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THE ANALYSIS OF ENVIRONMENTAL STATE OF VARIOUS-PURPOSE OBJECTS IN CASE OF THEIR ILLUMINATION WITH MERCURY CONTAINING SOURCES OF LIGHT

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Abstract. *The aim of the article is to analyze the hazard for humans in case of mercury light sources destruction. We investigated the objects, lightened with discharge light sources, and examined their environmental state.*

Keywords: human health hazard; demercurization; mercury; mercury light sources.

1. Introduction

Crisis processes in a world energetics, deepened in the last decades, rapid growth of energy sources cost, have forced humans to develop and apply new energy-saving technologies intensively. Indeed, energy conservation has become one of the prior directions of governmental policy at the legal level in many countries, including Ukraine. Since 1 January 2009 the Ukrainian government has prohibited to buy incandescent lamps for budget organizations and obliged the directors of enterprises and organizations to use only energy-saving discharge lamps for working rooms illumination according to governmental order of October 16th, 2008 N1337-p "On Application Measures For the Decreasing Power Consumption By Budget Organizations".

In the case of artificial light sources usage in rooms it is necessary to provide favorable hygienic conditions for eye work as well as take into account economical parameters, because insufficient illumination, unevenness of lighting in the field of vision leads to eyes tiring, decrease of working efficiency, which leads to the potential danger of wrong actions and accidents increases.

In the last years the light sources with mercury content are applied commonly in the rooms of various purposes. They are used for illumination of production facilities, industrial and domestic premises, where the nature light is insufficient, and they are also used for illumination of streets, squares, freeways, tunnels, sport facilities, storages, theaters, studios, used as decorative lighting and in the lighting advertisement.

The quantity of light sources with mercury content is already very significant and increases permanently (world production of fluorescent tube lamps approximates to 1,5 billions lamps a year).

Although the mercury mass in the light source is relatively small (e.g., to 5 mg in the compact lamp), certain part of discharge light sources is broken in the processes of exploitation, transportation, storage and utilization. In particular this pertains to luminescent lamps with discharge tube reaching 1.5 m and more.

The luminescent lamps are applied mostly in the premises, because in case of low ambient temperature their functioning is very unreliable or they are not working at all.

In Ukraine the amount of compact luminescent lamps increases every year. Now their quantity reaches 12–14 millions, but only up to 20 % are utilized [1, 5]. For example, the quantity of these lamps, which are already worked their resource, reaches over 500 thousand only in Kyiv, according to the data of State Department of Environmental Safety, and their solid storage raises the great concern.

In Poltava about 300 thousand gas-discharge lamps need immediate utilization every year, only 40 % of them belong to enterprises, which are controlled by regional Department of Natural Resources.

In Chernihiv the great dump of wasted luminescent lamps was revealed at the territory of former music instruments facility. Almost all of them are broken.

The total quantity of wasted mercury lamps, which are referred to 1st hazard class and located at the enterprises territories, is 1,7 millions. 495,8 thousand of them or 29 % is on the Donetsk oblast territory, 181,8 thousand (11 %) – on the Zhytomyr oblast, 124,5 thousand (7 %) – Sumy oblast, 122.8 thousand (7 %) – Rivno oblast, 101.6 thousand (6 %) – Zaporizhzhia oblast, 94,2 thousand (6 %) – Mykolaiv oblast, 78,5 thousand (5 %) – Kirovograd oblast, 140,2 thousand (8 %) – on Kyiv territory and 13 thousand are stored in Ternopil oblast (fig. 1).

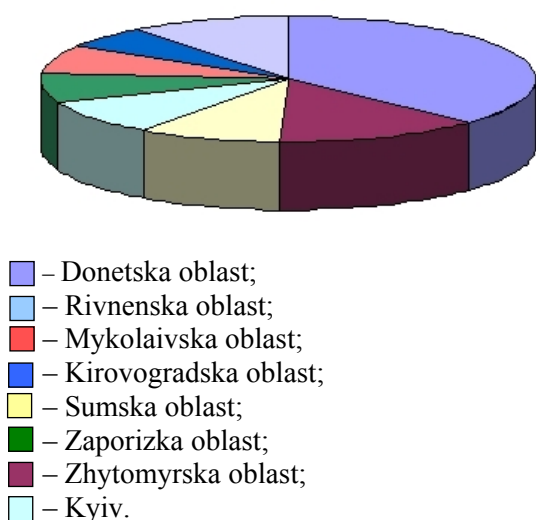


Fig. 1. Quantity of wasted mercury lamps at the territory of Ukraine

According to the certificates data the light mercury high pressure lamps, which are luminescent and mercury high pressure lamps with similar arc discharge lamp, the content of mercury is 0,03–0,09 % and they are not the material for product mercury, although the demercurization of 10 million of mercury lamps allows to get more than 1 ton of mercury. According to the requirements of current standard DSTU 3211–95 “Non-Ferrous Metals And Alloys Scrap And Waste” and point 3.1.1.10 of the standard “Mercury And Its Compounds” the utilization of wastes with mercury content under 0,3 % is not provided and is not profitable, so in most cases the products with mercury content are sent to the unorganized dumps and aren’t utilized.

Mercury is known to have increased pressure of saturated vapors even under normal conditions and it evaporates at high rate, which is growing with temperature growth, so in case of mercury containing device destruction the hazardous mercury atmosphere is formed imposing threat for living organisms. The ordinary room cleaning doesn’t solve the problem; on the contrary it worsens the situation, because the mercury comes into neighboring rooms and contaminates them. As a result of mercury evaporation, the mercury of broken lamps easily spreads over vast populated areas and often contaminates them to impermissible levels [2, 6].

It should be noted that danger of mercury migration and also poisoning of living organisms with mercury increases significantly due to peculiar physical and chemical features of metal mercury,

since mercury is characterized with high volatility and stability in the environment, it dissolves in precipitations, it is absorbed by soil and green plantations. It penetrates relatively easy through building materials (various concretes and solutions, construction boards, ruberoid, linoleum, mastic, painted surfaces), and it is also well adsorbed by plaster, carpets, textiles (especially with cotton), fur fabrics, shoes and hair. Metal mercury is broken into little drops after spill due to high surface tension, spreading to various surfaces; it easily penetrates into fissures of building, increasing the area of contamination.

The threat of mercury poisoning is enhanced, because human sense organs can’t feel the presence of mercury vapors in the air. Exactly this factor is the cause of chronic intoxication and micromercurialism in humans, staying in contaminated industrial premises for long periods. The chronic poisoning is increasingly diagnosed in people, working for long periods (sometimes during a few years) in premises, where air contains insignificant content of mercury vapors [3, 4].

Excessive use of mercury and their compounds, mercury containing devices, especially mercury lamps, and absence of control systems have lead to the situation when mercury contamination of various rooms appears everywhere.

Practically, almost 20 % buildings of school and preschool institutions in any city are characterized with the presence of local sources of indoor air contamination with mercury. In big industrial cities the mercury contamination is defined for 30–35 % of schools and 25–30 % of kindergartens [7].

Unbroken (undepressurize) discharge light sources with mercury content are known to be absolutely safe for humans, but very often some part of discharge light sources are broken in the rooms with workers: during room repair, substitution of lamps, unorganized storage of lamps in cellars and in storages. Although mercury mass in discharge light sources is relatively small, the danger of possible destructions of these light sources, especially luminescent lamps, which number reaches millions of units in industrial premises, is significant. Some part of discharge light sources is broken due to imprudence and simply negligent treatment, low efficiency of utilization system and often because of almost full irresponsibility for violation of exploitation instructions for mercury containing light sources.

Thus, conducted analysis shows that the requirements to lamps storage stipulated by GOST № 23216-78 and № 26834-83 aren’t implemented in

corpora almost everywhere in Ukraine. From year to year decreasing quantity of wasted luminescent lamps is sent for utilization that leads to mercury contamination of many rooms.

2. Problem statement

The aim and task of this work is to study mercury contaminations dynamics at the objects, illuminated with discharge light sources and the analysis of their environmental condition.

3. The solution of stated task

The results of mercury contamination levels study in certain premises in Kyiv region are given below. The studies were conducted from 2010 to 2013. We used the gaseous mercury analyzer АПТІ – 01М. The total number of inspected objects exceeds 200, 120 of them are schools, kindergartens and high educational establishments, 40 – industrial premises and recreational facilities, 40 – entrances of residential buildings. The compulsory objects of schools examination were cabinets of physics, chemistry, medical cabinet, auxillary premises. On the floors the samples have been taken in the halls (usually 2–3 points per floor). In preschool institutions the bedrooms, locker rooms, medical cabinet and auxillary premises have been obligatory checked.

The sampling was conducted at 0.2 m altitude from the floor surface. Not less than 3 measurements were conducted in every sample point for mercury concentration determination. Examination was made in the premises with closed doors and windows. The rooms have not been aerated for one hour before examination, if their area is over 50 m³ – for three hours. Air temperature in the investigated rooms was not lower than 18°C, the relative humidity of air – not higher than 90 %.

The conducted study resulted in definition of a range of objects, where mercury vapors concentration exceeded the limit allowable concentration (LAC) tens times. In particular, contamination has been detected in the kindergartens, industrial premises and private institutions (fig. 2). The highest level of contamination has been detected in the institutions, where the repair works with lamps demounting had been recently conducted. It clearly proves that mercury contamination of premises has appeared as a result of mercury income from broken luminescent lamps.

The survey conducted with the substantial number of the representatives of different occupational groups revealed that the vast majority of them has lack of knowledge about danger for

people from the destroyed discharge light sources, and about necessity of their recycling according to the strictly established rules.

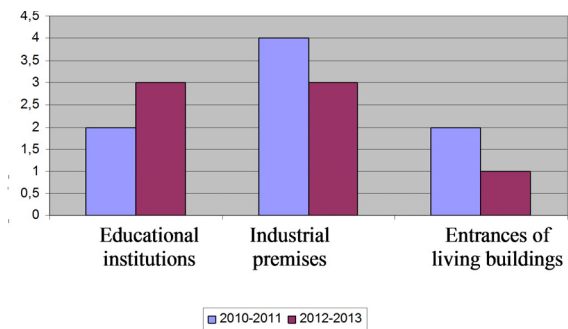


Fig. 2. Balance of mercury vapors concentration in relation to LAC in various purposes objects during 2001–2013

For example, out of over 3'000 students of National Aviation University interviewed before starting the course "Occupational health and safety" only 24 (less than 1 % of respondents) knew that the luminescent lamps contain mercury, and that it is unacceptable to destroy those lamps within the premises.

4. Conclusion

The study and the analysis of received and explored data show that application of discharge light sources with mercury content leads to appearance of numerous sites with excessive level of mercury contamination because of frequent destruction of this lamps in the premises. In most cases mercury contaminated sites has been revealed in the premises after repair works and it clearly shows that exactly broken discharge light sources are the cause of occupational mercury health hazard appearance.

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Т.І. Дмитруха. Аналіз екологічного стану об'єктів різного призначення в разі їх освітлення джерелами світла зі вмістом ртуті

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У статті проаналізовано небезпеку для людей у разі руйнування ртутних джерел світла. Проведено дослідження динаміки ртутних забруднень на об'єктах які освітлюються розрядними джерелами світла, проаналізовано екологічний стан цих об'єктів.

Ключові слова: демеркуризація; небезпека для людей; ртуть; ртутні джерела світла.

Т.І. Дмитруха. Анализ экологического состояния объектов различного назначения в случае их освещения источниками света содержащими ртуть

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В статье проанализирована опасность для людей в случае разрушения ртутных источников света. Проведены исследования динамики ртутных загрязнений на объектах которые освещаются разрядными источниками света, проанализировано экологическое состояние этих объектов.

Ключевые слова: демеркуризация; опасность для людей; ртуть; ртутные источники света.

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