

5. International Istanbul Textile Conference

19 – 21 MAY 2005 Swissotel the Bosphorus Istanbul
Recent Advances in Innovation and Enterprise in Textile and Clothing



boltoninstitute



***High performance and high tech textile products.
Manufacturing technologies and final applications.***



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Summary:

1. - Introduction/abstract.
2. - High performance and high tech technical textiles definition.
3. - H.P and H.T textile products versus main end uses.
- 4.- Technical fibres/raw materials main used in H.P and H.T textile products.
- 5 . - Manufacturing technologies in the textile cycle.
6. - Conclusions.

1. Introduction/abstract.

It is understood that textile industry constantly searches for innovations, mainly new products for technical application.

On one hand, high performance and high tech textiles are a class of products of remarkable importance in the branch of technical textiles, with good added value for the whole textile chain, and a market that is getting everyday more huge and important .

On the other hand, developing and manufacturing these kinds of products, on the whole textile process, is surely more expensive and complex than processing conventional technical textile products.

Also the final application, normally implies a different approach. There are really strong requirements to address, and no mistake is allowed.

This paper will explain the main difference between the high tech and high performance technical textiles products families, also it is not so simple to summarise in few pages a so huge and diversify kind of textile product.

Mainly:

Chemical and physical intrinsically characteristics of the raw materials.
Basics concepts how these products have to be processed in spinning, weaving and finishing.

Requirements of the final applications: examples in products for body protection and industrial end uses.



2. - High performance and high tech technical textiles definition.

The definition of a textile product as, “high performance and/or high tech”, is not well defined and rigid.

Before getting into the details on these topics, it is necessary to define what we intend, in the present lecture, for:

- high performance textile product.
- high tech textile product.



2. - High performance and high tech technical textiles definition.

2.1 - High performance textile products.

For “high performance textile product.” we intend a textile product that has one or more characteristics that give to it a plus in one or more end use, compared with the standard product used FOR the same end use.

For instance:

A - A textile product, used for curtains or upholstery that has a measured LOI (Limit Oxygen Index) that gives to it a permanent flame retardant characteristic.

B - A textile product, used for liquid filtration that has better performance at hydrolysis compared with the other similar products in the market: polypropylene>polyester.

C - A textile product, used for clothing, bed linen, bath towel etc, that has also antibacterial characteristics.



2. - High performance and high tech technical textiles definition.

2.2 - High tech textile products.

For “high tech textile product” we intend all those textile products that answer to one or more really technical requirements, and are projected and engineered for a specific technical end uses.

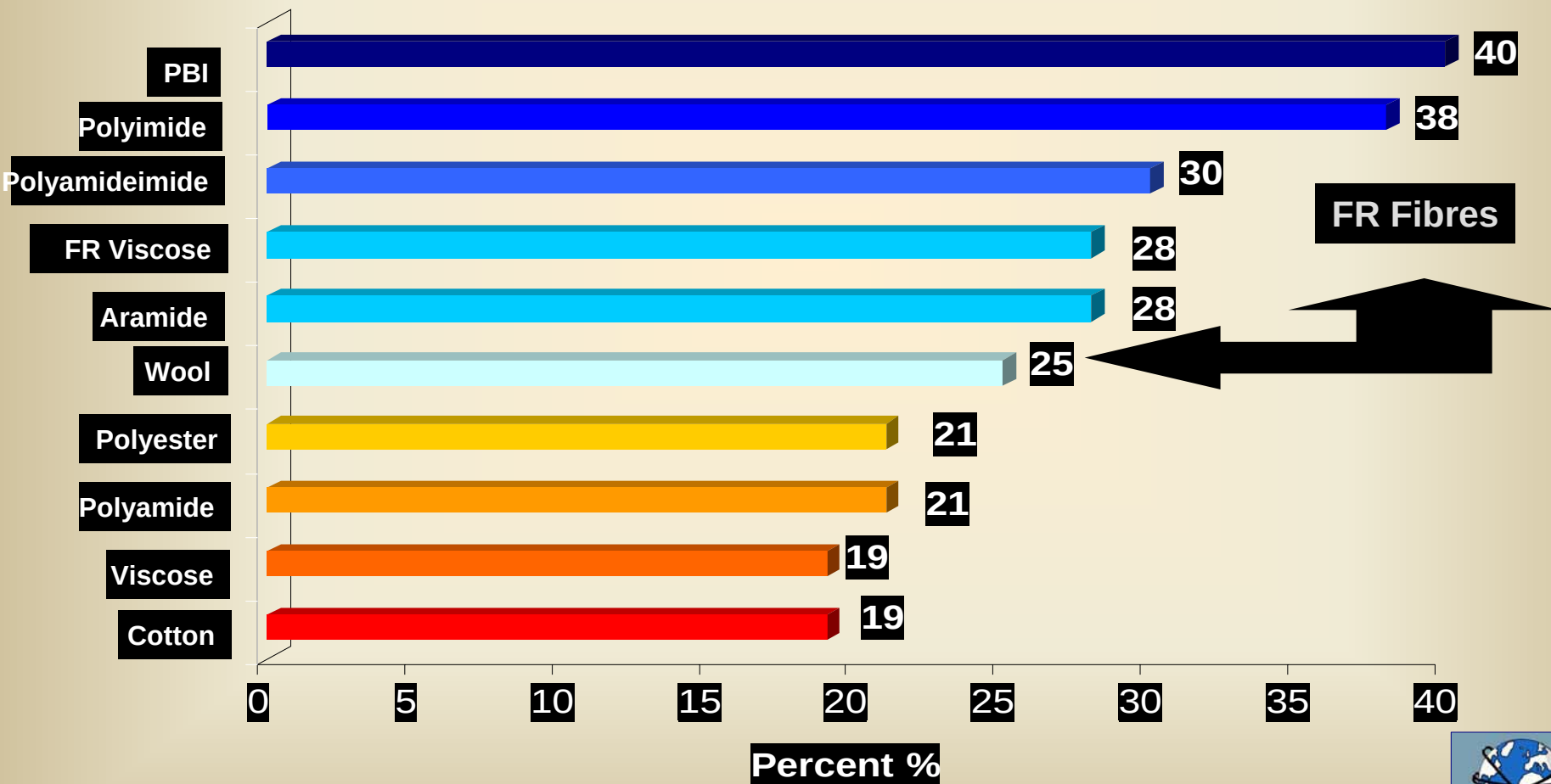
A - An industrial textile product, projected for aircraft or car industry compound reinforcement, that has to work in stress conditions, for the whole life of the final product, without any decrease of performance.

B - A body protection textile DDP , that has to protect the human body, for a determinate minimum time at a determinate temperature. (Ex. Formula 1 pilots uniforms > 15 sec. at a temperature > 340°C).

C - A textile hot gas filter, that has to work continually at high temperature, > 270C° in presence of alkali or acid attack, for the whole time it was projected. (Ex. filter bags for power station - temperature >300°C for a life not less than 1 year.)

2. - High performance and high tech technical textiles definition.

Limiting Oxygen Index (LOI)



3. - H.P and H.T textile products versus main end uses.

It is not possible, in a short lecture, to catalogue all the H.P and H.T textile product. We summarise the most important, on the market development point of view.

3.1 - H.P. Textile products

Industrial textiles - high tenacity textiles for belts, sails, medium level compound reinforcement etc, made with "commodities raw materials" as PES, PAM, PP etc.

Flame retardant textiles. - curtains, upholstery, mattresses, etc. made with modifications of standard polymers as PES fr, Modacrylic fibre, and blends of fr. fibres/yarns with commodities fibres/yarns, cotton, wool, viscose.

Antibacterial textiles - bed linen, bath towels, curtains, upholstery, mattresses, etc.

U.V. protective textiles - sun tents, clothing, etc.

I.R. absorbing textiles - Uniforms for soldier.

Filtration textiles - liquid filtration, low temperature gas filtration.

3.2 - H.T. Textile products.

Industrial textiles - textiles products for belts, sails, top level compound reinforcement, fire and high temperature protection, hot gas filtration, etc, that address at really strong and H.T. basic requirements as, for example in hot gas filtration:

LOI $\geq$ of a flame retardant fibre.

Thermo mechanical Resistance not less than 60%, after heat treatment at 260°C for 48 hours, or in alternative not less than 90% at 200° C° for 48 hours.

Degradation Temperature > 370°C

Melting Temperature > 285°C
without softening.

Textiles products for individual protection device: DPI. Body protection textiles - protective clothing that address the main requirements needs to protect the human body, in risk situation, mainly multipurpose risks:

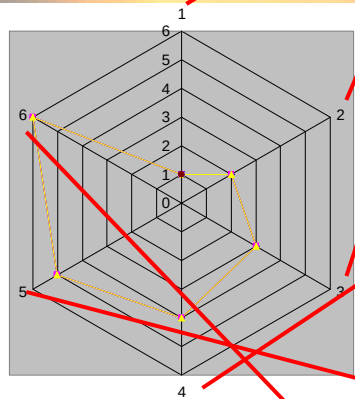
fire and hot temperature, cut, chemical, electrical, ballistic, electro-magnetic protection, etc.

For instance E.U. Fire Fighters uniforms, Formula 1 pilots uniforms, Petrol industry uniforms, etc.

3. - H.P and H.T textile products versus main end uses.

3.2 - H.T. Textile products.

TEXTILES PRODUCTS FOR INDIVIDUAL PROTECTION DEVICE: DPI.



• Fire and heat protection.

• Electrostatic protection.

• Electro-magnetic protection.

• Chemical protection.

• Antibacterial protection.

• Degree of comfort.

Degradation temperature
Glass transition temperature
Softening temperature
Melting temperature
Thermal conductivity
Thermomechanical resistance
Limit Oxygen Index LOI

Dielectric constant
Dielectric dissipation factor
Resistivity

Acid, alkali and solvent
resistance

Bioactive performance
Micro-organism resistance

Skin Model:
index of water absorption
and release, drying time.
Moisture resistivity
Liquid sweat absorption
Surface friction
Surface hairiness
Flexural rigidity

Definition of terms. (1)

Thermo-mechanical resistance: Percentage of the initial mechanical strength at ambient, after treatment of a given duration at a constant temperature in air, or after treatment up to a given temperature in air.

Degradation Temperature: Characteristic temperature of beginning of sensible weight loss.

Melting Temperature: Characteristic temperature of the transition of the crystalline phase of a semi crystalline polymer, from the solid state to the liquid state.



3. - H.P and H.T textile products versus main end uses.

Woven fabrics for DPI evaluation.

Example of DPI woven fabrics evaluation according to E.U. - UN Norms.

	21573		21574		21575		21576		21577		022081	
	lavato		lavato		lavato		lavato		lavato			
	art."F01301"		art."F05007"		art."F03033"		art.					
	ELU		ELUAPIC		ELU		ELU		FEBOE		HEBR	
	Blavil	33,5	Ticuna IR	58	Karmel	58	Protex	55	Homax speciale		Karmel	93
	Eckinox	6,5	Lena	38	Ticuna IR	58	Catana	45			Techonra (a-aramide)	5
			PES	12							Pamirama (E-stetH)	2
			Acciaio inox	1								
PES0AL m ²	300 g/m ²		332 g/m ²		254 g/m ²		291 g/m ²		174 g/m ²		185 g/m ²	
UNIEN 532	part.camburiane	0	part.camburiane	0	part.camburiane	0	part.camburiane	0	part.camburiane	0	part.camburiane	0
	part.incondoranza	0	part.incondoranza	0	part.incondoranza	0	part.incondoranza	0	part.incondoranza	0	part.incondoranza	0
	avanzamento fiamma	mm	avanzamento fiamma	mm	avanzamento fiamma	mm	avanzamento fiamma	mm	avanzamento fiamma	mm	avanzamento fiamma	mm
	fari	xi	fari	mm	fari	mm	fari	mm	fari	mm	fari	mm
	goccialemento	mm	goccialemento	mm	goccialemento	mm	goccialemento	mm	goccialemento	mm	goccialemento	mm
CONVETTIVO	HTH2	3	HTH2	6	HTH2	5	HTH2	4	HTH2	4	HTH2	4
	HTI24	4	HTI24	8	HTI24	6	HTI24	6	HTI24	6	HTI24	5
RADIANTE (20KW/m ²)		t1 11		t1 11		t1 11		t1 10		t1 10		t1 9
		t2 17		t2 16		t2 15		t2 15		t2 15		t2 13
CONTATTO (300°c)												
	fara		7,0		7,0		6,5		7,9		7,0	
PENET. LIQUIDI (4liq)	H2SO430%	7,6	H2SO430%	9,7	H2SO430%	4	H2SO430%	6,6	H2SO430%	18,9	H2SO430%	
PENETRAZIONE	NaOH10%	6,9	NaOH10%	1,2	NaOH10%	1,9	NaOH10%	3,5	NaOH10%	22,1	NaOH10%	
	n-octano	15,9	n-octano	10	n-octano	12,8	n-octano	10,1	n-octano	11,1	n-octano	
	iraprapanala	10,5	iraprapanala	11,9	iraprapanala	16	iraprapanala	19,2	iraprapanala	15,6	iraprapanala	
PENET. LIQUIDI (4liq)	H2SO430%	88,9	H2SO430%	75,7	H2SO430%	94,6	H2SO430%	74,7	H2SO430%	65,6	H2SO430%	
REPELLENZA	NaOH10%	87,4	NaOH10%	82,9	NaOH10%	85,3	NaOH10%	74,5	NaOH10%	65,3	NaOH10%	
	n-octano	15	n-octano	0,6	n-octano	23,9	n-octano	0,1	n-octano	0	n-octano	
	iraprapanala	65,1	iraprapanala	0,6	iraprapanala	17,9	iraprapanala	0,9	iraprapanala	2,2	iraprapanala	
VARIAZIONI DIMENSIONALI	ORDITO	-0,9	ORDITO	-2,3	ORDITO	-2,3	ORDITO	-2,9	ORDITO	-1,2	ORDITO	-0,8
	TRAMA	-1,1	TRAMA	0	TRAMA	-0,9	TRAMA	-0,3	TRAMA	-0,3	TRAMA	-0,9
TRAZIONI	ORDITO	766	ORDITO	1086	ORDITO	1276	ORDITO	1113	ORDITO	1266	ORDITO	951
	TRAMA	575	TRAMA	646	TRAMA	962	TRAMA	750	TRAMA	784	TRAMA	803

Fabric composition

Burning behaviour

Liquid fluid behaviour

Mechanical characteristics

3. - H.P and H.T textile products versus main end uses.

Woven fabrics for DPI evaluation.

Example of DPI woven fabrics evaluation according to E.U. - UN Norms.

	21573		21574		21575		21576		21577		022081	
	lavato		lavato		lavato		lavato		lavato			
	art."F01301"		art."F05007"		art."F03033"		art.					
	ELU		ELUAPR		ELU		ELU		PIERRE		PIERRE	
LACERAZIONE ELMENDORF	DELL'ORDITO 49 DELLA TRAMA 33		DELL'ORDITO 49 DELLA TRAMA 42		DELL'ORDITO 40 DELLA TRAMA 37		DELL'ORDITO 35 DELLA TRAMA 28		DELL'ORDITO 91 DELLA TRAMA 68		DELL'ORDITO 49 DELLA TRAMA 37	
PILLING	dapa 125 3-4 dapa 500 3-4 dapa 1000 3 dapa 2000 2-3 dapa 5000 1-2 dapa 7000 1-2		dapa 125 3 dapa 500 2-3 dapa 1000 2-3 dapa 2000 2 dapa 5000 1-2 dapa 7000 1-2		dapa 125 4-5 dapa 500 4 dapa 1000 3-4 dapa 2000 3-4 dapa 5000 3-4 dapa 7000 3-4		dapa 125 4 dapa 500 4 dapa 1000 3-4 dapa 2000 3 dapa 5000 3 dapa 7000 2-3		dapa 125 3 dapa 500 3 dapa 1000 3 dapa 2000 2-3 dapa 5000 1-2 dapa 7000 1-2		dapa 125 dapa 500 dapa 1000 dapa 2000 dapa 5000 dapa 7000	
RESISTIVITA' ELETTRICA SUPERFICIALE	3,1.10 ¹⁴		.		2,5.10 ¹³		2,8.10 ¹³		1,7.10 ¹⁴		2,0.10 ¹³	
SCHERMATURA ELETTROMAGNETICA (dB)	CAMPO PARALLELO ALL'ORDITO 0,0		CAMPO PARALLELO ALL'ORDITO 0,0		CAMPO PARALLELO ALL'ORDITO 0,0		CAMPO PARALLELO ALL'ORDITO 0,0		CAMPO PARALLELO ALL'ORDITO 0,0		CAMPO PARALLELO ALL'ORDITO 0,0	
	CAMPO PARALLELO ALLA TRAMA 3,6		CAMPO PARALLELO ALLA TRAMA 11,9		CAMPO PARALLELO ALLA TRAMA 0,0		CAMPO PARALLELO ALLA TRAMA 0,0		CAMPO PARALLELO ALLA TRAMA 0,0		CAMPO PARALLELO ALLA TRAMA 0,0	
	MAX (1100MHz) 5,6		MAX (1500MHz) 18,4									
	MIN (1900MHz) 1,7		MIN (1900MHz) 6,2									
R _{tot}	5,5		5,9		5,5		4		4,2		4,4	
R _{ct}	0,033		0,036		0,028		0,021		0,029		0,034	
TEMPI DI ASCIUGAMENTO	9		45		26		32		31		24	
INDICE ASSORBIMENTO E RILASCIO	0,492		0,549		0,481		0,908		0,734		0,572	
INDICE RILASCIO	0,492		0,529		0,463		0,562		0,565		0,558	
ANGOLO DI PIEGAMENTO	18		36		107		51		95		109	
ASSORBIMENTO ACQUA	>600		>600		>600		20		51		>600	
PELOSITA' SUPERFICIALE	2200		2600		1700		2000		1900		2000	
ATTRITO SUPERFICIALE												

Mechanical
characteristics

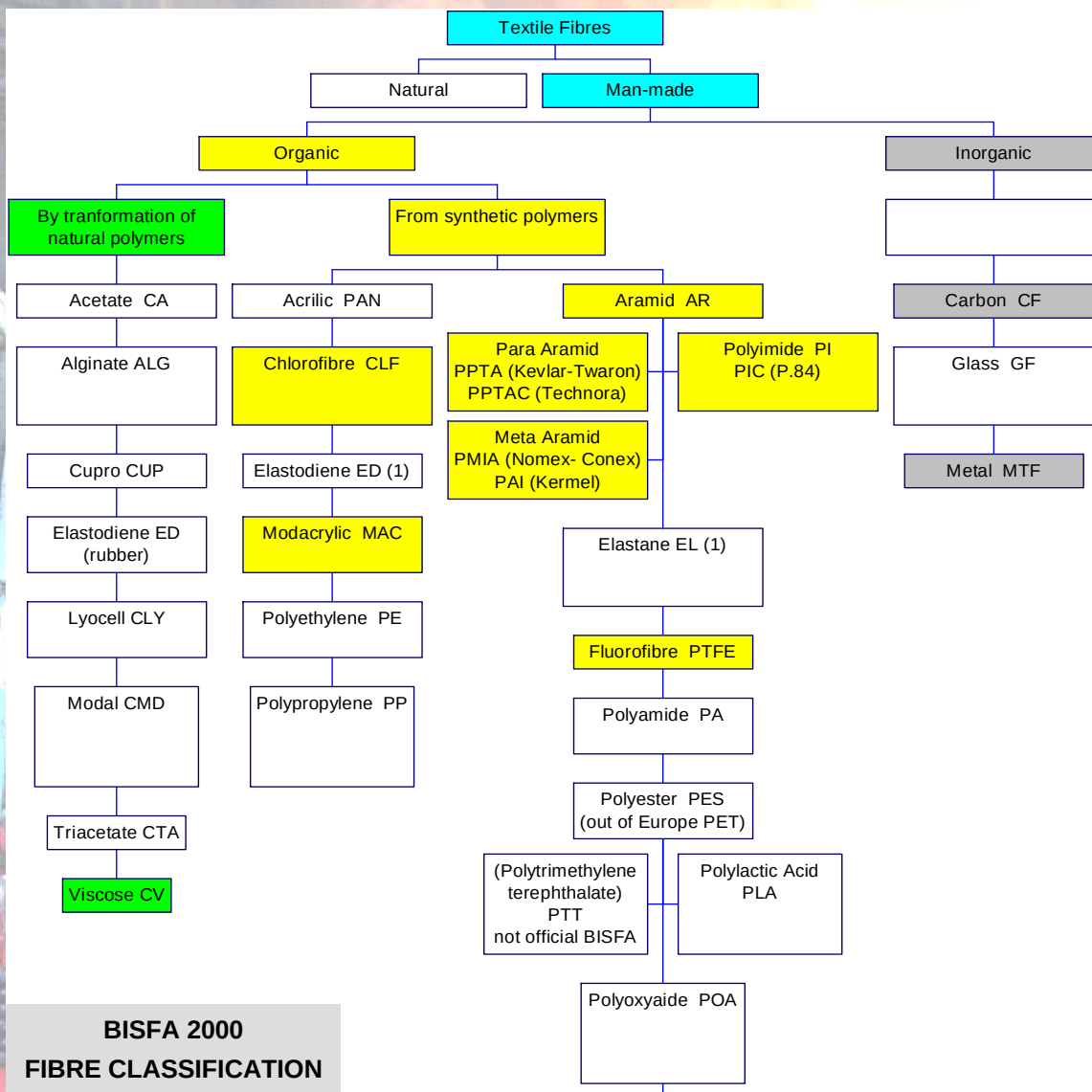
Electro-magnetic
behaviour

Comfort
behaviour

3. - H.P and H.T textile products versus main end uses.

Woven fabrics for DPI evaluation.

Example of DPI woven fabrics evaluation according to E.U. - UN Norms.



The fibrous composition of the evaluated fabrics is a majority of man-made fibres.

Two samples are containing an important percentages of natural fibres.

Wool in the fabric 21574 and cotton in the fabric 21576.

Also if these textile products are entirely destined to the human body protection, it was evaluated also the environment impact, when, at the end of their life, they have to be destroyed by burning in a standard incinerator.

The toxic gas emission, during burning, were verify taking as reference ATS 1000.001 (Airbus smoke and toxicity test) and IMO resolution MSC.61(67) Annex 1 – Part.2 : “Smoke and toxicity test”.

4. Technical fibres/raw materials main used in H.P and H.T textile products.

Excluding few exceptions, H.P and H.T textiles products are made and engineered starting from H.P and H.T. fibres, quite only man-made fibre. We are showing here the most important, on the technical application an market point of view.

4.1 - Flame retardant fibres.

They are mainly produced by three families of basic polymers:

From natural modified polymers

> cellulose – viscose CV - LOI 20 > viscose fr CV - LOI 26/28

(Lenzing FR ®), Visil ®)

From synthetic modified polymers

> polyester PET – PES - LOI 19/21 > polyester fr PET – PES - LOI 28/30

(Trevira cs ®, Securelle ®)

> acrylic PAN - LOI 19/21 > modacrylic fr MAC - LOI 28/34

(Kanekaron ®, Protex®)

From intrinsically flame retardant polymers.

clorofibre CLF - LOI 38/46

(Rhovil ®)

4.2 - Bioactive (antibacterial) fibres.

They are mainly produced by two families of basic polymers:

From natural modified polymers

> cellulose – modal > bioactive modal

(Modal Fresh ®)

From synthetic modified polymers

> polyester PET – > bioactive polyester

(Trevira bioactive ®)

> acrylic PAN > bioactive acrylic

(Amicor - Amicor Plus ®)

4. Technical fibres/raw materials main used in H.P and H.T textile products.

4.3. - High tech or/and high performance fibres.

4.3.1 Organic origin.

They are only produced by engineered synthetic polymers.

The most important, on the market point of view are:

Aramid.

Para-aramid (polyparaphenylene terephthalamide) PPTA . (LOI 27/29).

(Kevlar®, Twaron®.)

Para-aramid (copolymer, polyparaphenylene/3,4'-oxidiphenylene terephthalamide) PPTAC. (LOI 25)

(Technora®.)

Meta-aramid (polymetaphenylene isophthalamide) PMIA. (LOI 29/32)

(Nomex®, TeijinConex®.)

Meta-armid (polyamide imide) PAI. (LOI 32)

Kermel®.

Meta-armid (copolyimide) PIC. (LOI 36)

P.84

Fluoropolymer. (polytetrafluoroethylene) PTFE (LOI >90)

(Teflon®, Profilen®.)

Melamine. (melamine formaldehyde resin) MF (LOI 32)

(Basofil®)

Phenolic. (phenol-aldehyde resin) PHE (LOI 30/34)

(Kynol®)

Polybenzimidazole. (polybenzimidazole) PBI (LOI 41).

(Celanese PBI®)

PBO fiber. Poly-phenylene-2,6benzobisoxazole PBO (LOI 68)

(Zylon®)

Phenylene Sulphide. Poly-phenylene sulphide PPS (LOI 34)

(Procon®) (Torcon®,.

4.3.2 Inorganic origin .

Carbon fibre. > 99,9% carbon CF

Metallic fibre. 100% stainless steel, 100% silver, 100% copper. MTF

Glass. GF - Boron. B - Silicium carbide. SiC – Silica Sil.

These materials have mechanical and chemical characteristics very diversify, for instance:

Density that varies from 1,2- phenolic fibre, to 2,1-polytetrafluoro ethylene fibre.

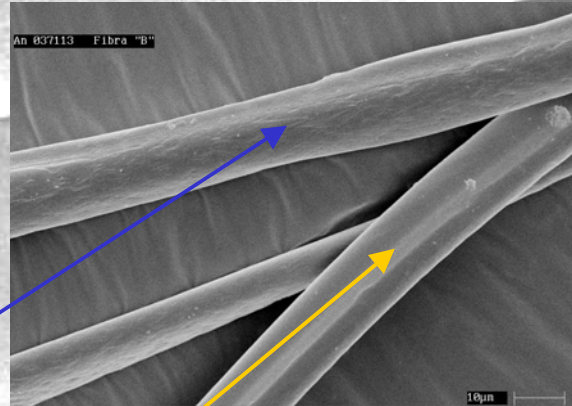
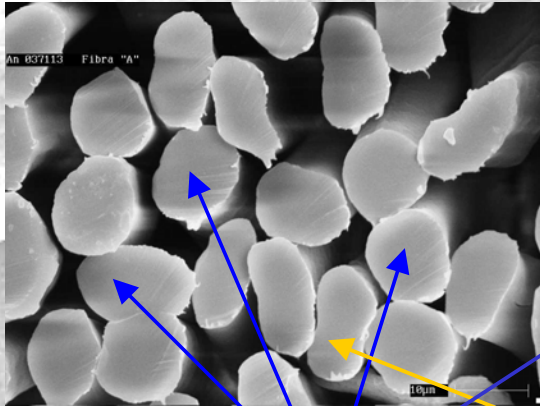
Electric resistivity, that place the carbon fibre at 0,8-3 ohm/cm, in some cases, is near to 10,0-19 ohm/cm, polytetrafluoroethylene.

Breaking Tenacity that is set from low levels, PBI 24cN/tex to very high, Para-aramid, 220 cN/tex.

Elongation at break that varies from < 10% - oxidised polyacrylonitrile, to > 100% - clorofibre

4. Technical fibres/raw materials main used in H.P and H.T textile products.

4.3. - High tech or/and high performance fibres.

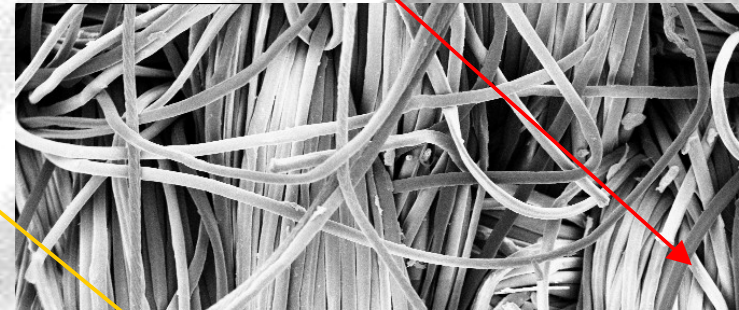
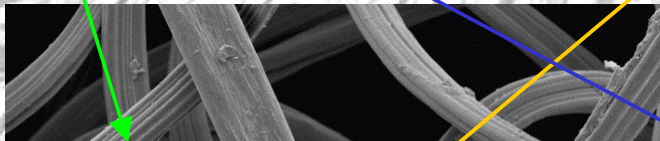


Polyamide/copper-antistatic/antibacteria

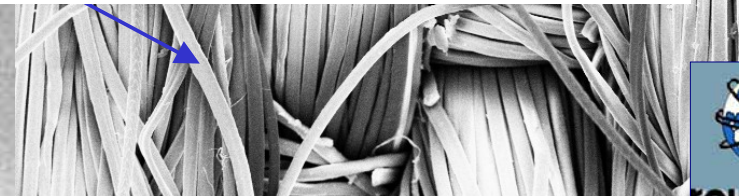
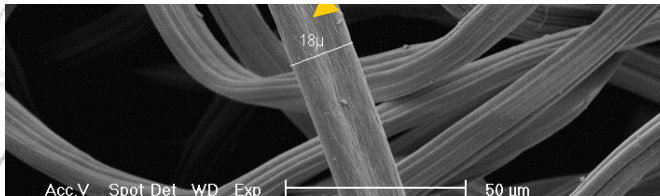
FR Viscose

Meta-aramid

Para- aramid

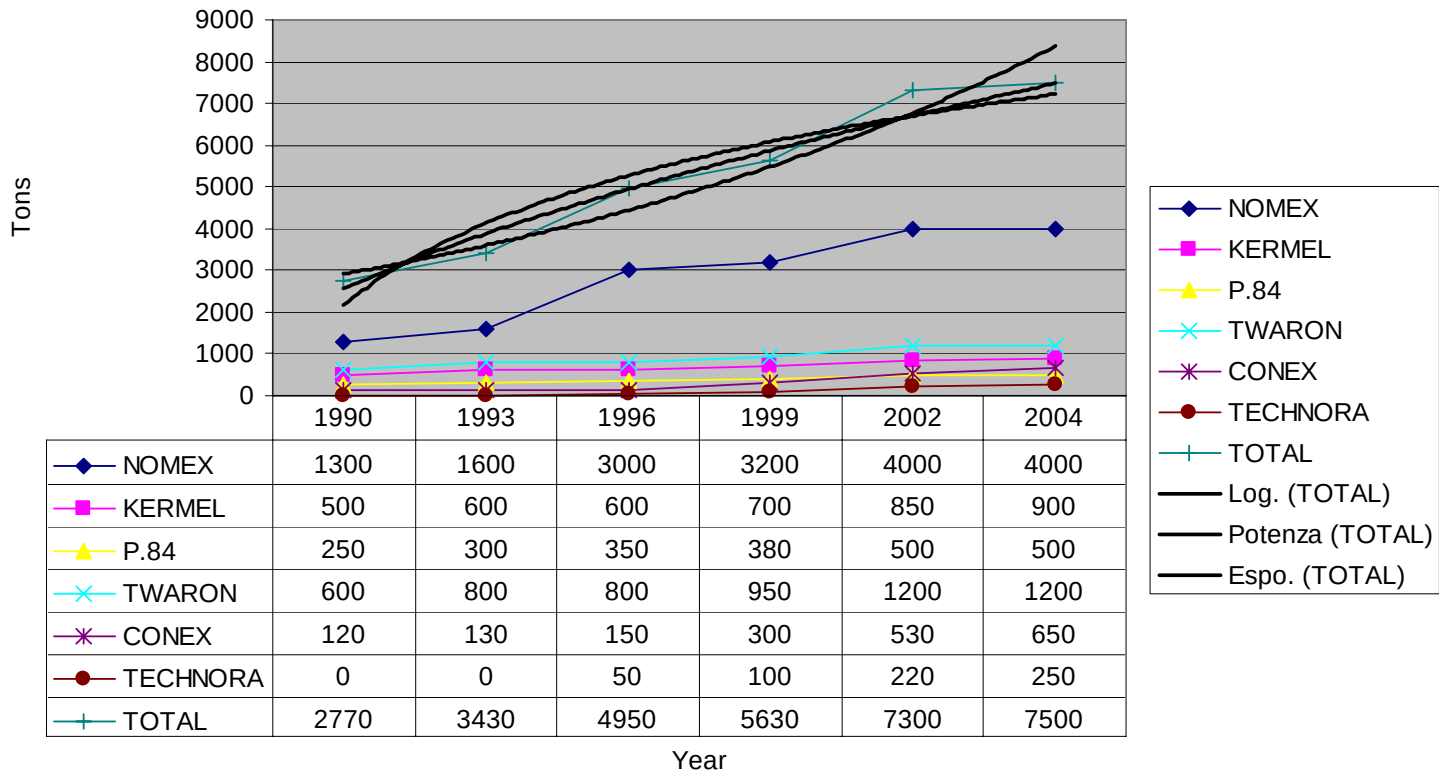


The products where textile industry will have the chance to grow are high tech and high performance textile products, made with high tech and high performance fibres.



4. Technical fibres/raw materials main used in H.P and H.T textile products.

HIGH TECH FIBRES E.U. MARKET EVOLUTION
STAPLE FIBRES FOR SPINNING AND DIRECT USES



5 . Manufacturing technologies in the textile cycle.

H.P. fibres just like flame retardant and/or bioactive fibres are used, for making spun yarns, both in pure and in intimate blends with other fibres, also not flame retardant.. Mixtures of different yarns, F.R., H.T. and standard, on the loom, are also possible.

H.P . fibres, being not particularly different from the “standard fibres” from which they have been developed, normally don’t need preliminary studies or especial trials, for setting the whole textile chain.

For high tech fibres, it is completely different.

They are very often used in intimate blends, among them, and with conductive fibres as 100% stainless steel, (Bekinox®), or organic synthetic fibres, metallic coated, (R.Stat®, X-Static®, etc.)

H.T fibres are also used to produce core-yarns, with metallic filament or pure carbon filament as core. It is necessary to build stable manufacturing processes, repeatable and economically effective. Owing to the very expensive price of these kind of fibres, (some as PBI and PBO overcome the 200 €/Kg, but also a “normal high performance fibre”, as aramide or PPS it is not cheaper than 25-30 €/Kg,) it is not allowed any kind of mistake during the whole textile process. Also the percentage of waste should be close to zero.

5 . Manufacturing technologies in the textile cycle.

Yarn manufacturing.



YARN MANUFACTURING

POLYMER
"0"

STAPLE FIBRE
1.1.S

FILAMENT
1.1.F

FIBRE DYEING
1.2.S

TWISTING
2.0.F

TEXTURIZING
2.1.F

Yarn dyeing

SPINNING
2.0.S

Cotton system ring
2.1.S

Worsted system
"2.4.S"

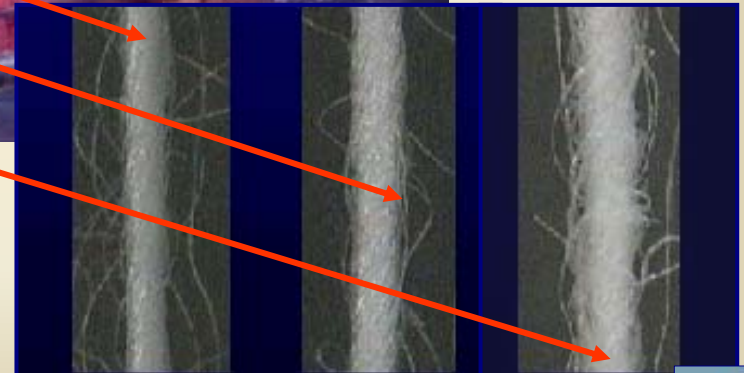
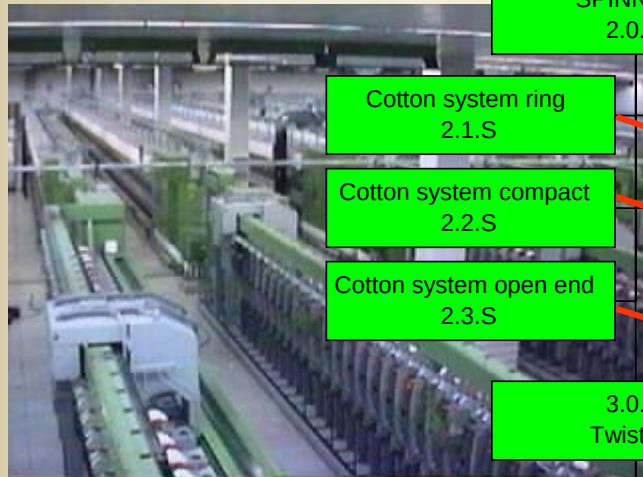
Cotton system compact
2.2.S

Woollen system
2.5.S

Cotton system open end
2.3.S

3.0.S
Twisting

Yarn dyeing



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5 . Manufacturing technologies in the textile cycle.

Yarn manufacturing.

5.1 H.T - Staple fibre Spinning

High tech staple fibre yarns, were till few years ago, quite only made with cotton ring spinning technology. The other systems of spinning were absolutely marginal. Now the situation has changed, and the volume of yarns made using long staple worsted system are increasing, mainly in E.U. reaching 30% of the market. The main advantage of long staple is a tenacity better than short staple. Staple yarns produced by "tear system", departing from tow or from continuous filaments, are an interesting nice, but only a nice. For spinning high performance fibres, it is absolutely necessary a perfect thermal and moisture setting of the spinning mill, with a really efficient air conditioning plant, able to maintain diversified conditions, among carding, drawing, spinning and twisting. Most of these products, mainly the blends of different fibres, need, with a standard temperature of 25°C, a quantity of water in the air, that could be in carding, more than 12 gr. for 1Kg of air, and in spinning equal or less than 10 gr. for 1Kg air.

It is essential to use refrigerant plants, also in non warm climates, for an efficient drying of the air.

As, spinning these fibres, every thread breakage on the ring, causes a sure reeling of fibres on the drawing cylinders, it is essential that the rings are endowed with "feed-stop" devices.

The whole spinning process must be adapted with the purpose to reduce the friction between fibres and metal. The majority of high tech fibres has high longitudinal tenacity, but very poor performance to the tangential abrasions.

It must be projected spinning diagrams, with regulations of the spinning and winding machines, that have to avoid any stress at the fibres, holding well present the physical and mechanical characteristics of every fibre component the yarn.

Besides the normal parameters of control of quality of the yarns, regularity, cleaning, tenacity at breaking, elongation at breaking, thin points, tick points, neps, hairiness, etc. it is necessary to introduce, in the quality control, parameters not generally used for normal yarns:

- Yarn shrinkage in hot water, vapour, hot air.
- Yarn modulus at 5%, 10%, 20% of the elongation.
- Microscopic inspecting of fibre abrasion.
- Control of the content of micro-fly into the yarn (staff-test).

It must be kept in mind, that many high tech yarns, are containing conductive fibres, and some of the normal frames, used for the quality control of the yarn, both during spinning process and laboratory check, don't work at all. For instance Uster regularimeter and capacitive clearness. Each mill has to develop internal tests using alternative testing instruments, for instance optics frames, and to correlate the obtained data with these tools, to data generally reported on yarns quality standards

5 . Manufacturing technologies in the textile cycle.

Yarn manufacturing.

5.2 - Yarn twisting

Most of high performances fibres, as PES fr and all high tech fibres are very sensitive to any tangential friction. So twisting of H.P. and H.T yarns must be made only on D.T. twisting frames, without the ring for the control of the balloon, to avoid any friction between the fibres and the metal ring.

Twisted yarns both from staple fibres and continuous filaments, normally are necessary of a thermosetting, with steam, under vacuum, at a temperature, $> 100^{\circ}\text{C}$.

5.3 - Filament yarns

Continuous filaments, are entirely produced by few fibre producers, and, on the market point of view, limited to aramid fibres. They don't need, in the yarn textile cycle, any kind of modifications, except, very limited cases, as, joining among high tenacity filaments (para-aramid, PBO, PTFE.) with conductive filaments, (metallic filaments or of carbon).

In terms of quantities, the use of continuous filaments it is limited, both for cost reasons, and for the impossibility to optimise the final products, blending different H.T fibres.

With to day's technology it is quite impossible texturing high performance filament, also with thermoplastics polymers just like PPS. On the market there are only flat filaments.

5.4 - Yarn dyeing.

All the H.P. yarns made with "modified standard polymer", flame retardant polyester, flame retardant viscose, bioactive polyester, bioactive acrylic, have similar dyeing performance of the basic fibre "mother".

High tech fibres are not dyeable or very difficult to dye.

When necessary, aramid fibres are dope dyed during extrusion.

Fastness of dope dyed fibres are at top levels, both in grey and blue scale.

It is possible package dyeing some types of meta-aramid fibres, with basic cationic dyestuff at high temperature, more than 130°C , using a high percentage ($>20\%$) of some kind of carriers, as benzil-alcool, in the dye bath. Fastness are very poor.

In the case, enough common, of flame retardant fibre and high tech fibre blended yarns, generally the high tech fibre is dope dyed, while the flame retardant fibre is normally dyed on cones.



5 . Manufacturing technologies in the textile cycle.

5.5 - Fabric manufacturing.

5.5. 1 - Weaving

5.5.1.1- Warping

Tensions in warping must be perfectly homogeneous. A high performance fabric often has very high density. In many cases the gr/mqs 3.000 are overcome. A warp not perfect, under these conditions, becomes not processable on the loom. In case of using conductive yarns, it is necessary to avoid warping frames with electric contacts.

Are also to avoid at all, sizes and oils, not fully water soluble, or not compatible with the final end use of the manufactured article.

5.5.1. 2 - Loom weaving

It is possible to weave with any type of loom, provided that has the proper characteristics for the typology of the fabric that it is had to produce. (fabric very light, very heavy, by spun yarns, by continuous filaments or both, etc.

Type of fabrics, produced with very rigid or slippery yarns, need to be woven on rapier looms with positive rapier.

Also in weaving, in case of using conductive yarns, it is necessary to eliminate any electric contact.

5.5.2 Finishing – Piece dyeing

Also in finishing and piece dyeing H.P. fabrics made with “modified standard polymer”, flame retardant polyester, flame retardant viscose, bioactive polyester, bioactive acrylic, have similar cycle of the basic fibre “mother”.

High tech fabrics were till few years ago quite only fibre dyed.

To day, fabrics based on meta-aramid fibres and blends with fr fibres, are in many piece dyed, on modified beam dyeing machines, under pressure. Fastness are not the top, but in many cases sufficient for not critical end uses. Finishing is instead very important, to reach the requisite of many final products.

Desizing and scouring have to be performed in perfect way. Small traces of size or oil on the fabrics, can compromise the performances of the final product.

Thermosetting is normally make at extreme conditions, in terms of level of temperature and time of treatment..

Some high tech fibres, don't lose their primary characteristics, as fire protection and heat resistance, even if the fabrics are submitted to particular treatments of finishing, as anti-crease, water-repellent, anti-bacteria, etc. In these cases it is necessary to select finishing products compatible with the characteristics of the used fibres.



5 . Manufacturing technologies in the textile cycle.

5.5 - Fabric manufacturing.

5.2 Knitting.

5.2.1 - Warping Warp knitting .

The manufacture of beams it is requested only for warp knitting. Are used, only continuous filaments, mainly of flame retardant fibres, PES fr.

There are also some fabrics of meta-aramid and para-aramid continuous filament, mainly used by backing for coating. The produced quantities are marginal.

5.2.2 - Circular knitting.

Single jersey and interlock knitted fabrics for protective underwear are mainly produced by spun yarns of aramid fibres, pure or blended with viscose fr.,

It is possible to use any type of knitting machine. In the case, enough common, of fabrics made by single yarns, it is often necessary, to give stability to finished knit fabric, to use yarns with opposite twist, S+Z. In case of using conductive yarns, it is necessary to avoid any electric contact.



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6 . CONCLUSIONS.

In the past ten years, H.P and H.T textiles had a constant evolution, in terms of new products introduced in the market, and increase of volume.

H.P products were developed following the “traditional textile way”, modifying step by step products already existing, trying to optimise their characteristics adding additives, as flame retardant and bioactive components, at consolidated polymer,

In designing H.T textile products, were made strong effort in terms of research and development, and today the market of these products, with an average yearly increase of 5% in terms of volume and turnover, is the only one that is giving at E.U. textile industry a really good added value and return of the investments.

New products are under development, now studied using computer simulation models, using in the search a limited number, but highly efficient, initial parameters.

In the intermediary calculations, to get the final simulations, every single value, fibre, yarn and fabric parameters have to give automatically new parameter to the database of the final product computer model.

Sure, developing new H.T. textile products needs consistent investments in terms of money, not only for hardware, new pants and machines, but also teaching people.

The role of the textile university research centres, in this specific sector, would be surely important, clearly if they will have the practical tools and the money, to develop these studies.



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