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ANNUAL REPORT 2019-20

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THE BOMBAY TEXTILE RESEARCH ASSOCIATION

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We have great pleasure in presenting the 66th 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 2020.

1. INTRODUCTION

The Indian Textile Industry is at a critical juncture in the global economy. While the industry has seen many successes in the past, its relevance is currently challenged by the lack of investment and focus in Research and Development (R & D). The industry has to keep innovating to stay relevant and compete globally in today's rapidly modernising world. A key challenge that we need to address is to train the talent and enabling their thought process for process and product innovation. Addressing this challenge will bring the Indian Textile Industry to the forefront of the global economy.

In the current scenario, the textile industry should concentrate on developing value-added products in the high technology platform. Efforts in product/process development and diversification into more knowledge-based products are the need of the hour. Hence, BTRA has taken major steps with financial assistance from the Ministry of Textiles, Government of India and others to develop expertise and provide services to the industry.

We at BTRA strongly believe the importance of R & D, particularly product/process development, cost reduction and efficiency in operations. The essence of R & D is (i) to make the existing products better, faster and at affordable prices and (ii) to develop new products. BTRA is also strengthening its training activities for providing need-based training to technical/supervisory and operator levels. In this regard, BTRA initiated the training activity on Effluent Treatment Plant, Water Recycling and Sustainable Technology. BTRA has been working on these and other 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 Six including one newly initiated project for the period under review. Details are as follows.

- ✓ In the project entitled 'Adhesion improvement for coated textiles by atmospheric plasma treatment' project, Dielectric barrier discharge plasma surface modification of polyester and nylon fabrics have been carried out to study the adhesion properties of the plasma treated fabric coated with polyurethane. Plasma processing parameters vs. treatment time and power were optimised for both types of fabrics to get maximum improvement in adhesion strength of the coated fabrics. Characterization of the plasma treated samples was done using SEM, AFM and XPS techniques. SEM results showed the surface roughness after plasma treatment, surface roughness was quantitatively measured using AFM. Further, XPS showed the formation of new hydrophilic reactive groups on plasma treated samples. Maximum improvement in adhesion was observed for nylon than that of polyester fabric. Desired tensile properties of the fabrics remain unchanged after plasma exposure.

- ✓ 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. Looking at the recent trends in business sustainability and environmental regulations, it seems that a roadmap ahead will be more strict to sustain the eco-management and to offer a clean environment to the coming generation.

- ✓ In the project entitled 'Development of cotton waste-based oil absorbent for oil spill clean-up', a solution to oil spill management has been proposed. As Oil spill clean-up is a global concern due to its environmental and economic impact, various commercial systems, including synthetic fibres like polypropylene, have been developed to clean up the oil spillage. But these methods pollute the environment in another way such as disposal of used oil sorbents, non-biodegradable in nature (hence non eco-friendly), etc. Hence, in this project work, waste cotton, which is bio-degradable, is used as oil absorbent, after subjecting into various modifications. Raw cotton waste has been procured and cleaned in a trash separator to separate out lint, trash, and micro dust of cotton fibre. The cleaned cotton waste was processed in a needle punching machine to make a non-woven lap. Water and oil absorbency property of this cotton waste was studied. To enhance the hydrophobic and oleophilic property of cotton by various techniques will be applied in future work.

- ✓ 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 fine particles 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 fibres with very small pores and diameters ranging from several microns to tens of nanometers. In this project, Nylon 6 polymer has been selected for the spinning of nanofiber and deposit the same on the surface of spunbonded Polypropylene to minimize the pore size and improve anticlogging properties of geotextile. Required spinning parameters have been standardized for Nylon 6 in the needle less electrospinning machine with wire electrodes. Deposition time has been standardized to obtain the required pore size of the nanofiber mat. Experiments on study of clogging behaviour and water permeability of the PVD substrate with nanofiber mat using falling head water permeability has been conducted successfully.

The performance of the prepared nanofiber deposited media for continuous use in presence of soil particle was studied earlier. Furthermore, under prolonged study, it was observed that water flow in presence of fine soil particles was found significantly higher in case of nanofiber loaded membrane compared to conventional membrane after 400h.Pores of the media were seen under electron microscope after use.

There was no soil intrusion in nanofiber loaded media whereas soil particles were seen in conventional media. Instrument

has been specially fabricated at BTRA for the validation test of the developed sample. One research paper has been accepted by the reviewers for the conference on earthquake engineering (ICRAEE). Research paper is under consideration in a peer reviewed journal.

- ✓ 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 because of their fast-electromechanical response. PVDF (Poly vinylidene fluoride) shows good piezoelectric property. Under this project, synthesis of ZnO nanorods has been done successfully and melt-blended with the PVDF in different percentages. Spinning of the blended polymer has been completed and loading percentage of Nano rods has also been optimized. Evaluation of the piezoelectric parameters of the prepared filament was carried out. Recently pilot scale trial of the fabric preparation was conducted. Fabric preparation was also successfully completed. Piezo-electric property of those fabrics was evaluated by oscilloscope combined with required circuit. Response of the fabric made out of composite filaments was found to be significantly better than the control samples. Towards commercialisation, sample prototype has been sent to the DEBEL (DRDO) for validation. One research paper has been accepted for publication in a peer reviewed journal.

- ✓ Project on 'Development of Test Method for Analysing Hexavalent Chromium (Cr-VI) 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 high toxicity, most of the government regulations have 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. This test method is not suitable for dyes and pigments due to the presence of high matrix interference. Under this project, an attempt has been made to develop test methods to test Cr-VI in dyes and pigments. About twenty-five dyes and pigments including Chrome pigments and few textile auxiliaries were collected from various manufacturers. The total chromium content in these dyes and pigments were estimated by microwave digestion followed by ICP-OES analysis. It was observed that in most of the chrome-based pigments, Chromium content is very high. This chromium could be either in trivalent or hexavalent or in both the forms. Hence to segregate the trivalent and hexavalent chromium various studies were done such as (i) effect of various acids and alkalies (ii) effect of oxidation and reduction agents (iii) effect of microwave digestion and conventional acid digestion (iv) effect of various temperatures (v) effect of activated charcoal and (vi) effect of bleaching agents. Since the separation of Cr-VI from dyes and pigments is a challenging job, the above-mentioned studies were not showing positive results to achieve the final goal. Three test methods have been developed for analysing trace level of Cr(VI) in water soluble dyes and textile auxiliaries under MOT sponsored project. The developed test method has been published as a national standard. Bureau of Indian Standard accepted the test methods and published the same as IS 17338-2019. A research paper has also been submitted for publication to The Journal of

Chromatographic Science, Oxford academy and is currently under review.

- ✓ Project on 'Mechanical Properties, Stability and Structure of Polymeric Composites Reinforced with Functionalized Fibres. Project work involves preparation of composite materials and their characterization. MoT sanctioned the fund and new JEOL; JSM IT 200 LV SEM machine was purchased. The surface morphological features of the material and prepared composites were analysed comprehensively by new SEM machine and same has been incorporated in the final project report.

❖ Product Development Assistance to the industry

- In the pilot plant of Technical Textiles Weaving, 5 samples (of 15 m in length) were developed for applications such as tyre cord and filter fabric
- In the Plasma Treatment Machine, twenty metres of fabric was processed for two academic / research institutes

❖ Calibration, Technical Services and Training

- ✓ BTRA calibration laboratory received accreditation from NABL as per ISO/IEC 17025:2005 standards for Mass, Balance, Volume and Force. BTRA is ready to provide calibration services to other NABL accredited testing laboratories for Mass, Balance, Volume and Force parameters.
- ✓ BTRA conducted several training programmes at the mills' premises as well in BTRA training centre covering subjects such as fabric inspection, post yarn operations, polyester manufacturing, processing and customer satisfaction, safety at work place, kaizen, 3M concept, leadership and communication, Good Work Practices & Utility Conservation at shop floor. BTRA imparted training (theory and practical) at the testing laboratories/pilot plants covering subjects such as Technical Textiles (Geotech), Textile Terminology, Spinning, Weaving and Processing Techniques, Yarn Testing and Sizing Testing, Mechanical & Chemical Testing and General Elements of Textiles. One hundred twenty five personnel were trained during the period under review.
- ✓ BTRA conducted comprehensive machine maintenance audit for spinning , weaving and processing , process and system evaluation in the accredited process house for leading brand. The consultancy was provided for new plant set up, DPR verification, fabric inspection with defect analysis back up, thermal power plant steam costing, process optimization, old and surplus machinery valuation for spinning, weaving, garmenting. About 70 mills were benefited by this technical service

❖ Others

In a nutshell, research and development and consultancy activities at BTRA have been directed towards innovative product/process or test method development and providing an essential database for the industry. In the years ahead, BTRA will strive to make its mark in the area of utility conservation, effluent load reduction, chemical management system, eco management for process house.

2. ON-GOING SPONSORED PROJECTS

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

Synthetic fibres are being used widely in commodity products due to its low cost and high tensile properties over natural fibres. Synthetic fibres have special chemical properties and physical characteristics which make them suitable for variety of applications. However serious drawbacks of these polymers are the low free surface energy and hydrophobic surface which result in weak molecular interactions and low binding strength with fibres when subjected to coating with polymers. The surface free energy of textile material can be tailored by various methods by physical and chemical modification. However, those techniques result in change in desired properties. Therefore, plasma surface modification is gaining increasing attention as environment friendly technique. Plasma, the fourth state of matter consists of electrons, ions, neutral atoms, free radicals and ultra-violet radiation. Reactive species in plasma can be used to suitably modify the surfaces of materials typically known as plasma surface activation or plasma surface modification. Recent development in the plasma treatment of textile materials has revealed that it has an enormous potential as an alternate technology for textile processing in terms of cost saving, water saving and eco-friendliness.

Polyurethane coated nylon and polyester fabrics finds applications in water –proof clothing, windcheater fabrics, parachute, photo diffuser fabrics, light weight tents, air duct fabrics, life vest/jacket, sportswear and many more. However as mentioned above they are also hydrophobic in nature and have low surface free energy. Therefore, it is difficult to get good adhesion between polymer and fabric. To modify the adhesion of coating, in this study we have used atmospheric pressure plasma treatment on nylon and polyester fabrics. Further, the comparative studied were carried out to understand the effect of plasma surface modification on two different polymers.

Plain woven nylon and polyester fabric with an average GSM of 100 were used in this study. Both fabrics were modified using helium gas atmospheric pressure plasma and coating of polyurethane was done by hand coating machine using knife over roller technique.
Coated samples were tested for various properties using standard test methods and comparison with untreated samples was performed to check the effectivity of plasma treatment.

Measurement of thickness and weight add-on study showed that coating layer applied on untreated and plasma treated samples were similar. Weight add-on (GSM of coated fabric – GSM of uncoated fabric) was found to be in the range of 360-380 gms/meter square for all the samples. Therefore, it can be concluded that the application of coating was uniform on all fabrics surface.

Wettability study showed significant improvement in wicking of the plasma treated samples. We found that in the case of nylon the wettability increased by 92% as compared to untreated nylon where as in the case of polyester the increase in wettability is 205% to that of untreated polyester fabric. Therefore, it may be said that polyester fabric is more modified by plasma than nylon.

Adhesion force was measured as peel off strength of the untreated and plasma treated coated samples. The adhesion bond strength of plasma treated coated nylon samples showed 20 -55 % increase compared to the untreated coated sample. In case of

polyester fabric, the increased in adhesion strength is in the range of 33 – 83 % as compared to the untreated polyester fabric. These results are in agreement with the results of wettability measurement.

Surface roughness of the plasma treated and untreated nylon and polyester fabrics were studied by SEM and AFM, it was found that after plasma treatment the surface of the samples become rough. This rough surface proved mechanical interlocking for coating chemical to improve coating adhesion.

Surface chemical changes by XPS study showed that carbon content decreased, while the C-N, C-O and CONH/ COOH content increased after plasma treatment for both nylon and polyester fabrics. The primary carbon containing bonds seemed to have been broken by plasma treatment and was helpful to generate oxygen containing hydrophilic groups. This improved the water absorption capacity of the sample and increased the adhesion property as well.

Effect of plasma surface modification on bulk property of the nylon and polyester fabric was analyzed by ASTM D 5035 standard test method. Results showed no significant change after plasma treatment as plasma is a surface modification technique and does not affect the bulk properties of the textile materials.

Conclusions:

Surface modification of nylon and polyester fabrics was carried out using helium gas atmospheric pressure plasma. Polyurethane coating was applied on the surface and adhesion study was done by peel off strength measurement. It was observed that after plasma surface modification wettability, surface roughness and adhesion strength of both the fabrics improved significantly. Further it was found that plasma treatment was more effective on polyester fabric as compared to nylon fabric. Incorporation of hydrophilic reactive groups on surface of plasma modified nylon and polyester was seen in XPS study. No adverse effect on the tensile strength of fabrics was seen after plasma treatment.

2.2 Analysis of Eco-management in Indian Textile Processing Industry

2.2.1 introduction

To understand the current scenario of eco-management system and the level of implementation in the textile processing industry, a study was needed and hence BTRA had undertaken this project.

BTRA audited 45 textile processing houses and 4 CETPs for eco-management awareness and implementation in their units. An analysis was done for ETP, boiler flue gas emissions, noise level, chemical management system and utility/energy conservation practices. This project is completed and the final report was also submitted to MOT. Also, the findings were published in a reputed textile journal.

Through this project, we have tried to;

- Analyse the current situation of eco-management in the textile processing industry
- Understand the gaps in the system and issues faced by the textile processing industry
- Recommendation and support to the industry with the available best and sustainable techniques for natural resource conservation.
- Training on effluent treatment, Chemical management system, water recycling and re-use to reduce the pollution load and to ensure business sustainability ecologically and economically.

Looking at the recent trends in business sustainability and environmental regulations, it seems that a roadmap ahead

will be more stricter and stricter to sustain the eco-management and to offer a clean environment to the coming generation.

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2.2.2 OBJECTIVES OF THE STUDY

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

2.2.3 ACTIVITIES DONE DURING THE STUDY

With this theme, the study was started in Jan 2017 and 45 mills (Types of mill participated is shown in fig-1) plus 4 CETPs were analysed for eco-management awareness and its implementation in their units. During the visit following activities were done: -

1) Basic data collection
2) Process mapping
3) Listing and identifying the significant impact
4) Chemical handling and it's management system
5) Waste disposal system
6) Water pollution, it's saving possibilities and Effluent treatment plant
7) Collection of Inlet and outlet effluent for content analysis
8) Noise level and Boiler flue gas emissions

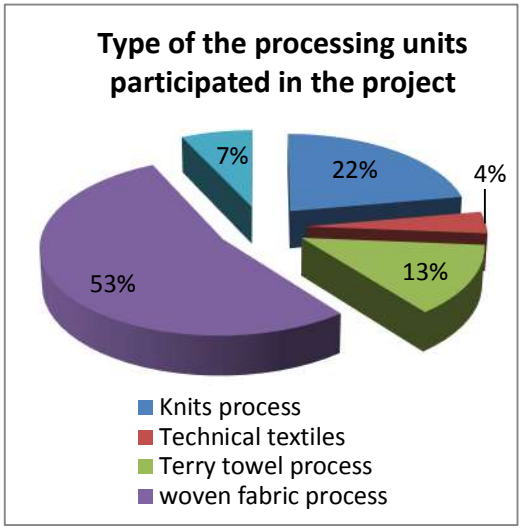
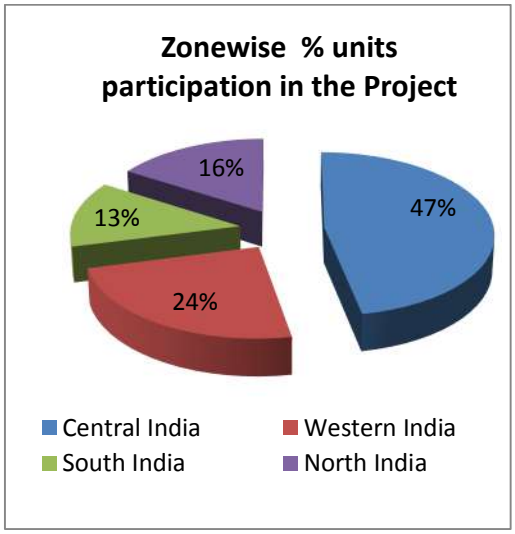


Fig -1 Types of participated mills



Fig– 2 Zone wise unit participation

2.2.4 FINDINGS AND OBSERVATIONS DURING THE STUDY

2.2.4.1 Effluent treatment plant: -

It was observed that out of 45 mills,

i. 25 mills were discharging their treated effluent to CETP
ii. 3 mills to the Sewage treatment plant.
iii. 4 mills were discharging their effluent to Inland surface stream after treatment, 2mills were using it in gardening and farming
iv. And 11 mills were operating ETP with Zero liquid discharge (ZLD) set up.

From many of the units wherever possible inlet and ETP treated outlet effluent samples were collected for analysis, from some of the units, the corresponding data and third-party test reports were collected. The mill type-wise has been summarised and analytical results are given in Table no. 1 & 2.

Table 1: ETP Inlet parameters

Parameters	unit	Woven process	Knits process	Yarn dyeing	Tech. textiles	Terry towel
pH	No.	5.35 - 13.35	6.95 - 9.4	6.9 - 10.2	6.02 -7.05	6.55 - 12.1
TSS	ppm	28-1068	273-2995	625 - 1260	160 - 499	186 - 1378
TDS	ppm	1029-12658	2568-11068	2497-3478	1085-1847	2125-7250
BOD 5 days	ppm	48-2177	88-600	200-1333	322-1875	36-753
COD	ppm	440-4777	403-2724	1451-3373	1514-5185	107-2219
Oil & grease	ppm	Nil- 330	Nil-123	Nil-141	137-562	nil

- In general, there is unit to unit variation in inlet effluent characteristics. For inlet effluent, the TSS level is higher in case of the Knits processing and yarn dyeing units, than the woven processing unit
- TDS level is also higher in the case of Yarn dyeing and knits fabric processing units. This is due to exhaust reactive dyeing, which is in the presence of salt.
- Oil and grease level is higher in the case of the Technical textile (synthetic base) processing.

Table 2 - ETP Outlet Parameters: - ETP setup wise

Parameters	Unit	Norms for ISW discharge	Primary treatment to CETP	Complete up to filtration without RO	ZLD(water feed to RO)
pH	No.	5.5-9	5.4-8.51	6.9 – 9.75	6.43-8.25
TSS	ppm	< 100	29-978	Nil - 740	Nil -752
TDS	ppm	< 2100	921-4308	664-7177	2088-6912
BOD 5 days	ppm	< 30	21-859	14-698	6-365
COD	ppm	< 250	120-2449	30-1295	20-1327
Oil grease	**ppm**	**< 10**	**< 1200**	**< 86**	**< 43**

Observations for the outlet effluent:

a) Majorly, in the case of Effluent, since it is treated partly and sent to CETP, the treatment is not effective.
b) In the case of ETPs with complete treatment including the filtration system, the outlet parameters showed improvement. However, they were not fulfilling the standard requirement.

c) The ETP outlet parameters compliance level is shown in fig 3. The compliance level for the parameters like TSS, TDS and COD is less i.e. 53, 30 and 53 % respectively, as compared to pH, BOD and oil & grease level.

d) Mill wise COD, TSS and TDS values are shown in fig 4,5 and 6

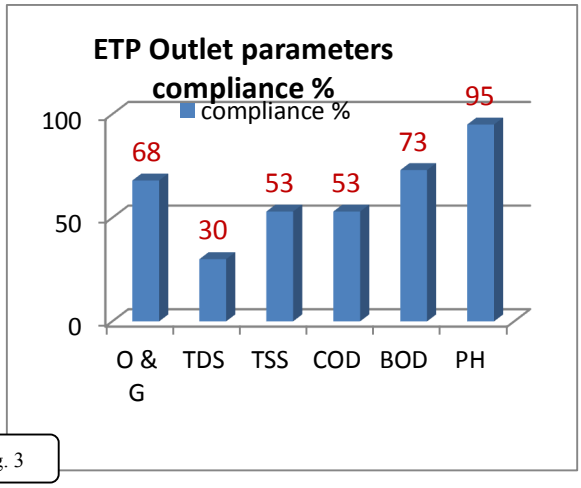


Fig. 3

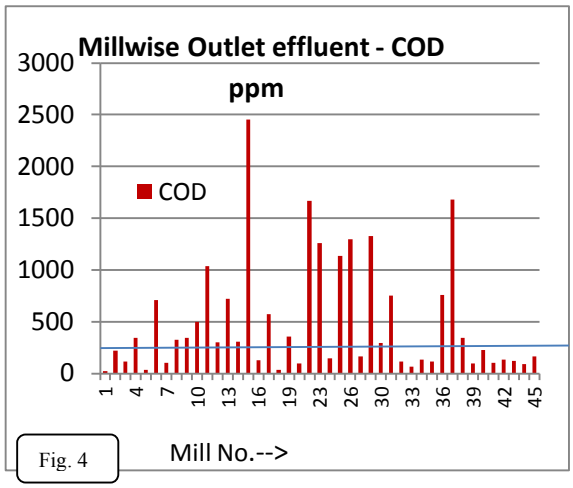


Fig. 4

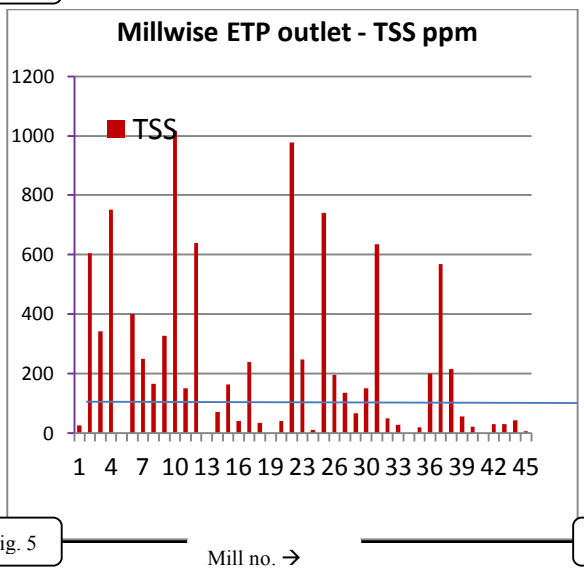


Fig. 5

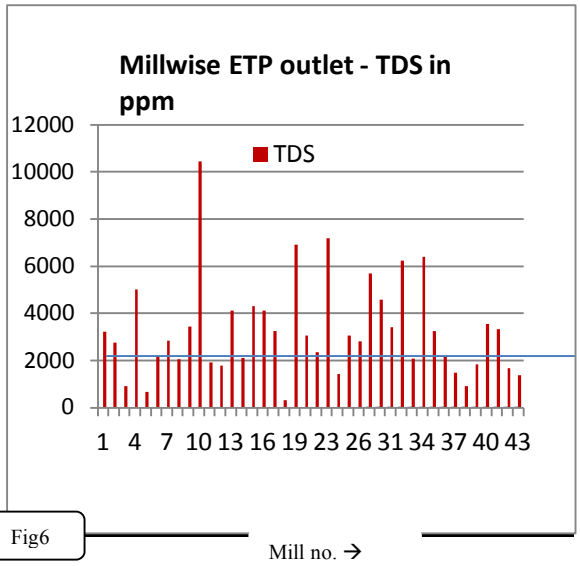


Fig6

2.2.4.2 Energy consumption pattern

Based on the power and fuel consumption data provided by the participating mills, the total energy consumption in Kcal per kg of the finished textile product has been calculated as shown in table 3.

At the moment, product type wise and process-wise, energy consumption benchmarking standards are not available for the textile industry. Such benchmarking is expected in the near future by the regulatory organization through the program like Perform, Achieve and Trade (PAT).

Table 3: The Process wise energy consumption Kcal/kg of product

Process Type	Total energy consumption Kcal/kg of product
Knits processing	5457 - 12818
Technical textile processing	4825 - 10701
Terry towel processing	4874 - 12088
Woven fabric processing	6679 - 28143
Yarn dyeing	5314 - 7145

2.2.4.3 The Boiler stack flue gas emissions level: -

During the evaluation, the data was collected for boiler stack flue gas emissions. Table 4 shows the data for the same. It was noticed that all the mill's flue gas emissions were found to be within the norms as per the Pollution Control Board guideline. Mills using pet-coke as a fuel were showing SO_2 emission level on the higher side as compared to the Mills using steam coal. However, it was noticed that in many of the mills, that online flue gas emission monitoring system was not used and maintained properly. The boiler stack flue gas emissions standards are dependent on the boiler capacity. However, for simplicity, we have taken standards as shown in table-4.

Table 4: Boiler stack flue gas emissions level.

Boiler range TPH	Fuel type	Stack emission		
		TPM mg/nM^3	SO_2 ppm	NO_x ppm
Emission limits*		< 150	< 100	< 50
< 5 TPH	Coal	54.6 -546*	16-213.5 **	24-49
	Fire wood	55-60.7	0.5-10	3-6
	Lignite	84.23	10.4-98	12-46
6-10 TPH	Coal	14-122	2.2-100	1-45
	Fire wood	18-140	1-12.6	2-17
	Pet coke	-	87-148	12.7-29
12-14 TPH		60.5-142	2-85	1-32

*-The boiler stack flue gas emissions standards are depending upon the boiler capacity. For 4 TPH boiler, the standard for particulate matter is < 800 mg/NM^3.
** For 4 TPH boiler the SO_2 emission standards are not specified.

2.2.4.4. NOISE POLLUTION: -

At different workplaces from mill gate to boiler house, the noise level was analyzed and it was found that the noise level on an average was less than 75 dB.

2.2.5 GAPS IN THE ECO MANAGEMENT SYSTEM

Based on the observations, test data and discussion made with mill personnel during the audit, the following were the gaps observed during the Eco-Management system analysis in the textile processing industry;

i. Understanding the importance of the "Eco-management awareness and its implementation" was required across the small and medium scale textile processing industry. Eco-management system implementation was the grey area in the SMEs. The awareness and also, let-go work culture towards the environment protection were the major areas of concern.

ii. Textile processing industry owners felt that the cost of water treatment and maintaining the Eco-management system in the unit was an extra burden on them. At present, in some of the zone, the ZLD is compulsory, while in others zones, it is not. This has led to unequal water treatment charges and hence it is directly affecting the manufacturing cost.

iii. Total energy consumption was varying from 4825- 28143 Kcal/kg of textile. Awareness regarding energy conservation is less among the operators

and some of the engineers. The product type-wise benchmarking norms for energy consumption are not available.

iv. There was no provision for measuring VOC/hazardous air emissions at the various processes in the process house. For example, during the heat setting, drying and chemical finishing process on stenter, relax dryer and vertical drying range, the fumes were seen to be emitting. There was no provision to monitor and control the same.

v. For Boiler chimney stack, periodical Flue gas analysis was done by some of the mills but in the case of some of the mills, it was not done. Although online stack flue gas emissions monitoring systems are available in the market, however, it was noticed that in many of the mills it was not installed. Less durability and maintenance cost of the online pollution measurement instrument seems to be the reason behind it.

vi. Customized ETPs were observed in the mills. No standard/unique ETP module was available for the textile processing industry. The industry is expecting standard authentic reference document on BATS in ETP

vii. For the CETP, there were no standards set for the inlet effluent parameters from the processing mills.

viii. In some of the mills, the inhouse-processes i.e slightly contaminated water and an uncontaminated water recycling approach was also observed. But, many of the mills are not trying to recycle such water to reduce ETP and ecological burden.

ix. Effluent sludge was disposed of at the negative price to the designated location as per the guidance of Pollution Control Board consent to operate. Boiler ash disposal was also one of the difficult management tasks faced by Mills.

x. Chemical Management system, availability of MSDS for each and every chemical, the pollution load from the various chemicals used in the process, the ways to reduce the chemical pollution load and its implementation was not understood completely by the industry. At many places, particularly mills working for domestic supply, the cost was the major factor for non-use of eco-friendly chemicals.

xi. There was still a lack of awareness required for the safety and health-related issues while handling chemicals, coal and other hazardous items in the mills.

xii. Many of the MSDS provided by the chemical manufacturers were not providing adequate information about the parameters like COD, BOD and other ecological information as listed in RSL and MRSL.

xiii. The inadequate knowledge and low competency of ETP operators and officials for proper treatment and water recycling technology was a common observation.

2.2.6 BTRA RECOMMENDATIONS

i. CPCB and State Pollution Control Board may start awareness creating programs for small and medium scale textile processing industry. This will improve the attitude and increase the responsibility level.

ii. Cost of water treatment should not be taken as a burden but it should be considered as an investment for future generation and environmental protection. One nation one rule i.e. for business sustainability, the same rules

for water treatment should be applied throughout the country.

iii. The energy conversation area needs to be focused by the Mill's engineering section. Implementation of the heat recovery system and utility saving is the major workable area. The norms for product type-wise energy consumption need to be developed by the regulatory organizations through the program like Perform, Achieve and Trade (PAT)

iv. The provision for monitoring and control of VOC/hazardous air emissions at the various processes in the process house is required to be made.

v. Online real-time stack flue gas emissions monitoring systems need to be followed by all the industries. The instrument durability and lower maintenance cost of the online pollution measurement instruments should be ensured by the instrument supplier.

vi. The processing type-wise standard approved ETP modules with reference documents and BATS in ETP needs to be develop on priority.

vii. For the better and assured performance of the CETP, the CPCB/State Pollution Control Board need to fix the norms for inlet effluent to the CETP.

viii. To reduce ETP and ecological burden, at every process house, the 3 R concepts (Reduce, Recycle and Reuse) needs to be implemented.

ix. The effluent sludge, depending upon the individual case, after the initial characterization and assessment studies, the industrial waste of concerned processing mill should be classified as hazardous or non-hazardous and according to that suitable management option like incineration may be selected.

x. Awareness to implement the chemical management system and to use eco-friendly alternative chemicals for existing hazardous chemicals are required.

xi. Awareness is required for the safety and health-related issues while handling the chemicals, coal and other hazardous items in the mills.

xii. All the chemical supplier should mandatorily provide an updated MSDS containing an adequate information about the parameters like COD, BOD and other ecological information as listed in RSL and MRSL.

xiii. CPCB/MPCB can start awareness creating programs, ETP certificate course training for the operators and technicians. To ensure the environmental management system adequacy as per consent to operate in each and every textile processing unit is recommended. This will ensure a better and sustainable environment.

xiv. For this, BTRA, Mumbai is ready to conduct the i) Training and ii) Adequacy audit report for CPCB/MPCB in the textile processing mills.

2.2.7 Training in ETP: -

Based on the need and outcome of the studies under this project, BTRA designed and organized an in-depth 12 days 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 was supported by "National Environmental Engineering Research Institute" (NEERI) and "Maharashtra Pollution control board" (MPCB)

During the inauguration of training program two books were published, namely 1) "ETP, water recycling and sustainable technology "and 2) Analysis of wastewater and restricted substances

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

Introduction:

Cotton waste, which are generated from various processes like carding, blow room etc. was collected, cleaned, pre-treated and processed in a carding machine to make web. The cotton web was converted to a non-woven batt through needle punching process. The non-woven fabric was chemically modified The chemically functionalized fabric was showing water contact angle of more than 150 ^{o} with an oil absorption capacity of 25-30 g/g. The chemical characterization of the sorbent was studied by using FTIR spectra and TGA. The morphology of the sorbent was characterized by SEM. The sorbent was found to be re-usable for at least 5-6 times with an oil recovery of more than 60%. Bio-degradability of the chemically modified cotton was also studied by soil burial test and was found be fully biodegradable. The oil absorption capacity of the developed sorbent was evaluated for oil on land surface, oil on surface water and under water also and was found to be superior to the synthetic polypropylene sorbent.

Experimental Work: Raw cotton waste procured from textile mills in their various processes like Carding, blow room, combing etc. was cleaned, pre-treated and processed to a non-woven fabric. Non-woven cotton fabric was chemically modified and was found to have good oil absorption and water repellent property.

In order to validate the concept of this technology, Oil and water absorption property of the chemically modified cotton sorbent of various cotton wastes were studied with motor oil and diesel engine oil. Table-1& 2 shows a comparative study of oil and water absorption capacity of sorbents prepared from carding waste and blow room waste against commercially available poly propylene sorbent.

Table-1 Absorption properties of sorbent in motor oil and water

Cotton waste-based sorbent	Absorption capacity of Oil (g/g) under static condition	Absorption capacity of oil in Water(g/g) under dynamic condition	Absorption capacity of Water (g/g) under Dynamic condition
Polypropylene mat	12.3	12.7	0.1
Carding flat stripping	30.3	29.1	0.016
Carding flat stripping lint	30.0	28.2	0.092

Table-2 Absorption properties of sorbent in diesel oil and water

Cotton waste-based sorbent	Absorption capacity of Oil (g/g) under static condition	Absorption capacity of oil in Water (g/g) under dynamic condition	Absorption capacity of Water (g/g) under Dynamic condition
Polypropylene mat	6.1	8.5	0.1
Carding flat stripping	12.5	13.1	0.1
Carding flat stripping lint	10.2	12.7	0.18

It was observed that under static conditions carding waste absorbs 30 -30.2 g/g motor oil and under dynamic conditions it absorbed 28.2-29.1g/g. At the same time commercial polypropylene, motor oil absorption capacity was in the range of 12.2-12.7 g/g. This clearly indicates that modified cotton waste-based sorbent has higher oil absorption capacity than polypropylene sorbent. The water absorption property of polypropylene was 0.1g/g and that of cotton waste sorbent was 0.01-0.18 g/g which clearly shows chemically modified cotton sorbent is more hydrophobic than polypropylene. Similar trend was also observed in the case of diesel oil in water (Table-2). This indicated cotton, being hydrophilic in nature has become hydrophobic after chemical modification and is in line with hydrophobic polypropylene. Since the viscosity of diesel oil is lower than motor oil, oil pick up was also lower. It is clear that modified cotton sorbent absorbs 2-2.5 times more oil than polypropylene fabric. At the same time water absorption capacity of both polypropylene and cotton sorbent was almost similar.

The morphology of the sorbent was studied by using Scanning Electron Microscope. Chemical characterization of the sorbent was also studied by using FTIR and DSC.

Sorbent has sufficient durability to reuse at least 5-6 times repeatedly. Soil burial test conducted on the chemically modified sorbent reveals that the product is fully bio-degradable under environmental conditions and thus mitigating its disposal problem unlike synthetic materials.

Conclusions

- The sorbent developed at BTRA will work very well to clean oil spillage in water bodies as well as land surface.
- Since the product is fully biodegradable, the material is eco-friendly.
- We are utilising a waste material to a value-added product using a green technology.
- To be able to attain Super Hydrophobicity with good degree of Oleophilicity on cotton waste by innovative technology is our major achievement in the project.A research paper has been submitted to peer reviewed journal for publication.
- Since the process development is being secured for IPR, a patent has been filed.
- The developed product is a sustainable material, economically viable and has a great scope for commercialization.

2.4 Nano-fibre application to enhance the anti-clogging properties of Geotextiles

Abstract

Prefabricated vertical drains (PVD) are one kind of geotextile filters for the consolidation of soft soil before the building of structure. This consists of a plastic core with formed flow path grooves on both sides along its length which acts as free draining water channel even at large lateral pressure, surrounded by a geotextile filter that maintain the hydraulic capacity of the grooves preventing clogging by soil intrusion. If the pore size of filter is larger than the fine soil particle, under lateral soil pressure the internal water flow paths of PVD gets clogged by fine soil particles, too many fine particles could reduce the PVD discharge capacity and increase the filter resistance. Small but appropriate pore size is needed for the filter jacket to prevent clogging and maintain the hydraulic capacity of the grooves. To avoid this problem, thin nanofibrous membrane was deposited on spun bond nonwoven membrane. The deposition of nanofiber was carried out using needle less electro-spinning 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 marshy land soil. Anti-clogging property and water permeability of the membrane with nanofiber layer were investigated during continuous use for a long time in presence of soil. Results showed that use of nanofiber membrane rather than only nonwoven membrane, significantly improved anti-clogging property. The intrusion of soil particles in the membrane pores was analyzed by Scanning Electron Microscope (SEM) after use.

Work done during reporting period

Water permeability of the nanofiber deposited media in presence of soil

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 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 were kept continuously in presence of soil for long time and time taken for water head fall to 5cm was recorded continuously. Initially, time taken by water head to fall 1 cm was less in existing nonwoven media compared to nanofiber media but after some hour, it increased and crossed the time taken through the nanofiber deposited media. This was because of low filtration resistance of existing non-woven media which hadincreased after some hours by intrusion of fine soil particles and clogging of pores. This phenomenon was not observed in the case of nanofiber deposited media.

Validation Testing

For the validation testing, we did not get the facility in India to test the developed sample, so we have designed and fabricated one instrument for the field testing of the sample and study is in progress. This instrument is tube like structure with provision to put the sample and fill the soil around it. During the testing, constant load will be applied over the soil for a stipulated time period. After that time consolidation behavior and amount of water present in the soil will be analyzed for

both with and without nanofiber membrane sample.

Conclusion

The electro spinning parameters were standardized for Nylon 6 in the needle less electrospinning machine with wire electrodes. Deposition time was standardized to obtain the required pore size in 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 existing nonwoven media compared to nanofiber deposited media. This increase in time was due to clogging of pores of nonwoven media by fine soil particles. Clogging of the pores was confirmed from the scanning electron micrograph. Deposition of nanofiber on the existing nonwoven filter media was found to be helpful to maintain the water flow through the channel and reduce the consolidation time before the construction.

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

Abstract

The present work is an attempt to demonstrate that incorporation of small amount of Zinc oxide (ZnO) nanorods enhances the β crystal percentage which is essential for improvement in piezo-electric performance of the polyvinylidene fluoride fiber. The ZnO nanorods were synthesised with aspect ratio of 26 and uniformly dispersed in PVDF by melt compounding process. Those compounded polymers were melt spun and subsequently cold drawn to obtain composite filaments. The effect of nanostructure, loading amount, melt draw ratio, cold draw ratio and drawing temperature were investigated. The incorporation of nanorods resulted in14% increase in β phase crystal content and 22% increase in piezoelectric performance compared to control PVDF filaments. The β phase crystal content has been analysed using the wide-angle X ray diffraction and FTIR spectroscopy. This increase in β phase crystal content for ZnO nanorods was 10% more as compared to circular ZnO nanoparticle reinforced PVDF composite filament. There was no significant change in mechanical properties of the composite filaments as compared to the control PVDF filament.

Experimental

ZnO nanorods were synthesised by available method and characterized. Synthesised nanorods were compounded with the PVDF and taken for melt spinning. During melt spinning different parameters such as melt draw ratio, cold draw ratio and drawing temperature were optimized. Fabric was woven from the filament spun at optimised parameter.

Work done during the reporting period

FTIR Analysis of filaments

Each crystalline phase of the PVDF shows different characteristic vibrations so filaments were analysed by FTIR spectroscopy. The overlay FTIR spectra of filaments (PVDF control and PVDF with ZnO nanorods) has been shown in the Figure 1. The peak at 760 cm-1 can be attributed to the wagging vibration of CF2 groups which is related to the α phase whereas peak at 840 and 880 cm-1can be attributed to the CF2-stretching which is related to β phase. It is observed that intensity of β phase peak intensity increases with addition of ZnO nanorods compared to control PVDF filaments. The relative amount of β phase has been calculated using the absorption intensity of β phase at 840cm-1 and α phase

at 760cm-1. The β phase fraction F(β) was calculated from the following equation.

$$F(\beta) = \frac{A(\beta)}{1.26 \times A(\alpha) + A(\beta)}$$

In this equation, A (β) is absorption band intensity of β phase at 840 cm-1and A(α) is the absorption band intensity of α phase at 760 cm-1. The relative β phase fraction increases from 0.44 for control PVDF filament to the 0.74 for 0.5% nanorod blended with PVDF which supports the contribution of nanorods towards enhancement of β phase crystals.

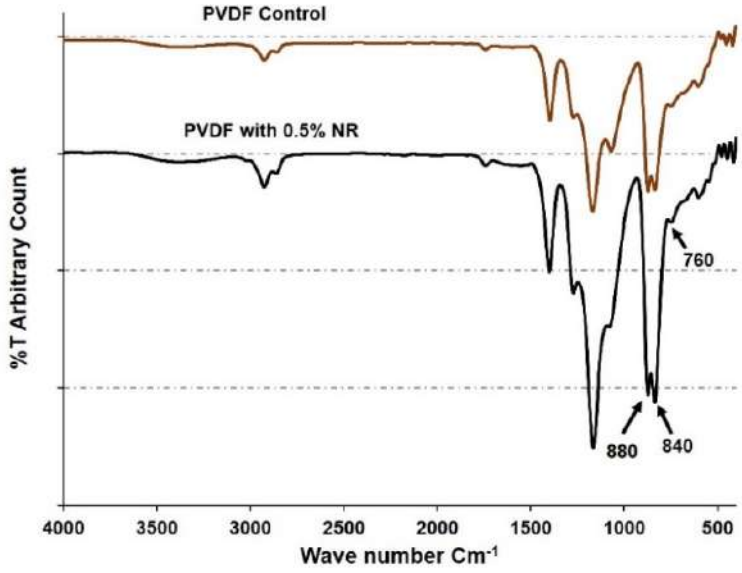


Figure 1. FT IR Spectroscopy of PVDF filaments with and without nanorods

Surface morphology of composite fibers

The scanning electron microscope images (SEM) of PVDF/ZnO composite filaments have been shown in Figure 2. Surface morphology of fibers was observed to be uniform in all cases. Moreover, there was no aggregation of ZnO nanorods in the composite fiber. The diameter of the composite fiber was also found to be uniform in the range of 31± 2 μm compared to the diameter of pure PVDF filaments in the range of 29 ± 1.5 μm. In the images, presence of few separate ZnO nanorods were clearly seen on the surface of composite fibers, which shows that nanorods are in highly dispersed condition. In the composite filaments, nanorods were found not only in dispersed but also in aligned condition. In most of the cases, position of nanorods were parallel to the axis of fiber.

EDX mapping of the composite filament with optimum loading of nanorods was also carried out to trace out the location of nanorods. Mapping images are shown in Figure 3. In the images, C, O and F are found to be uniformly distributed over the filament but Zn was present only at the position where ZnO nanorods were observed in the SEM images.

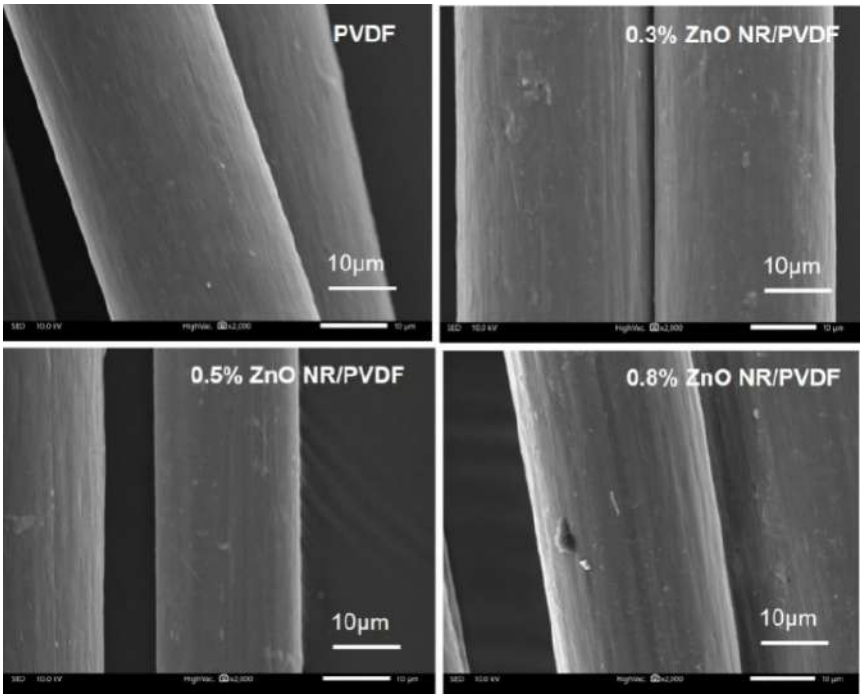


Figure 2: SEM images of PVDF and PVDF/ZnO composite filaments

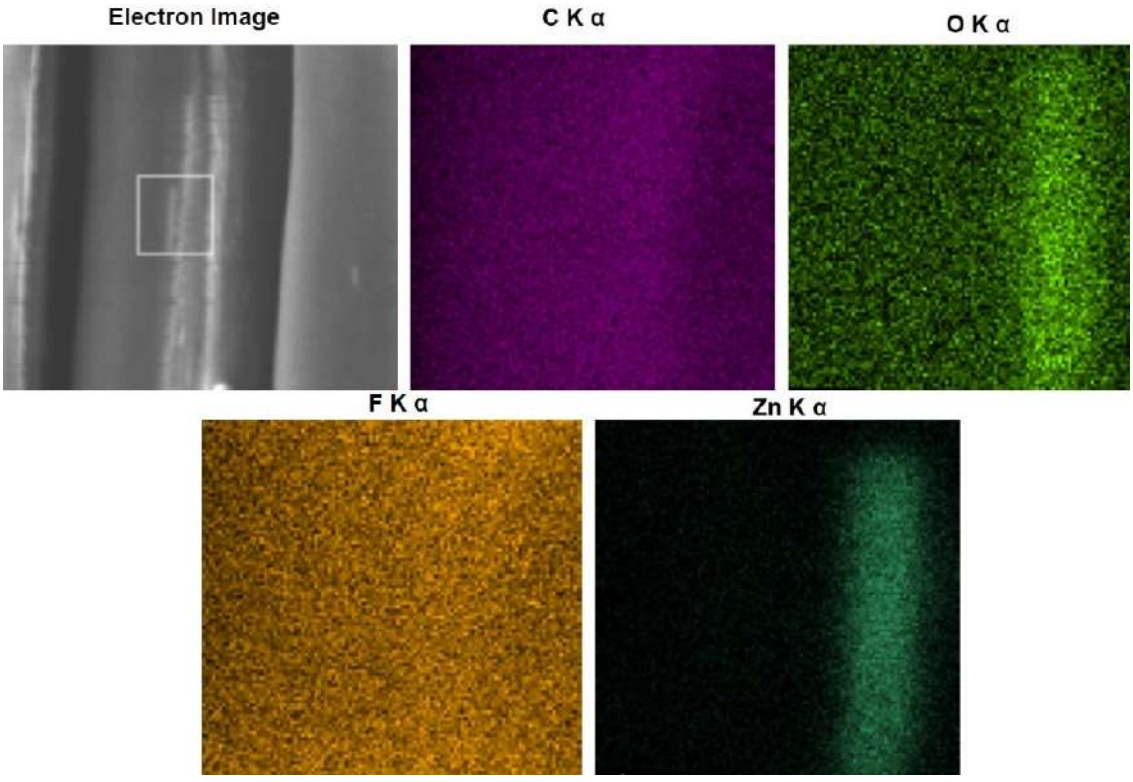


Figure 3: EDX mapping of 0.5% ZnO NR/PVDF composite filament

Mechanical properties of composite filaments

The mechanical properties of PVDF/ZnO nanorod composite filament at different loading percentage in comparison of pure PVDF filament is given in Table 1. There is no significant change in tenacity and elongation in case of composite filaments up

to 0.8% of ZnO nanorod loading compared to the control PVDF filament whereas the decrease in tenacity and elongation was observed at 1% of loading. At higher loading percentage, increase in filler population might be creating structural defect in the filament which may be causing reduction in tenacity. Whereas, the reduction in elongation% can be attributed due to the increase in stiffness of fibers with the nanorods.

Table 1. Tensile properties of PVDF and PVDF/ZnO nanorod composite filament

ZnO nanorod content (wt%)	Tenacity (g/den)	Tenacity (CV%)	Elongation %	Elongation (CV%)
0	2.50	5.69	25.00	10.03
0.3	3.27	6.54	23.60	11.34
0.5	2.41	5.93	24.75	09.98
0.8	2.45	5.86	24.05	12.85
1.0	1.80	9.3	22.45	12.60

Fabric preparation &Piezo testing

The fabric sample was prepared from the PVDF and ZnO/PVDF composite filaments using sample loom. Picks per inch and ends per inch were kept 36 for both the sample. These samples were taken for the evaluation of piezo response in term of voltage. During the evaluation, fabric was covered with aluminium electrode and connected to the digital oscilloscope which is shown in Figure 4. The output signal obtained from oscilloscope by the hand taping from a fix distance is given in Figure 5. The output signal in terms of voltage was found 4.4 V in modified fabric as compared to 3.6 V in control fabric by hand tapping from fixed height. Enhancement in signal was observed 22% after incorporation of ZnO nanorod.

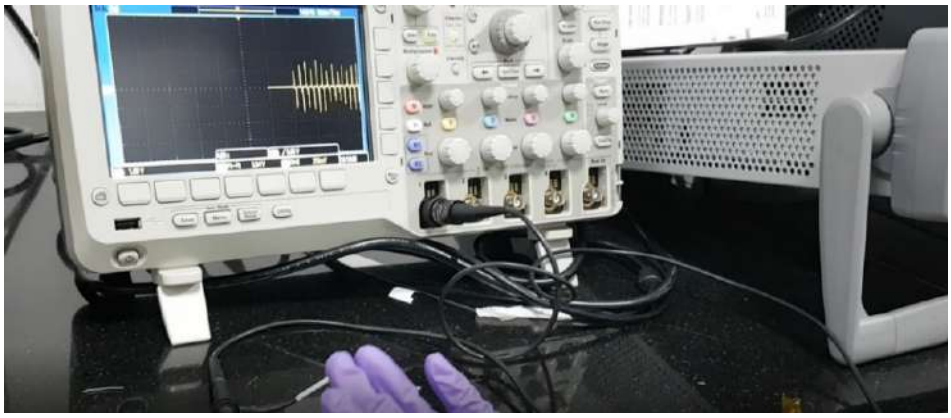


Figure 4: Setup during the evaluation of piezoelectric property

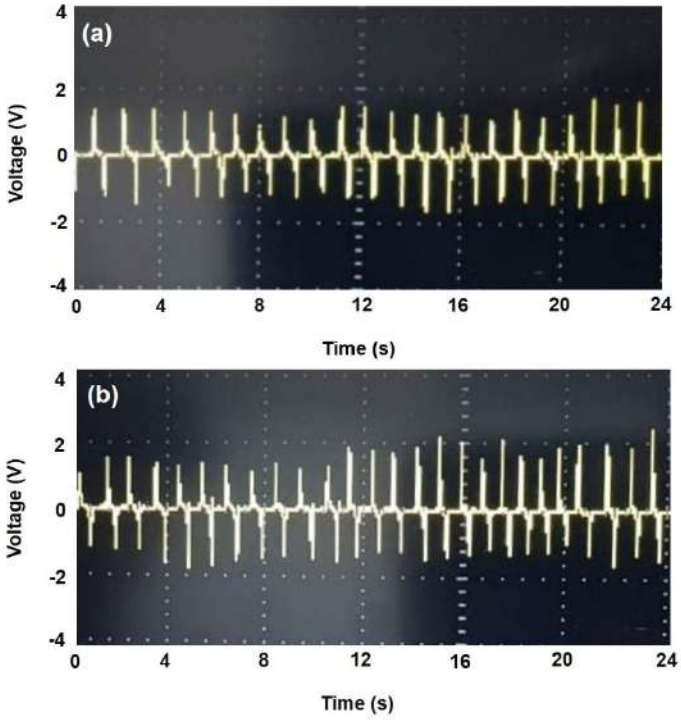


Figure 5: Output signal from the (a) control PVDF (b) PVDF/ZnO nanorod modified

Conclusion

The zinc nanorods were successfully synthesised with average aspect ratio of 26 by hydrothermal method. Those synthesised nanorods were melt compounded with PVDF and subsequently melt spun into filaments. The melt spinning process and drawing behaviour of filament was not affected by the addition of nanorods with high aspect ratio. Composite filament could be cold drawn up to maximum draw ratio 5 which is equal to the maximum draw ratio of PVDF spun at melt draw ratio 20. The highest total crystallinity of 74% was found at 0.5% loading of nanorods compared to 68% in control PVDF filament. Increase in β crystal percentage was observed 4% in the composite filament with 0.5% ZnO nanoparticles compared to control PVDF whereas this increase was 14% with 0.5% ZnO nanorods due to increase in interfacial interaction area. Nonpolar functionalization of ZnO nanorods did not help to enhance the β crystal formation further in composite filaments. The SEM and EDX investigation confirmed uniform dispersion of nanostructure in PVDF polymer. There was no significant change in mechanical properties of the filament at 0.5% loading of nanorods. Interestingly, incorporation of 0.5% ZnO nanorods could enhance the β crystal in PVDF up to a significant level compared to nanoparticle. This increase in β crystal showed enhancement in the piezoelectric property of PVDF filaments. This is suitable for sensor application.

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

Developed three test methods for analysing trace level of Cr(VI) in water soluble dyes and textile auxiliaries under MOT sponsored project. The developed test method has been commercialised by formulating a national standard. Bureau of Indian Standard accepted the test methods and published the same as IS 17338-2019. A paper for publication has also been submitted to The Journal of Chromatographic Science, Oxford academy and is under review.

2.7 'Mechanical Properties, Stability and Structure of Polymeric Composites Reinforced with Functionalized Fibres

Summary

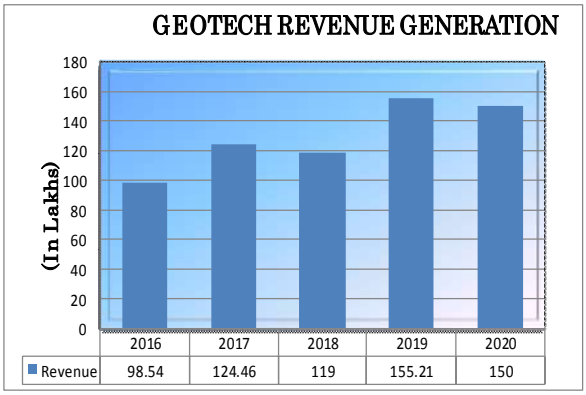
Composite is a product of two or more distinct components, which gives superior characteristics than those individual components. In other words, composites are nothing but the combinations of two materials in which one of the materials, called as the reinforcing phase (fibres/particles), and other material called the matrix phase. The main function of the matrix phase is to transfer the stresses between the reinforcing fibres/particles and to protect them from mechanical and/or environmental damage whereas the presence of fibres/particles in a composite improves its mechanical properties such as strength, stiffness etc. A composite is therefore a synergistic combination of two or more micro-constituents that differ in physical form and chemical composition, and which are insoluble in each other. Therefore, the objective of this project is to take advantage of the superior properties of both materials without compromising on the weaknesses of either.

In this project, prior to development of composites, the kinetics of unsaturated polyester resin and epoxy resin was studied in order to understand the time-temperature effect on their curing behaviour.

After understanding the curing behaviour of resins, the natural and synthetic fibres/fabrics viz. sisal, coir, banana, jute PET and PP were reinforced into them to obtain composites. Morphological, thermal, micro-structural and electrical properties of respective composites were studied which were found to depend on the kinds of material used. From Scanning Electron Microscopy(SEM) analysis, fewer breakages of fibers and cavity formation, better fiber to matrix interaction were observed in case of natural fibers than synthetic fibers. Hence, they are very suitable for composites. However, in practical application point of view, properties of these composites are not up to the mark. Therefore, in order to have further improvement in fiber to matrix interaction, surface modifications of jute fibers were done by alkali and plasma treatment where reasonable retention of mechanical properties maintained while carrying out modification. These surface modifications lead to positive improvement in the thermal and mechanical properties of resultant composites.

In parallel study, EMI shielding property of the surface modified and polypyrole coated jute/epoxy composite found better and perform satisfactorily.

3. Centre of Excellence for Geotech



BTRA (Bombay Textile Research Association) is recognised as Centre of Excellence (COE) for Geotech in the year 2008. BTRA has excellent state of art testing facility for Geosynthetics of International standard, accredited by NABL (India) as per ISO/IEC 17025 and GRI, USA. Earlier manufacturers of geosynthetics and User Industry were sending their sample to foreign labs, spending a lot of money and time. Now they save both money (3 to 5 times) and time. At the same time, they witness the test to get confidence in the test report which is not possible with foreign labs.

BTRA has excellent Asphalt and Soil testing lab facility.

BTRA is the second commercial Geotech lab in Asia accredited by GRI, USA. BTRA has information resource centre having many publications, Journals, Periodicals and Research reports for the industry people. Details of raw material suppliers and geosynthetic manufacturers are available with contact details.

BTRA has nonwoven development facility, needle punching and hydroentanglement. Various nonwoven manufacturers have used this facility for the development of nonwoven products for technical application and being used for the same. BTRA also has small loom for the development of woven technical fabrics. BTRA has developed woven products like Geobag, Geomattress for erosion and flood control applications.

BTRA imparts training to the entrepreneurs, students and industry persons in regard to the development of products and testing. Few entrepreneurs started manufacturing geotextile after taking training in BTRA. BTRA continuously helping industry for resolving their process or product-related issues (especially nonwoven industry).

BTRA is engaged in the development of test standards and specification for the Bureau of Indian Standards. BTRA also actively participated in establishing the specifications for Woven / Nonwoven geo bags for Ganga Flood Control Division, Ministry of Water Resources.

BTRA involved in standardising the specifications for products like Geogrid, Geocells, Geocomposites, PVD and Geotextile both made from synthetics and natural fibres (Coir& Jute) for various applications. Awareness about use of Geosynthetics created by BTRA through awareness program, Seminars and Conferences. This awareness resulted in the growth of the use of Geosynthetics in India.

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 in India and probably only the third institute outside USA 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.

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 2720Part-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.

Conferences / Meetings Attended

- Attended workshop of Design & Development of Connection strength tester along Mr.Pritesh Panchal-M/s Aimil Ltd at Starta Geosystems, Andheri on 9th May 2019.
- Attended the meeting with joint Secretary, MOT, GOI at TxC office, Mumbai on 24th May 2019.
- Attended the meeting on "Training Modules" along with Mr. Ajit Chavan, Secretary and Mr. Kartikay Dhanga, Director(Laboratories) at Office of Textile Committee, Mumbai on 28th June 2019.
- Attended BIS expert panel meeting on Geosynthetics, TX30 at BTRA, Mumbai on 19th July 2019.
- Attended BIS expert panel(13th) meeting on Geosynthetics, Tx30 on 20th August 2019.
- Attended 14th BIS Panel meeting on 19th September 2019 at BTRA, Mumbai.
- Attended 15th BIS Panel meeting on 14th October 2019 at BTRA, Mumbai.
- Attended 16th BIS Panel meeting on 29th November 2019 at BTRA, Mumbai.
- Attended BIS Tx 30 & Tx 33 meeting on standardization at Manak Bhavan, Mumbai on 3rd December 2019
- Attended 17th BIS Panel meeting on 17th December 2019 at BTRA, Mumbai.
- Attended Standardization meeting with Jt. Secretary, MOT, Udyog bhavan, New Delhi on 27th February 2020.

Standards and Specification formulated:

Test Standard for Geotextile (4), Geomembrane (1), Geogrid (2) & Specification for Geogrids (4), Geotextile (2), Geocomposite (1), Prefabricated Vertical Drain (1).

Exhibition Participation

- TECHNOTEX 2019 at Bombay Exhibition Centre, Goregaon, Mumbai between 29thto 31st August 2019.
- Techtextil 2019 at NESCO (Bombay Exhibition Centre), Goregaon, Mumbai between 20th November to 22nd November 2019

4. 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 one of the primary processes used to maintain instruments accuracy and is also the requirement of accredited testing laboratories.

Now, BTRA calibration laboratory received NABL accreditation as per 17025:2017 laboratory standards for Mass, Volume Balance and Force. BTRA is ready to provide calibration services to other NABL accredited testing laboratories 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 is Balance, Weight, Force – Standard balance 220 g-1 no's, 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 was 94.

5. 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 Schemes 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 has 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 have participated in these PT programs. We have 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.

6. 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.

6.1 Overview

Technical investigations carried out : 57

Technical enquires attended : 416

Local mill visits made [man-days] : 54

Outstation mill visits made [man-visits] : 64

6.2 Type of Assignments Undertaken

- TPP Steam Costing Audit
- Fabric Inspection
- LAPF Evaluation and improvement program
- Spinning and Weaving Maintenance Audit
- Nodal Agency –Technical Work
- Eco management analysis in the Indian Textile Industry
- Fume Toxicity Test program
- PMKVY participation handbook Preparation
- Packing Cost Reduction Audit
- Training of Assessors
- Machine Maintenance Audit
- NTC mills valuation Work

❖ **Product Development Assistance to the industry**

- In the pilot plant of Technical Textiles Weaving, 5 samples (of 15 m in length) were developed for applications such as tyre cord and filter fabric
- In the Plasma Treatment Machine, twenty metres of fabric was processed for two academic / research institutes

7. 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 26753 and section wise details are as follows.

7.1 Overview

Test Particulars	Number of Tests
Physical Testing	6811
Chemical Testing and Eco-parameters, Chemicals / Dyes / Auxiliaries Testing and Material Testing ***(non-textile items, water, oil, etc.)***	9412
Fabric Defect Analysis	600
Geotextile Testing	5994
Test Particulars	**Number of Tests**
Technical Textiles Testing ***(other than Geotech)***	
Microbiology Testing	489
Scanning Electron Microscope	517
Special Testing ***(Flammability, static charge, FTIR / DSC / TGA / X-ray/ GPC studies, Melt spinning trials, etc.)***	2811
Calibration Testing	119
TOTAL TESTS CONDUCTED	**26753**

7.1.1 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'

7.1.2 New Machinery / Instruments added

- High Volume Instrument
- Weighing Balance

7.1.3 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
- Analyzing migration of heavy metals from food packaging pouch established by using ICP OES.
- Analysis of free monomers in polymer samples and analysis of volatile organic carbon (VOC) by head space GC MS technique.
- Analysis of Maleic anhydride content in speciality chemicals and analysis of fatty acid in packaging materials

7.2 Technical Textiles Testing

BTRA carried out in total 5379 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 [Dumbbell 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 meter, weight per linear meter, thickness / density, yarn number, etc., certain unique tests are also undertaken. They are as follows.

- ✓ **FILTER FABRICS** (Woven and Nonwoven): 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 Breaking Load Machine Direction & Cross Direction, Grab Tensile Strength & Elongation, Index Puncture Resistance, Mullen Bursting, Pore Size by Porometer, Seam Strength, Static Puncture Strength (CBR Puncture Strength), Tensile Strength & Elongation (Warp and Weft), Tensile Strength (Before & After Exposure UV Xenon Arc), Trapezoid Tear Strength, UV Resistance Exposure to Light, Moisture & Heat in Xenon Arc, Water Permeability, Water Permeability of Filter, Wide Width Tensile Strength Machine Direction & Cross Direction
- ✓ **PVD BAND DRAIN**: Tensile Strength & Elongation (Wide Width), Water Permeability of Filter, Tensile Strength of Core, Grab Strength & Elongation at Break for PVD Composite, Trapezoid Tear for Filter Component only
- ✓ **GEO-MEMBRANELINER**: Density, Tensile Strength, Tear Strength, Puncture Resistance, Carbon Black Content, Melt Flow Index, ESCR, 2% Secant Modulus of Polyethylene Geomembrane
- ✓ **GEO-GRID**: Tensile Strength & Elongation (Single Rib) / Multi Rib, Carbon Black Content, Melt Flow Index, Aperture Size & Number of ribs per metre
- ✓ **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 Treatment (Heating)
- ✓ **METAL GABION**: Size, Thickness of Wire, Tensile Strength of Wire

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, Bacteria Filtration Efficiency [In-house Method]
- ❖ **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, Hexapod Tumbler Test, Lisson Test [Treading Wheel test], 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 / Methenamine) Test, Tuft Withdrawal Strength (Piled Carpets), Static Charge measurement, Surface Resistivity, Volume Resistivity, 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 (Methenamine) 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^{0}C for 2 hours, Pliability, Blocking Test, Gelling Test, Flexing Test [Dematia Method]

MEDICAL TEXTILES

- ✓ **COTTON WOOL PADS**: Acidity or Alkalinity [Methyl Orange / Phenolphthalein], pH at 26^{0}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^{0}C Temp.]

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**up to 13 mm Thick (Dumbbell Shape): Tensile Strength [In-house Method]
- ✓ **NYLON ROPES**up to 12 mm: Tensile Strength, Diameter of Rope, Linear Density

COMPOSITES

- ➔ **Glass Composites**: Flexural Strength, Lap Shear 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

7.3 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 2927 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^{O}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

7.4 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 Uirgin / 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
- HPTLC analysis
- HPLC analysis
- Total organic carbon [TOC] of water samples
- Acid digestion of metals / dyes / polymer / textiles etc.
- Triclosan

… and many more

7.5 Microbiology Testing

Textiles, being an integral part of our everyday life, have been involved in search of hygienic functional garments with application of anti-microbial finishes. BTRA carried out 418 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 [AATCC30 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

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.

Powerloom Service Centres (PSCs)

BTRA runs three Power loom Service Centers (PSCs) [at Ichalkaranji, Solapur and Madhavnagar-Vita]. In order to improve the quality, operating efficiency and productivity of power loom 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 power loom weavers/processors and on the spot, suggestions are made. The activities of these centers are given in the following Table-2.

Table – 2

Activities of BTRA Powerloom Service Centres

Activities		Ichalkaranji	Solapur	Madhavnagar - Vita
Total yarn and fabric samples tested for physical s & chemical properties		11031	3590	704
Number of technical assistance / trouble shooting / consultancy given		185	466	31
Total number of persons trained		176	262	93
Total number of trainee man-days		99	2884	1533
Total seminars / workshops conducted			8	04
Survey of closure of power looms	Units	376	408	347
	Looms	4902	6712	2986
Number of interactive workshops conducted for TUF scheme and Group Insurance scheme				04
Group insurance facilitations for power loom workers [number of beneficiaries]		357	1520	294
Number of Advisory / PPCICC meetings conducted		9	1	01
Number of samples for design development [non-CAD] / Analysis		-		03

8. INFORMATION DISSEMINATION / INDUSTRY INTERACTION

Lecture on 'Geocomposites'

BTRA organized a lecture on 'Geocomposites' at its premises on 08th April 2019 sponsored by the Flexituff International, Maccaferri and Techfab India.

Dr. George R. Korner delivered lecture on the following topics:

- Composite Application and Evaluation
- Testing of Geosynthetics with respect to Durability and Endurance for prediction of life.

Applications of Geocomposite Drainage Liner is increased in India, many entrepreneurs showed interest to know about it. Those having nonwoven plant wanted to start manufacturing Drainage composite. Similarly many users wanted to know as how to predict the life of geosynthetics. Hence, there was a very good interaction with the participants and Dr. George R. Korner; it was a great success.

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 Appendices–3 and 4.

9.SPECIAL EVENTS

BTRA organised many lectures and training programmes [at BTRA and at a Unit level] during the year under review.

9.1 BTRA organised the lecture on the topic "Advanced Green Composites" at its premises on 21st December 2019.

BTRA organised the lecture on the topic "Advanced Green Composites" at its premises on 21st December 2019, sponsored by the Flexituff Ventures International Limited.

Prof. Anil N Netravali, Jean & Douglas McLean Professor in Fibre Science and Apparel Design and Director of Graduate Studies, Cornell University, USA, delivered a lecture on the following topics:

- Green Resins from Plant Sources and Strengthening Mechanisms
- High Strength Cellulosic Fibres from Liquid Crystalline Solutions
- Cellulose Nanofibers- Electrospinning and Nanocellulose Self-Assemblies
- Advanced Green Composites with High Strength and Toughness
- Green Composites with Excellent Barrier Properties

This Lecture was based on the latest development in the field of 'Green' resins (with ways of strengthening them), High Strength Green Fibres (including micro and nano-cellulose fibrils/fibres) and Green Composites. The consequences of using conventional, petroleum-based materials and the need for green composites as well as the progress being made in this field were discussed. Prof. Anil N Netravali stated that significant research is being conducted utilizing sustainable fibres and resins mostly derived from plant, to fabricate 'Green' composites. The significant progress in the past 20 or so years in this field has led to the development of green composites with high strength or so-called Advanced Green Composites.

9.2 Conference

Dr. Anjan K. Mukhopadhyay Director, BTRA, was invited as Guest of Honour by Institute of Chemical Technology, Mumbai, during a Conference on "Characterization of Polymers & Polymeric Products 2019" at the Institute of Chemical Technology, Matunga, Mumbai on 18th September 2019.

9.3 Training Programmes Conducted

BTRA organised many training programmes [at BTRA and at Unit level] during the year under review. Details are provided in Appendix - 5.

9.4 BTRA Publications / Library

A list of BTRA publications, brought out during the period under review, is given in Appendix–7. 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–9. It receives around 30 foreign and 35 Indian journals / magazines / newsletters regularly. As on 31stMarch, 2020, the library has 22,961holdings. BTRA updates its website (www.btraindia.com) at regular intervals.

9.5 Academic Activities

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

10. 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.

- TECHNOTEX 2019 at Bombay Exhibition Centre, Goregaon, Mumbai between 29th to 31st August 2019.
- Techtextil 2019 at NESCO (Bombay Exhibition Centre), Goregaon, Mumbai between 20th November to 22nd November 2019
- IIT Expo Mumbai 2020 at Bombay Exhibition Centre, Goregaon, Mumbai between 5th March to 7th March 2020.

BTRA Stall view at various Exhibition in 2019

Various research publications, samples of technical textiles and posters depicting the research, testing, and 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. This is apart from various In-house projects that are being carried out. 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

Completed 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 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

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

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

On-going Projects

- Centre of Excellence for Geotech
- BTRA powerloom service centre – Ichalkaranji
- BTRA powerloom service centre – Solapur
- BTRA powerloom service centre – Madhavnagar

On-going Project

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
Dr. Anjan K.Mukhopadhyay Director, BTRA	"Characterization of Polymers & Polymeric Products 2019"	Institute of Chemical Technology, Matunga, Mumbai on 18th September 2019

Appendix–3

PAPERS PUBLISHED IN JOURNALS

Staff Name	Title	Journal Name
Mr. Amol G. Thite, Mr. Kumar Krishnanand, Dr. Prasanta K. Panda	'Electron beam-induced crosslinking of silk fibers using triallyl isocyanurate for enhanced properties'	'Journal of Applied Polymer-Science' April 2019, p. 47888 (1-10).
Mrs. Smita C. Deogaonkar, Ms. Pradnya Wakode, Mr. Kaushlesh P. Rawat	'Electron beam irradiation post-treatment for degradation of non-biodegradable contaminants in textile wastewater'	'Journal of Radiation Physics and Chemistry 165' June 2019, p. 108377(1-5).
Mr. M. P Sathianarayanan	"Development of test method for analysing hexavalent chromium content in dyes, pigments and textile auxiliaries"	Accepted in the "Journal of Chromatographic Science" June 2019
Mr. V. K. Patil & Mrs. Snehal Dhamdhere	COE-Geotech-BTRA	Textile Value Chain Issue No.2278-8972, Vol.7, Issue 11, Nov.2019
Mrs. Smita Deogaonkar & Ms. Pradnya Wakode, Mr. Kaushlesh P. Rawat	'Electron beam irradiation post treatment for degradation of non biodegradable contaminants in textile wastewater'	Radiation Physics and Chemistry, Vol 165, December 2019, 108377
Mr. Tanaji Kadam, Mr. Vijay Shirole & Mr. Akash Kanse	Analysis of eco management in Indian textile processing industry.	Colourage, Dec 2019
Mrs. Smita Deogaonkar	'Dielectric barrier discharge plasma induced surface modification of polyester/cotton blend fabrics to improve polypyrrole coating adhesion and conductivity'	Journal of the Textile Institute, January 2020, DOI: 101080/00405000.2019.1710905

Staff Name	Title	Journal Name
Mr. Tanaji Kadam and Mr. Vijay Shirole	Implementation of chemical management system (CMS) in the textile processing	Textile Value chain, March 2020.
Smita Deogaonkar-Baride, Narendra V. Bhat, Padma Vankar, and Anjan K. Mukhopadhyay	'Polypyrrole based fabrics: Synthesis and Applications (Review)'	"Pyrrole: Synthesis and Applications", Nova Publishers, USA, 2020.
Dr. Prasanta K. Panda & Ms. Archana Gangwar	Nanofiber coated prefabricated vertical drainage (PVD) membrane with improved anti-clogging property	BTRA Scan, Vol.XLIX, June 2019
Mrs. Smita Deogaonkar	Novel DBD Plasma pre-treatment on PET fabric for enhanced polypyrrole bonding and conductivity	BTRA Scan, Vol.XLIX, June 2019
Mr. Vijay Shirole, Mr. Tanaji Kadam and Mr. Akash Kanse	Need and Benefits of Machine Maintenance Audit in Textile Industry	BTRA Scan, Vol.XLX , September 2019
Ms. Archana Gangwar & Dr, Prasanta K. Panda	Polymer Nanofibers by Electrospinning and their Applications in the Protective Textile Materials: A Review	BTRA Scan, Vol.XLX , September 2019,
Mr. Sachin R Tambe	Natural fibers Reinforced Composites and Its applications: Review	BTRA Scan, Vol.XLXI, December 2019
Mr. M. P Sathianarayanan & Ms. Rina Nayak	Determination of Cr (VI) Content in Water Soluble Dyes by Pre Column Derivatization followed by HPLC Analysis	BTRA Scan, Vol.XLXI, December 2019
Mr. Vijay Shirole	'Textile Process Audit: An approach towards continual improvement'	BTRA Scan, Vol-XLXII, March 2020.
Ms. Archana Gangwar & Dr, Prasanta K. Panda	Electrospinning of Polyamide 6 Nanofiber using Wire Electrodes'	BTRA Scan, Vol-XLXII, March 2020.

Appendix – 4

TRAINING PROGRAMMES CONDUCTED

Subject	To Whom	Duration
	On-Site Training	
'Textile General'	Two staff Mr. Saket Sagar Joshi and Mr. Kashish Mehta at BTRA, Mumbai	For 12 days in May 2019
'Textile General'	One staff Mr.Gaurav H Dantkae at BTRA Mumbai	For 8 days in July 2019
'Fabric Inspection'	Six staff of Max Sure Engg Pvt Ltd at BTRA Mumbai	For 2 days in August 2019

Appendix – 5

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

Name of Staff	Occasion	Place	Date
Mr. Tanaji Kadam / Vijay Shirole / Vijay Gawde	Participated in a discussion on Maintenance audit of Nagreeka Export	Mumbai	2nd April 2019
Mr. Tanaji Kadam	Attended Cotton Guru Conclave2019	Mumbai	April 2019
Mr.V. K. Patil	Attended SION meeting at the office of Textile Commissioner	Mumbai	16th April 2019
Mr. Tanaji Kadam	Attended workshop on Discussion on Techno-Economic Viability Study	Mumbai	14th May 2019.
Mr. Akash Kanse	Attended workshop on Discussion on Waste Management	Mumbai	30th May 2019
Mr. V. K. Patil	Attended workshop on Design & Development of Connection strength tester	Mumbai	9th May 2019
Mr. V. K. Patil	Attended Jt. Secretary , MOT, GOI, meeting along with Dr. Anjan Mukhopadhyay	Mumbai	24th May 2019
Mr. V. K.Patil	Attended meeting to discuss the Training modules	Mumbai	28th June 2019
Mr. V. K. Patil	Attended meeting on BIS expert panel (13th) on Geosynthetics, TX30	Mumbai	19th July 2019
Mr. Vijay Gawde	Attended Samarth skill development - MOU function, New Delhi	New Delhi	14 August 2019
Mr. Tanaj Kadam/ Vijay Gawde/ Vijay Shirole & Akash Kanse	Attended Training in "Product Inspection and social compliance audit"	BTRA, Mumbai	09th September to 13th September 2019
Dr. Anjan Mukhopadhyay Director, BTRA	Attended conference on "Characterization of Polymers & Polymeric Products 2019"	Institute of Chemical Technology, Matunga, Mumba	18th September 2019
Mr. Tanaji Kadam	Attended Conference on " INDIA - opportunities for stratagic investments in Textiles"	IIM Ahmedabad	3rd & 4th October 2019
Mr. Tanaji Kadam	Attended PAMC - Project Meeting	Mumbai	15th November 2019

Name of Staff	Occasion	Place	Date
Mr. Vijay Gawde	Attended BIS meeting	Mumbai	28 November 2019
Mr. Tanaji Kadam	Attended ZDHC conference	Mumbai	10 December 2019
Mr. Tanaji Kadam	Attended MOT Meeting for technology upgradation	New Delhi	28th November 2019
Mr. Tanaji Kadam/ Mr. Akash Kanse	Attended Boiler 2020 conclave	CIDCO Exhibition Centre, Vashi	21st & 22nd February 2020

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 nos.] • Cuprammonium solution [8.8 litres] • Fluidity Tubes [7 nos.] • Hook for drove test [6 nos.]
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

- 2020 TECHNICAL MANUAL OF AATCC, AATCC. USA, 2019
- TEXTBOOK OF POLYMER SCIENCE, FRED W BILLMEYER, WILEY INDIA PVT LTD
- UNIT OPERATIONS OF CHEMICAL ENGINEERING/7TH EDITION, Warren L McCabe / Julisn C Smith/Peter Harriott, McGraw Hill Education(India)Pvt Ltd
- TEXTILE FIBER MICROSCOPY, IVANA MARKOVA, WILEY
- New Trends in Natural Dyes for Textiles, Padma Shree Vankar and Dhara Shukla, Woodhead Publication, UK 2018
- FUNDAMENTALS OF YARN WINDING, Milind Koranne, Woodhead Publishing India Pvt. Ltd., New Delhi, 2013 / reprint 2017

- SOIL ENGINEERING IN THEORY AND PRACTICE – Vol. 2: Geotechnical Testing and Instrumentation [2nd Edition], Alam Singh & G.R. Chowdhary, CBS Publishers & Distributors P. Ltd., New Delhi, 2014
- Energy Audit Manual – The Practitioner's Guide, R. Suryanarayanan, Energy Management Centre, Kerala and National Productivity Council, Chennai, 2017
- 2018 Technical Manual of AATCC, AATCC, USA, 2018
- CO2 EMISSION MITIGATION THROUGH ENERGY CONSERVATION – A Practical Guide, Dr. T. Sambandam, Shanlax Publications, Madurai, 2017
- Paul-High Performance Technical Textiles
- Markova-Textile Fibre Microscopy

CDs / Soft Copy Downloads

- **Latest International Standard Test Methods:** ASTM D6243D6243M.32869, ASTM D6496D6496M.33553, ASTM D6766.38539, 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 D6495D6495M.12788, and ASTM D6768D6768M.13844.

Appendix – 9

DIRECTOR'S ENGAGEMENTS

Month	Details
May, 2019	♣ Attended a meeting related to the progress of CoE and R&D projects under the Chairmanship of the Joint Secretary, Mr. Nihar Ranjan Dash on 24th May 2019, Mumbai. Attended the meeting to review the activities and achievements of TRAs in the last financial year under the Chairmanship of the Joint Secretary, Mr. Nihar Ranjan Dash, on 27th May 2019, New Delhi.
June, 2019	♣ Attended a meeting with Prof. Subhasis Chaudhari, Director IIT Bombay on 25th June 2019.
July, 2019	♣ Attended the Project Monitoring Committee meeting, organized by the Technology Development Board (TDB) at Grasim Industries Limited at Kharach, Gujarat as one of the experts on 18th & 19th July 2019.
August, 2019	♣ Attended the interaction meeting –Globalizing the Brand Khadi " The Pride of India" with Honorable Minister Mr. Niting Gadkari in Mumbai on 27th August 2019 ♣ Attended the Technotex 2019 on 29th August 2019 ♣ Attended the 9th Annual General Meeting and the Knowledge Sharing Session of ITTA in Mumbai on 30th August 2019.
September 2019	♣ Attended the conference on "Characterization of Polymers & Polymeric Products 2019" as Guest of Honour. This was organized by the Department of Polymer and Surface Engineering, ICT along with The Society of Industrial Chemistry and Recyclers Foundation on 18th September 2019.

October, 2019	♣ Visited Grasim Industries Ltd; R&D Center at Taloja for third party validation on 16th October 2019 ♣ Visited Grasim Industries Ltd; R & D Center at Bharuch for third party validation on 17th & 18th October 2019
November, 2019	♣ Attended the 12th meeting of Project Appraisal & Monitoring Committee (PAMC) under the chairmanship of Textile Commissioner on 15th November 2019, Mumbai. ♣ Attended a meeting to discuss on National Standards of Technical Textiles item under the Chairmanship of Secretary, Ministry of Textiles on 19th November 2019, New Delhi. ♣ Attended the stakeholders meeting to discuss on National Textiles Policy document - Technical Textiles Segment under the Chairmanship of Joint Secretary (R&D) on 19th November 2019, New Delhi. ♣ Attended India's first Hackathon on Technical Textiles alongside Techtextil India Exhibition on 22nd November 2019, Mumbai. ♣ Attended meeting with Mr. Sunil S. Gandhi, Sr. R&D Associate, GDC Laundry
November, 2019	Cti(Claims & Appraisal), Hindustan Unilever Ltd. and Ms. Prachi Desai, Manager-Consumer Technical Insights, Home Care, Unilever Industries Pvt. Ltd; regarding collaboration with BTRA on 26th November 2019, Mumbai.
December, 2019	♣ Attended the 23rd meeting of Geosynthetics sectional committee, TXD 30 in Joint session with 12th meeting of Industrial fabrics sectional committee TXD 33 on 3rd December 2019, Mumbai. ♣ Attended the Global Connect Initiative-"Strengthening Bilateral Trade Relation with Neighboring Countries" on the occasion of the 40th Year of India ITME Society on 20th December 2019, Mumbai.
February, 2020	♣ Director Chaired a session in the International Conference (ICTX 2020) Innovative Approaches for the Development of Sustainable Textile Products and Processes held in Kolkata from 9th and 10th February 2020.

Appendix – 10

DISTINGUISHED VISITORS TO BTRA

Name of the Visitors	Company
Mr. D. Mazumdar, President	Cheviot Company Limited
Mr. Nawal Kejriwal, whole-time Director	Cheviot Company Limited
Dr. Yaming Niu, PhD, Scientist	Kraton Polymers India Pvt.Ltd
Ms. Divya PS, Scientist	Kraton Polymers India Pvt.Ltd
Mr. G.R.Verma, President	Birla Corporation Limited
Mr. Anup Pandey ,General Manager	Birla Corporation Limited
Mr. Narendra Kajale, Vice President,	Technology & Innovation,TEXPORT Syndicate (India) Ltd
Mr. Charuchandra Dewasthale	Eximious Ventures P.Ltd
Mr. Kireet Joshi, G.M (QA & Technical Services	Shriram Rayons
Mr. Darshan Ranavat, ACA	S.B.Gabhawalla&Co

Name of the Visitors	Company
Dr. Kedar Chaudhari, Executive Director	Diversey India Hygiene Pvt Ltd
Dr. Prashant Pandey	Diversey India Hygiene Pvt Ltd
Mr. Cyril Pereira. Managing Director	Joseph Leslie Dynamics Mfg.Ltd
Mr. Mahesh Kudav, Managing Director	Venus Safety 7 Health Pvt Ltd
Mr. Lalit Aggarwal, Head-marketing	Reflectosafe
Mr. Kamlesh Dand	Safety Services
Mr. Mohammad, Chief Technical Officer	Karam Industries
Mr. Subhra Neel Saikia	Bigphi Technologies Pvt.Ltd
Mr. Nirmal Kumar TS, Chief Operating Officer	Akshay Software Technologies Ltd.
Ms. Rupali Chitnis, Manager	A.T.E. Enterprises Pvt Ltd
Mr. Wayne Furlan-Manager	Baker Hughes a GE Company
Mr. Raghuvendra Barki, Polymer Testing Engineer	Baker Hughes a GE Company
Mr.Darshak Ruparel	Khushboo Forwarders
Mr.Abhishek Kulkarni,Area Sales Manager	Atlas Copco (India) Ltd.
Mr. Indrani Dasgupta	Raybon Chemicals and Allied Products
Mr. Rajesh Kapadia, Fabric Manager	Purecotz Eco Lifestyles Pvt.Ltd
Mr. Amar Chheda, Sr. Executive-	Venus Safety & Health Pvt.Ltd
Mr. Rajendra B Joshi	Pragati Development, Yarn Manufactures, Distributors & Engineers
Mr V. Srinivasan, CEO	Texport Syndicate (IND)Ltd,
Mr. Sanjay Gandhi, DGMSales	Texport Syndicate (IND)Ltd,
Dr. Milind Khandwe, Technical Director	The Bhor Chemicals and Plastics Pvt. Ltd
Mr. Mangesh Shinde, Business Manager	Tensar Geosynthetics India Pvt. Ltd
Mr. S. K. Bandopadhyay, General Manager	Indian Oil Corporation
Mr. Saurabh Agarwal, Senior Manager	Indian Oil Corporation
Mr. Adit Mehta, Head of Business Development	Ebullient Packing Pvt.Ltd.
Mr. V. Ravikanth, Assistant Vice President	Reliance Industries Ltd
Mr. Andy CLow, group Leader	Textile Fibres,
Mr. Arun Jain, DGM	Discovery & Analytical Solutions
Mr. Omprakash W Shah, Partner	H. Enterprises
Mr. S. K. Som, Director	Quality Assurance & Technical Services
Mr. Ashwin Pathak, Director	APOS INC
Mr. Rakesh Pundir, Joint President	Grasim Industries Ltd
Mr. Akshar Chandra, Deputy General Manager	Grasim Industries Ltd
Mr. Dinesh Soni, Sales Director	Groz-Beckert Asia Pvt Ltd
Mr. Laxminarayan V. Kanki, Manager	A.T.E. Enterprises Pvt.Ltd
Mr. V. Mathivanan, I.O.F.S, Addl. General Manager	Ministry of Defence, Ordnance Clothing Factory

Name of the Visitors	Company
Dr. P. P. Raichurkar, Associate Dean	Mukesh Patel School of Technology Management & Engineering
Ms. Shweta Goilkar, Asst. Project Officer	Maharashtra Industries Development Institute (P) Ltd
Mr. D .M. Bhatia	Bhatia Texlab
Ms. Madhura Dalvi, Business Head	Cotecna Inspection India Pvt.Ltd
Mr. Narendra Ayare, Chief Advisor	Fine Organics
Mr. Govindraj C.S, CEO-Industrial Business and projects	IFB Industries Limited
Mr. B. M. Shetye, Vice President-Sustainability	IFB Industries Limited
Mr. P. P. Bhase, Director	Fan Services, Nashik
Dr. Henry Kibet Rotich, Director	Kenya Bureau of Standards
Mr. John W. Wepukhulu, Technical Manager	Premier Verifcation Quality Services L.L.C. Dubai
Mr. Siddharth Lulla, Consultant	Intellecap
Dr. Ravinder Tuteja, Head	Grasim Industries Limited
Mr. Haresh Pania, Film Director & Screenwriter	Sifar Dimension
Mr. Rajesh Balkrishna Padalkar, Managing Director	BLKRSNA, Media Events, Hospitality,
Mr. Suchit R Save, Associate Regional Service Manager	Environmental Health, Perkin Elmer (India) Pvt. Ltd
Mr. Tanmay Kandekar, Assistant Professor	National Institute of Fashion Technology
Mr. Mahesh Sawakare, Assistant Project Officer	Maharashtra Industries Development Institute (P) Ltd
Mr. Awinash G Belhe, Sr.Vice President	Reliance Industries Limited
Mr. S. Rajendren, General Manager	Reliance Industries Limited
Mr. Marc Directo, Chief Operating Officer	International Advisory Council
Dr. Rashmi Mishra Chowdhary, Chief Technology Officer	Gencrest LLP,
Mr. Pratap Pingale, Chief Executive Officer	Maharashtra Industries Development Institute (P) Ltd
Mr. Ramkrushna Latke, Deputy Manager-Enterprise	Tata Teleleservices (Maharashtra) Limited
Dr. Vivek Ganvir, Lead Scientist	Aditya Birla Science & Technology Company Pvt.Ltd
Dr. Dhirendra Singh, Senior Scientist	Aditya Birla Science & Technology Company Pvt.Ltd
Mr. Dhananjay Srivastava, Chief General Manager	Indian Oil Corporation Ltd.
Mr. Shailesh Kaushik, Empanelled Technical Advisor	The Textile Association (India)

Appendix – 11

OUTSTATION VISITS BY BTRA STAFF

- ✓ Anupam Tex Processors, Delhi
- ✓ Arti Textile Mills, Kolkata
- ✓ 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 & Style Pvt.Ltd, Delhi
- ✓ Cotton Blossom, SIPCOT Perundurai
- ✓ Dimond Mills, Ahmedabad
- ✓ District Industry Centre, Pune
- ✓ D'Decor Exports, Boisar
- ✓ Eakata Dyeing, Ludhiana
- ✓ G.S. Settia & Sons, Sonipat
- ✓ 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 Export
- ✓ 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

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 purposes
TXD 40	Composites and Speciality Fibres Sectional

Appendix – 13

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

Dr. P. R. Roy Chairman, Diagonal Consulting (India) B-509, Infinity Tower, Nr. Safal Profitare, Corporate Road, Pralhadnagar, Ahmedabad 380015	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.	Mr. V. Kannan Flat 303, Building 3B, Siddhachal Phase 6, Off Pokhran road no.2, Near Vasanth Vihar school, Thane (West), Pin: 400 610
Mr. K. L. Vidur Chartered Engineer B-401, NirmanVihar, Rajmata Jeejabai Road, Andheri (East), Mumbai 400093	Mr. Ullhas M. Nimkar, Row House No.25, Vasant Vihar, Thane (West) Pin 400 601.	Dr. Sanjiv Kamat Vice President Kothari Info Tech Ltd., B 1/ 04/05 Ground Floor, B Wing, Boomerang, Chandivali, Andheri (East), Mumbai 400072
Prof. R. R. Deshmukh Associate Professor, Physics Department, ICT , Matunga, . Mumbai 400019	Dr. Milind Khandwe The Bhor Chemicals & Plastics Pvt. Ltd., Plot No. B/18/2/1 in MIDC, Ambad, Nashik 422010	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
Dr. Vijay Ramkrishnan Sr. Vice President, Technical & New Businesses, Garware Technical Fibres Ltd Plot No.11, Block No. D-1,MIDC, Chinchwad, Pune 411019	Dr. Asim Tewari Prof – in – Charge, National Centre for Aerospace Innovation Research, Indian Institute of Technology Bombay, Powai, Mumbai 400076	Dr. Mujeebur Rehman GM- R&D & QA, Atul Ltd., Colours Division, R& D Department, Valsad Pin 396020
Prof. Bhaskar Thorat Head, Department of Chemical Engineering, Institute of Chemical Technology, Nathalal Parekh Marg, Matunga, Mumbai 400019	Prof. Anirban Guha Professor Dept. of Mechanical Engg. Indian Institute of Technology Bombay, Powai, Mumbai 400076	Mr. Shahrokh Bagli Chief Technology Officer Strata Geosystems (India) P. Ltd, Sabnam House, Plot No. A-15/16, Central Cross Road B MIDC, Andheri (E), Mumbai 400 093
Dr. Prakash Vasudevan Director, The South India Textile Research Association, Coimbatore Aerodrome P.O., Coimbatore 641 014.	Dr. A. Basu Director General The Northern India Textile Research Association, Sector 23, Rajnagar, Ghaziabad 201 002.	Mr. Pragnesh Shah Director, The Ahmedabad Textile Industry's Research Association, P.O. Ambawadi Vistar, Ahmedabad 380 015
Mr. K. Venkatarayan 301, Tulsi, Near Building No. 17-A, Vrindavan Society, Thane (West) 400601	Prof. N.V. Bhat 4/78, Palm View Society, Vidyavihar (East) Mumbai 400077	Dr. Anjan K. Mukhopadhyay Director The Bombay Textile Research Association Lal Bahadur Shastri Marg, Ghatkopar(West),Mumbai400086.

Appendix – 14

STAFF DETAILS

The total staff strength of BTRA as on 31st March 2020 was as follows:

Director	**1**
At BTRA	
◆ Scientific / Technical Officers	19
◆ Scientific / Technical Staff	25
◆ Skilled / Semi-skilled & Maintenance Staff	17
◆ Administrative Staff	16
Sub-total	**78**
At PSCs	
◆ Scientific / Technical Officers	0
◆ Scientific / Technical Staff	5
◆ Skilled / Semi-skilled & Maintenance Staff	1
◆ Administrative Staff	1
Sub-total	**7**
TOTAL	86@

@ - Including 19 contractual staff & 1 Trainee

Director : Dr. Anjan K. Mukhopadhyay

Research

Research Advisor : Dr. Padma S Vankar

Technical Services Division

Chief Textile Technologist : Mr. Tanaji I. Kadam
Senior Scientific Officer Grade-I : Mr. V. A. Gawde
Senior Scientific Officer Grade-I : 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

(i) 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

(ii) Chemical Testing Lab.

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

(iii) Microbiology Lab.

Senior Scientific Officer Grade-II	:	Mrs. Aruna D. Apte

(iv) Plasma Lab.

Senior Scientist	:	Dr. Prasanta K. Panda
Senior Scientific Officer Grade-II	:	Ms. S.S. Palaskar
Research Scholar	:	Ms. Archana Gangwar
Research Officer	:	Mr. Sachin R. Tambe

Engineering Services Section

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

Administration

Administrative Officer	:	Mr. Jignesh S. Jani
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
Executive Assistant	:	Mr. Vasant Gawde

BTRA PSC, Ichalkaranji	:	Mr. V.G. Kulkarni
BTRA PSC, Solapur	:	Mr. A.V. Patil
BTRA PSC, Madhavnagar	:	Mr. N.A. Chavan

Marketing

Lead Marketing	:	Mrs. Snehal B Dhamdhere
Executive Customer Co-ordination	:	Mrs. Swati A Bhaigade

Appendix - 15

LIST OF MEMBERS

- Banswara Syntex Ltd., Rajasthan
- Birla Century, Gujarat
- Birla Cotsyn (India) Ltd., Mumbai
- BMD Pvt. Ltd., Banswara
- BSL Ltd., Bhilwara
- Diversey India Hygiene Pvt. Ltd., Mumbai
- Finlay Mills Ltd., Achalpur
- Flexituff Ventures 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
- OCM Private Ltd, Punjab
- 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 P. 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
- Indian Oil Corporation Ltd., New Delhi
- Century Rayon (under the management & operation of Grasim Ind. Ltd.), Shahad