SOME ASPECTS OF TECHNOGENE SAFETY AND THEIR IMPACT ON FUNCTIONING OF PUBLIC SYSTEMS

Alla BESPALOVA, Vladimir LEBEDEV, Yuri MOROZOV, Inga URIADNIKOVA

Abstract: The questions of technogenic safety are observed at the example of situation at Ukrainian Donbas. It is sown that dust generated by enterprises refers to the factors that gradually accumulate and then disrupt the human health. The greatest danger is represented by dust particles whose dimensions are 5 μm or less. The exposure time of dust particles per person depends on the settling speed of dust particles which is found from the following considerations. For calculating the time of exposure an analytical study was made. It was established that the dust that has arisen as a result of man's anthropogenic activity is deposited extremely slowly - for hours. Based on the time of dust exposure, the certain rules recommended that minimize man-caused hazards.

Keywords: technogenic safety, dust. exposure time, man-caused hazards.

1 INTRODUCTION AND STATEMENT OF THE PROBLEM

Technogenic safety is a state of protection of the population, technical systems and the environment from man-made accidents and catastrophes that cause the emergence of emergencies of anthropogenic nature.

Threats to man-made security are created at all stages of the life cycle of systems: when designing (when the project unreasonably uses potentially dangerous work processes, materials and technologies, unreasonably understated and overstated safety criteria and standards); in the manufacture of technical systems and their components (when the regulatory requirements for technological operations, input and output control of materials and finished products, testing of the development of potentially dangerous components, components and systems are not observed). During operation (with non-observable safety standards and regulations, monitoring of the technical condition of critical areas and critical elements is not carried out, flaw detection and monitoring are not carried out, compensation of increasing safety requirements for modernization and repair of technical systems). evaluates the characteristics of strength, resource, reliability, survivability of load-bearing elements of system systems for cases of normal (normal) and abnormal (emergency) situations. The generalized indicator - the criterion of man-made safety is the risk taking into account the probability of occurrence of emergencies and catastrophes and the mathematical expectation of damage from them. Methods of enhancement T. C. consist in the normatively justified adoption of constructive, technological and operational solutions for each of them, in declaring and maintaining safety at the required level, in monitoring, diagnosing and monitoring the state of technical systems, taking into account the affected and damaging factors, in the readiness of systems, operators and personnel to actions in emergency situations.

From time to time the media reports of various accidents at enterprises, on industrial and transport disasters; entire regions are declared zones of ecological disaster. In most cases, this is due to the technosphere and occurs in the technosphere.

By definition [1], the technosphere is part of the habitat, transformed by the direct and indirect effects of technical means in order to best match the socio-economic needs of mankind. Technogenic human activity is considered as a gigantic conversion system. The object of transformation of this system is the planet Earth [2, 3, 4].

If one understands the natural environment and systems created by the human being under the human environment, then the technosphere must be taken into account in the geographical envelope of the Earth. If the standards of sustainable development of the state are set in the form of indicators of the quality of life of the population and the quality of the natural environment [7], the tasks of optimizing the use of natural resources and environmental protection can not be resolved without taking into account the technogenic safety (TS) of the technosphere. The inadequacy of the situation in the provision of TS to the level of modern technology has long troubled specialists. But, in general, the emphasis was put on health and safety, which seriously hindered the formation of modern scientific ideas about TS.

Two approaches are proposed in the consideration of the category "technogenic security":

a) in the system "man-production-habitat",
b) in the "society-technosphere-natural environment" system.

A) TS in industry is the sphere of human activity, an integral system with its own logic. TS should be understood as a combination of the properties of technical means (equipment, technologies, processes) to resist the combined effects of all factors leading to deterioration in health, trauma or death of personnel, as well as to harmful effects on the natural environment. In this case, it is supposed to consider a TS system consisting of objects, subjects, processes functioning in permissible flows of matter, energy and information in some space-time dimension. With this approach to the TS system, it is expected that the theory of security and its main directions will be applied: the theory of terminal control, the theory of analytic construction of regulators, the theory of reliability, etc. In connection with TS problems, it is worthwhile to pay attention to the erroneous concept of identity of reliability theory and safety theory.

The basic concept of reliability theory is failure, and the basic concept of safety theory is an emergency situation.

As noted above, the genesis of the absolute majority of ecological problems lies precisely in the technical activity of mankind [2, 3, 4, 6]. There are two ways to ensure TS: first, prevention of violations of normal operating conditions, protection from the harmful effects of operational loads, prevention of failures and failures of operators: secondly, preventing the dangerous development of arisen violations of normal modes of operation, the exclusion of cases of overgrowth of such violations in emergency and catastrophic situations for humans and the natural environment.

Scientific activities in the field of TB must be carried out in connection with the necessary elements of socio-economic sciences.

B) With a global approach, the sphere of man-caused hazards is divided into three indicators of technogenic risks or three types [3]:

1. The threat to life and health due to accidents, up to the global catastrophe;
2. The threat to life and health due to deformation of the components of the biosphere component;
3. The threat to life and health of people due to a lack of natural resources, down to a global exhaustion.

As is known [5], the problem of sustainable development arose as a result of the analysis of the world economy of nature management.

The conducted studies [2, 3, 8, 9] show that for the solution of this problem the ecological approach, like the concept of the ecosystem or the biosphere, is unsuitable.

Then it is necessary to consider:

1. A specific global system, within which the idea of sustainable development should be realized, is the sociosphere - the sphere of mankind's productive activity [9];
2. The solution of the TS problem is (more precisely, it should be in its final form) the technological component of the problem of sustainable development [3];
3. Implementation of the concept of biotic regulation of the natural environment is impossible without solving TS problems both on a global and regional scale. And it is conceptually important to understand that due to objective reasons (population growth in the world, the desire of all to “live well”), the level of TS will determine the level of environmental safety.

Proceeding from the foregoing, technogenic safety in the “broad” (global) sense is the state of the technosphere as a practically closed technological system for utilization and reutilization of natural resources involved in economic circulation. In its final form, it is the production-economic cycles that are as much as possible isolated from natural exchange and external sources of energy. Perhaps located even outside the planet Earth. Models for the development of a global system for the transformation of integrated resources for the use of natural resources (Fedorenko N.P and Reimers N.F), and also [10] are based on the understanding of two principles: “everything is connected with everything” and “nothing is given for nothing”. The central place in the resource models is occupied by the material and energy resources of living and inanimate matter.

The source of the material, as well as a significant part of the energy resources is the lithosphere. It is simultaneously an object of influence (the operand of the transformation system) for such leading industries as chemical, petrochemical and oil refining, mining and metallurgy and fuel and energy industries of the world economy.

These same industries are also the main “pests” of the environment in the industrially developed regions of Ukraine.

If the public system functions in the form of a state, then it is the task of state bodies to create a certain multifunctional system that maintains an acceptable level of technogenic security. The higher the stability of such a system in relation to external disturbances, the higher the level of technogenic safety of society and as a derivative of this, the higher the level of national security, the component of which is technogenic security.

2 OBJECTIVE

The purpose of this work is to study some types of external disturbances that affect the state control system.

2.1 Analytical studies

It is not difficult to see that the perturbations that affect the multifunctional control system can be of two kinds. Disturbances of the first type immediately cause frustration of the system, provoking instant refusals of it work, which can lead to explosions, fires and other emergencies.

Perturbations of the second kind last for a long period of time, the negative effect of their action gradually accumulates and only after a certain period of time leads to a breakdown in the work of the entire system. Very often, disturbances of the second kind act directly on the person, causing immediate damage to his health and gradually disabling an essential component of the system as a result of which her work is disrupted and the immediate harm to the health and life of the person is inflicted not only by the effects of perturbations of the second kind, but also by the results of the disorder of the whole life support and life support systems.

If we talk about Ukraine, at the present time the amount of accumulated waste on the territory of the Donbas is especially large. Thus, more than 38 % of the disturbed lands of Ukraine are located in the Donbas. These are dumps and quarries, slime, slag storage and settling tanks, solid waste landfills, which, taking into account the adjacent territories, pollute the atmosphere on an area of more than 600 000 hectares, with combustion products at a distance of up to 3 km, and with dust up to 1 km.

Dust just refers to the disturbances of the second kind, the negative effect of the dust effect gradually accumulates and only after a certain period of time leads to the disruption of the human factor, directly damaging to its health.

The greatest danger is represented by dust particles whose dimensions are 5 μm or less. These particles have the greatest pathogenic effect on the respiratory system of the human body. In addition, the settling time of these particles is measured in hours. Thus, even after the termination of work, the risk of dust exposure to the human body remains. Insignificant time of inhalation of these particles can lead a person to disability and death.

The exposure time of dust particles per person depends on the settling speed of dust particles which is found from the following considerations.

Let us consider the so-called particle drift model. We will start from the following assumptions:

- the motion of a particle is determined by the strength of Archimedes and the strength of resistance,
- the velocity vector of the particle at the initial instant of time is parallel to the acceleration vector caused by Archimedes' force,
- there is no interaction between the particles.

We can determine the velocity of the particle within the framework of this model. Taking into account the above assumptions, the equation of motion of a single particle can be represented in the following form:

$$m\frac{dv}{dt} = -C_D\frac{pS_m}{2}|v|v + (p_p - p)V_p g \qquad (1)$$

Where v is the particle velocity, ρ_p is the density of the medium. ρ is the density of the dust particle, C_D the empirical coefficient of resistance, S_m is the cross sectional area of the particle, g is the acceleration due to gravity, and V_p is the volume of the particle.

2.2 Influence of the particle shape on the deposition rate

The shape of the particles of the dispersed phase can differ from the spherical (snowflakes, polyhedral, ellipsoids, plates, fibers, etc.).

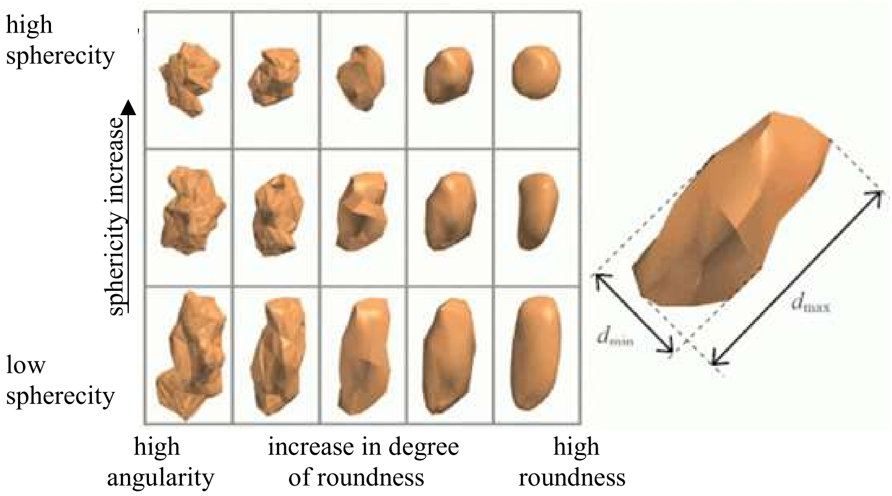


Fig. 1 The shape of the particles

Since the methods of dispersion analysis do not, in their majority, allow us fully characterize each particle of a disperse system in three dimensions, we use an approximation, in other words, the replacement of particles of real material by equivalent particles of regular geometric shape. When analyzing a particle under a microscope, its planar projection is visualized, in which case the particle can be characterized by a number of different dimensional parameters. It is important to understand that each method of determining the size is based on measuring the various physical characteristics of particles (maximum length, minimum length, volume, surface area etc.), and as a result, the sizes obtained by different methods will differ. Figure 3 shows the various options for answering the question what is the particle size. At the same time there are no erroneous results - each answer is subjectively correct - it reflects a physically measured characteristic.

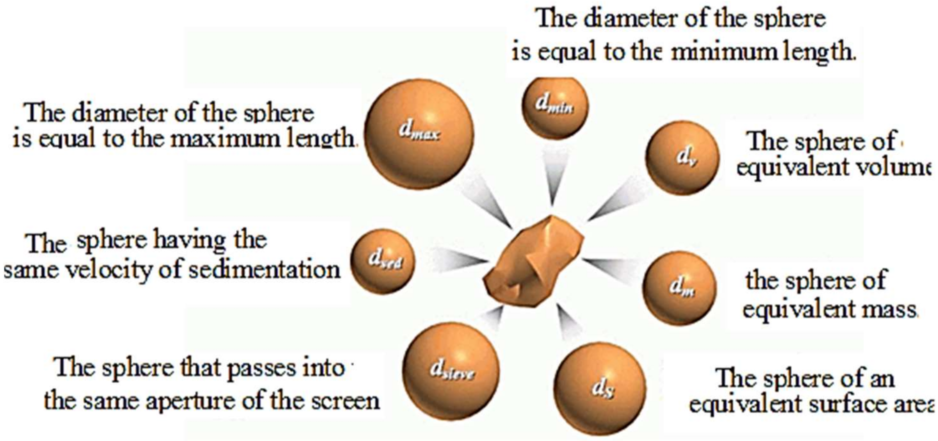
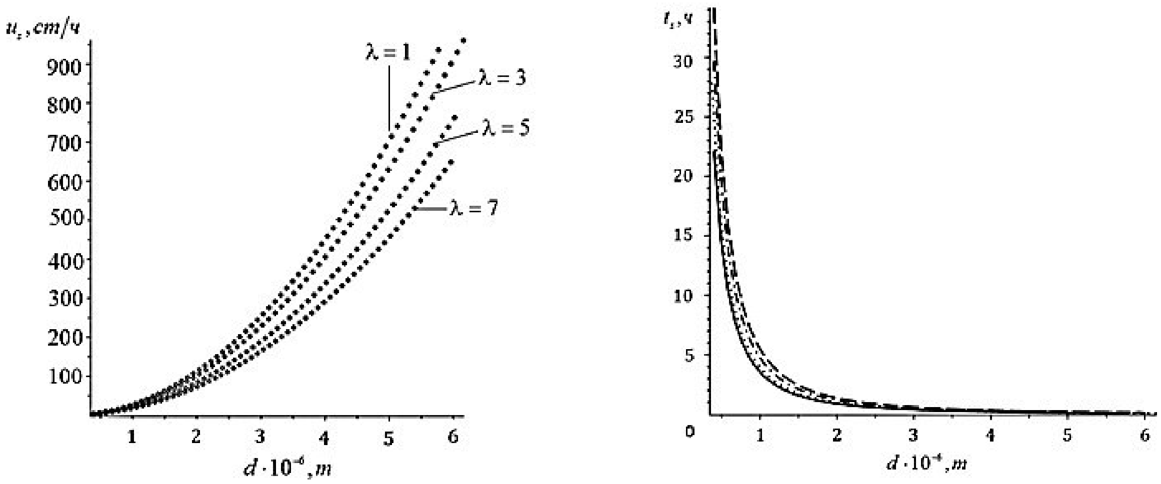


Fig. 2 Equivalent particle diameters

To calculate the motion of such particles, an equivalent diameter d_{pe} is introduced, which is equal to the diameter of a sphere with a volume V_p equal to the volume of a given particle:

If we represent the shape of a particle close to an ellipse with a large axis *a* small axis *b* and represent ellipticity as $\lambda = a / b$. then the results of calculations can be represented by the following graphs.



a) b)

Fig. 3 Dependence of the deposition rate of a particle (*a*) (cm/h) and the deposition time of a particle (hour) (*b*) on its geometric parameters

3 DISCUSSION

Analyzing the data of the graphs, it can be concluded that the dust that has arisen as a result of man's anthropogenic activity is deposited extremely slowly - for hours. If the generation of dust continues, then we have a permanent negative impact on the social system, and the negative consequences can affect for many years.

The lowest deposition rate and, consequently, the longest time in the atmosphere, have the smallest particles whose shape approximates the spherical.

4 CONCLUSIONS

Based on the example of dust exposure, it is possible to establish certain rules that minimize man-caused hazards.

1. Ensuring the permissible level of man-made risk in the „man-machine-environment" system at the local level, especially in the old industrial regions, such as the Donbass;
2. Ensuring a minimum level of impact of technogenic activity on the habitat and population on a regional scale. The main thing here:

minimization of reception of a waste; recycling and recycling of waste, emissions, discharges, i.e. provision of a production closed for materials and energy;
3. Recycling of waste that has already been accumulated; isolation and safe storage of toxic and radioactive waste;
4. State regulation and management of technogenic safety, technogenic programming. Technogenic safety must be organically built into the social and economic system of the state;
5. The scientific community should take vigorous measures to eliminate the „stains" in the education of decision makers at all levels of management of the technosphere and technogenic security in particular.

References

[1] KARMAZINOV, F. V., RUSAK, O. N. GREBENNIKOV, S. F. and others. *Security life: Dictionary-reference.* St. Petersburg : Lan, 2001. p. 254.

[2] GOLUBETS, M. A. *From the biosphere to the cosmos.* Lviv : Polly, 1997. c. 252.

[3] KHAZAN, V. B. *Technogenic security as a component of (eco) sustainable development.* Assemblage scientific works. Dnipropetrovsk : 2001. vp. 3. p. 163-167.

[4] VERNADSKY, V. I. *Reflections of the naturalist. Scientific thought as planetary phenomenon.* Moscow : Nauka, 1977. p. 51. 892.

[5] *Program of Action. Agenda for the 21^{st} century and other documents in the popular presentation.* Switzerland, Geneva : Center for Our Common future, 1993. p. 70.

[6] MOISEYEV, N. I.: *Ecological imperative.* Kommunist. 1986. No. 12. p. 110-111.

[7] SHAPAR, A. G.: *Criterias of those showing old steel rozvitku: naukovi pididi ix obgruntuvannya.* Science fiction. Dnipro-petrovsk. 2000. vip. 2 from. 8, 10.

[8] GOLUBETS, M. A.: *Living room.* Lviv, Polli : 1997. p. 186.

[9] GOLUBETS, M. A. *Some theoretical and applied aspects of sustainable development.* Selection of materials. K.: IPC of the society "Knowledge" of Ukraine. 2000. p. 27, 29.

[10] SAITOV, V. I., SOLOBOEV, I. S., CHERNYSHEV, A. A.: *Models of global system of transformation of integrated resources of nature use ...* Strategy for a way out of the global environmental crisis: Materials scientific readings. St. Petersburg : Publishing house of MANEL, 2001. p. 26-27.

[11] BASHKATOV, V. G., MARTOVITSKY, V. D.: *Environmental optimization of the technogenic environment in the Donbass.* Strategy of an exit from global ecological crisis: Materials of scientific readings. St. Petersburg : Publishing house of MANEL, 2001. p. 68-69.

[12] GRUDZIN, V. P.: *The global crisis of the Earth is the program stage of the cosmos.* Strategy for a way out of the global environmental crisis: Materials of scientific readings. St. Petersburg : Publishing house of MANEL, 2001. p. 12, 13.

[13] BEZPALOVA, A., LEBEDEV, V. *Investigation of the formation process of Hazardous and harmful production factors.* EUREKA : Physics and Engineering, 2017. Number 5.

Assoc. Prof. Alla BESPALOVA, CSc.
Odessa Academy of Construction and Architecture
str. Didrickson 4
65029 Odessa
Ukraine
E-mail: bespalova-a-v@mail.ru

Prof. Vladimir LEBEDEV, DrSc.
Odessa National Polytechnic University
Shevchenko av. 1
65044 Odessa
Ukraine
E-mail: wlebedev29@rambler.ru

Assoc. Prof. Yuri MOROZOV, CSc.
Odessa National Polytechnic University
Shevchenko av. 1
65044 Odessa
Ukraine
E-mail: morozovyu@gmail.com

Assoc. Prof. Eng. Inga URIADNIKOVA, CSc.
National University of Physical Education and Sports of Ukraine
str. Fizkultury 1
03150 Kyiv-150
Ukraine
E-mail: ingavictory@gmail.com

Prof. Vladimir Lebedev, DrSc. - was born in Odessa in 1938. The degree of Doctor of Sciences was in 1991 in the Higher Certification Commission of the USSR. For 25 years he was the Head of the Department of Materials Science and Technology of Constructional Materials at the Odessa State Academy of Refrigeration (OGAC) and the Odesa National Polytechnic University (ONPU). Currently, Professor of the Department of Materials Science and Materials Technology in ONPU. Author of more than 300 scientific works. Scientific interests is investigations of phase, structural and stressed components of the surface sprayed or welded layer on the working surface of the part during finishing grinding, in order to improve the reliability and durability of the part.

Assoc. Prof. Alla Bespalova, CSc. - was born in Odessa in 1954. Works at the Odessa State Academy of Construction and Architecture. In 2003, the degree of candidate of technical sciences was awarded by the Higher Attestation Commission of Ukraine. Since 2004, he is head of the department “Organization of Construction and Labor Protection” of the Odessa State Academy of Construction and Architecture. Author of more than 100 scientific works. Scientific interests is the technological reliability of building systems and occupational safety in construction.

Assoc. Prof. Yuri Morozov, CSc. - was born in Odessa in 1971. He has been working at the Odessa National Polytechnic University since 1999. Ph.D. in Physics degree received from the Higher Attestation Commission of Ukraine in 2000. Associate Professor of a chair of “Higher mathematics and modeling systems” since 2005. Author of more than 50 scientific papers. Scientific interests is the modeling of physical and technical systems.

Assoc. Prof. Eng. Inga Uriadnikova, CSc. - works at the National University of Physical Education and Sports of Ukraine (Kiev). Scientific interests concern the problems of managing man-made and environmental risks, energy security, human security and health and the ecology of sport. In 2001 she defended her thesis on the theme “Resource-saving technologies for heat carrier preparation for thermal power plants” where a number of ecological aspects of energy security were disclosed. She worked in a number of Ukrainian universities, as well as in a number of scientific research institutes of the Ukrainian Academy of Sciences. Scientific and pedagogical experience is more than 20 years. Currently she is an author and co-author of about 200 printed publications, including: 3 monographs (2 of which were published abroad), 15 copyright certificates and patents of Ukraine for inventions.