Investigation of some factors from the technological processing of leather for upholstery of car seats on their flammability

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Abstract. Natural leather is widely used for car upholstery and has a non-flammability requirement. In the present work, bovine leather intended for upholstery for car seats are studied. Various technological schemes of tanning have been applied, including combined; various finishing methods have been applied and two flame retardants have been used, namely Firex LFS and Flacavon B-45. It was found that the studied methods of combined tanning of investigated leathers do not affect the colour fastness to dry and wet rubbing, but the highest total flame combustion time of the source is given by aluminium-chromium re-tanned leathers and this indicator decreases depending on the type of re-tanning of the tested samples in the following order: chrome, aluminium, vegetable. Flacavon B-45 showed higher efficiency in terms of flame retardancy of the investigated leathers.

Keywords: leather, car seats, flame retardancy, tanning processes

1. Introduction

A global trend in recent years is a significant increase in the production of leather for upholstery compared to the leather for clothing and footwear. Numerous indicators that characterize the quality of leather for car seat upholstery include flammability. In our country the current standard refers to protective gloves against thermal hazards, heat and/or flame, as the combustion is performed by burner, the following indicators are determined: flame combustion time and residual smoldering time.

A method is known [1], which refers to upholstery of furniture and sources of ignition (smoldering cigarette and gas under pressure, comparable to the effect of lit matches).

The limitation of the flame on leathers depending on the re-tanning and fatliquoring agents has been studied [2]. Standard methods were used: Vertical burning test and oxygen index test [3]. Caesalpinia Spinosa fruit extracts have been studied as a pre-tanning agent for the treatment of fire-resistant leathers [4], eliminating the use of aldehydes, synthans and mineral salts in combined vegetable tanning.
Considering the conditions for the possible ignition of the leather during the movement of the vehicle by the driver, the most suitable method is considered for assessment of the ignition process, in which is used as an ignition source smoldering cigarette [5].

In this regard, it is of interest to characterize this method on variants of combined tanning (re-tanning of pre-tanned white leathers) and finished bovine leather for car seats on some performance properties, including and their fire resistance.

2. Experimental

In the present study have the following objectives:

1. Investigation of the method of combined tanning (re-tanning of aluminum pre-tanned bovine leathers) on some performance properties of leather for haberdashery;

2. Study of the influence of the method of combined tanning and processing to increase the fire resistance of bovine leathers intended for car seats;

3. Characteristics of the method: “Furniture: Assessment of the ignitability of upholstered furniture - Part 1: Ignition source: Smouldering cigarette” [1].

To solve the first task, bovine leather samples intended for car seats were processed and the physico-mechanical parameters were determined, as well as the colour fastness of the finish layer to dry and wet rubbing and their fire resistance.

The samples were taken by the method of asymmetrical strips of half bovine leather, treated until the pickling process inclusive.

The method for estimating ignition was applied on 6 parallel samples of treated bovine leathers and a statistical calculation of the results was made.

8 variants were studied, 2 samples per variant. The samples from the 1, 2, 3 and 4 variants were pre-tanning by formaldehyde to the wet-white product according to the prospectus data of “Schill & Seilacher” [6].

The samples of the 1 and 2 variants are chrome-retanning, and those of the 3 and 4 - vegetable.

The samples of the 5 and 6 variants are pre-tanning by aluminum, the samples of the 5 variant is chrome re-tanning, and on the 6 sample is vegetable. The leathers from the 7 and 8 variants are vegetable pre-tanning with mimosa extract according to a known scheme [7].

After neutralization, dyeing and fatliquoring process of all samples, treatment was performed to impart flammability of samples 1, 3, 6 and 7 with the flame retardants Firex LFS (product of condensation of methylene-containing and nitrogen-containing compounds of oxyaryl and inorganic salts), and for samples 2, 4, 5, 8 - with the flame retardants Flacavon B-45 (combination of halogen and phosphorus salts of organic and inorganic origin) [8]. All samples were finished according to methods for finishing the bovine nappa furniture [9].

According to the given standards, the physico-mechanical parameters [9], the indicators of colour fastness of the finish layer to dry and wet rubbing [10], as well as their flammability according to [5] are controlled.

A statistical calculation of the data for ignition of the bovine leather samples for furniture upholstery was performed according to the indicators: beginning of smouldering /s/ and total flame combustion time of the source (cigarette) /s/.
3. Results and discussion

The results obtained for the physico-mechanical properties of aluminium and vegetable pre-tanning bovine leathers for upholstery, depending on the type of their re-tanning, are shown in Table 1.

Table 1. Physico-mechanical results of aluminium and vegetable pre-tanning bovine leathers for upholstery, depending on the type of their re-tanning

| № variant | Type re-tanning | Elongation at cracking of the face layer of leather, % | Strength of the facial leather layer, N/mm² | Elongation at leather rupture, % | Tensile strength, N/mm² DIN EN1336
|------------|----------------|------------------------------------------------------|---------------------------------------------|----------------------------------|-----------------------------------|
| Variant 5  | Al – Cr - Vegetable | 55,3                                                 | 22,5                                        | 58,6                             | 25,2                              |
| Variant 6  | Al – Vegetable - Al | 57,5                                                 | 11,4                                        | 57,5                             | 11,9                              |
| Variants 7, 8 | Vegetable - Al | 60,3                                                 | 14,4                                        | 61,6                             | 14,9                              |

From the data for the elongation at the cracking of the facial leather layer and the elongation at the leather rupture it can be seen that all the studied variants show relatively high values, the highest being for the vegetable-aluminum tanned leathers.

The data on the strength indicators show that the results for the tensile strength indicator meet the requirements of the standard only for aluminum-chromium-vegetable samples (variant 5), and for the others they are relatively lower. This is probably determined by the chrome tanning process.

Table 2 shows the results of the durability of the finishing of bovine leather upholstery depending on the tanning scheme, as well as the type of fire protection treatment.

Table 2. Influence of tanning and flame resistance methods on the resistance to finishing layer of the bovine leather to dry and wet rubbing

| № variant | Tanning scheme | Dry rubbing resistance, degree | Wet rubbing resistance, degree |
|------------|----------------|-------------------------------|-------------------------------|
| Variant 1  | Aldehyde - Cr | 4/5                           | 3                             |
| Variant 2  | Aldehyde - Cr | 4/5                           | 3/4                           |
| Variant 3  | Aldehyde - Vegetable | 5                      | 3                             |
| Variant 4  | Aldehyde - Vegetable | 4/5                       | 2                             |
| Variant 5  | Al – Cr - Vegetable | 5                       | 4/5                           |
| variant 6  | Al – Vegetable - Al | 4/5                       | 3/4                           |
| Variant 7  | Vegetable - Al | 5                             | 3/4                           |
| Variant 8  | Vegetable - Al | 5                             | 2/3                           |
The data on colour fastness to wet rubbing for all tested samples meet the requirements of the standard, which for pigmented leather at 250 rpm are at least 3 on the grey scale, except for the samples of variants 4 and 8 (treated with Flakavon B-45). Table 2 shows that the colour fastness to wet rubbing of the tested leathers for variants 4 and 8 does not meet the requirements for the use of Flakavon. The treatment of the leathers with this flame retardant leads to a reduction of the degree of resistance to wet rubbing in all variants - 2, 4, 6, 8.

The results for colour fastness to dry and wet rubbing of finished bovine leather upholstery show that they do not depend on the tanning scheme, but to some extent depend on the type of the flame retardant used. This effect can probably be explained by the weaker binding of the flame retardant agent to the dyed and fatliquored leather tissue [12].

The results obtained from the ignition of the tested bovine leather samples, pre-tanned and re-tanned in different variants and treated for incombustibility with both flame retardants, are shown in Table 3.

### Table 3. Dependence of ignition of bovine leather samples from the tanning method and from the type of incombustibility treatment

| № leather sample | Tanning method       | Beginning of flame combustion /s/ | Beginning of smouldering /s/ R = 22s | Total flame combustion time of source, /s/ | R = 22 s |
|------------------|----------------------|-----------------------------------|---------------------------------------|------------------------------------------|----------|
| Aldehyde - Cr    | 1                    | -                                 | 60                                    | 822                                      |          |
| Aldehyde – Cr    | 2                    | -                                 | 175                                   | 709                                      |          |
| Aldehyde – Vegetable | 3                | 116                               | 56                                    | 542                                      |          |
| Aldehyde – Vegetable | 4                | 116                               | 238                                   | 624                                      |          |
| Al – Cr – Vegetable | 5                | 183                               | 592                                   |                                          |          |
| Al – Vegetable – Al | 6                | 76                                | 692                                   |                                          |          |
| Vegetable – Al   | 7                    | 60                                | 606                                   |                                          |          |
| Vegetable – Al   | 8                    | 124                               | 668                                   |                                          |          |

From the results obtained, the effect of “beginning of flame combustion” can be noted in variants 3 and 4, followed by variants 6 and 7. In most samples, respectively: variants 2, 4, 5, 8, the index of “beginning of smouldering” has higher values, which shows that treatment with Flacavon gives better fire resistance to the tested leather samples.

Regarding the indicator “total flame combustion time of the source” has the highest values at the variants 1 and 2 (chrome re-tanned), followed by variants 7 and 8, and lastly: variants 3 and 4 (with combustion effect). These data show that the indicator “total flame combustion time of the source” decreases depending on the type of re-tanning of the investigated samples in following order: chromium, aluminium, vegetable.

From these results it can be concluded that the highest value of the indicator “total flame combustion time of the source” have the leather samples, which mineral re-tanning and those treated with the flame retardant Flacavon B-45.

The data from the statistical calculations of the results of 6 parallel measurements for flammability of bovine leather for upholstery, which tanned through combined tanning agents, according to the following indicators: “beginning of smouldering” (Smax) and “total flame combustion time of the source” (Ctotal) are given in table 4.
Table 4. Flammability indicators statistics of bovine leather for haberdashery

| Statistics and indicators | Beginning of smouldering /s/ | Total flame combustion time of source, /s/ |
|---------------------------|-----------------------------|------------------------------------------|
| $R_i$ - arithmetic mean deviation | 192,0 | 704,0 |
| $S$ - standard deviation | 21,0 | 51,0 |
| $R$ - confidence interval /$\rho = 0,05; \nu = 5$/ | 22,0 | 55,0 |
| $S_r$ - random error | 10,9 % | 7,3 % |

The data in Table 4 show that the random error $S_r$ for both indicators is relatively high, being smaller for the indicator “total flame combustion time of the source” ($C_{total}$) - 7.3%.

These data characterize the studied method of ignition as guaranteeing sufficient uniformity of the respective indicators.

4. Conclusions

It was found that the studied methods of combined tanning do not affect the resistance of the finish layer of bovine leather for upholstery towards colour fastness to dry and wet rubbing. It was found that the flame retardant *Flakavon B-45* reduce the resistance of the finish layer of bovine leather for upholstery towards the wet rubbing, but slows the beginning time of smouldering of the tested leathers. The highest “total flame combustion time of the source” show the re-tanning leathers with Al-Cr for haberdashery and those treated with *Flacavon-B-45*.

It was found that the anti-inflammatory treatment of leather for upholstery is more effective when using *Flacavon B-45*.

The tested method for ignition of leather upholstery for car seats guarantees sufficient uniformity of the indicators: beginning of smouldering /s/ and total flame combustion time of source /s/.

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