

Design of special purpose products made of nanomodified collagen-containing materials with radio-frequency discharge

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Abstract. Research results shows that RF-plasma treatment increases the adhesion of the coating film to the leather uppers and resistance to abrasion and repeated bending of uppers, which define the ability of material to preserve its consumer properties and characterize longer safety of special purpose footwear form during its wearing.

1. Introduction

Textile industry is a significant multiple-discipline sector of the economics, which influences on the stable and balanced social and economic development of the country and provides an independent and intellectual levels of the society.

From the branch work effectiveness point and taking into account of situation around the external economic rate huge and massive tasks connected to the renew of high-quality production and continuous process of labor protection improvement need to be solved by the domestic producers [1,2]. High productivity of labour is not only the result of interaction of human, nature and technique but also right organized labor activity.

Physical activity and capacity for work of the specialist is provided by the rationally chosen equipment. Enterprises provide their workers with means of individual protection, which include garment and footwear of special purpose. Means of individual protection protect from adverse impact during the operation of work. The main aim of use of means of individual protection is prevention of industrial injuries.

Garment and footwear of special purpose are operated in severer industrial conditions than domestic. Because of this the construction and technology of garment and footwear of special purpose have specific features. The level of deterioration of uppers materials are determined by physical activity, which in turn is divided into biomechanical determined by anatomical and physiological features of a man and sanitary and hygienic properties connected to the whole or part hygroscopicity of material [3]. Any means of individual protection, regardless the end use, must be ergonomic, harmless, safe, ensure the unimpeded normal functioning of the human body during the planned period of operation.

Materials used at special purpose footwear production differs a lot from the deterioration of model footwear by character and level of exploitation deterioration and also service life. Character, terms of advent and the intensity of defects development of uppers, lining and bottom of footwear are



determined by the sorts and properties of used materials, footwear design, detail disposition and operation conditions or complex of impacts at the operation.

Russian leather, yuft of chrome style tanning or dense chrome leather of the skins of cattle are usually used for the production of external special purpose footwear details [4]. State All-Union standard 3123-78 "Leather production. Terms and definitions" picks out group of leather, which is considered as leather which is operated in severer conditions. That differs this type of leather from model, which is operated in normal nature conditions without taking into account of professional activity and condition of man. Leathers of special purpose are usually used for the production of clothes and footwear for workers of power structures, energy, oil and gas and other complexes.

Considering the operation and ergonomic characteristics of footwear, the most visible changes of area and volume of uppers take place during its operation. It is explained by the intensive mechanical influence on it. Form and sizes of foot vary during the process of work, so form and sizes of footwear are also vary. By the relying on the beams foot, bending at the phalange joints, expands in this area. At this time foot changes its location and press on the uppers details, which stretch, and then shrink.

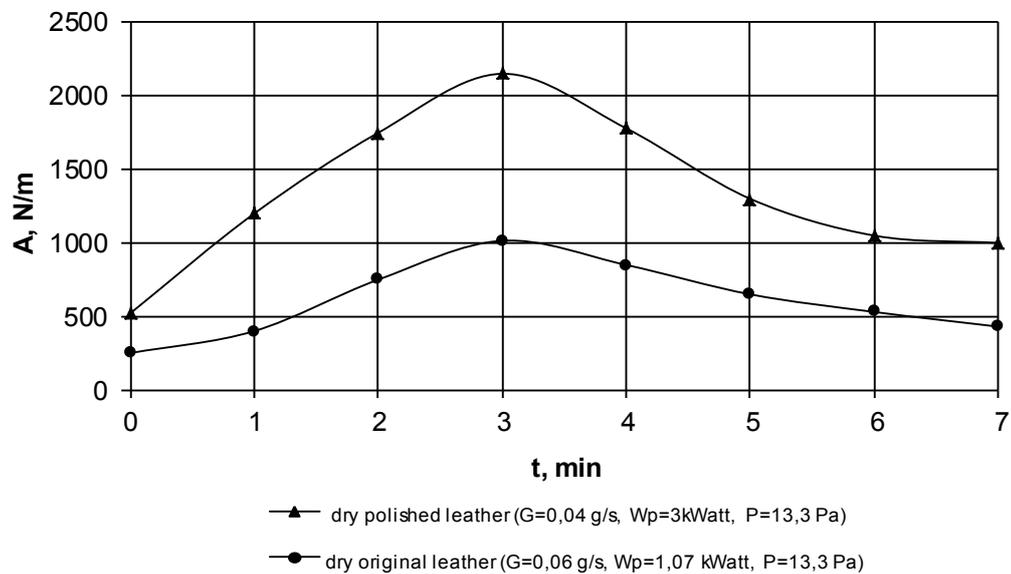
Repeated deformations promote the uppers deterioration [5]. In addition in the toe-beam part of footwear non-vanishing creases are appeared. This leads to the coating surface defects or through-holes on the uppers materials. Besides the stretches and bindings uppers details are exposed to friction, beats, punctures and other impacts.

Product quality and consumer properties of uppers materials depend on adhesion durability of coating to the leather and depend on properties of coating compositions themselves. Water-soluble polymeric film-forming agents are widely used in methods of protective and decorative finishing of materials surfaces [6]. Leather coating must satisfy the complex of properties, which are defined by the technology of its production and conditions of operation of products made of it. Coating dye, applied to the face surface of leather, penetrates to the elastic porous structure of the papillary layer and must forms the coating which joins the high elasticity with enough durability.

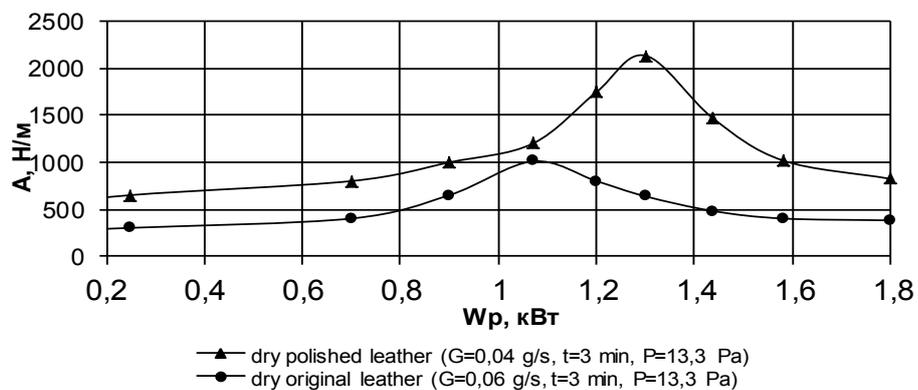
Currently, the existing manufacturing products of special purpose technology of nano-modified leather materials reached their limits. The further development of this direction to create high-quality and competitive products for special purposes can only rely on high technology. These technologies today are plasma technologies. The choice of these technologies should be made taking into account their thermal, cardinality, gas dynamic and energy characteristics [7-18]. Analysis of plasma properties showed that in order to improve the surface characteristics of the materials and increase the top coating adhesiveness and polished natural leathers in this case is the most suitable radio-frequency plasma reduced pressure [19-23].

2. Results and discussion

Polished and original leather was activated by the radio-frequency plasma (RF) of low pressure to increase surface characteristics of uppers materials and adhesion [7,8]. Modification of the coating film adhesion during the surface treatment of polished and original leather by the RF-plasma is shown in fig. 1. Coating adhesion to the leather increased in 3-4 times after the 3 minutes treatment (fig. 1(a)). Coating adhesion to the leather with origin face surface increases as the power of the charge increases up to 1.07 kWatt (fig. 1(b)); to the polished leather as the power of the charge increases up to 1.3 kWatt.



a)



b)

Fig.1. Modification of adhesion to the modified leather depending on: a) time of plasma treatment; b) charge power

To define the influence of the RF-plasma stream to the acryl film the following researches were carried out. A film without being applied to the leather was treated by the plasma.

Table 1. Coating adhesion durability to the original and polished modified leather.

| Leather type | Adhesion incensement in times | |
|--|-------------------------------|---------------|
| | Dry condition | Wet condition |
| Original leather with emulsion coating | 3,7 | 2,4 |
| | 1,5 | 1,3 |
| Polished leather with emulsion coating | 4 | 3,2 |

Plasma treatment leads not only to the modification of interaction of film and leather but also to the structure modification of the film itself. According to the data of the table 1 adhesion durability of coating film after the RF treatment for original and polished leather increased, especially in a dry condition. At the same time tensile strength was increased by 15-20%.

For the regularities research of plasma influence on the coating dying of leather mechanical indicators of leather were defined as the operational properties are one of the basic properties and characterizes quality of products and their destination. RF plasma treatment leads to the incensement of different mechanical properties of leather after applying of the emulsion coating (table 2).

Table 2. Influence of plasma treatment on the operational characteristics of leather with emulsion coating: a – polished leather, b – original leather.

| Indicators | With RF-plasma | | Without RF-plasma | |
|---|----------------|------|-------------------|------|
| | a | b | a | b |
| Tensile strength, MPa | 17,0 | 18,4 | 14,7 | 15,2 |
| The stress at cracking of an face layer, MPa | 16,2 | 17,7 | 13,9 | 14,5 |
| Elongation at tension 10 MPa, % | 35 | 35 | 36 | 37 |
| Resistance of the coating to repeated bending, points | 4 | 4 | 3 | 3 |
| Coating film adhesion, N/m | | | | |
| - to dry leather | 920 | 2433 | 230 | 656 |
| - to wet leather | 421 | 887 | 133 | 371 |
| Abrasion resistance, turns | 60 | 50 | 50 | 40 |

Tensile strength was increased by 10-20%, the strength of the front layer by 10-20%, resistance of the coating to repeated bending by 35%, abrasion resistance by 20-25% after the RF-plasma treatment.

3. Conclusions

Research results shows that RF-plasma treatment increases the adhesion of the coating film to the leather uppers and resistance to abrasion and repeated bending of uppers, which define the ability of material to preserve its consumer properties and characterize longer safety of special purpose footwear form during its wearing.

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