R & D PROJECTS - 2011-12

1. GOVERNMENT SPONSORED PROJECTS

1.1 Completed projects

(i) Project title : Ultrasonic Cleaning of Garments (Sponsored by Ministry of textiles, Govt. of India)

Objectives :

- Fabrication of garment cleaning gadget using ultrasonic technique
- Optimization of washing process parameters
- Evaluation of washing efficiency using newly developed gadget.
- Evaluation of economic benefits of the new washing technique.

Research outcome :

- There are four key factors for any cleaning application.These are thermal energy, chemical energy, mechanical energy and time. The success of a cleaning application depends on the balance and relationship of three types of energies. The fourth parameter time do not have any effect on these three energies, but any increase or decrease in the production rates at any particular step of the manufacturing process does effect the balance of these energies.

- Ultrasonic is one type of mechanical energy used as a successful cleaning process. To a great extent, the type of mechanical energy selected depends on the relationship of the heat applied to the process and the type of chemistry used. A more successful approach considers all of these parameters.

- Ultrasonic application is done in the presence of water with detergent (chemical). Ultrasonic therefore is able to enhance the cleaning efficiency.

- Under this project ultrasonic garment washing machine was developed and various parameters were optimized. The results of cleaning efficiency in terms of whiteness index (Conventional vs Ultrasonic machine) are shown in the Table 1. From the table it is clear that the cleaning efficiency in terms of whiteness index is better in the ultrasonic cleaning process than conventional process.

TABLE : Cleaning Efficiency of the New Developed Ultrasonic Cleaning Gadget for Garments

Frequency - **40 KHz**
Whiteness Index [White fabric (Unsoiled)] - 78.5513
Reflectance [White fabric (Unsoiled)] - 60.764

CONVENTIONAL WASHING MACHINE WHITENESS INDEX READINGS	ULTRASONIC WASHING GADGET WHITENESS INDEX READINGS

WHITENESS INDEX				WHITENESS INDEX			
S. No.	Before	After machine wash	Difference	S. No.	Before	After machine wash	Difference
1	48.960	69.173	20.213	1	46.524	71.126	24.602
2	47.771	71.992	24.221	2	47.514	72.605	25.091
3	48.505	71.570	23.065	3	49.440	75.072	25.632
4	47.702	70.105	22.403	4	49.272	76.389	27.117
5	50.637	70.970	20.333	5	49.370	72.232	22.862
6	48.495	68.358	19.863	6	47.341	73.082	25.741
7	46.875	70.508	23.633	7	47.474	72.387	24.913
8	44.864	72.530	27.666	8	47.164	69.963	22.799
9	46.588	70.066	23.478	9	44.661	74.215	29.554
10	47.765	69.429	21.664	10	48.583	72.759	24.176
11	49.238	67.335	18.097	11	48.056	73.801	25.745
12	47.709	67.282	19.573	12	48.241	73.593	25.352
13	47.207	70.557	23.350	13	50.376	74.995	24.619
14	46.186	69.996	23.810	14	51.975	75.976	24.001
15	45.880	72.906	27.026	15	47.640	73.878	26.238
16	45.728	70.014	24.286	16	43.620	74.858	31.238
Average	47.953	65.950	**22.668**	Average	47.953	73.558	**25.605**

- From the study it was found that the ultrasonic washing technique not only gave efficient cleaning but also more economical as compared to conventional washing. It gave better cleaning in lesser time with lesser amount of detergent at lower temperature, using less water for washing than in a machine wash.

(ii) Project title **:** Developing shield of corn fabrics for enhancing the protection from flame (Sponsored by Ministry of Textiles, Govt. of India)

Objectives :

- To study the properties of corn fibre in terms of its low flammability, resistance to bacteria and UV protection
- To study the compatibility of corn fibre in spinning with other fibres
- To study the blend proportion of corn fibre with cotton and other conventional fibres with a view to achieve desired properties
- To develop 100% corn and its blended yarns
- To produce woven/knitted fabrics from 100% corn and its blended yarns
- Testing the resulting fabrics for their properties
- To analyze the low flammability of the fabrics to be used to develop fire retardant fabrics
- To assess anti-bacterial and UV-protection properties of the fabrics to be used for inner garments/sports wear

Research outcome :

From the study following conclusions are made.

- Although Corn fibre has shown 99.5% antibacterial protection, it was found that the fabric made out of this fibre did not show antibacterial protection after scouring. Similar behavior was also found in blended fabrics.

- Even though Corn fibre LOI is high i.e. 23, it may not be suitable as a FR material because of its low melting point (169^{o}C); on exposure to flame, the fibre shrinks, melts, and drips. However, it liberates less smoke while burning.

- Due to low moisture absorption (0.4%), the fabrics exhibited poor absorbency and low wicking property.

- The chemical processing of this fibre has to be carried out at low temperature due to its low melting point.

- Finally it may be concluded that though the fibre manufacturer has claimed to be a good FR fibre useful to manufacture sportswear, jacket, outer coat, innerwear, apparels etc, the study reveled that the finished fabric does not process satisfactory/adequate anti-bacterial, UV protection, and FR properties.

(iii) Project title **:** Developing armor using Hi-Modulus Polyethylene (HMPE) fibre (Sponsored by Ministry of Textiles, Govt. of India)

Objectives :

- To study the properties of HMPE fibre in terms of its strength, density and abrasion resistance

- To study the compatibility of HMPE fibre in spinning with other fibre

- To study the blend proportion of HMPE fibre with cotton

- To develop 100% HMPE and its blended yarns

- To produce woven/knitted fabrics from 100% HMPE and its blended yarns
- Testing the resulting fabrics for their properties

- To analyze the strength of the fabrics to be used to develop armor

- Testing abrasion resistance and other properties of the fabrics to be used for clothing

Research outcome :

- Dyneema and Cotton Dyneema blends were tested for their various physical and chemical properties. Results are shown in the Table given on next page.

- Cotton Dyneema 70/30 blended fabric showed lower impact energy as compared to other fabrics. Impact energy of 100% Dyneema fabric (single layer) was found 5.2 Joule. When two layers of 100% Dyneema fabric were taken, the impact energy was 18.6 Joule, and in case of three layers, it was 24.01 Joule.

- Tensile strength (Warp and Weft wise) of 100% Dyneema fabrics was found to be higher as compared to Cotton Dyneema 70/30 and Cotton Dyneema 50/50 blended fabrics.

- Tear strength (Warp and Weft wise) of 100% Dyneema fabrics was found to be higher as compared to Cotton Dyneema 70/30 and Cotton Dyneema 50/50 blended fabrics.

TABLE : Fabric Properties of Dyneema and its Blends

Test Parameter	**100% Dyneema**	**Cotton Dyneema 50/50**	**Cotton Dyneema 70/30**
Total Impact Energy (J)	5.2	6.19	2.50
Tensile Strength, N			
Warp	2736	2017.6	1601.95
Weft	1842.5	1458.2	1197.2
Tear Strength, N			
Warp	620	137.2	106.82
Weft	600	Above 137.2	113.68
Pilling Grade	2.5	2	3
Abrasion Resistance (cycles)	No yarn breakages upto 1050 cycles	1052	630
Air permeability (cc/cm2/sec)	5.42	8.02	8.62
Water Vapour permeability (grms/m2/day)	2035.71	2022.10	2065.86
Wicking (sec)			
20 mm length	12.5	65	47
30 mm length	32.5	130	102
Absorbency (sec)	1	144.2	64.6

- Pilling was found lower in Cotton Dyneema 70/30 blended fabric as compared to 100% Dyneema fabric and Cotton Dyneema 50/50 blended fabric.

- In the case of 100% Dyneema fabric, abrasion resistance was found high. With the decrease of Dyneema in the blends, abrasion resistance decreased. In the case of 100% Dyneema fabric, no yarn breakage was found upto 1050 cycles.

- Cotton Dyneema 70/30 blended fabric showed higher air permeability as compared to other fabrics. Air permeability of 100% Dyneema fabrics was found to be lower as compared to Cotton Dyneema 70/30 and Cotton Dyneema 50/50 blended fabrics.

- Water vapour permeability of Cotton Dyneema 70/30 was found to be higher as compared to 100% Dyneema fabric and Cotton Dyneema 50/50 blended fabric.

- Wicking time was higher in Cotton Dyneema 50/50 blended fabric as compared to 100% Dyneema fabric and Cotton Dyneema 70/30 blended fabric.

- Absorbency was found higher in 100% Dyneema fabric as compared to Cotton Dyneema 50/50 and Cotton Dyneema 70/30 blended fabrics. In the case of Cotton Dyneema 50/50 blended fabric, absorbency was low.

Finally it was concluded that-

- Fabrics using 100% Dyneema and Cotton Dyneema blends have shown high tensile and tear strengths.

- The impact energy of 100% Dyneema fabric (single layer) was found low to impart stab resistance required in the armor for military and para-military forces. However, impact energy increased when 2 and 3 layers were used.

- Dyneema Fabric (with three layers) can bear 24 Joule impact energy (close to level 1 protection). This can benefit military and para-military forces that endanger their lives in riots or other emergencies.

- Dyeing of 100% Dyneema and Cotton Dyneema blended fabrics showed poor and uneven dyeing which points out that the developed fabrics are not suitable to be used as clothing for military and para-military forces.

- Other properties such as abrasion resistance, air and water vapour permeability of the fabrics, required for clothing, were found good.

(iv) Project title **:** Data Verification, Analysis and helping Bureau of Energy Efficiency (BEE) in target setting for textile sector under PAT (Sponsored by Bureau of Energy Efficiency, Ministry of Power, Govt. of India)

Objectives :

- Verification of data collected from the designated consumers of the textile industry

- Normalization of data collected from textile industry to same units

- Gate-to-Gate analysis of energy consumption of different sectors of textile industry

- Calculation of Specific energy consumption of designated consumers

- Clustering of the collected data according to the gate-to-gate SEC

- Setting reference SEC for the different sectors of Textile industry

- Setting up targets for designated consumers according to the Energy Conservation Act, 2001

Research outcome :

- Verification of data collected from Designated consumers of Textile has been accomplished.

- Normalization factors for the conversion of the Final Products in single unit have been setup.

- Gate to gate specific energy consumption of all the textile designated consumers has been calculated.

- Targets for Indian textile industry have been calculated and given to the respective designated consumers.

2. IN-HOUSE PROJECTS

2.1 Completed projects

(i) Project title **:** A Comparative Study of Various Flammability Tests on Different Fabrics

Objectives :

- To study the effect of GSM, Fibre type, Fabric geometry (fabric grain - warp & weft, orientation of fabric at different angles (0^o, 30^o, 45^o and 90^o) etc. parameters on the burning behaviour of various fabrics.

- To establish a correlation between burn rate and orientation of fabrics (horizontal, inclined & vertical)

- To study the effect of direction of ignition on the flammability behaviour of various fabrics using the LOI apparatus
- To compare Vertical Flammability behaviour of various fabrics in ambient atmospheric conditions with controlled atmospheric conditions

- Preparation of a booklet on various flammability test standards

Research outcome :

- The results indicate that the properties of fabrics like GSM and fibre composition affects the burning behaviour of fabrics whereas, fabric grain (warp and weft) does not have any significant effect on the burning behavior of the fabrics.

- It was also found that the angle of specimen orientation plays a crucial role and the burnt rate increases with the increase in the angle.

- Direction of ignition is also important and it was found that the fabric requires less oxygen (it burnt fast) when ignited at the bottom edge than top edge.

(ii) Project title **:** Optimization of Techniques for Quantification of Cellulosic Fibre Blends

Objectives :

- To make different blend compositions using various cellulosic fibres (cotton, modal and bamboo)

- To determine the moisture regain of various blend ratios using standard test methods

- To optimize the test method for quantification of blends

- To characterize the molecular structure of cotton and bamboo using FTIR technique

Research outcome :

- FTIR study was carried out to identify the various fibres.
- Moisture regain and solubility test were conducted according to the standard test methods. It was found that cotton has minimum moisture regain and the bamboo has the maximum. A graph was plotted in between moisture regains and relative humidities On the basis of this blends were quantified.
- With various concentrations of sulphuric acid (blend solution), the solubility of various fibres was determined. On the basis of this study, the concentration of blend solution was optimized for different cellulosic blends.

(iii) Project title **:** Assessment and improvement of Wrinkle Recovery of Cotton and Modal Blended Fabrics

Objectives :

- Application of commercially available resin finish on cotton, rayon, modal and cotton-modal blend (50:50) fabrics
- To evaluate the performance properties of the finish in terms of colour fastness to washing

- Application of softener along with wrinkle resistance finish improving tear strength of the selected fabrics

- To test and compare physical and mechanical properties of treated and untreated samples

Research outcome :

- The study revealed that the crease recovery angle increases with the increase in the concentration of resin. This increase in crease recovery angle may be attributed to increased in cross linking of cellulose chains.

- It can be seen that the fabric tear strength increases with increase in concentration of resin. The use of polyethylene softener also improves the tear strength of the fabric

(iv) Project title **:** Comparison of Limited Flame Spread Behaviour of the Base Fabric for 'Shamiana'

Objectives :

- To conduct a survey to find various types of fabrics being used in shamiana in Delhi and NCR regions

- To collect samples of fabric being used for making 'Shamiana'

- To evaluate the physical and burning behavour of these fabrics

- To select suitable fabric for 'Shamiana'

- To apply temporary as well as permanent flame retardant finish on the selected fabrics

- To conduct test on the finished fabric to determine their physical and FR properties

Research outcome :

- Polyester has emerged as the most sought material for 'Shamiana' used by commercial tent makers as it possesses numerous advantages over other tent fabric such as higher tensile and tear strength, low mass, easy to dry etc.

- Cotton and polyester fabric do not have any flame retardant properties. Fire has always been a matter of concern for public safety.

- Commercially available FR finish was applied on cotton and polyester samples. Thereafter the flammability characteristics were checked for any improvements in fire retardant behaviour.

- All the samples treated with commercial FR finish passed the ISO 15025 and ASTM 4723-99 standard specifications.

- Commercially available finish for cotton as well as polyester could withstand 20 washings. So, it is semi-durable finish.

(v) Project title : Assessment of Fabric Comfort Properties for Selected Lingerie

Objectives :

- To study the current market scenario and customer buying behaviour towards lingerie
- To collect lingerie from various price ranges
- To evaluate properties of collected samples in terms of :

  a) Physico-chemical parameters like fibers composition, construction type, gauge/ thread count, fabric thickness, weight and bursting strength.

  b) Comfort parameters like fabric hand, air permeability, water vapor permeability and wettability.

Research outcome :

- The results revealed that there is a wide range of fabrics used for lingerie products. Even within one price range, there is lot of variation in types of fabrics used thus varied physio-chemical and comfort properties.
- Knits are the most commonly used fabric construction, though in low price range woven fabric are also used.

(vi) Project title : Evaluation of Eco-friendly Substitutes for Carbon Tetrachloride as a Stain Remover

Objectives :

- To collect garments/fabric samples having various types of stains from manufacturing units and export houses.
- To study the common stain removal practices and the chemicals used to remove stains caused by marking and machine oil in the industry during manufacturing process.
- To select an eco-friendly alternative to hazardous chemicals used in the industry to remove oil based stains.
- To evaluate the effectiveness of the non-hazardous chemicals.

Research outcome :

- The mixture of two organic solvents gave the compara- tive results for removal of most of the stains.

(vii) Project title : A Comparative Study on Dyeing Behaviour and Physico-chemical Properties of NYCO and Polycot Combat Uniform Fabrics

Objectives :

- To review the literature related to the performance of Combat uniform fabric in combat field

- To assess the present specifications for polycot blended uniform fabric being used by the Military & Paramilitary forces and to identify gaps if any

- To dye NYCO (50/50) and Polycot (50/50) fabric by ex-haust and semi-continuous process

- To comparatively evaluate the colour-fastness and physio-chemical properties of dyed NYCO and Polycot fabrics

- To apply Flame Retardant finish on NYCO and Polycot fabrics and to evaluate the flammability character before and after finish application

Research outcome :

- NYCO was found to be the next generation, multifunctional fabric, widely in use for combat uniforms in the developed countries. In India, the polycot (50:50) fabric used for combat uniforms can be replaced by NYCO (50:50) fabric.

- The dyeing of NYCO and polycot fabric by all possible methods and techniques revealed that exhaust method of union dyeing gave better results in terms of K/S values and colour fastness properties. Also, exhaust method union dyeing with acid/vat dyes of NYCO and with disperse/vat dyes of polycot gave better results in terms of colour fastness properties.

- The abrasion resistance of NYCO was found to be far superior to that of polycot. Also, tear and tensile strength of NYCO came out to be better than that of polycot. Thus, overall it was concluded that NYCO is more durable than polycot.

- The flammability was tested of both the fabrics. NYCO when burnt gave char and ash like residue which does not stick to the skin, while polycot had molten dripping debris, which does stick to the skin.

(**viii**) **Project title** **:** Reduction of Style Changeover Time in Garment Industry

Objectives :

- To study SMED Methodology and how it could be applied in garment industry

- To make an effective & dedicated team for conducting style-changeovers i.e. COT team which will include Mechanic, QA, Production Supervisor, I.E. & Production Manager/Factory Manager

- Train the people for SMED concept/quick changeover

- To observe factors affecting Style Changeover Time

- To convert observed factors into internal & external factors as per SMED Methodology

- Brainstorm ways to externalise the remaining internal activities

- Streamline the remaining internal activities

- Streamline the external activities

- Document & control the new process

Research outcome :

The internal and external factors were observed and following points were observed :

- From the above facts it is clear that almost 60% time of batch setting loss is due to layout change & m/c setting time therefore our main concentration was on how we can reduce these factors.
- A COT Checklist assure that there would be minimum time spent on internal activities and completing this checklist automatically convert half of the internal factors into external one
- Before implementing SMED Methodology the changeover time was 2.5 hrs but after implementation it reduced to only 12 mins
- After reducing the measured factors effectively the line is controlled & monitored by COT team until the line reaches its given GSD based targets with approved quality. Generally this time depends upon complexity of style but ranges in between 4 hrs to 48 hrs.

(ix) Project title **:** Development of Treatment and Recycling of Effluent from Garment Washing Plant

Objectives :

- Reduction in water consumption in garment washing through selective segregation and treatment.

Research outcome :

- This work was taken up as part of water audit of a textile processing unit in Panipat.
- Preliminary work completed and Water Audit report submitted to the client
- Around 40% saving in water consumption in garment washing can be achieved by adopting the suggested effluent segregation, treatment and recycling scheme.

(x) Project title **:** Optimization of process parameters for selected non-woven fusible interlinings

Objectives :

- To develop a data bank on characteristics of selected interlinings and face fabrics used in readymade garments
- To identify problems encountered in their use
- To optimize process parameters i.e., temperature, pressure and time for selected fusing materials on the basis of visual and performance test
- To suggest remedies for problems in fusing

Research outcome :

- Based on the findings it is evident that temperature,pressure and time have to be carefully planned to optimise the level of performance and quality of garments.

- It is also felt that an absence of optimal combination of parameters for fusing process is a deterrent in the manufacturing of quality garments.

- It was observed that the specimens which were fused at lower temperature, lower pressure and for lesser time were showing more delamination.

- Higher bond strength was observed in the specimens which were fused at higher temperature under higher pressure for longer time.

- Shine/glazing was the problem observed only in dark color fabrics when subjected to higher temperature under higher pressure.

(xi) Project title **:** Development of water filtration device using textile material for military and paramilitary personnel

Objective :

- To evaluate selected non-woven synthetic fabric filters in terms of physical properties such as GSM air permeability and thickness

- To use fabric filters in single and double layers and assessment of its filtration efficiency

- To combine the selected composite filter with suitable activated carbon (powdered and granular form) to make the filtered water odour free and drinkable

- To evaluate the filtration efficiency of composite filter using various combinations of materials as per standard test method for drinking water in terms of: turbidity, odour test and residual chlorine test

Research outcome :

- A small non woven filter system/water purification sys tem was developed using activated carbon and other ingredients.The filtered water was tested for various test standards related to drinking water. Results were encouraging. There is a need to have further study to confirm the results at large scale.

(xii) Project Title **:** Extraction of textile fibres from corn husk

Objective :

- To optimize the extraction conditions of cornhusk fibres.

- To analyse the physio- chemical properties of extracted cornhusk fibres and compare them with other cellulosic fibres.

- To dye the cornhusk fibres with selected classes of dyes.

Research outcome :

- Extraction of fibres was carried out by combined chemical and enzymatic treatment.

- Physio-chemical properties were analysed and it was found that the properties of cornhusk are very similar to the cellulosic fibre like cotton, linen and milkweed. The unique properties of cornhusk fibres like moderate strength, high elongation, high moisture regain and high water retention would provide unique properties to products made from corn fibres.

- Cornhusk fibres exhibit good dye uptake with all dye classes.

(xiii) Project Title **:** Development of flame resistant and chemical resistant laboratory coat/apron

Objective : ·

- To apply selected commercially available flame retardant water and oil repellant finishes on the fabric

- To evaluate the efficacy of finishes fabric in terms of: Flame resistance (IS 11871, ISO 15025), water and oil repellency (IS 390 /AATCC 118), and Chemical resistance (ISO 6530)

Research outcome :

- Various finishing chemicals were applied on the fabric for flame and oil repellency

- Water repellency was tested as per IS 390, the rating of the finished sample was 70 indicating partial wetting of top surface only.

- Oil repellency was tested as per AATCC 118. Rating showed a decline in absorbency with the increase in the grade and surface energy of the solutions used. Good oil repellency was achieved on the treated fabric with a grade 5.

- Chemical resistance was evaluated using ISO 6530. Maximum repellency was found to sodium hydroxide and maximum penetration was in the case of xylene.

- No afterglow and after flame were observed in inclined flammability test and surface exposure flammability test.

(xiv) Project Title **:** Development of nylon 66 and excel fibre blended fabric for protective clothing

Objective :

- To review literature related to the performance of combat uniforms in the combat field.

- To assess the dyeing behavior of Nyex (Nylon + Excel).

- To evaluate the color fastness of dyed Nyex fabrics.

- To evaluate the physical and chemical properties of Nyex and compare them with Nyco combat uniform fabric.

Research outcome :

- Nyex was dyed with acid and reactive dyes and colour value was evaluated by Computer colour matching system. The study revealed that Nyex fabric picked up more dye and thus darker than nyco fabric

- Durability properties of Nyex were evaluated and compared with Nyco fabric. Nyex fabric was found to be similar in durability properties of Nyco fabric when tested for Abrasion resistance, tensile strength, pilling resistance, etc. But Nyex was better than Nyco in tearing strength.

- For comfort properties, Nyex and Nyco fabrics were tested for water vapour permeability and air permeability. Nyex was found to be better than Nyco in comfort properties.

- In the safety aspect, flame retardant properties of Nyex were found to be comparable to Nyco.

(xv) Project Title **:** Development of protective material from nylon 66 and corn (man-made fibre) blends

Objective :

- To review the literature of corn fibre and combat uniform.

- To assess the dyeing behavior of various corn fibre blended fabric

- To evaluate physiochemical properties of the blended fabric for combat uniform

- To assess the flammability behavior of the blended fabric for combat uniform

Research outcome :

- Various blends of Nylon 66, Corn and Cotton were manufactured.

- These blends were dyed using Acid dye and vat dye. The colour fastness properties of reserve dyed corn blended fabrics were tested and it was found to be satisfactory or above when compared with reserve dyed polycot.

- The durability and comfort properties of all the fabrics were evaluated. Corn blended fabrics performed excellently for durability as compared to polycot, which indicates its longer durability in combat field.

- On comfort properties corn fibre displayed better results as compared to polycot which indicates its better comfort property as compared to polycot.

- Safety in terms of protection from fire was evaluated by conducting tests like LOI(Limited oxygen index), inclined flammability test, electrical resistance test and surface ignition test on polycot and all corn blended fabric. It was found that blends with higher content of corn fibre burns at room temperature, melts and drips which is an undesirable property for combat uniform.

- 50/50 nylon 66 and corn passed the colour fastness test, durability and comfort test but it failed to meet the safety requirements. It provides excellent U.V. protection as compared to other blends.

- In inclined flammability test and electrical resistance test all the samples including polycot passed the criteria.

- The 50/10/40 (nylon66, corn and cotton) provides better performance than other blends, so it can be considered as an alternative to polycot uniform.

(xvi) Project Title **:** Comparative study of Nyex, Nyco and Polycot Blends for use in combat uniform

Objectives :

- To compare characteristics and wear properties of Nyex, Nyco and Polycot Blends
- To assess comfort of the three blends with respect to air, water & moisture properties
- To ascertain safety with respect to fire and chemicals of Nyex, Nyco and Polycot
- To determine contact heat & electrical resistivity of three blends
- To substantiate choice of best fabric combat uniform

Research outcome :

- Abrasion resistance and thread breakage results indicate that nyco and nyex blends are more durable than polycot blend which indicates their longer serviceability in the combat field.
- Comfort in terms of air permeability, water vapour permeability, moisture regain and water absorption was evaluated. Nyco and Nyex blends were found to be more comfortable then polycot blended fabric.
- Nyex and Nyco gave better result as there was no melt dripping, no hole formation, they were less permeable to heat in turn much protective to the underlying skin.
- It was observed that application of chemical resistant finish is durable after washing.
- Contact heat and electrical resistivity test were also done but there the blended fabrics did not respond well.