



Flame resistant leathers for the aviation industry

M. Breulmann, M. Mangler, C. Reineking
Clariant Produkte (Deutschland) GmbH

Throughout history, leather has been used for its special characteristics, an unmatched combination of properties and, of course, as an important part of fashion, especially for the shoe, handbag and garment industries.

In more recent times the aviation industry has rekindled its appreciation of leather as a valuable material, promoting and taking advantage of its characteristics and perceived feel of luxury: the high technical demands for quality and performance, economy and efficiency have been achieved.

In particular, there is a demand for flame retardancy, and a new approach based on EasyWhite Tan is described that achieves these critical specifications as well as meeting the need for secure and environmentally friendlier ingredients and processes.

The globalisation of business and affordable flights for the mass market have contributed to a strong increase in air traffic, not only from intercontinental flights using large aircraft, but also regionally and domestically, with small- to medium-sized aircraft. It is in this segment where leather commands an important market share, but not only in Europe and the US: in 2012 there were 560 flights every week between Madrid and Barcelona, for example, but 700 between Cape Town and Johannesburg, 860 between Mumbai and New Delhi, and an astonishing 1,130 flights every week between Rio de Janeiro and Sao Paulo¹.

A principal reason for the use of leather in aircraft interiors is its durability, thereby extending the life cycle of the interior and so reducing the frequency of its maintenance. Another major advantage is that leather seats are easy to clean, thus reducing the turn-around time between flights to a minimum.

Leather used for aircraft interiors has to meet several specifications, not only from a physical and chemical point of view, but also one of its most important criteria: flame retardancy. The flame retardancy test includes clear definitions regarding burning time, flame extinguishment, smoke density, emissions development and their composition, all of which are

specified in the Test Reports given as *Panel 1*. Of course the specific weight of the leather and weight reduction are other key factors; it contributes to fuel savings and one way to achieve this is by utilising thinner leather, which, however, will not always reach the necessary certified tear strengths for seat construction.

Currently, leather used in aircraft interiors is mainly based on chrome tanned leather, which is treated with flame retardant products to fulfill specific demands, especially for flammability.

There may be some operational issues in the application of flame retardant materials to leather in order to achieve the desired results. It is exactly at this point where a different approach was taken, moving away from the traditional way of producing aircraft interior leather, and switching to the new chrome free leather tanning system EasyWhite Tan. This is based on Clariant's Granofin Easy F-90 Liquid, which already has flame resistant properties as an integral part of its chemistry.

Challenges for the production of aircraft leathers

A structured approach was necessary to find the best way to produce aviation leather without the use of any flame retardant agent, the main challenges being:



Panel 1: Test Reports and Specifications for Aviation Leathers

(1a) 12 sec. ignition vertical test according to:

- 14 CFR Part 25 §25.853 (a) and Appendix F Part I, Amdt. 116
- JAR 25 §25.853 (a) and Appendix F Part I para. (a)(1)(ii), Change 15
- EASA CS-25.853 (a) and Appendix F Part I (a)(1)(ii), Amdt.6
- ABD0031 Chapter 7.1.2, Issue F and Test Method AITM 2.0002A
- D6-51377 Chapter 4.1, Issue F and Test Method BSS 7239

✓ Test passed
No after flame time
zero drips

Vertical:

Sample No.	Ignition Time in (Sec)	Total Burn Time in (Sec)	After Flame Time in (Sec)	Number of Drippings	Drippings Burn Time (Sec)	Burn Lengths in (mm)
leather 1	12	12	0	0	0	15
leather 2	12	12	0	0	0	15
leather 3	12	12	0	0	0	15
leather 4	12	12	0	0	0	20
leather 5	12	12	0	0	0	10
Average	12	12	0	0	0	15
Limits			15		5	203

(1b) Smoke density according to:

- 14 CFR / JAR / CS Part 25 §25.853 (d) and Appendix F Part V(b), Amdt.116
- ABD0031 Chapter 7.3.1., Issue F and Test Method AITM 2.0007A
- D6-51377 Chapter 4.1, Issue F and Test Method BSS 7238

✓ Test passed
Smoke development
below the maximum
after 4 min

Non Flaming (NF)
Density Smoke at (min)

Sample No.	1 min	2 min	3 min	4 min	5 min	6 min	DS max up to 4 min
leather 1	1	7	30	100	136	176	100
leather 2	1	7	49	116	160	196	116
leather 3	1	8	58	123	169	211	123
Average	1	7	46	113	155	194	
Max	1	8	58	123	169	211	

(1c) Smoke density according to:

- 14 CFR / JAR / CS Part 25 §25.853 (d) and Appendix F Part V(b), Amdt.116
- ABD0031 Chapter 7.3.1., Issue F and Test Method AITM 2.0007A
- D6-51377 Chapter 4.1, Issue F and Test Method BSS 7238

✓ Test passed
Smoke development
below the maximum
after 4 min

Flaming (F)
Density Smoke at (min)

Sample No.	1 min	2 min	3 min	4 min	5 min	6 min	DS max up to 4 min
leather 1	5	40	95	139	163	174	139
leather 2	11	46	116	164	200	214	164
leather 3	6	20	45	88	114	124	88
Average	7	35	85	130	159	170	
Max	11	46	116	164	200	214	

(1d) Toxicity according to:

- ABD0031 Chapter 7.4, Issue F and Test Method AITM 3.0005
- D6-51377 Chapter 4.1, Issue F and Test Method BSS 7239

✓ Test passed
All gas development
during test are far
below the maximum limits

Gas	Gas Limit After 4 min in ppm	Non Flaming (NF)		Flaming (F)	
		Sample Number		Sample Number	
Hydrogen Cyanide HCN	150 ppm	1 2 3	0 0 0	1 2 3	0 0 0
		Average	0	Average	0
Carbon Monoxide CO	1000 ppm	1 2 3	1 1 1	1 2 3	5 5 5
		Average	1	Average	5
Nitrous Gases NO-NO2	100 ppm	1 2 3	0 0 0	1 2 3	1 1 1
		Average	0	Average	1
Sulfur Dioxide Hydrogen Sulfide SO2 – H2S	100 ppm	1 2 3	0 0 0	1 2 3	0 0 0
		Average	0	Average	0
Hydrogen Fluoride HF	100 ppm	1 2 3	0 0 0	1 2 3	0 0 0
		Average	0	Average	0
Hydrogen Chloride HCL	100 ppm	1 2 3	0 0 0	1 2 3	0 0 0
		Average	0	Average	0

- Vertical flammability test, involving burning for 12-60 seconds
- Self-extinguishment within a defined period of time
- Toxicity test and volumes of such toxins emitted during combustion (acute toxicity)
- Smoke density
- Heat release during combustion
- Specific weight
- Physical strengths at a relatively low thickness
- Application of flame retardant agents

From the start it became clear that leather tanned with Granofin Easy F-90 Liquid was naturally flame retardant with definite self-extinguishment properties. This fact simplified the work which then involved finding a synergistic retanning and softening combination to create the correct qualities and attributes of the leather. These properties were not limited to the technical and aesthetic points of view, but also considered from the point of view of commercial viability.

The aviation leather test requirements

All tests were carried out at independent certification institutes in Europe to the relevant specifications. These norms included:

- 12/60 sec. ignition vertical test
- Smoke density test method (Non flaming and flaming)
- Toxicity test

All of the procedures used are specified and set down for each test method in *Panel 1*.

For all tests carried out, samples of two different hides in a standard grey colour were prepared and sent to two different certification institutes. The test results are displayed in *Panel 1*.

This shows that the leather tanned and retanned to formulation (detailed in *Panel 3* and *Panel 4* respectively) passed all the requirements for aviation leather. Crucially this was without the addition of any flame retarding agents.

The importance of this tanning system within the total process is made clear in *Panel 2* which shows the results on this leather



Panel 2: Combustion of comparative leathers

Tannage:
EasyWhite tannage



Tannage: Standard
chrome tannage



The retannage used on both leathers is given in Panel 4.
No flame retardant agents were used in either process.

using the special retanning formulation (detailed in Panel 4) when compared to conventional chrome tannage without the use of any flame retardant agents.

Weight reduction and physical strengths

These new aviation leathers exhibit stronger physical strength at any given substance than many leathers. Of particular importance for seat construction is of course the additional tear and stitch tear strength.

This allows for the production of a thinner, lighter leather and this has a direct effect on the all-important weight reduction. A reduction of 0.2 mm in the thickness of the leather could generate up to 150 grams of weight reduction per m² of final leather.

Application of flame retardant agents and effects of mechanical action

For the usual current method of production of flame retardant leather, every stage of the process is important. However, although all products are carefully selected and tested, the application of specific flame retardants is unavoidable.

These are normally used at the end of the retanning and fatliquoring stages, in a fresh bath at very high offers. These flame retardant agents are widely based on materials that are not chemically fixed to the leather. Normally, they are only physically deposited within the leather fibres and spaces in-between the fibres. This makes an even distribution more difficult as leather does not have the same structure across the hides and, furthermore, it leads to inefficiency, expensive waste, increased effluent loadings and ultimately more expense.

It is arguable that it may not be possible to conduct setting out on such treated hides as normal, for fear of squeezing the flame retardant agent out of the leather. Consequently hide area yield, milling properties, over-elasticity and substance control is under question.

However, in this approach the tanning component is chemically bound to the fibres during the tanning process, hence stays in the leather and is not squeezed or washed out. This promotes very even and consistent flammability resistance throughout the hide.

Panel 3: EasyWhiteTan

Process	%	Chemicals	Time
Tanning	20%	Water 28°C	
	10%	Granofin® Easy F-90	240 min
Add	20%	Water 45°C	420 min
Add	0,25%	Fungicide	60 min
Drain			
Wash	50%	Wash 20°C	20 min

Panel 4: EasyWhiteTan

Process	%	Chemicals	Time	COMMENTS
Wash	300%	Water 30°C		
	0.1%	Formic Acid	45 min	pH 3.8 / Drain
Retan	100%	Water 30°C		
	2%	Sodium Formate	45 min	pH 4.3
	5%	Silicone Polymer ¹	15 min	
	12%	Phenolic Syntan Liquid ²	30 min	
	12%	Phenolic Syntan Liquid ²	30 min	pH 4.7
	2%	Naphthalene Sulphonate Powder ³		
	5%	Tara ⁴		
	5%	Phenolic Syntan Powder ⁵	20 min	pH 4.8
	3%	Dyestuff ⁶	90 min	
	50%	Water 50°C	10 min	
	2x0.7%	Formic Acid	30 min	pH 3.8 / Drain
Wash	200%	Water 50°C	10 min	Drain
Fatliquor	100%	Water 50°C		
	3%	Acryl Polymer ⁷	10 min	
	7%	Synthetic Ester ⁸		
	15%	Silicone Polymer ¹	60 min	
	2x0.5%	Formic Acid	30 min	pH 3.6 / Drain
Wash	300%	Water 20°C	10 min	
Set Out / Vacuum Dry 45°C – 2 min / Hang Dry				
Products:				
(1) Tergotan PO-62 Liquid		(5) Tanicor SG Powder		
(2) Syncotan MRL Liquid		(6) Meliderm HF Dyes Powder		
(3) Coralon OT Powder		(7) Tergotan PMB Liquid		
(4) Granofin TA Powder		(8) Derminol SO-31 Liquid		



Advantages of the system

TANNING

To understand the full impact of the process it is necessary to start with the tanning itself as set down in *Panel 3*. This process includes the complete elimination of the pickling, basification or other additional products for fixation, as would normally be required for the standard tanning of leather with metal salts or with organic products. This technology brings a considerable reduction in the number of controls needed throughout the tanning. During a normal tanning process, every step needs a visual, pH and temperature control, making a total of approximately seven controls. With this system only one control is needed to establish the temperature and float levels and just one more is required at the end. The number and quantity of chemicals used during the tanning is also reduced from the usual six to just two. The tanning process water consumption can be reduced by as much as 40 to 50% compared to the standard, and processing time may be reduced by as much as 30%.

RETANNING

It is very important to consider the savings and advantages during the retanning, and the process used is given as *Panel 4*.

- Time can be saved as it is no longer necessary to apply flame retarding agents
- Less chemicals are needed as no additional flame retardant is used
- Water usage is reduced as the last additional after-treatment step is eliminated
- Less wastewater
- No colour changes in the leather due to after-treatment
- No change in physical properties of the leather

- Simple and reliable processes
- Time and cost savings

Conclusions

When work on aviation leather started in spring 2012, the aim was to couple the environmental benefits of the EasyWhite Tan System in the production of flame retardant leather and partially reduce the use of flame retarding agents. Instead it was found that it is possible to produce flame resistant leather without the use of flame retardant products to meet the requirements for aviation leathers based on this system as long as a synergistic retanning and fatliquoring routine is observed.

Based on extensive investigation work, including the use of different raw materials from different sources, and coupled with different pre-tanning scenarios, it is concluded that it is entirely possible to produce commercially viable flame retardant aviation leather as described in this paper.

The technical and commercial advantages of using this system are convincing in their own right. The test results demonstrate that it is possible to meet requirements for aviation leathers without the addition of any flame retarding agents.

The leather industry now has a totally new approach available for the production of flame retardant leathers. This opens new up possibilities, not just for the aviation leather sector but for all mass-transit vehicles which are equipped with leather interiors. There are of course other areas of application for this leather in public places.

Sources:

(1) Eurostat and The Economist

STYLES MAY HAVE
CHANGED...
THE DEMANDS
FOR STYLE HAVEN'T

www.quakercolor.com



adding colour and finishes to the
automotive world for over six decades



QUAKER COLOR
A Step Ahead...

a division of McAdoo & Allen, with roots in
the leather industry for over a century