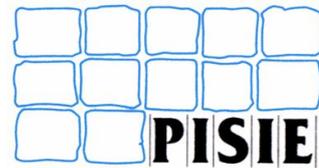
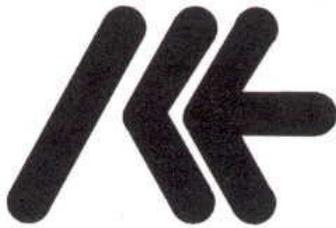


**TRAINING COURSE FOR  
TANNING MANAGERS AND ENTREPRENEURS  
FROM SYRIA**

**10 - 15 October 2010**

**Project PISIE n. 10-015**



POLITECNICO INTERNAZIONALE PER LO  
SVILUPPO INDUSTRIALE ED ECONOMICO

**Workshop on “Leather Chemical Options”  
(*R. Vago*)**



# TANNING CHEMICAL ISSUES

## INTRODUCTION

This contains the contribution of individual Italian companies with technological innovation of the tanning process.

The issues are divided according to the same arguments presented in the summary above.

## TOPICS

1. TECHNOLOGIES FROM RAW HIDES TO PICKEL

2. TECHNOLOGIES FROM PICKEL TO WET-BLUE

3. TECHNOLOGIES FROM WET-BLUE TO CRUST

4. TECHNOLOGIES FROM CRUST TO FINISHED

<b>Cl<sup>-</sup> SO<sub>4</sub><sup>2-</sup> Reduction</b>	1 TECHNOLOGIES FROM RAW HIDES TO PICKEL
<b>Cr<sub>2</sub>O<sub>3</sub> Reduction</b>	2 TECHNOLOGIES FROM PICKEL TO WET-BLUE

## ABSTRACT

### GUIDELINES FOR AN ECOLOGIC BEAMHOUSE

- reduction of chloride in the waste water
- reduction of sulphate in the waste water
- reduction of tanning chrome in the waste waters

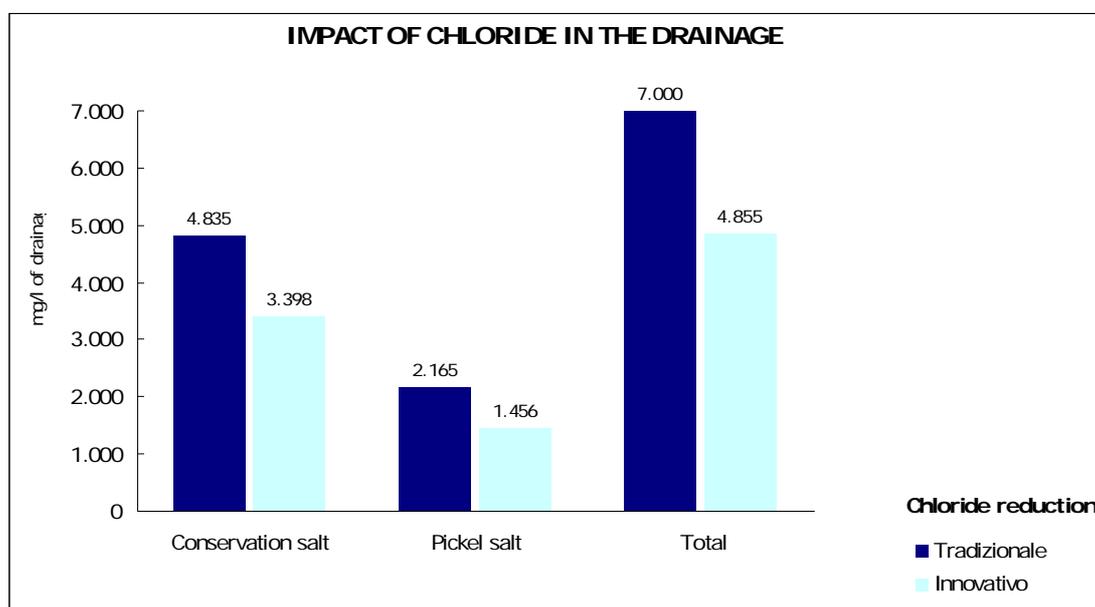
## DESCRIPTION

### Guidelines for a reduction of chloride in the waste water

The sodium chloride in tanning is basically used in the raw skins conservation process, and in the pickel stage, to inhibit the acid swelling.

The incidence of chloride in the environmental impact, relatively to the abovementioned processes, has a significantly different weight.

CHLORIDE ORIGINATING FROM PRESERVATION  
 MECHANICAL DE-SALTING PROCESS  
 UTILIZATION OF FRESH SKINS  
 REDUCTION OF CHLORIDE USED IN PICKEL STAGE



### Guidelines for the reduction of sulphate in the waste water

Most of sulphates in the waste water come from the delimiting , pickel and tanning process, and from the sulphide in the drainage of liming process, which becomes sulphate during the depuration phase. Less important contribution of sulphate, above all when in presence of the full cycle, are imputable to the dyes and the retanning agents.

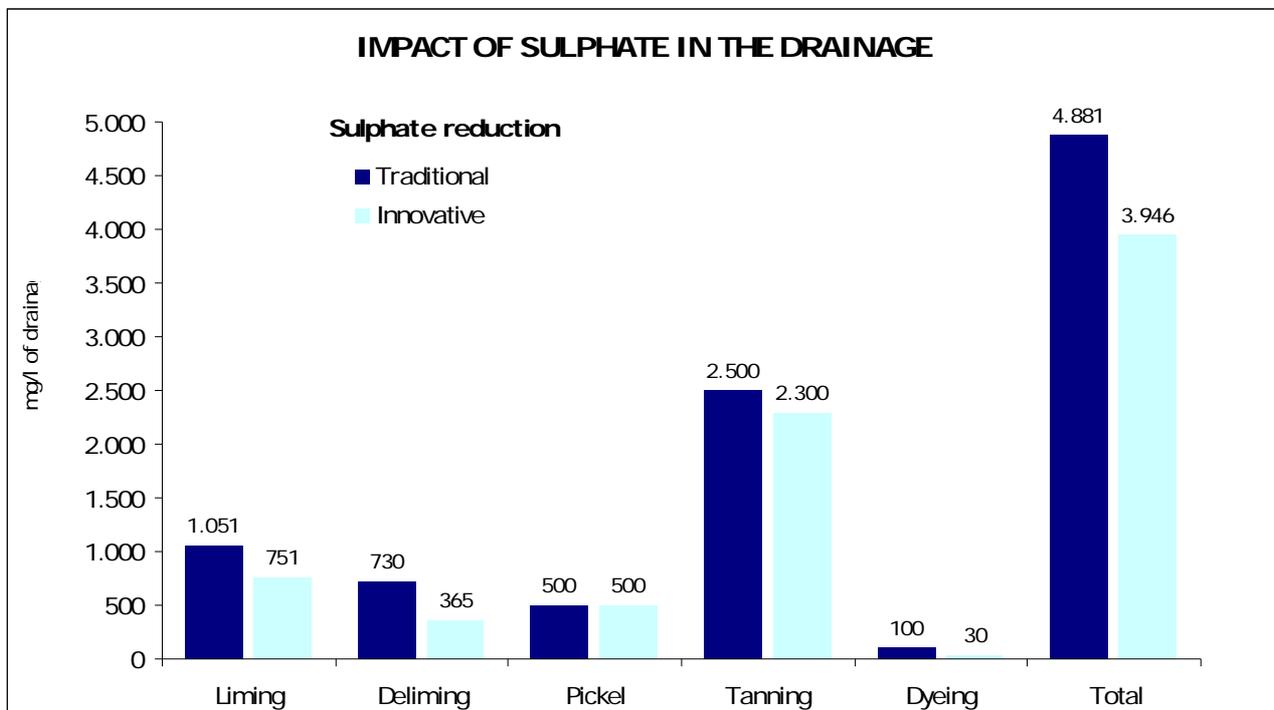
REDUCTION OF SULPHATE ORIGINATED FROM OXIDATION OF SULPHIDE

REDUCTION OF SULPHATE IN THE DELIMITING PROCESS

REDUCTION OF SULPHATE IN PICKEL

REDUCTION OF SULPHATE IN TANNING PROCESS

REDUCTION OF SULPHATE CREATED BY DYES AND RETANNING AGENTS



## Guidelines for reduction of tanning chrome in the waste waters

The reduction of chrome content in the waste waters after tanning process can be prevalently done in two way:

- Recovery of chrome through precipitation with alkali and dissolution with sulphoric acid. The chrome properly reintegrated with fresh tanning agent is utilized in further chrome tannings
- Optimization of the chrome fixation efficiency on the leather and the exhaustion of the baths

RECOVERY OF CHROME

OPTIMIZATION OF CHROME FIXATION PERFORMANCE ON THE LEATHER

QUANTITY OF CHROME SALT (AS Cr2O3)

SIZE OF THE BATH

FINAL TANNING TEMPERATURE

DURATION OF TANNING PROCESS

pH AT TANNAGE END

MASKING EFFECT

PROCESSING WET-BLUE

## For further information



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## ABSTRACT

The leather industry, by its very nature, is a high human exposure industry that generates significant quantities of waste effluent. The long term survival of the leather industry is dependant upon maintaining a high quality product whilst being committed to reducing the environmental impact of the overall tanning process. A key part of the tanning process is the pretanning or tanning stages.

In order to improve the environmental image of tanning, high profile tanneries are keen to evaluate more environmentally friendly, less hazardous alternatives to existing process chemicals. For this reason, **Vandotan PH** tanning agent offers an exciting option for the leather industry, either as a standalone chrome free process or as an integral part of a low chrome process.

## ENVIRONMENTAL BENEFITS TO THE LEATHER INDUSTRY

The use of **Vandotan PH** as primary tanning agent offers tanneries the combination of a versatile high performance tanning process with minimal environmental disturbances.

### MINIMAL EFFLUENT CONCERNS

- ◆ **Vandotan PH** is readily biodegradable and doesn't bio-accumulate.
- ◆ **Vandotan PH** (based on THPS) is readily converted into the environmentally benign species THPO within the tannery drums. For most applications there will be no residual THPS left in the drums when the float is dropped.

### RECYCLABLE SHAVINGS

- ◆ Unlike chrome shavings, **Vandotan PH** wet white shavings are biodegradable and can be easily disposed of at landfill sites.
- ◆ Wet white shavings are a freely available source of nitrogen and can be readily used as a supplementary, nitrogen rich fertiliser for a variety of composting applications.

### REDUCED CONSUMPTION OF PROCESS CHEMICALS

- ◆ **Vandotan PH** exhibits a synergism with mineral and/or synthetic tannins, which can potentially result in a reduced requirement for such chemicals.
- ◆ **Vandotan PH** can, in certain processes (sheep/goat skins), be used without a pickling stage resulting in a reduction in the discharge of environmentally damaging pickling chemicals, such as salts and mineral acids which significantly contribute to effluent COD loadings.

### CHROME EXHAUSTION

- ◆ **Vandotan PH** can be used to enhance the uptake of chrome based tanning agents and reduce the subsequent effluent loading.
- ◆ **Vandotan PH** can be used to eliminate problematic chrome (VI) from leather substrates.

## PROCESS DESCRIPTION

### INNOVATIVE TECHNOLOGY

**Vandotan PH** is an advanced tanning agent based upon the active ingredient THPS – Tetakis Hydroxymethyl Phosphonium Sulphate.

It's a total metal free product, easy to handle, with a very good penetration skill. The resulting tanned leathers show a very good lightfastness which lead to a milky colour wet white, able to be dyed by light shade dyestuffs, avoiding the undesirable yellowness of common wet white.

Other important fastnesses achieved in the automotive application are:

Light fastness, Heat fastness, Tear strength, Elongation, Breaking.

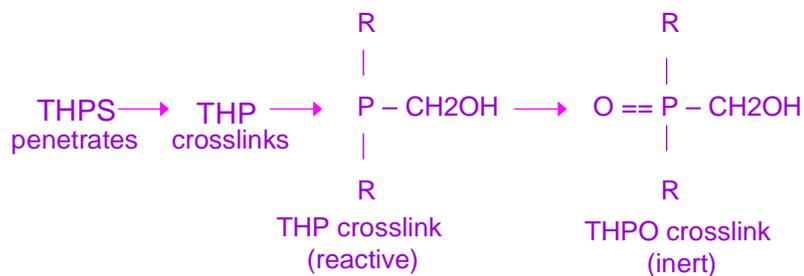
### MECHANISM

Its tanning mechanism is allowed to penetrate into the pelt substrate in the unreactive form of THPS. Once the penetration is complete, THPS is converted into its active crosslinking form, usually by raising the pH of the system. The reactivity of **Vandotan PH** is dependant upon pH, concentration and temperature.

As shown in the below formulations:

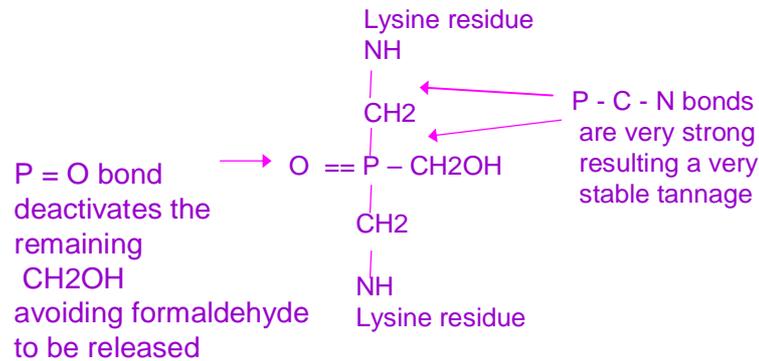
- Product penetrates in cationic quaternary form (THPS)
- Crosslinking occurs via collagen amino groups
- Conversion to tri-substituted, active form on basification (THP)
- Tannage starts around pH4 and continues crosslinking up to pH 7

## The Basic Facts - Tanning Schematic



Increasing pH

## The Basic Facts - Tanning Result



## RESULTS

### APPLICATION TECHNOLOGY

#### Tanning system :

After a pickling at pH 3,2-3,5 **Vandotan PH** is added to the tanning float in amount of 4-5 % on pelt weight. The penetration time, before to start with basification, is about 2 hrs, depending on the pelt thickness. The through cross-section must be monitored by a Selenium Indicator P (III)/(V) ratios. In order to crosslink the leather amino-groups, a slowly basification must be maintained up to pH 5,5-6,5.

The residual not reacted THP must be deactivate by oxidative washing with Hydrogen Peroxide or Borax. To scavenge "in-process" HCHO with appropriate washing-scavenger (Sodium meta-bisulfite) is recommended whether a very low HCHO leather is required (< 10 ppm).

#### Mix Tanning system:

A reduced Chrome usage is allowed when a mix tanning system is carried on. The use of 1% basic chromium sulphate in conjunction with 2% **Vandotan PH** is sufficient to give a fully tanned quality leather in terms of softness, fullness and handle. The reduced chrome usage is reflected in the levels of chromium detected in the effluent. Typical values of 120ppm Cr were measured compared to, typically, 3600ppm Cr for a conventional chrome tannage. The resultant crust could be ironed at 100°C and lasted at 115°C without any signs of shrinkage.

## EXPERIMENTAL DATA

### Properties and Characteristics

The wet white quality achieved by **Vandotan PH** system after retanning, is summarised in the following table:

	<b>Wet white Glutaraldehyde</b>	<b>Wet White Vandotan PH</b>
Shrinkage Temperature	68-72 C	75-80 C
Tear Strength	25-20 N	40-45 N
Stitch	87 N	120 N
Elongation	45%	54%
Light Fastness	3/4	4
Heat Fastness (aging 120C-4 hrs)	3/4	4
Fogging	5,5 mg	3.8 mg

### For further information

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**DESCRIPTION**

KLF TECNOKIMICA has just recently developed a process of tanning FREE METAL, it allows to obtain white leather with a shrinkage temperature of 80 ° C + -1, completely free of metals such as chromium, aluminum, zirconium and titanium.

The tanning is completely organic based.

The finished leathers have a good softness, and brilliant shades of dye and filled with natural good technical characteristics, as reported in the analytical data described below and with very low rates of free formaldehyde.

Our process takes place through a special preparation of the leather; during pre-tanning, it allows already to obtain a well-tanned leather, with a sufficient swelling of collagen fibers that are prepared to fix definitely the synthetic products used in the next phase of retanning.

The hides thus prepared are reactive with fatliquoring products that are well secured to the fiber, giving the desired softness, this factor is very important in this type of leather that are usually hard and not very workable in terms of smoothness.

The process is based on combined action of two chemicals whose basic constitution is organic, capable of fixing the collagen fibers, forming a stable complex equal to that of a normal natural tannin, which has higher molecular size of normal synthetic organic products which are usually used to obtain white leather-free metals.

By the following procedure we treated both cattle hides both sheep-goat skins, obtaining excellent results in both types of leather.

We exhibit below the procedure done on hides of cattle from Europe and the setback weight 22/24 kg

Free Metal Leather Tanning Process: Pickled calf Ph 2.5

TRIAL IN KLF		<b>TANNING PROCESS</b>			
<b>Date</b>	11/02/2010	<b>Client</b>	KLF TECNOKIMICA		
<b>Article</b>	Metal free		<b>Kind of leather</b>	<i>Pickled calf</i>	
<b>thickness</b>		<b>weight</b>		<b>%refer to</b>	Pickled weight + 50%

PRODUCTS	°C	%	Kg.	Rot. Min	Check Operations
water	20	100			
WATER	20	70			
SALT		8		10	
FORMIC ACID		1		30	
SULPHURIC ACID		1		120	OVER NIGHT
					MORNING PH 3 DRAIN 2/3
<b>PAROLIT FC</b>		1.5		120	
<b>PAROLIT JX</b>		1		60	
<b>PAROLIT JX</b>		1		120	
<b>WATER</b>	38	100			
SODIUM ACETATE		3		90	<b>IN 2 PORTIONS</b>
SODIUM BICARBONATE		2		300	OVER NIGHT
					MORNING PH = 5.5/6 DRAIN
WATER	38	150			
IDROFIL A500		1.5		50	DRAIN WASHING
WATER	35	100			
FILTAN GN		1.5			
SOLFOIL 912H		2		60	DRAIN
					HORSE UP OVER NIGHT SAMMING
					SHAVING
					RE-TANNING PROCESS

TRIAL IN KLF		<b>RETANNING PROCESS</b>			
<b>Date</b>	14-02- 2010	<b>Client</b>	KLF TECNOKIMICA		
<b>Article</b>	White leather		<b>Kind of Leather</b>	<i>N.1 Wet white leather</i>	
<b>Thikiness</b>	1.1-1.3	<b>weight</b>	<b>% refer to</b>	Shaved	

PRODUCTS	°C	%	Kg.	Rot. Min	Check Operations
WATER	30	250			
LEDER RIV PO2		3			
OIL PV		2		30	
FILTAN GN		6		20	
FILTAN GN		6		30	DRAIN
WATER	35	150			
SODIUM FORMIATE		2			
SODIUM BICARBONATE		0.3		60	PH = 6 DRAIN WASH
WATER	30	100			
EMULOIL CRS		2			
LEDEROL ES/F		2			
SOLFOIL HW		2		30	
FILTAN RE		4		20	
LEDERFILLER CK		3			
FILTAN GN		20		180	OVER NIGHT
					MORNING DRAIN
WATER	45	150			
LEDERTAN RC		3		20	
LT BIANCO		2			
EMULOIL CRS		3			
SOLFOIL HW		4			
LEDEROL ES/F		5			
IDROFIL SOAP		0.5			
IDROFIL 1000		0.5		60	
FILTAN RE		3		40	
FORMIC ACID		1		30	
FORMIC ACID		1		30	
LT BIANCO		2		20	
FORMIC ACID		1		30	DRAIN WASH
					SETTING OUT- HANG-STAKING

## RESULTS

In this type of work, what is most important is preparing the leather to the next phase of retanning and fatliquoring, which gives the characteristics of the leather in terms of fashion and the effect of soft hand required including finishing.

Indeed, in leather free metal, is essential tanning skin sufficiently to obtain good swelling of collagen fibers with the setting and curing of the same tanning agent reaching a shrinkage temperature of 78-80 ° C. The first tanning is that defines the main characteristics of the finished leather.

With most free metal processes, you get leather flat and hard, this is because the collagen fibers are not sufficiently tanned and cross from tanning so that it can not crosslink them. These organic tanning as mentioned above, are usually molecules not large enough as those of the natural tannins and thus the protein structure does not change the point of a real tan, but you get the so-called "pseudo-tanning."

With process PAROLIT FC and JX PAROLIT by KLF, the tanning is complete, the chemical agents acting on the fiber are well penetrated in the section of the fibrous structure of the dermis, cross linked fibers and permanently attached.

You get a leather with the typical characteristics of synthetic tanning similar to a real vegetable tanning.

Here below are the results of analytical data, chemical and physical achievements:

**Determination of tear load Part 2: Double edge tear (UNI EN ISO 3377/2)**

Test	Average thickness		Tear extension		Load				Load / Thickness			
	GOAT	CALF	GOAT	CALF	GOAT		CALF		GOAT		CALF	
n°	mm	mm	mm	mm	Kg	N	Kg	N	Kg/mm	N/mm	Kg/mm	N/mm
longitudinal	1,16	1,13	42,0	44,3	5,3	52,0	9,4	92,2	4,6	44,8	8,3	81,6
longitudinal	1,16	1,13	50,1	46,4	6,4	62,8	11,0	108,4	5,5	54,1	9,8	95,9
transversal	1,16	1,06	45,2	45,4	5,5	54,4	8,2	80,4	4,8	46,9	7,7	75,9
transversal	1,20	1,06	51,5	47,0	6,4	63,3	8,7	85,8	5,4	52,7	8,3	80,9
average	1,17	1,10	47,2	45,8	5,9	<b>58,1</b>	9,3	<b>91,7</b>	5,1	49,6	8,5	83,6

**Determination of tensile strength and percentage extension (UNI EN ISO 3376 - I.U.P.6)**

Test	Average thickness		Average cross-sectional area		Tear extension				Tear load				Load / Sectional area			
	GOAT	CALF	GOAT	CALF	GOAT		CALF		GOAT		CALF		GOAT		CALF	
n°	mm	mm	mm <sup>2</sup>	mm <sup>2</sup>	mm	%	mm	%	Kg	N	Kg	N	Kg/mm <sup>2</sup>	N/mm <sup>2</sup>	Kg/mm <sup>2</sup>	N/mm <sup>2</sup>
longitudinal	1,23	1,23	12,30	12,3	31,4	62,8	22,9	45,89	20,44	200,54	27,49	269,68	1,66	16,30	2,23	21,93
longitudinal	1,22	1,25	12,20	12,5	32,8	65,5	26,8	53,59	22,39	219,66	26,39	258,89	1,84	18,00	2,11	20,71
transversal	1,24	1,11	12,40	11,1	29,0	58,1	26,3	52,65	24,09	236,34	20,94	205,44	1,94	19,06	1,89	18,51
transversal	1,24	1,15	12,40	11,5	26,9	53,7	27,9	55,87	27,89	273,60	23,19	227,51	2,25	22,06	2,02	19,78
average	1,23	1,19	12,33	11,85	30,01	60,04	26,00	52,00	23,70	232,54	24,50	240,38	1,92	<b>18,86</b>	2,06	<b>20,23</b>

**Determination of distension and strength of grain -- Ball burst test (I.U.P.9 UNI EN ISO 3379)**

Test	Strength estension		Strength load				Tear extension		Tear load			
	GOAT	CALF	GOAT		CALF		GOAT	CALF	GOAT		CALF	
n°	mm	mm	Kg	N	Kg	N	mm	mm	Kg	N	Kg	N
1	10,16	10,99	26,39	258,8	32,24	316,3	13,56	14,98	52,40	514,1	60,90	597,4
2	12,05	10,95	34,78	341,2	31,39	307,9	15,26	14,17	60,46	593,1	56,40	553,3
3	11,33	9,39	39,56	388,1	31,88	312,7	14,24	11,99	58,11	570,1	54,09	530,6
<b>Average</b>	<b>11,18</b>	<b>10,44</b>	37,17	329,4	31,63	312,3	14,35	13,71	56,99	559,1	57,13	560,4

**Determination of water vapour permeability (UNI EN ISO 14268:2006)**

Test	RESULT				
	GOAT	CALF			
n°	mg/(cm <sup>2</sup> h)	mm			
1	16,4	13,8			
2	17,1	13,5			
<b>Average</b>	<b>16,8</b>	<b>13,7</b>			

**CHEMICAL ANALYSIS**

ANALYSIS		
	GOAT	CALF
PH	5,00	4,8
DIFFERENTIAL INDEX	0,52	0,6
HUMIDITY (%)	10,30	10,7
ASHES (%)	5,50	4,8
FORMALDEHYDE (mg/Kg)	28,00	30,0
XENOTEST (scala di grigi)	4,00	4,0
SHRINKAGE TEMPERATURE (°C)	80,00	85,0
Cr, Al, Ti, Zr (mg/Kg)	assenti	assenti
SUBSTANCES EXTRACTED WITH CH <sub>2</sub> CL <sub>2</sub> (%)	11,60	8,1
TANNING DEGREE	22,10	25,70

**For further information**



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<b>LOW DENSITY AND TOXICITY FUME DEVELOPMENT FIRE PROOFING PRODUCTS</b>	4. TECHNOLOGIES FROM CRUST TO FINISHED
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## **ABSTRACT**

Development of fire proofing products for drum treatment of leather in wet-blue to obtain leathers resistant to fire and with low dense and toxic gas emission in compliance with regulations NF F 16-101, BS 5852, DIN 54 341, UNI 9175 and ASTM E 1537-98.

## **DESCRIPTION**

It seems that obtaining features of excellence in leather such as those required by the aeronautic, naval and furnishing market intended for large public venues can only be achieved thanks to the use of fire proofing agents and not through simple recombination of the working composites. The best available technologies have been emphasized by identifying the synergies between the products and the various methods of application, granting considerable reductions in the products used and immediate ecological and economical advantages for the company.

In terms of the combustion fumes toxicity and opacity, which are considered by the users of leathers to be yet another requirement for fire resistance, there is renewed importance granted to the absolute balance in the choice and methodology of products. Higher than necessary fire proofing quantities contribute to improving the extinguishing of flames and embers but can, however, have a negative effect on combustion gases produced by increasing the opacity beyond the allowed limits.

In regards to opacity observations, it was also confirmed by the toxicity tests for which were observed, at a flame resistance clearly higher than the requested parameters, higher quantities than the requested values of carbon monoxide, hydrogen cyanide and of halogen acid.

Stefani Chimis has developed recipes/products for the production of fire proof leathers that satisfy the strictest regulations (NF F 16-101, BS 5852, DIN 54 341, UNI 9175, ASTM E 1537-98).

## RESULTS

In terms of toxicity and opacity of the combustion fumes, which are considered by the users of leathers to be yet another requirement for fire resistance, the importance of absolute balance in the choice and methodology of products offered is renewed. Quantities of greater than necessary fire proofing contribute to improving the extinguishing of flames and embers but can, however, have a negative effect on combustion gases produced by increasing the opacity beyond the allowed limits.

In regards to opacity observations, it was also confirmed by the toxicity tests for which were observed, at a flame resistance clearly higher than the requested parameters, higher quantities than the requested values of carbon monoxide, hydrogen cyanide and of halogen acid.

1 Despite the fact that the hide is an extremely heterogeneous support and its treatment may be affected by numerous factors, an effective fire proof product can be obtained through the appropriate study of working types and times and by taking advantage of the synergies between the various composites, which can be attributed to three fundamental classes:

- Anti-resistant agents
- Ember-resistant agents
- Smoke-resistant agents

2 The combination of the effects of these substances meets the requirements of highly selective tests, such as the FAR A, and the analyses of the specific optic density of the fumes, both in "no flaming" and in "flaming" modalities.

**For further information**



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**ABSTRACT**

Nanocomposites obtained by modification of polymeric materials with charges of nanometric size to increase the abrasion resistance.

**DESCRIPTION**

Nanocomposites, obtained by modification of polymeric materials with charges of nanometric size, represent a new class of materials which are drawing the attention of both the industrial world and the scientific community. The new materials, which derive from the combination of reinforcements on a nanometric scale with the traditional polymeric compounds, have outstanding physical and resistance properties for their specific intended application. Justification of this behaviour is not wholly due to the matrix reinforcement interaction effect, but rather from what has been defined as "nano-effect", which is the huge contact area generated when charges reach the nanometric size, combined with a polymeric interphase layer with much higher properties than the matrix. The aim set by the above mentioned research was to implement the water drop and solvent resistance of the finishing film, while increasing water vapour permeability.

Product blends based on crosslinkable polyurethane resins were prepared by trapping simple or functionalised nanocharges inside them. Leathers finished with polymers of this type are supposed to have greater abrasion resistance with better wet and in-alcohol rubbing performances. The aim is to combine the advantages of inorganic charges (perspiration properties and hardness) with organic binder charges (elasticity and chemical resistance). Alkylamine groups (-RNH<sub>2</sub>) provide an example of organic functionalization of silica nanoparticles, able to chemically react with the groups present on leather and/or on the polymeric material establishing strong covalent bonds. Specific supplementary functionalization aims are the building of strong particle matrix bonds, uniform dispersion and limited particle agglomeration within the polymeric solution.

The characteristics obtained are reported in brief in the table (Table 1).

	Veslic dry no variation or breaking after n° cycles	Veslic wet no variation or breaking after n° cycles	Veslic with alcohol no variation or breaking after n° cycles	Taber value on grey scale after 300 cycles	Bally no variation or breaking after n° cycles	pot life	Spreading
Particles 30 nm approx. "S" 5%	40.000	2.000	150	4-5	50.000	poor	good
Particles 80 nm approx. "L" 5%	40.000	2.000	150	4	50.000	poor	good
Particles 250 nm approx. "T" 5%	40.000	2.000	150	4 small white abrasion	50.000	poor	good
Particles. "S" 9%	40.000	2.000	150	4-5	50.000	poor	good
Particles. "L" 9%	40.000	2.000	150	4-5	50.000	poor	good
Particles "T" 8.%	40.000	2.000	150	4-5	50.000	poor	good
Particles. "S" 13 %	40.000	2.000	150	3-4	50.000	poor	fairly good
Particles. "L" 13%	40.000	2.000	150	3-4	50.000	poor	fairly good
Particles "T" 13%	40.000	2.000	150	3-4	50.000	poor	fairly good
Blend 1:1 Particles T + S 9%	40.000	2.500	150	5	100.000	poor	good
Standard without nanoparticles	40.000	2.000	150	3-4	50.000	good	good

As can be observed there have been substantial variations in the abrasion resistances.

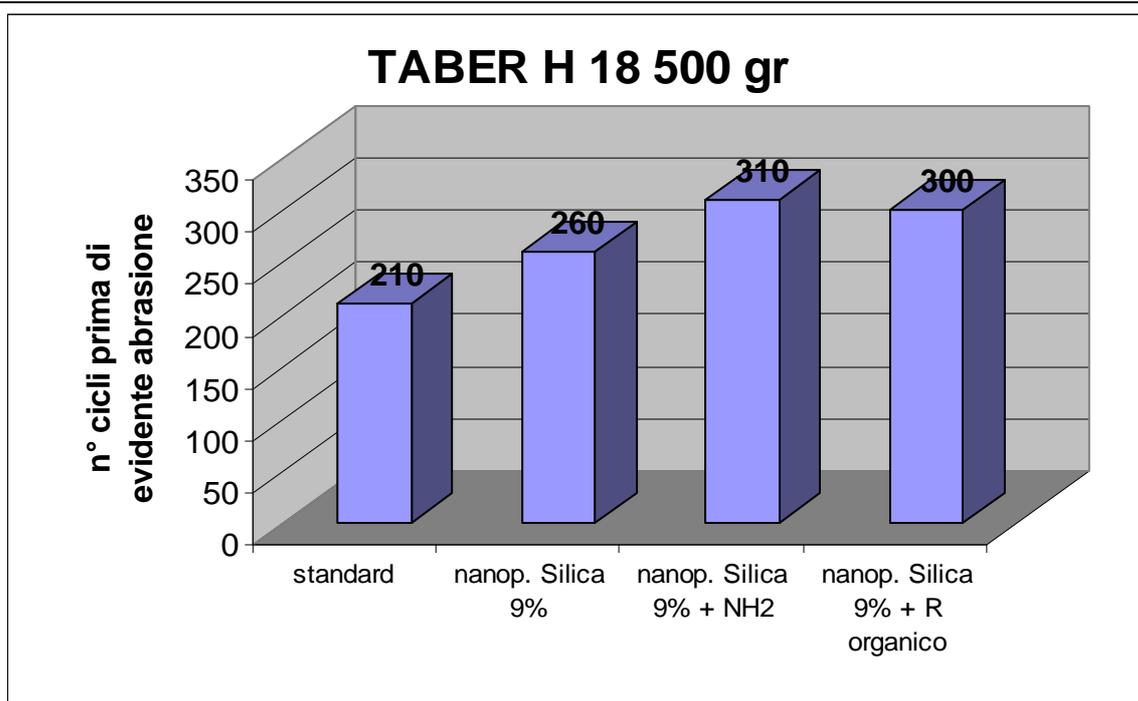
Taber tests demonstrated the effectiveness of a blend of differently sized nanoparticles compared with the effectiveness of a single type (Blend 1:1 Particles T + S).

Furthermore, II and III type nanoparticles were used and introduced with the same formulation used to constitute the initial fixing agent.

The results of the tests are shown in table 2

	Veslic dry <b>no variation or breaking after n° cycles</b>	Veslic wet <b>no variation or breaking after n° cycles</b>	Veslic with alcohol <b>no variation or breaking after n° cycles</b>	Taber <b>value on grey scale after 300 cycles</b>	Loss of weight after abrasion mg	Bally <b>no variation or breaking after n° cycles</b>	pot life
Particles type I - 9%	40.000	2.500	150	4-5	23.3	100.000	poor
Particles type II - 9%	100.000	5.000	260	5	19.8	100.000	Very good
Particles type III - 9%	100.000	5.000	260	5	18.0	100.000	Very good
Standard without nanoparticles	40.000	2.000	150	3-4	30.0	50.000	good

Taber test - Abrasion resistance (until abrasion of the film)



These additional tests, using functionalised nanoparticles, emphasized a notable improvement in general performance.

The chemical modification of nanocharges, moreover, also solved the problem of the short life span (pot-life).

It was also clear that fixing agents gained greater storage, electrolytes and frost stability.

No negative aesthetic variation was observed, in film opacity and evenness, and neither “touch” nor “hand” were in any way compromised by the addition of nanocharges.

The possibility of also easily formulating glossy nano-fixing agents has been demonstrated.

## RESULTS

The research demonstrated how the introduction of SiO<sub>2</sub> nano-particles in polyurethane formulations for fixing agents considerably increases mechanical resistances, in particular abrasion resistances.

A hybrid inorganic-organic chemical bond between nanoparticles and the polymer is needed in order to reduce the hydrophilic behaviour of nano-particles: this solution increases the rubbing resistance of the film in wet conditions and alcohol.

Further investigations on the influence of particle size on the final performances of the fixing agent were also indispensable.

Furthermore, organic functionalizations of nano-particles revealed the positive influence both on the chemico-physical stability of the final product, and on the mechanical and aesthetical properties of the final finishing film on the different leather articles.

#### For further information



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## SUMMARY

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Cl- SO4-- Reduction	LETEx SPA	4
Cr2O3 Reduction	LETEx SPA	4
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FREE METAL TANNING	KLF TECNOKIMICA SRL	11
LOW DENSITY AND TOXICITY FUME DEVELOPMENT FIRE PROOFING PRODUCTS	STEFANI CHIMIS SRL CENTROCAMPIONATURA	18
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