Comparative Study of Nylon/Cotton & Nylon/Excel Fabrics

By: Sushil Hada & Ganesh Jadhav

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With advancement of technology, durability & safety of defense personnel clothing has become a major cause of concern. Defense persons are required to move, live, survive in a hostile environment. They have to carry or wear all the necessities for comfort and survival and thus need the most lightweight, compact, durable, and high performance personal clothing and equipment. From the aesthetic point of view the fabric should have good handle & drape, air permeable & should be water vapour transferable. Also, it should be UV light resistant & bio degradable. Traditionally PC blends were being used for the Army uniforms. Concept of Nylon / Cotton added newer dimension to the uniforms giving better durability & safety. This paper deals with the study carried out at TRADC comparing Nylon / Cotton fabric with the Nylon/Excel blended fabric.

Traditionally PC blends were being used for the Army uniforms. Concept of Nylon/Cotton added newer dimension to the uniform fabrics giving better durability & performance. This paper deals with the study carried out at TRADC comparing Nylon/Cotton fabric with the Nylon/Excel blended fabric. The study focused mainly on the defense uniform application. The fabric was printed in a camouflage pattern & tested for different physical & chemical parameters of performance fabrics. Product runnability at every stage of the yarn & fabric preparation process was studied. The study was carried out in joint association with NITRA (Northern India Textile Research Association).

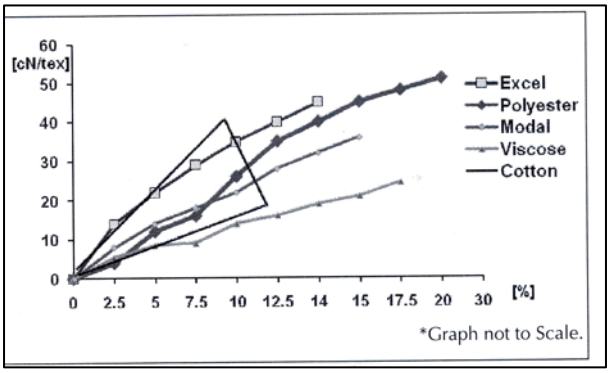
What is Excel?

Birla Cellulosic has developed a new type of rayon fibre produced through solvent spinning technology & they use trade name 'Excel' for the same. Excel is a regenerated cellulosic fibre manufactured from wood pulp. It is stronger than most natural cellulosic fibres (Cotton, Viscose). Moisture regain of Excel is around 13% & it transfers moisture effectively giving better comfort properties. It is having almost 80 -84 % wet to dry strength ratio. Abrasion resistance of Excel is very good as compared to cotton or other cellulosic fibres. Unique features of Excel include heavy performance & durability coupled with excellent comfort properties. Fabrics made out of Excel are having good lusture, sheen & drape.

Parameter	Excel	Cotton	Viscose	Polyester
Tenacity (CN/TEX)	>37	21-35	24-26	46-54
Elongation (%)	12-15	7-9	19-21	22-24
Wet-Dry Tenacity Ratio %	82-84	108-112	50-52	100
Moisture regain (%)	13	8.5	11-12	0.4

Excel fibre shows a unique property of fibrillation when come in contact with water. Fibrillation is the longitudinal splitting of the strong, highly crystalline fibre to give micro-fine surface hairs. It gives a unique Peach skin feel to the fabric. If undesirable it

can be controlled by some modifications in the process at the time of wet processing of the fabrics.



Stress – Strain Behaviour of Different fibres

The stress strain curve of Excel in comparison with other fibres is as shown in the graph above.

Nylon 6, 6

Nylon 6, 6 was selected for blending with Excel because of following unique properties,

- High Tenacity &durability
- High elongation
- Excellent abrasion resistance
- Highly resilient.

This study was carried out in joint association with NITRA. They supplied the Nylon 6, 6 from INVISTA. The fibre properties were tested as below,

Test Parameters	Test Method	Test Results
Fibre Length (mm),	IS: 10014-1981	35.92
CV%		1.99
Fibre denier,	ASTM D-1577:1996	1.74
CV%		9.23
Tenacity (gpd)	ASTM D-3822 :2001	6.61
Elongation at break%,	ASTM D-3822:2001	48.09
CV% of elongation		25.12

Due to the above said attributes of Excel & Nylon we decided to study Excel/Nylon blended fabric in Ripstop weave to be compared with Cotton/Nylon fabric for protective clothing of defense personnel.

Study Brief

Two blends were identified for the comparison. We have taken Nylon/Cotton 50/50 & 30/70 blends to be compared with Nylon/Excel 50/50& 30/70 blends respectively as shown in the below mentioned table.

Material/Blend percentage	Warp Count	Weft Count
Nylon/Cotton (50:50)	2/40s Ne	16s Ne
Nylon/Cotton (30:70)	2/40s Ne	16s Ne
Nylon/Excel (50:50)	2/40s Ne	16s Ne
Nylon/Excel (30:70)	2/40s Ne	16s Ne

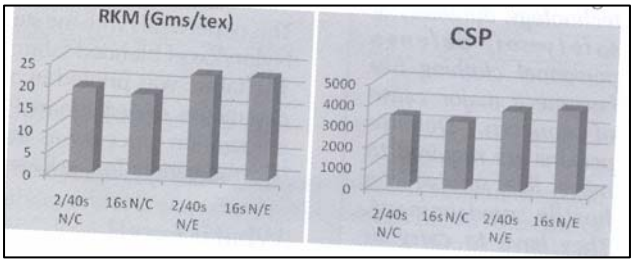
This study was divided in to three phases,
Phase 1 - Optimization of spinning parameters for spinning compatibility of Excel & Cotton with Nylon 6, 6.
Phase 2 - Weaving of both the blends keeping same parameters.
Phase 3 - Pretreatment & printing of both the blends.

1. Yarn Manufacturing

During spinning of above yarns runnability of Nylon/Excel blends found to be better as compared to Nylon/Cotton, may be due to the inter- fibre friction or cohesiveness between the fibres. At blow room stage to get a compact lap & better runnability water & lubricant percentages were increased for the Nylon/Cotton blends. Spinning of Nylon/Excel is feasible & offers advantages in uniformity, yarn quality & breaking strength over the standard Nylon/Cotton blend yarn. Below mentioned are the values of yarn testing.

Test Parameter	Test Method	N/C 02/40s	50/50 16s	N/E 2/40s	50/50 16s
Lea Strength,lbs	IS:	173.5	204.1	191.3	234.7
CV%	1671-1970	2.7	4.7	2.2	2.1
CSP		3398	3214	3832	4005
RKM (Gms/tex)	ASTM D	19.07	18.08	22.83	22.86
CV%	2256-2009	7.5	7.1	8.3	9.1
Elongation at break %	ASTM D	11.07	10.17	10.16	11.24
CV%	2256-2009	17.3	18.7	6.1	6
UsterU%	ASTM D	8.83	8.31	8.48	8.47
CV%	1425-1996	11.13	10.49	10.71	10.71
Imperfections/Km					
- Thin places (-50%)		0.3	0	0	0
- Thick places (+50%)		6.3	6.5	4	6.3
- Neps (+200%)		3.8	6	17	11

From the above results & below mentioned graphs it is clear that Nylon/Excel blends is better than the Nylon/Cotton blends in case of Single thread Strength as well as CSP. As Strength is the basic requirement for the performance fabric like defense clothing, Nylon/Excel scores at yarn stage.



2. Fabrics Manufacturing

Weaving was carried out on Tsudakama Zax - N loom having speed of 550 rpm. Following are the process parameters for weaving,

- Ends/Inch (EPO-92
- Picks/Inch (PPO - 50
- Fabricgreywidth-65"
- Reed Cou nt - 88
- Weave-Ripstop.

Parameters for all the four blends were same as mentioned above. Weavi ng performance was satisfactory for all the four blends.

3. Pretreatment & Printing

For processing different routes were followed for the Cotton & Excel based products. The processing routes for both the products are as below,

- **Pretreatment**
  - For Excel Based Fabrics:
    Singeing → Desizing → Normal Washing → Drying → Heat Setting
  - For Cotton Based Fabrics:

Singeing→Desizing→Washing→Peroxide bleaching→Washing→Drying→Heat Setting

- **Printing**
  - For Excel and Cotton Based Products both,

RFD Fabric → Vat dyeing in thermosol m/c → Development in Pad-stream m/c

- **Chemical Finishing**
  - For Excel Based Products,

Padding → Resin Finishing → Curing → Drying

Resin finishing was done for Excel based products to avoid the fibrillation effect undesirable in the protective clothing.

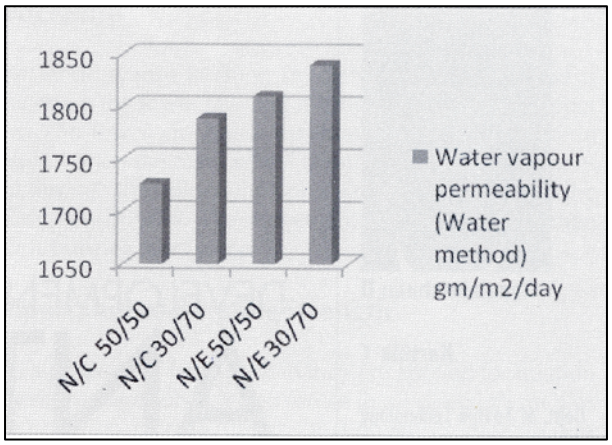
Results and Discussions

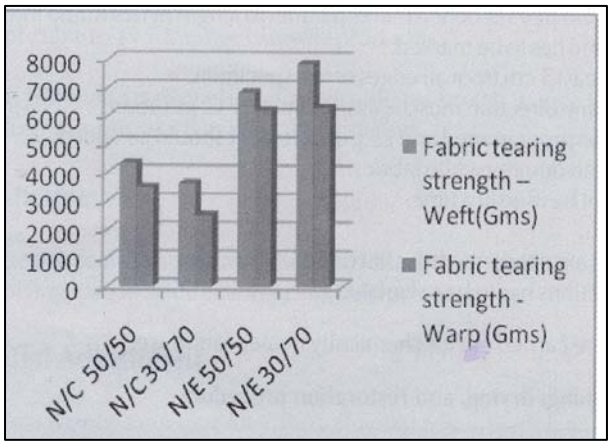
Below table shows the finished fabric test results of the project samples. All the tests were performed with the IS test methods (Indian Standards).

Parameters	Test Method	Nylon /Cotton 50/50	Nylon Excel 50/50	/Nylon /Cotton 30/70	Nylon / Excel 30/70
Fabric tearing strength Warp (Gms)	-IS: 6489-1 983 (RA2008)	3490	6210	2510	6310
Fabric tearing strength Weft (Gms)	-IS: 6489-1983 (RA2008)	4350	6840	3640	7850
Fabric Tensile Strength (Warp)	IS: 1969-1985 (RA2006)	1186N	1092.9 N	994.4	1092.3
Fabric Tensile Strength (Weft)	IS: 1969-1985 (RA2006)	752.1 N	748.9 N	670.2	851.5
Abrasion Resistance	IS:12763 -1989 RA05	No thread Breakage	No thread Breakage	No thread Breakage	No thread Breakage
Pilling rating	IS: 10971-1984 RA06	4-5	4-5	4-5	4-5

Wrinkle Recovery (after 24hrs)	AATCC 128	4	4	4	3
Water vapour permeability (Water method) gm/m2/day	ASTM E-96	1725.92	1809.35	1788.21	1839.31

From above table & the below mentioned graphs, it is clear that Nylon/Excel blended fabrics scores over Nylon/Cotton blended fabrics in following ways,





- Spinning performance of Nylon/Excel blend is good as compared Nylon/Cotton blends resulting in better yarn quality.
- Greater yarn strength due to better fibre tenacity of Excel as compared to Cotton.
- Tearing strength of Nylon/Excel fabric is almost two times greater than that of Nylon/Cotton fabric. Also the strength increases with the increase in percentage of Excel in the fabric.
- Water vapour permeability of Nylon/Excel blends is better than that of Nylon/Cotton blends which shows better comfort properties of Excel. Also, the same increases with the increase in the percentage of Excel in the fabric.
- Finished fabric pilling rating of 4 - 5.
- Excellent abrasion resistance.
- Excel blended fabrics shown degradation in the wrinkle recovery (after 24 hrs) as compared to the cotton fabrics.

Conclusion

From the above study it is clear that Nylon/Excel blends are having higher strength & durability as compared to Nylon/Cotton blends. Also, the comfort properties are better in case of Excel blends. Compatibility of Excel with Nylon is better than that of Cotton so, the spinning performance & yarn quality is better in case of Excel blends.

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