DETERMINATION OF THE TOXICITY INDEX OF TEXTILE MATERIALS

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Abstract: This article provides information on determining the toxicity indicators of textile materials using the AT-05 analyzer and comparing the results with standard values, as well as calculating the significance of the difference in average sample values

Keywords: Green Space, Aral Sea Tragedy, Energy, Paint and Make-up, Toxicity Index.

Environmental protection is a pressing issue in the world. In particular, it is proposed to declare 2025 as the “Year of Environmental Protection and “Green” Economy” in Uzbekistan. It is noted that not only Uzbekistan, but also many countries in the world are clearly feeling the negative consequences of climate change. Air and water pollution, soil erosion, desertification, and excessive use of fossil fuels are leading to global warming, an increase in natural disasters, and harming the environment and public health. In response, the country launched the “Green Space” nationwide project three years ago. Together with other countries, the Regional Climate Strategy was launched. The Central Asian University for Environmental and Climate Change Studies was established in Tashkent. Uzbekistan also initiated two important resolutions adopted by the United Nations in this regard. At the same time, it was noted that “green” energy is becoming one of the drivers of our economy. This program emphasizes the need to prioritize issues such as the introduction of “green” technologies, water conservation, a sharp increase in green areas, mitigating the consequences of the Aral Sea tragedy, solving the waste problem, and most importantly, improving public health [1].

It is known that textile materials undergo dyeing and finishing stages, as a result of which toxic substances may remain in the fabrics, data on the toxicity of some dyes have been confirmed by research and recommendations for toxicological control have been given [2].

In world practice, several thousand individual dyes and several hundred textile chemical auxiliaries are used in the finishing of textile products, including alkalis, acids, salts, oxidizing agents, organic solvents, reducing agents, organic and inorganic substances, low and high molecular weight compounds. It follows that they represent a set of chemical compounds belonging to different hazard classes and, accordingly, can be a source of harmful effects on the human body [3], as a result of which the human body is observed to manifest itself in the form of redness, skin damage, suffocation, weakness, dizziness, memory loss, nausea.

The problem of the safety of textile materials used for special clothing remains relevant today, since chemical fibers and yarns are used in the production of textile clothing, and in addition, special clothing is treated with various chemicals to give it fire resistance, oil, water resistance, flame retardant, electrostatic and other properties.

During the wearing of the product, migration of chemical compounds occurs in the air gap formed between the clothing and the body. As a result, harmful substances are released and enter the human body through the respiratory tract (adsorption through the respiratory tract) and through the skin, which negatively affects, leading to a decrease in immunity and an increase in the number of allergic diseases [4].

In the production of various products (bedding, sheets, towels, sports and work clothes, underwear, socks, shirts, etc.), fabrics with bactericidal (Latin bacteria, Latin caedo-“to kill”) and fungicidal (Latin fungus-“fungus”, Latin caedo-“to kill”) properties are used. The substances used to disinfect such fabrics contain compounds that differ in toxicity (Latin toxicus “poisonous” or toxicity) and biological nature. In many cases, products made from such materials come into direct contact with human skin and are used by different segments of the population, including patients in medical institutions, so their safety must be assessed [5].

Toxicity is a property of a chemical substance that, when exposed to a certain amount, can cause impairment, illness, or even death. “Toxicology” is the science that studies the patterns and course of the development of the pathological process (poisoning) that occurs as a result of the effects of toxic substances on the human or animal body [6].

“Toxicity index - I_t” is related to toxic-hygienic indicators and characterizes the effect of toxic substances on living cells.

An analysis of literary sources showed that there is no single opinion on the influence of the fiber content of the material on the level of toxicity. Researchers Morilova L.V. et al. [7] argue that in order to ensure the safety of textile materials in terms of toxicity, the content of synthetic fibers should be minimal. In their opinion, the addition of even 5% polyurethane fiber increases the toxicity of the material. Studies by other scientists refute this opinion [8].

As a result of studies by Pankevich D.K. et al., it was found that the relationship between the fiber content and the toxicity index is characteristic of textile materials, and the presence of a large amount of synthetic fibers increases the toxicity of the material [9].

The toxicity index of textile materials is determined according to the GOST 32075-2013 standard [10]. This standard defines methods for studying the toxicity indices of textile materials and ready-made clothing. According to the specified standard, a point sample, pieces 10 cm long along the width of the fabric, and a working sample 10x10 cm in size are taken from textile materials. If it is not possible to cut out samples from ready-made clothing, an elementary sample with a mass of 1.0±0.01 g is prepared. Experiments are performed on an AT-05 [11] type analyzer.

The AT-05 type analyzer is designed to create digital images of the objects under study, highlight the necessary objects in digital images and measure their linear dimensions for implementing toxicity assessment methods.

The use of the analyzer determines the level of toxicity of solutions and extracts in textile materials by assessing the effect of a suspension of bull spermatozoa on their mobility. The device operates in laboratory rooms with artificial conditions of air temperature from +15 to +350C and relative humidity of 80%. The test process, processing of experimental results, calculation of the toxicity index, coefficient of variation and all indicators of the experiment are carried out automatically.

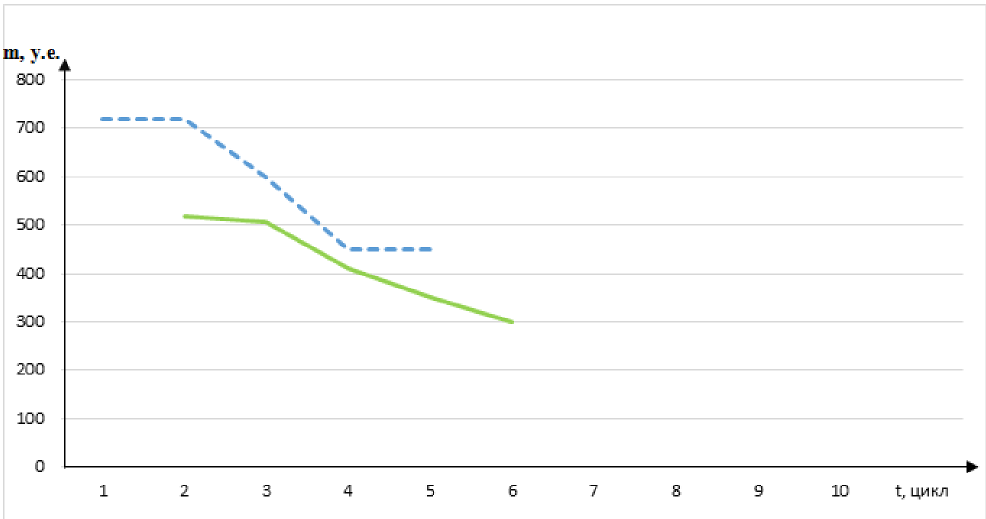
For the research work, control and experimental samples were taken from cotton fiber fabric and tested on an AT-05 type analyzer according to the GOST 32075-2013 standard. The results are presented in Table 1.

Table 1

	Control sample, conditional indicator					Experimental example, conditional indicator				
cycle	1	2	3	4	5	1	2	3	4	5
1.	871	510	727	766	762	488	505	672	384	575
2.	656	812	948	544	637	473	586	613	435	388
3.	748	446	546	370	668	565	371	581	352	302
4.	345	455	493	555	417	267	500	403	314	235
5.	528	489	391	480	373	416	307	343	218	229
$t_{o'r}$	12,6	13,1	13,1	11,3	12,7	12,7	12,0	12,7	11,8	11, 3
S	745	704	855	532	693	513	590	647	440	506
I_t, %	96					77,2				

According to the standard GOST 32075-2013, if I_t=70÷120%, it is estimated that there is no toxicity index in textile materials.

Therefore, from the analysis of the results presented in the table, it can be estimated that there is no toxicity index in the control sample and experimental samples. The graph constructed based on the results of the table is presented in Figure 1.



- control sample, - experimental sample

Figure 1. Graph of textile materials by toxicity index.

When the sample results are statistically processed, the sample's cumulative indicators are determined. The sample is considered part of the population. Their properties are evaluated according to the sample's cumulative indicators. Therefore, we calculate the guaranteed error of the cumulative indicators.

The average guaranteed error of the sample is calculated according to the following formula:

$$m_x = \frac{t\sigma}{\sqrt{n-1}} \qquad (1)$$

here: t - guaranteed level of measurement results depending on the number of measurements (table 2); σ - mean square deviation [5].

Table 2

n	3	4	5	10	20	30 and over
t	4,5	3,3	2,3	2,3	2,1	2

The average value of a batch of products x_T is calculated using the following formula:

$$x_T = x_{yp} \pm m_x; \qquad (2)$$

The mean square deviation error is calculated using the following formula:

$$m_\sigma = \frac{2\sigma}{\sqrt{2n}} \qquad (3)$$

The average squared deviation in the product group is calculated according to the following formula:

$$\sigma_T = 2 \pm m_\sigma; \qquad (4)$$

The error of quadratic unevenness is calculated according to the following formula:

$$m_C = \frac{2C}{\sqrt{2n}} \qquad (5)$$

The quadratic unevenness in the mass product is calculated according to the following formula:

$$C_T = C \pm m_c. \qquad (6)$$

It is necessary to compare the product sizes of two different options using the guaranteed criterion of t_1, average value differences. In case of a large number of measurements (n>30), the criterion is calculated using the following formula:

$$t_1 = \frac{\lfloor x_{1'p} - x_{2'p} \rfloor}{\sqrt{\sigma_1^2/n_1 + \sigma_2^2/n_2}}, \qquad (7)$$

where: x_{1yp} and x_{2yp} are the average size of each two samples; σ_1 and σ_2 - mean square deviation; n_1 and n_2 - the number of measurements.

If there are $t = 2$ or more in the calculation results, then it can be confirmed that their average values are different from the average distribution of 955 out of 1000 according to the normal distribution, that is, the difference of the averages is $/x_{1o'r} - x_{2o'r}/$ significant and guaranteed. If it is $t_1 \geq 3{,}29$, the difference in means is close to 100 percent. The calculation results are presented in Table 3.

Table 3

Indicators	m_X	$x_{T_{o'r}}$	m_σ	σ_T	m_C	C_T	t_1
Control sample	706	706±6	4	12,6±4	4	14,7±4	
Experience is an example	545	545±5	3	12,1±3	4	14,7±4	

$$t_1 = \frac{\lfloor x_{1'p} - x_{2'p} \rfloor}{\sqrt{\sigma_1^2/n_1 + \sigma_2^2/n_2}} = \frac{706-545}{\sqrt{\frac{12,6^2}{25}} + \sqrt{\frac{12,1^2}{25}}} = \frac{161}{4,9} = 33$$

Conclusion: since the difference between the means of two different groups of samples is 1, it is close to 100%, which is considered significant.

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