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Evaluation of Higienic Properties and Ecological Safety of Glove-Haberdashery Leather

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Abstract: Results of calculation of an ecological optimality of application technologies of using in chrometitanic chromealuminium, chromelyumotitanic of complex connections for receiving glove and haberdashery leather are given in the article. In semi-working conditions processes of a tanning of glove and haberdashery leather by ecologically harmless dubitel were carried out at the corresponding parameters and expenses of chemical materials. The received integrated coefficients of wastelessness of production of glove and haberdashery leather showed that offered technologies are "conditionally waste-free".

Key words: Ways of a tanning · Ecologically safe dubitel · Glove and haberdashery leather · Waste-free technologies · An ecological optimality

INTRODUCTION

At present time the problem of protecting of environment and rational exploitation of natural resources is very actual, because of intensive development of science and technique and growing human activity in all branches of vital activity as well. For a long time all industrial wastes and effluents were discharged into aquatic systems, or received in the soil without any purification and control. It was considered, that nature itself is capable to recycle dangerous wastes by the processes of self-cleaning. However, during last years the incidents of negative influence of pollution on people's health and environment caused by technogenic discharge of tannery wastewaters, exceeding standards for maximal permissible concentration, are becoming frequent.

In order to provide ecological safety of environment and leather industry the most prioritized directions should be chosen, that are renewal of materials and technologies, employment of ecologically harmless and waste-free technologies.

Ecological safety is total combination of operations, conditions and processes, which directly or indirectly do not lead to damage of environment and human being [1].

Provision of ecological safety of leather goods has two components: the first is the influence of leather material upon human ecology and the second – the influence upon environment of leather industry itself.

Solution of the first problem must be carried out according to the Technical regulations "Requirements to the safety of the products of light industry", namely of leather- haberdashery goods, providing chemical and biological safety for the life and health of the consumer [2].

According to present Technical regulations biological safety means negative influence of the finished product upon the consumer's organism, caused by discrepancy of physical and chemical properties to stated requirements for a certain type of product.

Cloth, leather haberdashery goods and footwear are in close contact with human body. It is well known, that if human body surface is considered to be 100%, then hands are nearly 4.5% and this means that gloves protect 5-20% of human body [3].

Palms are the area with the greatest concentration of sweat glands (nearly 200 per 1 sm^2). Therefore in order to provide comfort conditions in the inner space of gloves (humidity of air 65-90%, temperature 20-25°C) the

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moisture, released by human skin, should be removed, so one should not feel discomfort. Moreover, glove leather should prevent ingress of moisture on the skin from the outside with rainfall.

So, on the one hand glove leather should remove out excessive moisture from the inner space of gloves and on the other hand – protect human skin from direct interaction with moisture.

Experimental: According to the requirements, stated by Technical regulations for haberdashery goods, the evaluation of ergonomic properties, that is hygienic properties of glove- haberdashery leather, had been carried out by the methods of physical tests. Hygienic properties determine the climate in the inner space of gloves. They are characterized by waterproof, hydraulic permeability and thermal insulation properties: waterproof properties of gloves are defined by their ability not to pass water and not to get wet; hydraulic permeability properties of gloves depend on water absorption, water vapor permeability of material and degree of fitting of gloves to the hands; thermal insulation properties are characterized by thermal resistance of gloves in air-dry and wet state. Gas exchange properties are defined by gas permeability of material [4].

Qualitative organoleptic estimation of glove-haberdashery leather demonstrated that this leather had the following properties: completely tanned, with good appearance, soft to the touch, with even surface and coloration, with smooth and well processed reverse side [5-7].

Hygienic evaluation of glove- haberdashery leather had been carried out in laboratory conditions [8, 9]. The results of physical investigation of glove-haberdashery leather obtained are compiled in Table 1.

Data, represented in Table 1, indicate that glove-haberdashery leather obtained corresponds to the standard requirements by its hygienic properties.

Chemical danger is outreaching of concentration of harmful chemical compounds over permissible level. Thus, in order to evaluate chemical danger of product it is necessary to take into account the fact of conformity or exceeding of chromium content in manufactured leather. According to the standard index of present Technical regulations permissible concentration of chromium in leather goods contacting with human skin should not exceed 3.0%. Chemical analysis of glove- haberdashery leather, processed by various tanning methods, shows that chromium content in the leather processed by chromium tanning is 3.8%, that is significantly higher, than permissible level, with chromium-titanium tanning – 3.2%, with chromium-aluminum tanning – 3.2% and with chromium-aluminum-titanium tanning – 3.0%. These results show that glove- haberdashery leather, manufactured at minimal expense of chromium tanner (9.0% from raw hide mass) using ecologically harmless tanners, is harmless for human skin.

Ecological safety of manufactured leather was confirmed by chemical and toxicological tests. Evaluation of toxicity of chemical compound, namely, chromium-aluminum-titanium complex mineral compound, carried out in toxicological laboratory has shown, that this kind of tanner refers to the hazard class 4 (low hazard), flameproof and explosion-proof, so its application for production of glove- haberdashery leather is ecologically harmless [10].

So, complex mineral tanners used, being ecologically harmless compounds, do not influence human organism, namely in contact of glove-haberdashery leather with human skin.

Table 1: The results of physical tests of glove- haberdashery leather, produced from domestic rabbit pelts

The name of quality index	Standard index	Experimental sample
Thickness, mm	0.4-1.2	1.2
Humidity, %	12-18	16
Hygroscopicity, % (16 hours later)	35-65	42
Water permeability, ml/cm^2*h		
In static conditions	1-4.5	1.5
In dynamic conditions	10-45	35
Water absorption, % (24 hours later)	Not less than 60	52
Water permeability, %		
After 2 hours	30-40	32
After 24 hours	20-65	56
Water vapor permeability, mg/cm^2*h	0.5-11.6	8.6
Air permeability, m3/m^2*sec	0.005-0.01	0.01
Thermal conductivity, W/m*0C	0.06-0.22	0.08

Requirement of ecological cleanliness in the establishment of enterprises is dictated by the necessity of minimal negative influence upon the components of environment. Numerous ecological studies have shown that building of waste water treatment plants can not prevent pollution of objects of hydrosphere totally. Great number of various compounds, which are necessary for human society, are consumed and processed with formation of large amount of wastes thrown out into environment. Valuable raw material in some cases is processed according to the scheme of single incomplete use, followed by dumping of its essential part with all negative effects for environment [1, 11].

Qualitative characteristics of wastewaters essentially depend on technological operations, chemical materials and kind of leather raw material. Therefore in order to reduce negative influence of wastewaters on environment it is purposeful to improve leather processing technology. So, in solution of the second problem, we suggest to use chromium saving technology, providing reducing of chromium consumption by glove-haberdashery leather tanning process without lowing of tanning effect due to the partial replacement of it by ecologically harmless titanium and aluminum mineral compounds, which in complex with chromium promote greater absorption by dermis collagen. It significantly helps to improve ecological characteristics of waste tanning solutions and to eliminate harmful influence upon environment.

The most priority direction of the development of technological problems, allowing improving of ready leather quality along with ecological situation, is application of combined tanning with ecologically harmless complex mineral tanners. Application of ecologically harmless chromium-titanium, chromium-aluminum and chromium-aluminum-titanium compounds for tanning glove-haberdashery leather provides reduction of concentration of toxic chromium in chromium containing waste water and negative influence upon environment [12, 13].

Chromium saving technology of tanning with chromium-titanium, chromium-aluminum and chromium-aluminum-titanium tanners had been carried out by partial replacement of chromium compounds, which belong to the second class of harmfulness, by less dangerous components: titanium and aluminum, belonging to the fourth class.

Application of ecologically harmless aluminum and titanium compounds in the technological process of manufacturing of leather improves its merchantable properties. But weak activity of one-component tanners brings about advantages of combination of tanners. By variation of tanner's ratio one can influence the certain properties of semi-finished products and obtain leather with appointed properties. Chromium atoms give thermal resistance, aluminum – plastic properties, titanium – fullness and shape stability. The main advantage of complex mineral tanners is their solubility and good resistance to hydrolysis. At the same time chromium concentration in spent solution in the case of application of ecologically harmless complex mineral tanners is essentially lower [14].

Soaking-liming, pre-tanning, tanning processes according to the elaborated technology of manufacturing of glove- haberdashery leather with the application of chromium-titanium, chromium-aluminum and chromium-aluminum-titanium tanning methods under corresponding conditions and chemical material expense have been carried out at the tannery, as well as dying-fatliquoring processes, according to standard method of glove-haberdashery leather manufacturing.

Experiments conducted allowed to establish, that physical-mechanical properties of glove- haberdashery leather meet standard requirements for glove-haberdashery leather and have the following differences: chromium0titanium tanned leather overcomes chromium tanned one in strength index; chromium-aluminum tanned leather – in elongation rate, chromium-aluminum-titanium tanned leather – in strength and plastic-elastic indices.

Application of ecologically harmless complex compounds intensifies tanning effect, structuring of the dermis, skin resistance to water, sweat and mold. Leather quality is improved, process duration is decreased, production cost is reduced and utilization of raw material is improved.

At the same time complex of reorganization measures, namely, purposeful and economical use of leather raw material and elaboration of low-waste technology should be undertaken.

At present time according to the resolution of EEC UN and "Declaration on low-waste and non-waste technology and utilization of wastes" the term "non-waste technology" is interpreted as follows: "Non-waste technology is practical application of knowledge, methods and means in order to provide the most rational utilization of natural resources and energy and to defend environment within the needs of the people' [15].

The main principle of non-waste technology is organization of technological cycles with maximal extraction and utilization of all components of initial raw material with minimal quantity of all kinds of wastes and ejections [16].

Ecological optimality of technological process is defined by the level of wastelessness, taking into account the scale of consumption of natural resources, mass of wastes placed in the environment and risk index [10].

Calculation of ecological optimality of chromium-titanium, chromium-aluminum and chromium-aluminum-titanium tanning technology

The integral coefficient of wastelessness is calculated by the formula:

$$k_{\xi} = k_m * k_e \quad (1)$$

where k_m- is the completeness of the use of raw materials index;

k_e - is ecological index.

The completeness of the use of raw materials index is defined according to the formula:

$$k_m = \frac{\sum G_i \cdot \left(V_p - V_o\right)}{\sum G_i V_p} \quad (2)$$

where G_i - is the actual consumption of i-resource components per 1 unit of the product.

$$G_i = \frac{1}{p} \quad (3)$$

where p- is the impoverishment degree of the solution,

V_p - is production volume

$$V_p = m_d * d \quad (4)$$

where,

m_d - Is the mass of the tanner,

d - Is the impoverishment degree of the tanner;

V_o - Is the volume of utilized wastes:

$$V_o = V_p \,.\, P_i \quad (5)$$

where P_i - is the index of the relative risk of the waste. Ecological index is defined by the formula:

$$k_e = 1 - k_o \quad (6)$$

where k_o - is capacity index for wastes

Capacity index for wastes is calculated according to:

Table 2: The results of calculation of integral coefficients of wastelessness of glove- haberdashery leather production technology

	Coefficient values			
Tanning method	Km	Ko	Ke	Kξ
Chromium-titanium	0.9417	0.0201	0.9799	0.9228
Chromium-aluminum	0.9474	0.0149	0.9851	0.9333
Chromium-aluminum-titanium	0.9577	0.0226	0.9774	0.9361

$$k_o = \frac{\sum V_i P_i}{\sum G_i V_i} \quad (7)$$

where V_i - is the volume of the utilized i-kind of waste, placed in the environment;

$$V_i = (m_d \,.\, 0{,}20 - V_o) \quad (8)$$

where 0,20 – is the maximal degree of absorption of chromium oxide in chromium tanning technology.

In the cases, when k_{ξ} = 0,9 – 1,0 the technology is regarded as “relatively non-waste” and “low-waste” when k_{ξ} = 0,7 – 0,9 [10].

The results of calculations of ecological optimality of chromium-titanium, chromium-aluminum and chromium-aluminum-titanium tanning technology are compiled in Table 2.

So, the results of calculations show, that the technologies, based on the application of ecologically harmless chromium-titanium, chromium-aluminum and chromium-aluminum-titanium complexes, are “conditionally non-waste”, because integral coefficients of watelessness of production for pointed compounds are within the interval 0.9-1.0 [17].

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