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Safety of Goods from Polymer Composites: Organizational and Methodological Aspects

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The factors affecting the increase in the chemical danger of goods from polymer composites on the example of furniture made of laminated chipboards and medium density fiberboards are considered in the article. The limits of formaldehyde concentration growth due to the deviation of operating conditions from the standard parameters modeled in order to verify the product safety requirements are shown.

Keywords: chemical safety, furniture made of laminated chipboards and medium density fiberboards, information for consumers.

The basic mission of technical regulation – to ensure safety of Russian citizens from threats to life and health – is carried out by the adoption of safety requirements at different stages of the product life cycle in technical regulations (TR) and declaring obligatory following these requirements for manufacturers and others who place the products on the market. To ensure consumer safety during the products operation it is not only necessary for the product to meet TR requirements, but also to provide all information about the rules and conditions of its safe use.

The magnitude of risk to life and health of the consumer is determined by the degree of conformity of the requirements related to technical regulations standards to hygienic standards, as well as the actual conditions of the goods usage. The urgency of the problem and some practical aspects of ensuring consumers safety will be considered on the example of furniture.

The technical regulations of the Customs Union (CU) "Furniture Safety" declares that full compliance of the rules of normal use provide mechanical, chemical, fire and electrical safety of furniture products. The TR specifies two conditions obligatory for the furniture chemical safety:

1. Mandatory sanitary-epidemiological and hygienic evaluation of polymer composites used in the manufacture of furniture, as well as finished products for compliance with "General sanitary-

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epidemiological and hygienic requirements for products subject to sanitary-epidemiological supervision (control).

2. The presence of protective and decorative coatings on the surfaces of furniture parts made of derived timber products.

The specific requirements for product safety and testing methods are established in international and national CU member countries` standards, inter-related with the developed TR.

However, in our opinion, neither in the document nor in the relevant standards due attention is given to the rules of furniture normal usage which ensures its chemical safety.

The discussion of the TR by the experts in the field of word-processing industry in professional literature has also shown that with the TR entry into force the main problem for the industry will be to ensure chemical safety of furniture, primarily by the level of formaldehyde emission [1].

It is known that formaldehyde has toxic effects. It irritates the eyes, mucous membranes and respiratory tracts. It causes headaches and nausea, occurrence of immunopathologic reactions. International Agency for Research on Cancer (IARC) has classified formaldehyde in Group 2A. The agent (mixture) may be classified in this category when it is potentially carcinogenic to humans on the basis of strong evidence [2].

In our opinion the problem of furniture chemical safety, taking into account the level of formaldehyde emission, has the following organizational and methodological aspects:

1. The possibility of deviation of operating conditions from the modeled parameters of testing chemical safety of furniture and wood-based panels.

The levels of chemicals released into the air from furniture and wood products, are defined according to the GOST 30255-95 "Furniture, wood and polymeric materials. The method to determine formaldehyde emission and other harmful volatile substances in climate chambers", which assumes providing three main parameters during the test:

air temperature – (23 ± 2) ºC ;

relative humidity – (45 ± 5) %;

air change – 1 ± 0.1 volume per hour.

To test modular furniture (wardrobes, tables, etc.) as well as wood materials, the saturation of the camera makes 1 м^2 of the surface area of a product or a sample plate for 1 м^3 of volume.

Primary formaldehyde – found in laminated chipboards (LCB) during their manufacture, fills the air spaces between the wood particles. It diffuses to the surface of the plate through the complex system of internal pores, and then comes into the air. For formaldehyde this process is stretched out over time because of the low permeability of protective and decorative coatings (laminations). Gradually its content in the plates reduces, but the destruction of carbamide-formaldehyde resin with formaldehyde emission extends over the entire life cycle of products, especially at elevated temperature and humidity of the environment.

The research of chipboard samples by chamber method has shown [3] that at +23 ºC increase in relative humidity from 45 to 70, and 90% causes an increase in formaldehyde emissions, respectively, 1.4 and 1.6 times. A similar increase in relative humidity, while the temperature rises to +30 ºC entails 1,9 and 2.4 times increase of formaldehyde content in the air.

It is shown that with the multiplicity of air changes less than 0.5 volume per hour the equilibrium concentration of formaldehyde in the room comes in 14-16 hours, the approximation of the multiplicity

of air changes to 1 volume per hour is accompanied by a 3 times decrease in the equilibrium concentration of formaldehyde.

Consequently, furniture and laminated chipboard panels, which confirmed the chemical safety in the tests under standard conditions, may release more formaldehyde than Maximum Permissible Concentration (MPC) in a real-life operation, if the temperature and humidity conditions, air or space saturation with surfaces of wood materials are different from the simulated values for the relevant parameters.

2. The difference of formaldehyde emission standards:

– in Hygienic Standards 2.1.6.1338-03 "Maximum Permissible Concentration of pollutants in the air of populated areas," the daily average Maximum Permissible Concentration of formaldehyde for atmospheric air of populated areas should make 0.003 mg/m³;
– for the purposes of the sanitary-chemical evaluation of furniture according to the GOST 16371-93 "Furniture. General technical conditions", as well as in accordance with the General sanitary-epidemiological and hygienic requirements for goods subject to sanitary-epidemiological supervision (control) Maximum Permissible Concentration of formaldehyde released into the indoor air during furniture usage should make 0.01 mg/m³;
– for the sanitary-chemical evaluation of laminated chipboards (LCB) – the basic material in a modern furniture production – in the GOST R 52078-2003 "Chipboard plates coated with films based on thermo reactive polymers" the rate of formaldehyde emission for the E1 grade plates should make not more than 0.124 mg/m³.

Taking into account the identity of the standard conditions used to test furniture products and LCB samples in climatic chambers, it is not clear how it is possible to manufacture furniture which release not more than 0.01 mg/m³ formaldehyde into the indoor air with E1 grade panels (with the norm of formaldehyde emissions to 0.124 mg/m³).

The existence of the considered factors necessitates monitoring of indoor air in order to assess chemical risks to the furniture consumer in real conditions of its operation.

24 school class rooms in different districts of Krasnoyarsk where the life of the furniture made from 2 to 18 months at the beginning of the experiment were selected as the object of the study. The class rooms were equipped with desks and bookshelves made of LCB, student chairs with seats and backs bent from solid Medium Density Fiberboards manufactured by dry felting (MDF), foiled with synthetic veneer. All series of measurements were carried out in the heating season – under comparable conditions of temperature (22 ± 3 ºC) and humidity (45 ± 5%) in all the class rooms surveyed.

Given the relatively low level of saturation of the rooms with furniture (0.41-0.55 m²/m³) and compliance with the parameters of temperature and humidity to the standard values, the insufficient ventilation has the greatest negative impact on the composition of air in the class rooms. To assess this effect the most typical adverse operating conditions of two types were simulated in the experiments.

In the conditions of the first type the concentration of formaldehyde in the classrooms after 12-15 hours without ventilation was measured. Such situation is typical to the beginning of morning classes and may be regarded as critical, i.e. the most dangerous because of the accumulated concentration of formaldehyde for the night period without ventilation.

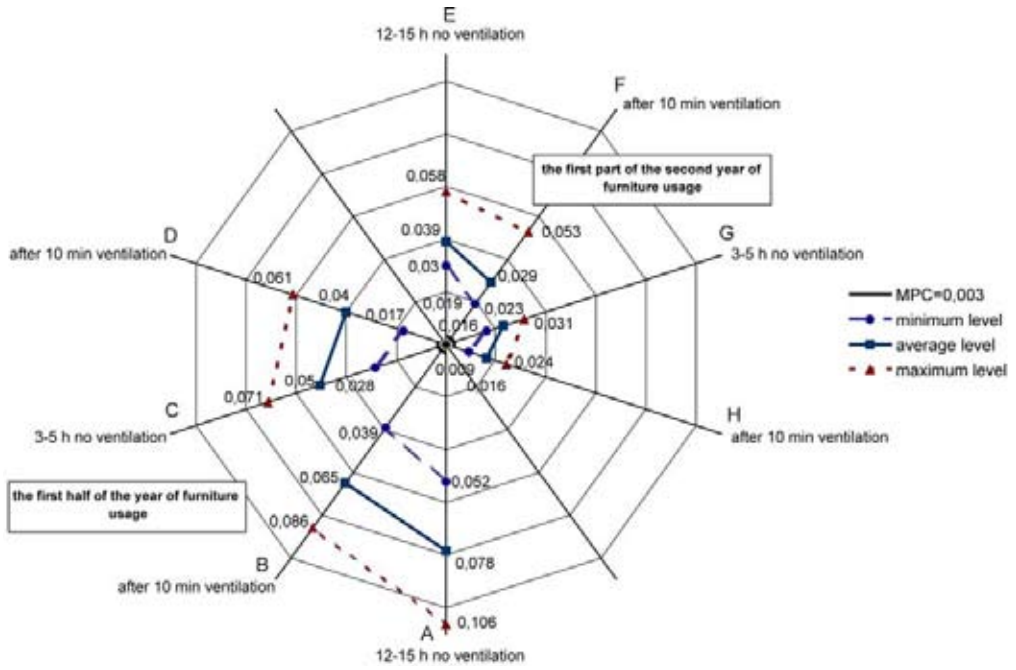

Fig. 1. Dynamics of the concentration of formaldehyde in the air of classrooms in different experimental conditions, mg/m³

The second type of operating conditions simulates the danger of formaldehyde accumulation in the classrooms that are not ventilated for 3-5 hours, when they are not ventilated during the breaks between classes.

In the models of both types after the first air sampling there was 10-minute intensive ventilation and the concentration of formaldehyde was measured again using the method of photometric analysis according to the GOST 30255-95.

The results of air samples tests for formaldehyde content (Fig. 1) clearly demonstrate the influence of the prolonged absence of ventilation in the rooms and the life of the furniture on this indicator. In the first half of the year in conditions when there is no ventilation for 12-15 hours the maximum value of formaldehyde content in the air makes 0.106 mg/m³, the minimum value – 0.052 mg/m³, and an average value – 0.078 mg/m³ which reaches 26 times excess of MPC (beam A in Fig. 1) for the atmospheric air of populated areas – 0.003 mg/m³. After 10 minutes ventilation the concentration of formaldehyde decreases and makes from 0.039 to 0.086 mg/m³ (beam B in Fig. 1) – an average to 22 MPC (0.065 mg/m³). Such multiple excess of hygienic standards constitute a serious threat to the normal state of health for people staying in the rooms with new furniture made of wood for a long time.

The survey of teachers showed that with the detected concentrations of formaldehyde they do not feel unpleasant smell and have no concerns about the chemical composition of air. Accordingly, the motivation for airing is not actual pollution, but the temperature rise over its comfort level +23 ... +25 ºC.

Even in the case of less prolonged absence of air change – 3 to 5 hours – in a series of experiments, the formaldehyde content in the classrooms ranged from 0.028 to 0.071 mg/m³ (beam C in Fig. 1) the

average value of formaldehyde 17 times exceeded MPC (0.050 mg/m³). After 10 minutes through ventilation the concentration of formaldehyde in the classrooms tested decreased and reached 0.017-0.061 mg/m³ (beam D in Fig. 1), reduced it an average to 13 MPC (0.040 mg/m³).

In the first part of the second year of furniture usage the situation with formaldehyde pollution is markedly improved, but it is still far from hygienic norms. So the maximum 12-15 hours lack of ventilation showed 9-19 times excess of MPC (0.030-0.058 mg/m³), concentration of the toxicant makes an average 13 MPC (beam E in Fig. 1). After 10 minutes through ventilation the concentration of formaldehyde in the classrooms tested decreased and reached 0.019-0.053 mg/m³ (3-18 MPC) (beam F in Fig. 1).

With 3-5 hours absence of forced air change concentration of formaldehyde in the classrooms tested ranged from 0.016 to 0.031 mg/m³ (5-10 MPC), and the average content of formaldehyde in the air reached 8 MPC (beam G in Fig. 1). After 10 minutes through ventilation concentration of formaldehyde in the classrooms tested decreased and reached 0.009-0.024 mg/m³ (3-8 MPC) (beam H in Fig. 1).

According to TR "Furniture Safety" rules and conditions for safe product operation should be specified in the instruction manual. They should focus on the use of a product for its intended purpose taking into account the allowable loads and protection of the furniture surfaces from water and temperatures above +40 ºC.

In our opinion, it is necessary to specify the microclimate parameters (temperature, relative humidity and air change), as well as the saturation of the room with furniture, ensuring its chemical safety. The absence of the requirement to provide such information in TR, in essence, leads to violation of consumers' rights. They are deprived of the opportunity to obtain all necessary information about the conditions of the product safe operation, and as a consequence can systematically take risks for their health and wellness.

References

1. Technical Regulations of the Customs Union 025/2012 "Safety of furniture products" [Electronic resource]: the decision of the Eurasian Economic Commission Council of. 15.06.2012 № 32. Mode of access: ConsultantPlus.

2. Pylev L.N. Monographs of International Agency for Research on Cancer (IARC) to evaluate the carcinogenic risk of chemicals to humans // Toxicology Gazette. 1997. № 1. P. 32-33.

3. GOST R ISO 16000-2-2007. Air in closed space. Part 2. The sampling for formaldehyde content. Basic principles. – Entry into force. 01.10.2007. M.: Standartinform, 2008. 19 p.

Организационно-методические аспекты обеспечения безопасности эксплуатации полимерсодержащих потребительских товаров

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Рассмотрены факторы, влияющие на повышение химической опасности эксплуатации товаров из полимерсодержащих материалов, на примере мебели из древесных плит. Показаны пределы роста концентрации формальдегида вследствие отклонения типовых условий эксплуатации изделий от стандартных значений параметров, моделируемых для подтверждения соответствия продукции требованиям безопасности.

Ключевые слова: химическая безопасность, мебель из древесных композиционных материалов, информация для потребителей.