ASSESSMENT OF THE INFLUENCE OF GLOVE AND HABERDASHERY SKIN PRODUCTION TECHNOLOGY ON THE ENVIRONMENT

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ABSTRACT. Results of calculation of ecological optimality for application technologies of using chrome-aluminium, chrome-titanium, chrome-aluminium-titanium of complex compounds for production of glove and haberdashery leather are given in the article. In semi-working conditions tanning processes of glove and haberdashery leather by ecologically harmless tanner were carried out at the corresponding parameters and expenses of chemical materials. The received integrated coefficients of waste lessen of production of glove and haberdashery leather showed that offered technologies are "conventionally waste-free".

KEY WORDS: glove and haberdashery leather, ways of tanning, ecologically safe tanner, waste-free technologies

EVALUAREA INFLUENȚEI ASUPRA MEDIULUI A TEHNOLOGIEI DE PRODUCȚIE A MĂNUȘILOR ȘI ALTOR OBIECTE DE GALANTERIE DIN PIELE

REZUMAT. Articolul prezintă rezultatele calculului nivelului optim din punct de vedere ecologic pentru aplicarea tehnologiilor de utilizare a compușilor complecși de crom-aluminiu, crom-titan, crom-aluminiu-titan la obținerea pieilor pentru mănuși și alte obiecte de galanterie. În condiții de semi-operabilitate, s-au realizat procese de tăbăcire ecologică a pieilor pentru mănuși și alte obiecte de galanterie, la parametri corespunzători și cu cheltuielile aferente materialelor chimice. Coeficienții integrați ai producției de piele pentru mănuși și alte obiecte de galanterie cu nivel redus de deșeuri au arătat că tehnologiile prezentate sunt „fără deșeuri generate în mod convențional".

CUVINTE CHEIE: piele pentru mănuși și obiecte de galanterie, metode de tăbăcire, tăbăcărie ecologică, tehnologii fără deșeuri

ÉVALUATION DE L'INFLUENCE ENVIRONNEMENTALE DES TECHNOLOGIES DE PRODUCTION DES GANTS ET AUTRES ARTICLES EN CUIR

RÉSUMÉ. L'article présente les résultats du calcul du niveau optimal d'un point de vue écologique pour l'application de technologies pour l'utilisation de composés complexes de chrome-aluminium, chrome-titane, chrome-aluminium-titane dans l'obtention de cuir pour les gants et autres articles de mercerie. Dans des conditions semi-professionnelles, des processus de tannage écologique du cuir pour les gants et autres articles de mercerie ont été effectués, à des paramètres appropriés et aux dépenses liées aux matières chimiques. Les coefficients intégrés de production de cuir pour les gants et autres articles de mercerie à faible gaspillage ont montré que les technologies présentées sont « conventionnellement sans déchets ».

MOTS CLÉS : cuir pour gants et mercerie, méthodes de tannage, tannage écologique, technologies sans déchets

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INTRODUCTION

For practical realization of main principles of ecological safety, numerical estimation of the influence of proposed technologies upon the environment should be carried out.

The solution of this problem can be obtained through technical-ecological and ecological-economical estimation of technologies [1, 2]. Material balance of glove-haberdashery leather production, represented on Figure 1, is used for calculation of technical-ecological and ecological-economical indices of technological cycle [3-5].

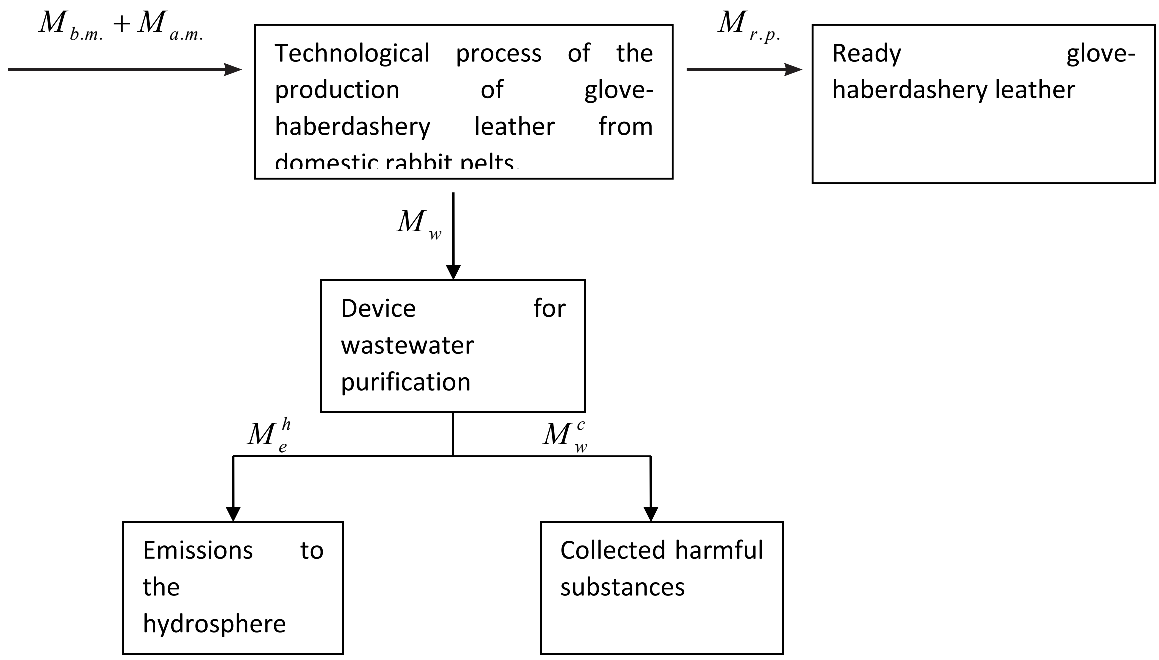

Figure 1. The scheme of the technological process of glove-haberdashery leather production

In terms of environmental defense technology, material balance of the production of glove- haberdashery leather has the following form:

$$M_{b.m.} + M_{a.m.} = M_{r.p.} + M_w \tag{1}$$

$$M_w = M_w^c + M_e^h, \tag{2}$$

where $M_{b.m.}$ and $M_{a.m.}$ are masses of basic raw material and auxiliary materials;

$M_{r.p.}$ – mass of ready product;

M_w – total mass of wastes;

M_w^c – mass of collected wastes;

M_e^h – mass of wastes, discharged into hydrosphere.

Equation (1) takes into account capture coefficient of device for wastewater purification:

$$M_{b.m.} + M_{a.m.} = M_{r.p.} + M_e^h(1-\zeta_r) + \zeta_r M_e^h \tag{3}$$

K_{ef} is introduced for evaluation of the influence of glove-haberdashery leather production technology upon the environment.

For quantitative evaluation of the treatment facilities of waste processing technology of glove- haberdashery leather production, the following coefficients are introduced: K_{pc} – is the coefficient of exploitation of productive capacity; K_{rm} – is the coefficient of complete use of raw materials; G_f, G_p – are actual and design capacity of the production cycle, consequently.

Technical-ecological coefficient, characterizing the level of rational functioning of technological process, is the following:

$$K = K_{pc} * K_{rm} * K_{ef} \quad (4)$$

For glove-haberdashery leather production process the coefficient of exploitation of productive capacity is $K_{pc} \rightarrow 1$, the coefficient of complete use of raw materials, characterizing technological output of leather $K_{rm} \langle 1$. The coefficient, characterizing the level of the influence of technological process upon environment, is $K_{ef} \rightarrow 1$. So, technical-ecological coefficient, characterizing the level of rational functioning of glove-haberdashery leather production technology, is less than 1. Physical meaning of K points out the level of rational exploitation of natural resources [6].

In order to evaluate ecological-economical level of glove-haberdashery leather production the following coefficient is introduced:

$$R = K * E_n, \quad (5)$$

where E_n – is nature protection expenditures (tg) per one unit of product.

EXPERIMENTAL

Materials and Methods

Environmental and economic sense of R is to express the specific proportion of all rational costs for production of one unit of glove-haberdashery leather. This method of calculation puts on equal economic status realization of nature protection measures and technological engineering works as well. The increase of nature protection measures expense should be limited by economic conditions and directly related to the minimal level of profitability of technological process (optimal expense), because its deviation entails changes in technological process. Initial data for calculation of K and R coefficients are represented in Table 1.

Table 1: Data for calculation of technical-economic and ecological-economic indices of functioning of technological process

Index	Unit of measurement	Value
Production volume:		
• Projected, G_p	dm^2	20.0
• Actual, G_f		19.3
Nature protection expenditures per one unit of product, En	tg/unit of product	0.23
Consumptions:		
• of basic raw material, $M_{b.m.}$	kg	
• of auxiliary materials, $M_{a.m}$	(unit)	1.5
Mass of ready product, $M_{r.p.}$	kg (unit)	1.2
Total mass of wastes:		
• mass of collected wastes, M^c_w	kg	0.21
• mass of wastes, discharged into hydrosphere, M^h_e	kg	0.09

The results of calculation of technical-economic and ecological-economic indices of functioning of technological process are presented in Table 2.

Table 2: Results of calculation of K and R coefficients

Coefficient	Value
Coefficient of exploitation of productive capacity, K_{pc}	0.965
Coefficient of complete use of raw materials, K_{rm}	0.8
Coefficient of the influence of technological process upon the environment, K_{ef}	0.9
Coefficient of collection of harmful substances: in water, ζ_g	0.7
Coefficient, characterizing technical-ecological level of functioning of technological process, K	0.695
Coefficient, characterizing ecological-economic level of functioning of technological process, R	0.160

Human industrial activity results in negative influence upon the environment, which consists in certain qualitative and quantitative anthropogenic changes. One of the main sources providing a large negative effect on hydrosphere is wastewater of leather industry. Large-scale industrial water consumption makes the problems of protection of water quality in natural pools and rational exploitation of water resources to be the most actual national economic problem. In order to prevent further environmental degradation, it is necessary to provide measures for protection and science-based rational exploitation of natural resources. These problems have been reflected in public policy, incorporated in the environmental code of the republic of Kazakhstan and in the law "About environmental protection", in the Concept of ecological safety, supported by a system of laws and normative-technical documents [7, 8].

Characteristic feature of leather enterprises is great consumption of water and therefore large volume of wastewater. Wastewater of leather industry belongs to the group of particularly ecologically hazardous wastes because of the presence of various toxic chemical substances in high concentrations [9].

Reduction of environmental loading of nature (namely, natural waters) is possible by improving the existing system of quality criteria of environment. When assessing the impact of the technology on the environment, ecosystem response to the proposed technological solutions should be taken into account. Environmental response on the technogenic emissions can be demonstrated by integral evaluation.

In glove-haberdashery leather production tanning is regarded the most ecologically dangerous process because of the use of chemical substances. Therefore, ecological safety of technological process is evaluated by the index of ecological safety of tanning method:

$$K_{ies} = \frac{\varphi^a}{m}, \qquad (6)$$

where φ^a – is the background, or a threshold response;

m – the change of environmental state.

RESULTS AND DISCUSSIONS

Based on this method of calculation of pollution influence upon hydrosphere, taking into account the maximal allowable concentrations and integral criteria of ecological safety, the mechanism of environmental response on technogenic emissions is discussed on the example of the tannery «TarazKozhObuv».

Using characteristics of wastewater of an enterprise, reduced concentration of harmful substances, discharged by the tannery into a common sewer system, is estimated.

In this case the calculation is carried out with respect to the concentration of suspended solids, formed in the chromium and combined tanning processes, according to the formula:

$$C_p^f = C_1^f + C_2^f \frac{MPC_1}{MPC_2} + C_3^f \frac{MPC_1}{MPC_3} + \ldots + C_n^f \frac{MPC_1}{MPC_n}, \qquad (7)$$

where MPC is maximal permissible concentration.

According to the data obtained from «TarazKozhObuv», actual reduced concentration of harmful substances, discharged by the tannery into a common sewer system, has been determined.

Formula (7) allows calculating ecological safety coefficient for chromium tanning technology, $K_{ies} = 0.9$ and for complex mineral tanner, $K_{ies} = 0.8$

According to Figure 2, demonstrating the dependence of coefficient of ecological safety index on

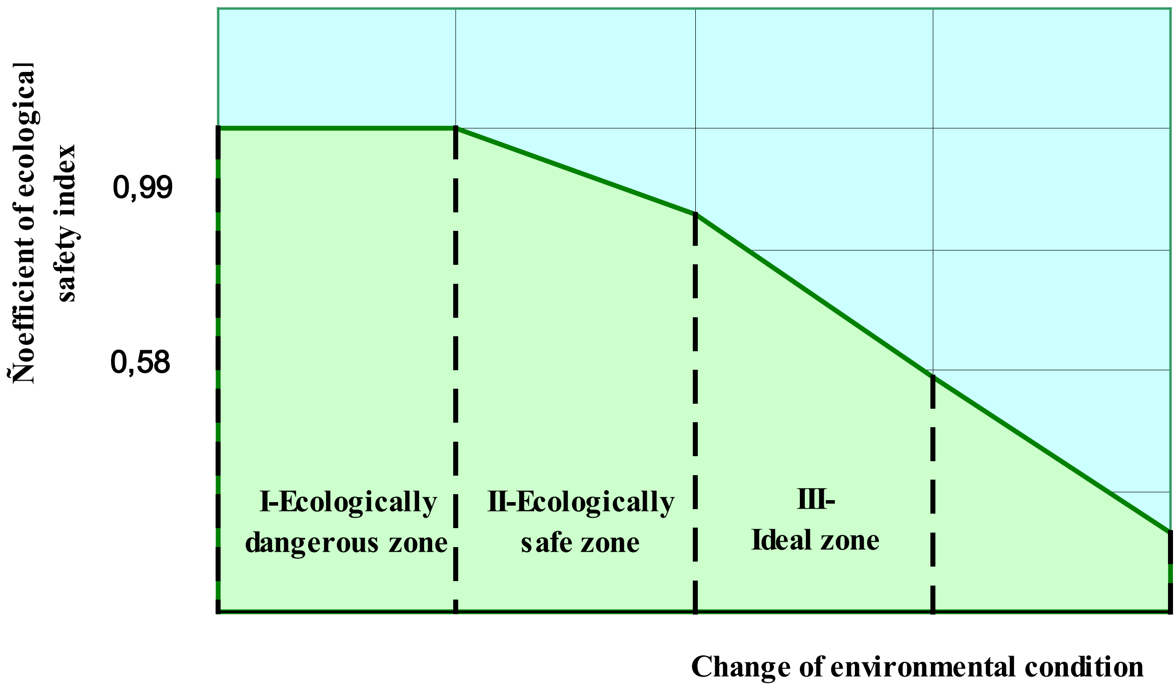

Figure 2. Dependence of K_{ies} on the value of change of environmental condition (m)

the value of change of environmental condition, we can conclude that water bodies receiving wastewater are environmentally friendly for the reduced value of the concentration of harmful substances for combined tanning.

Waste liquids after tanning are locally purified in contact reservoirs at chromium sedimentation station, discharged into the waste storage and then bypassed into the secondary ponds (filtration fields).

Based on the characteristics of tannery wastes the pollution level, excess of the level of contamination and the value of decreasing coefficient for ground water are estimated.

The level of environmental contamination (namely, ground water) by harmful substances in the concentrations, exceeding maximal permissible concentration, is calculated by formula:

$$d_i = \frac{C_i}{MPC_i} , \qquad (8)$$

where d_i – the level of pollution by i-substance

MPC_i - maximal permissible concentration of i - substance, mg/l.

To determine the level of contamination, exceeding maximal permissible concentration, the following formula is used:

$$\Delta d_i = d_i - 1 , \qquad (9)$$

where Δd_i – is exceeding of pollution level by i-polluting substance over maximal permissible concentration

The final stage is calculation by the following formula the total level of contamination of ground waters, taking into account coefficients of equal efficiency:

$$d_w = 1 + \sum_{i=1}^{n} \alpha_i * \Delta d_i , \qquad (10)$$

where α_i – is the coefficient of equal efficiency for i-contaminant

n – is the number of contaminants.

The results of contamination level, exceeding of pollution level and values of decreasing coefficients for ground waters, are presented in Table 3.

Table 3: Calculation results of water contamination level, exceeding maximal permissible concentration, and values of decreasing coefficients for ground waters

Method of tanning	Parameter		
	The contamination level of ground waters	Exceeding of pollution level of maximal permissible concentration	Decreasing coefficient
chromium tanning	dCr=2.74	ΔdCr=1.74	K_w=0.7
combined tanning	dCr=1.2 dTi=1.2 dAl=1.25	ΔdCr=0.28 ΔdTi=0.2 ΔdAl=0.25	K_w=0.9

The results obtained show that ground waters are susceptible to contamination by chromium tanning of glove-haberdashery leather (K_w=0.7) to a greater extent than by combined (chromium-aluminum) tanning (K_w=0.9).

Change of chromium content in waste solutions, when using complex chromium-titanium, chromium-aluminum and chromium-aluminum-titanium tanners are discussed on the basis of material balance of tanning process.

Application of complex mineral compounds for tanning will reduce chromium content in waste solution due to partial replacement by ecologically harmless tanning metals and due to greater absorption of complexes by dermis collagen as well, so chromium oxide content in the solution will reduce: in chromium-titanium – for 10.9 times; chromium-aluminum – for 10.1 times; chromium-aluminum-titanium – for 21.2 times.

In present technology in order to settle chromium compounds, waste solutions after tanning are mixed with the general flow of industrial waters in the ratio 1:15-20. For example, in «TarazKozhObuv» over 8000 m^3 of wastes instead of 400 m^3 are treated every day. Base cost of wastewater treatment to existing technology is 1.26 tg/m^3, and to propose technology base cost of purification from chromium compounds will be 0.252-0.126 tg/m^3 due to the decrease of wastewater volume in 5-10 times.

Calculation and comparison of expenses for waste disposal for existing and proposed technologies are carried out in the following order:

1. For existing technology total quantity of chromium compounds (in terms of Cr_2O_3) in wastewater of «TarazKozhObuv» is as follows

$m_{Cr_2O_3} = 4{,}01\ tones$;

2. Parameter of relative aggressiveness ($A_{Cr_2O_3}$) of Cr_2O_3 is defined on the base of maximal permissible concentration – 0,5 vg/l,

$A_{Cr_2O_3} = 2$;

3. Reduced mass of chromium oxide, polluting environment, $M_{Cr_2O3} = 8.02$ (conventional tones);

4. The value of pollution damage ($D_{Cr_2O_3}$) of environment by chromium compounds,

$D_{Cr_2O_3} = 100891{,}6$ (tenge);

5. Standard payment for storage (S) of wastes, for which processing technologies are available, but there is no production capacity, $S_{Cr_2O_3} = 2190955$ (tenge per tonne);

The rate of payment for the storage of waste, for the processing of which there are technologies, but necessary production capacities are not available, $S_{Cr_2O_3} = 2190955$ (tenge / t);

6. Value of payments (P) for accommodation (storage, disposal) of wastes

$M^{n}_{Cr_2O_3} = 3{,}6892$, $P_{Cr_2O_3} = 8082871$.

CONCLUSIONS

Expected savings for the proposed technology of accommodation (storage, disposal) of wastes are: for chromium-titanium (concentration of chromium compounds 47.2%) – 4267.8 thousand tenge; chromium-aluminum (concentration of chromium compounds 56.8%) – 3491.8 thousand tenge and chromium-aluminum-titanium (concentration of chromium compounds 33.4%) – 5383.2 thousand tenge.

Tannery is one of the main polluters because of the use of chromium compounds, thereby, ecological problem should be solved by the development of environmentally friendly leather technology by introducing chromium saving technology, based on the use of ecologically harmless complex mineral tanners, providing conformity of chromium content with its maximal permissible concentration in wastewater, and through the elaboration of ecologically harmless, resource saving “conventionally waste-free” technologies of rational and complex utilization of natural resources, providing completeness of their processing and diminishing of wastes, followed by the discharge of harmful substances in the environment.

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