauges / testing instruments and testing stores accessories for the mills. The details are given in Appendix-9.

7.0. Powerloom Service Centres (PSCs)

BTRA runs three Powerloom Service Centres (PSCs) [at Ichalkaranji, Solapur and Madhavnagar-Vita]. In order to improve the quality, operating efficiency and productivity of powerloom clusters, BTRA PSCs provide technical consultancy, testing services, training in loom working, loom maintenance, disseminating information through training programmes, workshops, demonstrations and discussions. Liaison visits are made by BTRA staff to have a first-hand view of the problems faced by the powerloom weavers/processors and on the spot suggestions are made. The activities of these centres are given in the following Table-2.

Table – 2

Activities of BTRA Powerloom Service Centres

Activities		Ichalkaranji	Solapur	Madhav-nagar-Vita
Total yarn and fabric samples tested for physical s & chemical properties		11424	3293	825
Number of technical assistance / trouble shooting / consultancy given		273	394	40
Total number of persons trained		110	255	95
Total number of trainee man-days		-	2861	1559
Total seminars / workshops conducted		13	9	4
Survey of closure of powerlooms	Units	512	408	350
	Looms	6732	7114	2922
Number of interactive workshops conducted for TUF scheme and Group Insurance scheme		13	-	4
Group insurance facilitations for powerloom workers [number of beneficiaries]		976	3043	295
Number of Advisory / PPCICC meetings conducted		1	1	1
Number of samples for design development [non-CAD] / Analysis		-	-	7

7. SPECIAL EVENTS

7.1‘Sustainable Eco Management System in the Textile Processing Industry’ Conference at BTRA

BTRA organised Awareness-cum-knowledge sharing session on the topic "Sustainable Eco Management system in the Textile Processing Industry" on 27" April 2018 at BTRA, Mumbai. This Conference was based on the theme of BTRA project “Analysis of Eco-Management In Indian Textile Processing Industry’’, sponsored by the Ministry of Textiles, Government of India.

In this conference, major focus was given on the current status of eco-management in the textile industry, GAP analysis, the recommendations with best available techniques for environment protection, textile effluents, effluent treatment plant, chemical management system, energy conservations practice, sustainability in textile sector etc. Textile industry experts and BTRA subject matter experts presented following papers based on recent trends and of immediate importance to the textile processing industries.

- Analysis of Eco management in Indian textile processing Industry - Theme, objectives, analysis and the next journey
- Chemical Management System (CMS) - A tool for sustainability
- *Zero Liquid Discharge Technology in textile effluent
- Energy conservation and re-engineering in the textile industry
- Overall sustainability in textile processing - A case study

More than 50 textile mills' representatives participated. The conference deliberated on best available techniques and possibility of adopting them in the industry. Participant mills gained lot of information on the above subject and their doubts were cleared in the Q&A session from knowledgeable experienced persons from textile processing sector. Mr. S.K. Saraf, Chairman, BTRA, Mr. Narendra Dalmia, Deputy Chairman, Dr. Anjan K. Mukhopadhyay, Director, BTRA and BTRA scientists were present in this conference.

7.2 Training on 'Effluent Treatment Plant, Water Recycling and Sustainable Technology'

Around the globe, textile industry is under pressure to comply with ecological and environmental legislation and consumer safety guidelines. Consumer awareness of the impact of hazardous chemicals is growing and Government, NGOs and International Brands are getting stricter with compliance issues. The textile industry thus needs a better understanding of the issues involved and also the guidance to implement Eco- compliance systems at their end. BTRA has taken the initiative and conducted a specialized in-depth training program on Effluent Treatment Plant (ETP), Water Recycling and Sustainable Technology.

The training program was inaugurated on 20th Aug 2018. Mr. Sunil Chari (Managing director- Rossari Biotech Ltd) was the Guest of Honour. Mr. S.K. Saraf (Chairman- Governing Council BTRA), Dr. Anjan K. Mukhopadhyay (Director-BTRA), Mr. Sanjay Harane (Advisor-BTRA), BTRA scientists and participants from Textile Industry were present. The handbook on ETP, water recycling & sustainable technology and Analysis of waste water & restricted substances were published during this inaugural function.

This training program on ETP, water recycling & sustainable technology is based on the need and outcome of the studies under MOT sponsored ongoing BTRA project "Analysis of the eco-management in the Indian textile processing industry" . One of the objectives of this training program is to develop skills and bring awareness with a focus on water effluent treatments, water recycling activity and the final impact of pollution on the eco- system. It is worth noting that "National Environmental Engineering Research Institute" (NEERI) and "Maharashtra Pollution Control Board" (MPCB) have given their full support.

During the first part of training session of six days duration, the BTRA experts and Trainers explained in detail the pollution source, pollutants from textile industry , restricted substance and their effect on eco-system, Pollution removal processes, Environmental norms, various effluent and restricted substances related test procedures, textile effluent characteristics, stage-wise waste-water treatment, recycling with advanced filtration system complying with zero liquid discharge (ZLD) requirements, ETP design for capacity, MIS and costing for daily operations, cost reduction techniques, checkpoints in ETP, chemical management system, Best management practices and Best available techniques for greener and cleaner sustainable textile production etc.

7.3 Award/Recognition

(i) BTRA bags the "Excellence in Innovations in Textile Sector" award.

BTRA was selected by the Ministry of Textiles for award in the 'Excellence in Innovations in Textiles sector'. The Ministry of Textiles (MoT) has constituted a special committee to assess and recognize the best innovations in Indian Textile Industry. The special committee was constituted which included eminent leaders of the Indian Textile Industry. The committee invited applications from Indian Textile companies and Textile Research Associations (TRA), to identify and reward out-of-the-box thinking and innovative ideas which has an edge over the existing technology and has cost cutting, energy saving and ecofriendly approach.

The award winning innovation is related to the integration of electronic components and nano-technology resulting in the birth of intelligent fabrics possessing specific properties. This filament with enhanced piezo-electric property can be used as sensor, actuator or generator as a part of garment. This filament will be able to replace the use of existing sensors, actuators and generators that are hard and fragile and affect the comfort of the wearer.

The award ceremony was held on 6th January, 2019 at Taj Mahal Hotel in New Delhi, it was during the award giving ceremony.

Award conferred by the Vice President of India, Mr Venkaiah Naidu and was received by Dr. Anjan. K. Mukhopadhyay, Director, BTRA. The Textile Minister, Mrs. Smriti Irani was also present on the dais

8. INFORMATION DISSEMINATION / INDUSTRY INTERACTION

8.1 Papers Presented & Published

Many research papers of topical interest are presented in various meets and published in journals. The same are given in Appendix- 2 and 3.

8.2 Training Programmes Conducted

BTRA organised many training programmes [at BTRA and at Unit level] during the year under review. Details are provided in Appendix-4.

8.3 BTRA Publications / Library

A list of BTRA publications, brought out during the period under review, is given in Appendix–6. BTRA library serves its users and textile units with 'Current Awareness Services' on a regular basis, through the publication of 'BTRA Scan (Quarterly)' and 'BTRA Bulletin (Monthly)'.

BTRA Library has added many specialized books especially in the areas of geotextiles, nonwovens, composites and nanotechnology. The details of additions to library are given in Appendix–8. It receives around 30 foreign and 35 Indian journals / magazines / newsletters regularly. As on 31st March, 2019, the library has 22,948 holdings. BTRA updates its website (www.btraindia.com) at regular intervals.

8.4 Academic Activities

BTRA offered internship to 25 students from Various technical education institutes during the period under review.

9. EXHIBITIONS PARTICIPATION

BTRA participated in the following exhibitions and various research publications and posters depicting the research and consultancy activities of BTRA were displayed during the occasion.

- Tecoya Trend 2018 Exhibition during 5th and 7th April 2018 at Mumbai.
- Technotex India 2018 Exhibition held on 27th June 2018 at Mumbai
- GTTES 2019 Exhibition during 18th to 20th January 2019 at Mumbai.

BTRA Stall view at Technotex India 2018 Exhibition held on 27th June 2018 at Mumbai

BTRA Stall view at GTTES Exhibition during 18th to 20th January 2019 at Mumbai

Various research publications, samples of technical textiles and posters depicting the research, testing, training and consultancy activities of BTRA were displayed during the occasion. Visitors were given brochures related to testing, publications and training as promotional materials to the visitors.

Acknowledgements

The major portion of R & D work at BTRA is based on the financial assistance provided by the various sponsoring agencies. The generous support from the sponsors has also enabled BTRA to build a good and useful infrastructure, which efficiently supports the R & D work. Our in-depth gratitude goes to the Ministry of Textiles, Government of India for their generous support and to the Board of Research on Nuclear Science, under Department of Atomic Energy, Government of India and Defence Research & Development Organisation, under Ministry of Defence, Government of India. Thanks are also due to members of BTRA for giving constant encouragement and support to BTRA scientists / technologists to continue their work in uplifting the industry.

Appendix – 1

SPONSORED PROJECTS

On-going Projects

Ministry of Textiles, Government of India, New Delhi

- Studies on effect of plasma treatment for adhesion improvement of coated technical textiles
- Analysis of Eco-management in Indian Textile Processing Industry
- Development of electronic servo control drive industrial TFO twister for heavy denier filament yarn
- Development of cotton waste based oil absorbent for oil spill clean-up
- Nano-fibre application to enhance the anti-clogging properties of geotextiles
- Melt spinning of PVDF / ZnO nanostructure hybrid filament for wearable smart textile
- Development of test method for analysing hexavalent chromium content in dyes, pigments and textile auxiliaries
- Centre of Excellence for Geotech
- BTRA powerloom service centre – Ichalkaranji
- BTRA powerloom service centre – Solapur
- BTRA powerloom service centre – Madhavnagar

BRNS, Department of Atomic Energy, Government of India, New Delhi

- Studies on performance enhancement of textile effluent treatment plant by electron beam method

New Project Initiated

Defence Research & Development Organisation, Ministry of Defence, Government of India, New Delhi

- Preparation of nanofibre based protective clothing against chemical warfare agent

Appendix–2

PAPERS PRESENTED IN CONFERENCES / SEMINARS

Staff Name	Subject	Occasion/Venue/Date
M/s. Tanaji Kadam	"Eco management in Indian textile processing industry: Theme, objectives, analysis and next journey"	Conference on sustainable eco management by BTRA Mumbai on 27th April 2018
Mr.R.A.Shaikh	Proficiency testing scheme on textiles	2nd PT/RMP Conclave by NABL held at Hotel Ramada Plaza Palm Grove, Juhu, Mumbai on 31st August 2018
Mr. V.K. Patil	"Geosynthetic Products: Types and its Applications"	Seminar on "Geosynthetics" at Hotel Ambassador Palava, Chennai, jointly organized by The Department of Handlooms and Textiles, Govt.of Tamilnadu and Sardar Vallabhbhai Patel international School of Textiles and Management, Coimbatore on 19th December 2018.
Dr. Anjan K. Mukhopadhyay /Mr. Amol .G . Thite	Silver Nanoparticles Functionalized Cotton Fabric by Electron Beam Radiation Technology	58th Joint Technological Cotton Conference of TRAs held at NITRA Gaziabad on 15th and 16th February, 2019.
M/s. Smita Baride	Study of Atmospheric Pressure Plasma Pre-Treatment on Polyester Fabric for Improved Polypyrrole Bonding and conductivity	58th Joint Technological Polyester Conference of TRAs held at NITRA Gaziabad on 15th and 16th February, 2019.
Dr. Prasanta Panda and Ms. Archana Gangwar	Nanofiber Coated Prefabricated Vertical Drainage (PVD) Membrane with improved anti-clogging property	58th Joint Technological Vertical Conference of TRAs held at NITRA Gaziabad on 15th and 16th February, 2019.

Appendix–3

PAPERS PUBLISHED IN JOURNALS

Staff Name	Title	Journal Name
Mrs. Smita Baride	'Improvement of polypyrrole coating adhesion on polyester fabric by atmospheric pressure plasma technology'	'COLOURAGE' p. 29 – 35'. June 2018,
Mrs. Smita Bardie	'Dielectric barrier discharge plasma induced surface modification of polyester/cotton blend fabrics to improve polypyrrole coating adhesion and conductivity'	Journal of the Textile Institute, July 2018
Mr. Amol G Thite/ Mr. Kumar Krishnanand/ Mr. D.K.Sharma/ Dr. Anjan Mukhopadhyay	'Multifunctional finishing of cotton fabric by electron beam radiation synthesized silver nanoparticles'	'Radiation Physics and Chemistry' p.g. 173 – 179'. September 2018,
Mrs. Pragati S Kulkarni/ Mr. Tanaji Kadam	An Introduction to lean six sigma in the Textile Industry	BTRA Scan, 47(2), p. 1 – 8, June 2018,
Mrs. Smita Deogaonkar	Novel DBD Plasma pre-treatment on PET fabric for enhanced polypyrrole bonding and conductivity	BTRA Scan, 47(2), p. 9-18,June 2018,
Mr. V. K. Patil	Geosynthetics: Boon to Infrastructure Industry	BTRA Scan, 47(3), p. 1-15, Sept 2018,
Mr.M.P.Sathianarayanan/ Ms. Rina Nayak/ Yogesh Hande	Determination of Cr(VI) content in water insoluble dyes,pigments and textile auxiliaries	BTRA Scan,47(3), p.16-22, Sept 2018,
Mr.M.P.Sathianarayanan/ Ms. Rina Nayak/ Yogesh Hande	Determination of Cr(VI) content in water soluble dyes by HPLC-Post Column derivatization followed by Spectrophotometer Analysis	BTRA Scan, 47(4), p. 1-11, Dec 2018,
Mr.S.Subramanian/ Mr.R.A.Shaikh/ Mr.V.K.Shinde	Relevance of proficiency testing of textiles and geotextiles	BTRA Scan, 47(4), p. 12-13, Dec 2018,

Appendix – 4

TRAINING PROGRAMMES CONDUCTED

Subject	To Whom	Duration
	On-Site Training	
'Four Point Fabric Inspection'	Eighteen staff of M/s. TRADC, Kharach	For 2days in April 2018
'Good Work Practices and Utility Conservation'	Twelve staff of M/s. Dhanalaxmi Fabrics, Dombivali	For 1day in April 2018
'Training for textile elements and processing'	One person from M/s. Dhanshree Textiles, Pali	For 4days in April 2018
Internship Training	Two students from M/s. SNDT Women's University, Juhu	For 1day in April 2018
'Textile Costing'	Fifteen staff of M/S.NTC Mills, Mumbai	For 2days in May 2018
'Training of Assessors'	Twenty-nine staff of M/s. Textile Sector Skill Council, Mumbai	For 6days in May 2018
'Good Work Practices'	Fourteen staff of M/s. Kint Craft International, Delhi	For 1day in May 2018
'Good Work Practices'	Thirteen staff from M/s. Anupam Tex Processor	For 1day in May 2018
'Good Work Practices'	Eighteen staff from M/s. Jain Textile Industries, Delhi	For 1day in May 2018
'Processing & Weaving'	One staff from M/s. Natural Fibre and Fabrics	For 1day in May 2018
'Wet Processing'	One staff of M/S. Brijesh Natural Fibres and Fabrics	For 1day in June 2018
'Weaving'	Thirty staff of M/s. Weaving Cluster, Wadvani Dist-Beed	For 4 days in June 2018
'Textile Terminology and Testing'	Two staff of M/s. Yash Chokhani and Rishab Pagaria, Mumbai	For 1 day in June 2018
'Training on Textiles'	Five staff in Mumbai.	For 3 days in November 2018
Program on Cleaner production in Textile Processing and ETP.	M/s. Smita Deogaonkar from BTRA	For 10 days at BTRA, August 2018
Chadar Cluster-Mktg'	M/S. Solapur Chadar Cluster, Mumbai	For 2 days inMumbai, January 2019

Appendix – 5

CONFERENCES / SEMINARS / TRAINING PROGRAMMES / WORKSHOPS ATTENDED BY BTRA STAFF

Name of Staff	Occasion	Place	Date
Mr. V.K. Patil	Expert panel meeting of BIS on Geosynthetics (TX-30)	The Office of Indian Technical Textiles Association, Mumbai	16th April 2018
Mr. Vijay Gawde	Participate in seminar at Samarth Skill Development	Delhi	14th May 2018
Mr. Tanaji Kadam / Mr. Vijay Gawde	LIVA Confluence-2018	Hotel Grand Hayat, Mumbai	25th May 2018
Mr. Tanaji Kadam	Purchase Committee meeting for Cetcon Yarn Dyers	DIC Pune	24th May 2018
Mr. V.K.Patil	Curtain Raiser of Technotex 2018	New Delhi	17th May 2018
Mr. V.K.Patil	Review of Technotex 2018 with secretory MOT	Udyog Bhavan, New Delhi	21st May 2018.
Mr. Tanaji Kadam	NTC house for 9 mills valuation assignment charges	NTC House in Mumbai	19th June 2018
Mr. Tanaji Kadam	lecture on the subject “Sustainable Chemistry”	ICT, Mumbai	29th June 2018.
Mr. V.K Patil	Meeting of BIS panel expert on Geosynthetic	ITTA, BTRA Mumbai	11th June 2018
Mr. V.K Patil	Meeting (TX-30) usage of Geosynthetic demand & local source	Textile Commissioner Mumbai	29th & 30th June 2018
Mr. Vijay Gawde	Samarth Skill Development Textile Committee	Delhi	11th July 2018
Mr. V.K.Patil	BIS meeting on Medical Textiles, Tx	Manak Bhavan	02nd July 2018
Mr. V.K.Patil	GOI Empower committee for NER state project approval	Udyog Bhavan	04th July 2018
Mr. V.K.Patil	BIS expert panel meeting on Geosynthetics	ITTA, BTRA-Mumbai	31st July 2018

Name of Staff	Occasion	Place	Date
Mr. V.K.Patil	Meeting related to Upgradation of spinning mills Empanelment	Maharashtra State co-op Textile Federation Ltd., Mumbai	21st August 2018.
Mr. V.K.Patil	Meeting on SION scrutiny and approval	office of Textile Commissioner, Mumbai	26th September 2018.
Mr. V.K.Patil	Meeting of Tx35 BIS on Agrotextile	SASMIRA,Mumbai	27th September 2018.
Mr.R.A.Shaikh	Meeting for TX 31 by BIS	CIRCOT Mumbai	28th September 2018.
Mr. V.K.Patil	8th meeting of Expert Panel- Geosynthetics	ITTA Office, BTRA Mumbai	30th October 2018
Mr.R.A.Shaikh	Purchase committee meeting for Bid Evaluation of Tender to purchase HVI machines.	Cotton Corporation of India Office at CBD Belapur, Navi Mumbai	19th November 2018
Mr. Akash Kanse	BEE Training on ‘Textile Cluster’	Chennai	12th and 13th December 2018
Mr. V.K. Patil	SION meeting at o/f Textile Commissioner,	Mumbai	31st January 2019
Mr. V.K. Patil	Meeting at National Conclave on Technical Textile and Curtain Raiser for Technotex 2019	Mumbai	29th January 2019
Mr. V.K. Patil	Meeting of Mandates of Technical Textiles With Jt.Secretary,	MOT at Udyog Bhavan,New Delhi	4th February 2019
Mr. V.K. Patil	BIS meeting of Tx 30 & Tx 33	Manak Bhavan, Mumbai	26th February 2019
Mr. Tanaji Kadam	Committee meeting for fixation of shrinkage and elongation norms for Tamilnadu Govt School uniforms at Handloom and Textiles	Chennai	6th March 2019
Mr. Tanaji Kadam	9th PAMC meeting at Textile Commissioner Office	Mumbai	27th January 2019

Appendix – 6

PUBLICATIONS RELEASED BY BTRA

BTRA Scan	4 Issues [Quarterly]
BTRA Bulletin	12 Issues [Monthly]

Appendix – 7

OTHERS

PRODUCTS / CHEMICALS / INSTRUMENTS / GADGETS SOLD ON REIMBURSABLE BASIS	• Viscosity cups [27 no.] • Cuprammonium solution [8.2 litres] • Fluidity Tubes [6 no.] • Hook for drove test [2 no.]
INSTRUMENTS / GADGETS CALIBRATED	• Various instruments at BTRA Test Laboratories and at 3 BTRA PSCs are calibrated regularly
INSTRUMENTS SERVICED	• Servicing of several equipments / instruments at BTRA Test Laboratories

Appendix – 8

NEW ADDITIONS TO BTRA LIBRARY

- 2018 TECHNICAL MANUAL OF AATCC, AATCC. USA, 2018
- SUSTAINABILITY IN FASHION AND APPARELS – Challenges and Solutions, Dr. M. Parthiban, et al., Woodhead Publishing India Pvt. Ltd., New Delhi, 2017
- 2018 TECHNICAL MANUAL OF AATCC, AATCC, USA, 2018
- CHEMISTRY FOR ENGINEERS, Abhijit Mallick, MV Learning, New Delhi, 2014
- TEXTILES – ADVANCES IN RESEARCH AND APPLICATIONS, Boris Mahltig, Nova Science Publishers, USA, 2018
- Engineering Cotton Yarns with Artificial Nerual Networking, Dr.Tasnim N.Shaikh & Sweety A.Agrawal, Woodhead Publishing India Pvt. Ltd, New Delhi, 2017
- Pollution Control in Textile Industry, S.C.Bhatia, Woodhead Publishing India Pvt. Ltd, New Delhi, 2017
- Handbook of Textile Testing and Quality Control,Grover,2011
- Textile Yarns Technology Structure and Applications,Goswami,2011
- Handbook on ETP, Water Recycling, and Sustainable Technology, BTRA Publication 2018
- Analysis of Wastewater and Restricted Substances, BTRA Publication 2018
- Weaving Calculation, Costing & Projects, Dr. M. K.Talukdar and Dr. Anirban Guha, Shree Samarth Krupa Publications 2018-Ahemedabad
- New Trends in Natural Dyes for Textiles, Padma Shree Vankar and Dhara Shukla, Woodhead Publication,UK 2018

CDs / Soft Copy Downloads

- Latest International Standard Test Methods: ASTM D5887D5887M.37515, ASTM D5888.6005, ASTM D5889D5889M.8419, ASTM D5890.11962, ASTM D5891D5891M.31879, ASTM D5993.16196, ASTM D6072D6072M.18727, ASTM D6102.21965, ASTM D6141.30598, ASTM D6243D6243M.32869, ASTM D6495D6495M.12788, ASTM D6496D6496M.33553, ASTM D6766.38539 and ASTM D6768D6768M.13844.

Appendix – 9

DIRECTOR'S ENGAGEMENTS

Month	Details
April, 2018	♣ Attended a meeting, along with BTRA Chairman Mr. S.K. Saraf, at Ernest & Young Office, Mumbai on 3rd April, 2018 ♣ Attended a meeting related to CoE at Textile Commissioner's Office, Mumbai on 6th April, 2018 ♣ Attended a meeting related to plasma at Arvind Mills, Ahmedabad on 7th April, 2018
May, 2018	♣ Attended the 2nd subcommittee meeting of Technotex-2018 at TXC office, Mumbai on 05th May, 2018 ♣ Attended the stake holders meeting under Chairperson of the Hon'ble Minister of Textiles in New Delhi on 14th May, 2018 ♣ Attended the LIVA Confluence 2018 award evaluation in Mumbai on 22nd May 2018 ♣ Attended the LIVA Accredited Partners Forum (LAPF) Confluence 2018 awards programme, organized by BIRLA Cellulose as part of the jury in Mumbai on 25th May 2018. ♣ Inaugurated TANTU exhibition a display of graduation project work of students of textile design at NIFT Mumbai on 25th May 2018.
June, 2018	♣ Attended the International Conference on Nonwoven Textiles in Mumbai on 06th June 2018. ♣ Attended the meeting of the Hon'ble Minister of Textiles with concerned experts/officials on issue of defence related Technical Textiles in New Delhi on 22nd June 2018 ♣ Participated as a panelist in the session on "Strengthening Infrastructure for New India" in the Technotex 2018 in Mumbai on 28th June 2018 ♣ Attended the meeting of Textile Commissioner's office Mumbai on 29th June 2018
July, 2018	♣ Attended the 1st meeting of the committee on preparing a R&D plan for the futuristic growth of Technical Textiles in India under Chairmanship of Dr.V.K.Sarswat, member NITI Ayog, New Delhi on 19th July, 2018 ♣ Attended the meeting along with Mr.Harane with Dr.Supate at MPCB. Mumbai on 24th July 2018
August, 2018	♣ Attended the 2nd meeting of the committee on preparing an R & D plan for the futuristic growth of Technical Textiles in India under the Chairmanship of Dr.V.K.Saraswat, member NITI Ayog, New Delhi on 03rd August 2018 ♣ Attended the Textile Technology Conclave at IIT Bombay on 23rd August 2018. ♣ Along with Mr.Sharad Saraf , Chairman, Governing Council attended the 3rd meeting of the committee on preparing an R & D plan for the futuristic growth of Technical Textiles in India under the Chairmanship of Dr.V.K.Saraswat, member NITI Ayog, New Delhi on 28th August 2018
September, 2018	♣ Attended the farewell meet of Dr. Kavita Gupta, Textile Commissioner, organized by TEXPROCIL and SRTEPC in Mumbai on 15th September, 2018. ♣ Attended the AGM of ITTA in Mumbai on 20th September, 2018.
October, 2018	♣ Attended the meeting of Nodal Officers of MOT to review the progress made for implementation of recommendations dated 30th July 2018 of the committee of secretaries for giving boost to technical textiles in India in New Delhi on 4th October 2018. Attended the 2nd round discussion with Innovators as one of the Jury member of the Inno Tex 2018 for the Central Zone in Mumbai on 23rd October 2018.

Appendix – 9 (Contd.)

DIRECTOR'S ENGAGEMENTS

November, 2018	♣ Attended a "One-day Workshop on Plasma Applications in Textile Processing" as member of Advisory Panel held in Gandhinagar, Gujarat on 20th November 2018. ♣ Attended the 5th meeting of the Technical Committee to indentify HSN codes for Technical Textiles in Mumbai on 29th November 2018.
December, 2018	♣ Director visited the Technocraft plant at Murbad on 22nd December 2018
January 2019	♣ Attended and received an award on "Excellence in Innovations in Textile Sector" during an outreach event an Award ceremony organized by the Ministry of Textiles on 06th January, 2019 in New Delhi. ♣ Attended the inaugural session of GTTES-2nd Global Textile Technology and Engineering Show 2019 on 18th January 2019 in Mumbai. ♣ Attended the National Conclave on Technical Textile and Curtain Raiser of Technotex 2019 on 29th January 2019 in Mumbai. ♣ Attended a meeting for R & D work with BARC Scientists on 30th January 2019 at Kharghar, Mumbai. ♣ Attended the meeting along with the Governing Council Chairman, Mr.Sharad K Saraf with the MPCB Chairman on 31st January 2019 at Mumbai.
February 2019	♣ Attended a meeting on Boost to Technical Textiles in India under Chairmanship of JS (Technical Textiles) on 4th February, 2019. ♣ Attended the Joint Technological Conference of the TRA's from 15th to 16th February, 2019 held at NITRA, Ghaziabad.
February 2019	♣ Attended the 11th PAMC meeting on 18th February, 2019 in New Delhi. ♣ Visited Maccaferri on 18th February, 2019 in New Delhi. ♣ Attended the 22nd meeting of Geo-synthetics Sectional Committee, TXD 30 in joint session with 11th meeting of Industrial Fabrics Sectional Committe, TXD 33 on 26th February 2019 in Mumbai.
March 2019	♣ Attended the Project Monitoring Committee meeting, scheduled by the Technology Development Board, DST on 04th & 5th March 2019 in Kharach, Surat. ♣ Attended the 10th meeting of the Project Approval Committee (PAC) for component I & III under R&D scheme on 26th March, 2019in New Delhi.

Appendix – 10

DISTINGUISHED VISITORS TO BTRA

Name of the Visitors	Company
Mr. Amit Bhojne, National Manager (Sales)	Icon Analytical
Mr. Shardendu Verma, V.P. (Operations)	Linen Art Pvt. Ltd
Mr. S. Nandakumar, Technical Director	Bombay Test House
Mr. Prashant Chaudhari, Senior Executive (Sales),	JEOL Solutions for Innovations
Ms. Radhika Boddu, Marketing Manager	Textile Excellence
Mr. Mehul Shah,	Amber Home
Mr. Mahesh Rathod, Sr.Project Manager	Technosoft Engineering Projects Limited
Dr. Chetan Hazaree, HOD-R&D (TIIC)	L & T Ltd
Mr. Tapas Nandi, Regional Sales Director	Suarer Volkmann
Mr. Amol Nikam	Jupiter Fincorp
Mr. Prasad Pant, South Asia Director	The ZDHC Foundation.
Mr. J. C. Kulkarni, Manger-Sales & Product Support	Uster Technologies (India) Marketing Pvt. Ltd
Mr. R.M.Karvekar,M.E., Chief Technical Officer	MCS Testing Machines MCS Mehatronic.
Mr. Amit Kumar Malik, Sr. Manager	Hydraulic and Engineering Instruments (HEICO).
Mr. Deepak M Jain, Partners	M. S. Textiles
Ms. Dipanwita Sahani, Assistant General Manager	Bank of India
Ms. Gauri Kunte, Assistant Manager, Process Development	Finor Piplaj Chemicals Ltd.
Dr. Christina Raab, Implementation Director	The ZDHC Foundation.
Mr. Rohan M Patil, Director	Nirtech Pvt.Ltd.
Mr. Prashant Adsul, Co-Founder & Director	Telsa Innovations Pvt.Ltd.
Mr. Yogesh Garg, Managing Director,	Dilo Group Engineering for Nonwovens.
Mr. Mangesh Suryavanshi, Proprietor	Surya Venetian Blinds
Mr. Surabhi Jain,Manager	Indofil Industries Limited.
Mr. Asesh Sarkar,Consultant	Xinova
Mr. Vijay Moghe, Business Manager- Textile	Rishabh metals & Chemicals Pvt.Ltd.
Dr. M.S.Yogendra Kumar, Scientist	Ministry of Defence, Bangaluru
Ms.Jyostana Sreevastava,Vice President-Business	Rishabh metals & Chemicals Pvt.Ltd
Mr. Ilkhom Khaydarov, Chairman	Uzbekistan Textile and Garment Industry Association.
Mr. Dinesh M. Anam, Head- R & D Innovations	PRS Permacel Pvt. Ltd.
Mr. Manish Upadhyay, Sr. Executive Application Engineer	Khosala Profile Pvt. Ltd.
Mr. Prasad Shetty, Business Development Executive	Yashaswi Academy for Skills
Dr. T. Senthikumar, Scientist	ICAR-Central Institute for Research on Cotton Technology

Appendix – 10(Cont.)

DISTINGUISHED VISITORS TO BTRA

Name of the Visitors	Company
Mr.Harish Vadodaria	Industrial Atomizer Co.
Mr. Nitesh Shetty	JEOL India Pvt.Ltd
Mr. Ritvik Rao	Sampurn(e)arth Environment Solutions Pvt.Ltd.
Mr. Manoj Jalan	Dombivli better Environment System Association & Nav Bharat Industries
Mr.Prashant Somani	Navjeevan Synthetics Pvt.Ltd
Dr.T. Senthikumar, Scientist	ICAR-Central Institute for Research on Cotton Technology
Mr.Harish Vadodaria,	Industrial Atomizer Co.
Mr. Nitesh Shetty	JEOL India Pvt.Ltd
Mr. Ritvik Rao	Sampurn(e)arth Environment Solutions Pvt. Ltd.
Mr. Manoj Jalan	Dombivli Better Environment System Association & Nav Bharat Industries
Mr.Prashant Somani	Navjeevan Synthetics Pvt.Ltd
Mr.Rohan Patodia	Prime Hitech Textiles LLP Prime Urban development India Ltd(Textile Division)
Mr.Rakesh Damani	Gulnar Plastics Pvt.Ltd
Mr.Binoj Nair	Kandui Industries Pvt.Ltd
Mr.Satyapriya Dash	Human Protection business (Woven)
Mr.Rahul Dev Mal	Research & Development (R&D)
Dr. K.H.Sinur, Scientist	Advanced Systems Laboratory, Hyderabad.
Mr.B.M.Gode	Trutzschler India Private Limited
Mr.Mahadev Haval	Maccaferri Environmental Solutions Pvt Ltd
Mr.Mayur Chintaman Joshi	Global Beam Technologies India
Mr.Joe Silva	Drill Chuk and Accessories
Mr. Raju Jaiswal	Carpet Yarn Dyers
Mr. Ratan Pathak	Wilton Weavers Pvt.Ltd
CA. Jeet Gala	Centra Advisors LLP
Mr. Paresh Trivedi	Chembond Polymers and Materials Ltd
Mr.Dinesh Soni	Groz-Beckert Asia Pvt.Ltd
Mr.Amit Dayal	Grasim Industries Ltd
Mr. Tripti Parsani	SFZ Global India, Salalah Free Zone Company S.A.O.C
Mr. Atul Agarwal	Vrijesh Natural Fibre & Fabrics (India)Pvt.Ltd
Mr. Nirendra Kumar	Indian Oil Corporation
Mr.Chandrakant M.Khetan	Entremonde Polycoaters Ltd
Mr.Harish Mehta	Menzel Engineering India Pvt.Ltd
Mr.Pradeep Modi	Just Textiles Ltd
Mr.Subhasis Chatterjee	20 Microns Limited

Appendix – 11

OUTSTATION VISITS BY BTRA STAFF

- Adinath Dyeing & Printing, Ludhiana
- Akash Printers, Ahmedabad
- AKR (Rohini Dyeing), Perundurai
- Ankur Textiles, Ahmedabad
- Anupam Tex Processors, Delhi
- Arti Textile Mills, Kokatta
- Aruna Textile Processing, Erode
- Barshi Textile Mills, Barshi
- Beek Bee prints Pvt.Ltd. and Ginni Filaments, Mathura
- Best Colour solution, SIPCOT Perundurai
- Birla Century Mills, Bharuch
- Brijesh Natural, Vapi
- BSL Suiting, Bhilwara
- Bureau of Energy Efficiency, New Delhi
- Central Pollution Control Board (CPCB), New Delhi
- CETP Solapur,Maharashtra
- Chinko Silk Mills, Surat
- Chaddar Cluster solapur
- Color & Styke Pvt.Ltd, Delhi
- Cotton Blosom, SIPCOT Perundurai
- Dimond Mills, Ahmedabad
- District Industry Centre, Pune
- D'Decor Exports, Boisar
- Eakata Dyeing, Ludhiana
- Exim Knits-Perundurai, Thangamann Processors, Saradaa Processors, Brindhaa Processors, SRG apparels and Mercury Processors, Tirupur
- G.S. Settia & Sons, Sonipet
- Ganga Fashions Pvt. Ltd., Surat
- Garware Wall Ropes Wai
- Gimatex Industries Ltd, Dholka, Ahmedabad
- Gonawala & Sons, Surat
- Groundwater Survey and Development Agency, Nashik
- Haryana Tex Print, Faridabad
- Jain Textile Industries, Delhi
- Jayavishnu Tex Processors, Tiruppur
- Kamal Textiles, Ahmedabad
- Kanti Fashion Fab, Ahmedabad
- Knit Craft International Pvt Ltd, Delhi
- Kanswa Textiles and Cottwell fabrics Solapur
- Komal Texfab, Ahmedabad
- Krishna Textile Processors, Perundurai
- Krishna Textile Processors, Perundurai
- Kumar Cotton, Ahmedabad
- Kunjubehari Processors, Faridabad
- Kusumgar corporates, Vapi
- Maccaferri Environmental Solutions Pvt. Ltd., Gurgaon
- Manas Geotech Pvt.Ltd, Haryana
- Mangal Textiles, Ahmedabad
- MANTRA,Surat
- Meroo Textiles,Sheela Textiles,Marda Textiles,Kanheya Textiles
- Mfatlal Industries Ltd, Nadiad
- Ministry of Textiles, Government of India
- Mukesh Industries, Ahmedabad
- Nagreeka Exports, Kolhapur
- New Bhopal Mills, Bhopal
- New Delhi zone LAPF audits for Bliss Impex, shahi Expor
- Nisan Exim, Ahmedabad
- Pee Vee Textiles, Wardha
- PI Cottex, Ludhiana
- PVM Enterprises, Ludhiana
- Raj Nagar Textile Mills, Ahmedabad
- Rinku Processor, Ahmedabad
- RSR Mohota Spinning & Weaving Mills, Hinganghat
- Samir Synthetic Mill, Ahmedabad
- Selvam Process, Tirupur
- Shiny Textile Processing, Erode
- Shivam Devansh Fab Pvt. Ltd., Faridabad
- Shruti Enterprises, Silvassa
- Shyam Textiles, Ahmedabad
- Sintex Industries, Chiripal Industries, Balkrishna Textiles- Ahmedabad and Bindal silk mills, Surat
- SSM Processors, Erode
- STL Global Limited, Delhi
- Tamilnadu Co-operative Textile processing Mills, Erode
- Unifront textile Process, Erode
- Vaibhav Processing Mills Erode
- Weaving Cluster Vadvani, Beed
- Welspun India Ltd, Vapi

Appendix – 12

BIS MEMBERSHIP

BTRA staff involved in the following standard development committees of Bureau of Indian Standards.

Sectional Committees	Title
TXD 01	Physical methods of test
TXD 05	Chemical methods of test
TXD 07	Textile speciality chemicals and dyestuffs
TXD 14	Textile Machinery and Accessories
TXD 28	Silk and silk products
TXD 30	Geo-textiles and industrial fabrics
TXD 31	Man-made fibres, cotton and their products
TXD 32	Textiles protective clothing
TXD 33	Industrial fabrics
TXD 35	Technical textiles for Agrotech applications
TXD 36	Technical textiles for Meditech purposes
TXD 37	Technical Textiles for Sportech Applications
TXD 38	Technical Textiles for Mobiltech Applications
TXD 39	Technical Textiles for Clothtech Applications
TXD 40	Composites and SpecialityFibresSectional

Appendix – 13

MEMBERS OF THE GENERAL ADVISORY COMMITTEE FOR RESEARCH AND LIAISON
[2018-2021]

1) Dr. P.R.Roy Chairman, Digital Consulting (India) B-509,Infinity Tower, Nr. SafalProfitare, Corporate Road, Pralhadnagar, Ahmedabad 380015 Prroy1941@gmail.com 07940307836/09824090693	2) Dr. M. K. Talukdar, M/s.Kusumgar Corporates, 101/102, Manjushree Bldg., Hatkesh Co-op. Society, Corner of N.S.Road No.5, JVPD Scheme, Juhu, Mumbai 400 056. mktalukdar@kusumgar.com 9987267005	3) Mr. V. Kannan Vice President, Business Development, Reliance Corporate Park, Bldg. No. 8, 1st Floor, 'A' Wing,Thane Belapur Road, Ghansoli, Navi Mumbai 400701 v.kannan@ril.com (D) 022-44780245/9987048023
4) Mr. K.L.Vidur Chartered Engineer B-401, NirmanVihar, RajmataJeejabai Road, Andheri (East), Mumbai 400093 klvidur@gmail.com 022-42151476/9820601476	5) Mr. Ullhas M. Nimkar, Row House No.25, Vasant Vihar Thane (West) Pin 400 601. ullhas.nimkar@nimkartek.com 9867607369	6) Dr. Sanjiv Kamat Vice President Kothari Info Tech Ltd., B 1/ 04/05 Ground Floor, B Wing, Boomerang, Chandivali, Andheri (East), Mumbai 400072 sykamat@kothariinfotech.com 9820702356
7) Prof. R.R.Deshmukh Associate Professor, Physics Department, ICT , Matunga, Mumbai 400019 rr.deshmukh@ictmumbai.edu.in 9960588675	8) Dr. Milind Khandwe The Bhor Chemicals & Plastics Pvt. Ltd., Plot No. B/18/2/1 in MIDC, Ambad, Nashik 422010 mkhandwe@bhor.com	9) Dr. B.V.S. Viswanadham Dr.-Ing (Ruhr University, Bochum Germany), Dean (Infrastructure Planning & Support) and Professor of the Dept. of Civil Engg. Indian Institute of Technology Bombay, Powai, Mumbai 400 076 viswam@civil.iitb.ac.in viswam@iitb.ac.in dean.ips@iitb.ac.in 022-25767080/9167297344
10) Dr. Vijay Ramkrishnan Sr. Vice President, Technical & New Businesses, Garware Wall Ropes Ltd., Plot No.11, Block No. D-1, MIDC, Chinchwad, Pune 411019 vramkrishnan@garwareropes.com 020-33526407/9607930901	11) Dr. AsimTewari Prof – in – Charge, National Centre for Aerospace Innovation Research,Indian Institute of Technology Bombay, Powai ,Mumbai 400076 asim.tewari@iitb.ac.in 022-25767521/9930057521	12) Dr. Mujeebur Rehman GM- R&D & QA, Atul Ltd., Colours Division, R& D Department,Valsad Pin 396020 Mujeeb-ur_Rehman@atul.co.in 02632-230451/23329192/ 09824130844

13) Prof.Bhaskar Thorat Head, Department of Chemical Engineering, Institute of Chemical Technology, Nathalal Parekh Marg, Matunga, Mumbai 400019 bn.thorat@ictmumbai.edu.in thoratbn@gmail.com 022-33612001(D) 022-33612101/1111	14) Prof.AnirbanGuha Associate Professor Dept. of Mechanical Engg. Indian Institute of Technology Bombay, Powai, Mumbai 400076 anirbanguha1@gmail.com 022-25767590 / 9619057590	15) Mr. Shahrokh Bagli Chief Technology Officer Strata Geosystems (India) Pvt Ltd, Sabnam House, Plot No. A-15/16, Central Cross Road B MIDC, Andheri (E), Mumbai 400 093 shahrokh.bagli@strataindia.com 8879077727
16) Dr. Prakash Vasudevan Director, The South India Textile Research Association, Coimbatore Aerodrome P.O., Coimbatore 641 014. director@sitra.org.in 0422-4981688	17) Dr. A. Basu Director General The Northern India Textile Research Association, Sector 23, Rajnagar, Ghaziabad 201 002. mail@nitratextile.org 0120-2783638	18) Mr. M. N. Subramanian Director, The Ahmedabad Textile Industry's Research Association, P.O. AmbawadiVistar, Ahmedabad 380 015 director@atira.in 079-26301969
19) Mr. K. Venkatarayan 301, Tulsi, Near Building No. 17-A, Vrindavan Society, Thane (West) 400601 k.venkatarayan@gmail.com 08098797575/ 9821851870	20) Prof. N.V. Bhat 4/78, Palm View Society, Vidyavihar (East) Mumbai 400077 bhatnarendra@yahoo.co.in 9869966512	21) Dr. Anjan K. Mukhopadhyay Director The Bombay Textile Research Association Lal Bahadur Shastri Marg, Ghatkopar (West), Mumbai 400 086.

Appendix - 14

STAFF DETAILS

The total staff strength of BTRA as on 31st March 2018 was as follows:

Director	**1**
At BTRA	
◆ Scientific / Technical Officers	19
◆ Scientific / Technical Staff	25
◆ Skilled / Semi-skilled & Maintenance Staff	17
◆ Administrative Staff	18
Sub-total	**80**
At PSCs	
◆ Scientific / Technical Officers	1
◆ Scientific / Technical Staff	4
◆ Skilled / Semi-skilled & Maintenance Staff	2
◆ Administrative Staff	1
Sub-total	**8**
TOTAL	*88*@

@ - Including 23 contractual staff

Director : Dr. Anjan K. Mukhopadhyay

Technical Services Division

Chief Textile Technologist : Mr. Tanaji I. Kadam
Senior Scientific Officer Grade-I : Mr. V. A. Gawde
Technical Services Executive : Mr. V. R. Shirole

Library, Information & Publication

Library Assistant : Ms. Sharayu Joshi

Electronics

Senior Scientific Officer Grade-I : Mr. V.K. Shinde
Junior Scientific Officer : Mr. P.S. Ajgaonkar

BTRA Test Laboratories

Laboratory Manager : Mr. R.A. Shaikh

Physical Testing Division

Junior Scientific Officer	:	Mr. D.R. Yadav

Scanning Electron Microscope

Senior Scientific Officer Grade-II	:	Mr. Amol G. Thite

Geotech Cell

Senior Scientific Officer Grade-II	:	Mr. R.R. Menon
Junior Scientific Officer	:	Mr. G.R. Mahajan
Research Officer (Soil Mechanics)	:	Mr. Prashant C. Muke

Chemical Testing Lab.

Senior Scientific Officer Grade-I	:	Mrs. S.P. Vairagi / Mr. M.P. Sathianarayanan / Mrs. Chandrakala L.M.
Senior Scientific Officer Grade-II	:	Ms. A.U. Shenoy / Mrs. Smita A. Baride / Ms. Tejaswini R. Ghadyale
Junior Scientific Officer	:	Mrs. M.P. D'Souza / Mrs. S.D. Mayekar

Microbiology Lab.

Senior Microbiologist	:	Mrs. Aruna D. Apte

Plasma Lab.

Senior Scientific Officer Grade-I	:	Dr. Prasanta Kumar N. Panda
Senior Scientific Officer Grade-II	:	Ms. S.S. Palaskar
Research Scholar	:	Ms. Archana Gangwar / Mr. Sachin R. Tambe

Engineering Services Section

Senior Scientific Officer Grade-I	:	Mr. D.H. Yadav

Administration

Administrative Officer	:	Mr.Jignesh S.Jani
Accounts Officer – P. Gr.	:	Mrs. S.S. Surve
P.A. to Director	:	Mrs. Rohini B. Mangalore
Purchase Officer	:	Mr. M.H. Bondre
Junior Accounts Officer	:	Mrs. Mugdha M. Shinde
Junior Accounts Officer	:	Mrs. Veena A. Dwivedi
Junior Admin. Officer	:	Ms. Sanjori S. Sonawane

BTRA PSC, Ichalkaranji	Officer In-charge	:	Mr. V.G. Kulkarni
BTRA PSC, Solapur	Officer In-charge	:	Mr. A.V. Patil
BTRA PSC, Madhavnagar	Junior Scientific Officer	:	Mr. N.A. Chavan

Appendix - 15

LIST OF MEMBERS

- Banswara Syntex Ltd. [Unit: BTM], Rajasthan
- Birla Century, Gujarat
- Birla Cotsyn (India) Ltd., Mumbai
- BMD Pvt. Ltd., Banswara
- BSL Ltd., Bhilwara
- CTM Technical Textiles Ltd., Ahmedabad
- Diversey India Hygiene Pvt. Ltd., Mumbai
- Donear Industries Ltd., Mumbai
- Eurotex Industries & Exports Ltd., Kolhapur
- Finlay Mills Ltd., Achalpur
- Flexituff International Ltd., Mumbai
- Garware Technical Fibres Limited, Pune
- Hindoostan Mills Ltd., Karad
- Hindustan Unilever Ltd. (Biopolymer Unit), Pondicherry
- Indo Count Industries Ltd., Mumbai
- Indonet Plastic Industries, Vadodara
- Jaya Shree Textiles & Industries, Rishra
- Jeevan Nonwovens, Navi Mumbai
- Kadri Wovens, Tamil Nadu
- Kusumgar Corporates, Mumbai
- Maharshee Geomembrane (India) Pvt. Ltd., Vadodara
- Mirachem Industries, Mumbai
- Morarjee Textiles Ltd., Nagpur
- Nagreeka Exports Ltd., Kolhapur
- National Textile Corporation Ltd. (Western Region), Mumbai
- Pee Vee Textiles Ltd., Jam, Samudrapur, Wardha
- Purity Techtextile Pvt. Ltd., Navi Mumbai
- Red-Star, Navi Mumbai
- RSWM Ltd., Gulabpura, Bhilwara
- Raymond Ltd., Thane
- R.S.R. Mohota Spg. & Wvg. Mills Ltd. (Mohta Industries Ltd.), Hinganghat
- Reliance Industries Ltd., Mumbai
- Ruby Mills Ltd., Mumbai
- S. Kumars Limited, Dewas, MP
- Shri Ambika Polymers Pvt. Ltd., Gujarat
- Siyaram Silk Mills, Silvassa
- Strata Geosystems (India) Pvt. Ltd., Daman
- Supreme Nonwoven Ind. Pvt. Ltd., Mumbai
- Techfab (India) Industries, Mumbai
- Technocraft Industries (India) Ltd., Murbad
- United Bleachers Ltd., Tamil Nadu
- Unitop Aquacare Ltd., Thane
- Visaka Industries Ltd., Nagpur
- Wellknown Polyesters Ltd., Mumbai
- Welspun India Ltd., Mumbai
- Wex Technologies Pvt. Ltd., Pune