Проблемные статьи | **Problem Articles**

UDC (УДК) 656: 613+615+504+612

SUSTAINABLE TRANSPORT DEVELOPMENT IN THE XXI CENTURY BEGINING: HYGIENIC, TOXICOLOGICAL AND ECOLOGICAL ASPECTS

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From the standpoint of sustainable transport development it is necessary to define the place of the problem and ways of further development of transport medicine. These tasks are closely connected with the development of basic and applied sciences, reforming the health maintenance of transport workers, their reliable and safe operation. An important aspect of transport medicine is ecological because transport makes a significant impact on the environment, accounting for example about 25 % of global energy consumption and carbon dioxide emissions. Not by chance, sustainable transport will be paid a great attention to the Paris France Sustainable Innovation Forum 2015 to be held from 30 November to 11 December 2015. It will be made a new international agreement to reduce emissions into the atmosphere (COP 21) in addition to the Kyoto Protocol (CRP- eleven). Medicine Transport and in solving these problems has an important role.

Keywords: *transportation, water supply, polymeric materials, dangerous goods, environment*

Introduction

Modern transport is a complex, open, dynamic, anthropogenic, supersystem that performs communicative, productive, informational, integrative, recreational functions in all parts of the world. All kinds of activities in the transport sector are built in a strictly regulated co-ordinates of space and time. Transport is the backbone component of any social and economic system at the international, national, regional and local levels. All this is determined by its features, such as:

- Ensuring all activities of modern humans;
- Cross-border and transnational nature of the carriage of goods and passengers;
- The integration of transport systems achievements in virtually all areas of human knowledge;
- Advanced development of transport technologies and the organization of transport process;
- Participation millions of workers in the implementation and enforcement of transport process;
- Participation of almost the entire population of the Earth's inhabitants in the transport process as workers, passengers, tourists, drivers of private vehicles and pedestrians;
- The role of transport as one of the most important, and in some cases — the leading man-made pollutants [1-3].

This list can be significantly expanded. However, the above listed features (arguments) are sufficient to substantiate the relevance and explain the reasons for including the problem of sustainable transport development by UN Secretary General Ban Ki-moon as one of the six building blocks for sustainable development and challenges facing humanity in the period

after 2015 (providing the world's population with energy, food, water, as well as the protection against pollution, fisheries resources and biodiversity of the oceans) [4]. And almost all of the above mentioned tasks, regardless of their expressed substantial heterogeneity and conceptual features, in one or another way are related to the sustainable development of the transport industry. Last one, on the macro- and microlevels; have to develop ahead of the rest of science and economic activities, as it is their precondition and sometimes even obvious imperative provision.

As to the sustainable development of transport it is necessary to at least briefly highlight some of the key concepts in this global problem. First of all, we are talking about the concept of "sustainability", which has not only many definitions, but is not semantically unambiguous. That is the reason of its uncertainty, and even contradictory [5,6]. We agree with the authors [6, p. 1876], that "terminology represents an integrated framework for all related terms and serves as a basis for communication within a particular scientiыc ыeld. In addition, in sustainable development, various terms are used to describe different strategies, actions, effects, phenomena, etc. Movement from usage of inappropriate terms and unambiguous deыnitions can help us to make more rapid progress in sustainable development science and engineering".

The most frequently "sustainability" is understood as a state of the elements of any economic, environmental or other systems when their initial states reliably determine their future prospects [7]. The stability of the system — the ability to stably operate, develop and return to equilibrium, source or close to steady state after any internal or external influence. However, it is recognized, that any self-developing system periodically makes a transition from one stable state to another [8].

Like many other socio-economic system, transport is characterized by the fact that in its operation leading role played by the human factor. It involves the social relations of people in the process of consolidated transport product creation, and consumption as a link between the elements inside and outside of the system. And although in socio-economic terms, transport is characterized by a variety of features, from the hygienic positions (habitability of the movable carriers, best of life, safety of people) the most important are such as water factor, dangerous goods, polymeric materials, and from psychophysiological — professional competence and health of drivers, as well as all operators of the transport system.

All of these positions require updated approaches to their modern definition, a comprehensive assessment, the further development and improvement.

Therefore, ***the aim of this study*** was to clarify the role of the medicine of transport in the prospects for sustainable development of the transport sector on the basis of assessing the contribution of hygienic, toxicological and environmental factors, the search for the ways to optimize working conditions, habitability of mobile vehicles to maintain the health potential of transport workers and population, solving the actual problems of environment protection.

Results and discussion

The results of the last years field observations and experimental studies, a meta-analysis of the literature confirm uniformity of taking place in different parts of the world environmental changes, their depending of the influence of anthropogenic pressure, which is becoming irreversible character and global significance.

At the September 25, 2015 in New York the General Assembly of the United Nations, which comprises 193 members of the state of our planet, adopted of the new framework, "Transforming Our World: the 2030" Agenda for Sustainable Development, which is composed of 17 goals and 169 targets to wipe out poverty, fight inequality and tackle climate changes over the next 15 years [9].

At least two goals (6 and 14) in the United Nations document are directly related to the water factor, the protection of natural water from man-made pollution and the problem of providing the population with quality water. Indirectly, this issue takes on many points, because it needs to be addressed comprehensively. In this respect, it corresponds to the implementation of sustainable water supply in transport. Therefore, the analysis of this factor needs special consideration.

1. Water supply and as a prerequisite habitability and human activity factor in transport systems

The problem of providing the population with quality drinking, washing and technical (processing) water (for the smooth functioning of the sanitary and other systems, responsible for human activity and production) is one of the primary in hygienic terms, including and especially in the transport sector [10, 11]. If in the aviation and automobile transport, it is mainly limited to drinking and, to a lesser extent, of washing components, the railway and, in particular, water transport has all three components, which are complemented by the priority environmental protection (Fig. 1) . The data, presented in the figure, shows that the system is complex and multifaceted.

Almost until recently all efforts of designers, builders and hygienists focused primarily on the sources of replenishment, pipelines and water storage tanks (materials and coatings, whether cement or paint composition metals) [12,13]. It includes elements that relate to providing water factor adaptation, rehabilitation and recreational functions that goes far beyond the concept of “water supply”. This water must meet three conditions: epidemiological

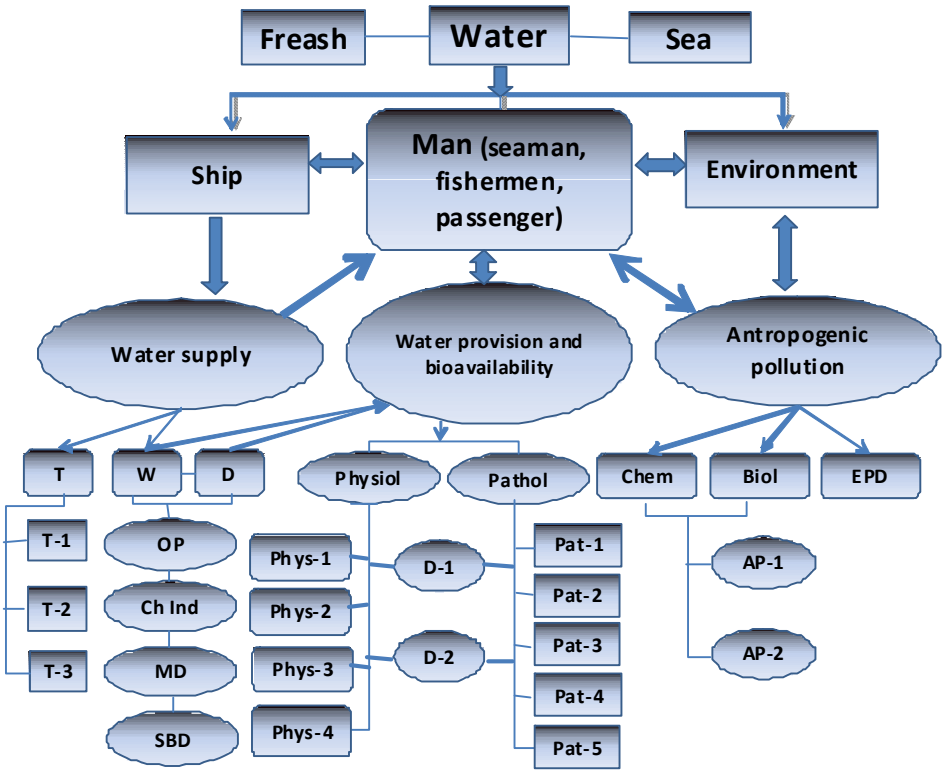

Fig. 1. The modern marine vessel water supply system

(D — drinking, W — washing, T — technical water; T-1 — ballast, T-2 — bilge water, T-3 — water for tank washing; OP — organoleptic properties, Chl — chemical indices, MD — microbial contamination, SBD — species biodiversity; Physiol — the physiological role of water: Phys-1 — health, Phys-2 — adaptation, Phys-3 — recreation, Phys-4 — rehabilitation; D-1 — disadaptation; D-2 — diseases; Pathol — pathological properties: Pat-1 — neuropsychiatric, Pat-2 — cardiovascular, Pat-3 — digestive, Pat-4 — nephrotic, Pat-5 — skin diseases; Chem — chemical — and BIOL — biological contamination: AP-1 — changes in species composition and ecological disbalance, AP-2 — risk of infectious and parasitic diseases transfer; EPD — esthetic and psychologial discomfort) .

safety, toxicological harmlessness and physiological optimality [14].

Does this means that the water supply, on the one hand, and the water provision and bioavailability on board, on the other hand, represent a challenge to sustainable transport on this criterion? Of course, no. Although measures to optimize water supply is usually more evident on productivity for many contingents of transport workers, a physiologically optimal quality and drinking regime have important adaptogenic function in terms of health, the prevention of fatigue and regulation of vital activity in the broadest sense. Unfortunately, in a number of positions and the development of poor physiological component underlies the seamen disadaptation, and a number of water factors depending diseases. The very numerous documents and programs of WHO, IMO, ISO, EU Directives aimed at optimizing the water supply. Such measures are justified primarily on the population level. With regard to the role of transport workers, physiological component of the problem greatly increases and assumes the character of an important condition for a reliable occupational activity. That is one of the most important elements to ensure, ultimately, sustainable development of the transport industry.

However, such proposals, especially the draft regulations and legislation, should be the subject to qualified scientific expertise and public discussion as a hasty, often behind the scenes decisions fraught with negative consequences for the sustainable development of the economics and public health. Unfortunately, we can cite many examples of the negative, not only for the transport sector, but also a more comprehensive global projects. So, surely, we should agree to reasonable criticism of S.H. Frisbie et al. [11], who have subjected to a detailed analysis the latest edition of the WHO Guidelines for Drinking-water Quality [15]. It removed there from, suspended or not installed or raised recommended levels for a number of inorganic toxic substances, such as manganese, molybdenum, nitrites, aluminum, boron, nickel, uranium, mercury and selenium.

Given the unlimited character of the planned WHO changes, it can be expected in the near future revision of standards for other toxic substances. Experts consider it necessary to bring together governments, scientists, practitioners and other stakeholders to prepare balanced proposals on the basis of a systemic approach and the concept of risk, taking into account the objectives of sustainable development [7]. Transportation, in this plan, can be a robust model, because there is a pronounced specificy of the transport industry and the importance of the water factor is particularly high [10].

To actively protect public health in different countries, experts proposed to use more precise data, at least, go back to the previous editions of the Guidelines for drinking-water quality, which is increasingly a global answer to the preservation of public health [16].

All this applies to the standards of drinking water transport facilities. However, it is not limited to this aspect of the problem, but also covers other, first of all environmental components. Transport is one of the pollution of natural waters due to oil spills, discharges of wastewater, ballast water treatment and engineering. If until recent time the leading water pollutant of the oceans were oil and petroleum products, discharged from ships and shore facilities [17], now the problem has expanded significantly. This is an intensive marine pollution with particulate matter, as well as plastics and their chemical components [18]. The toxic effects may be caused by human contact with contaminated water or disposal (incineration) products of plastic waste [19, 20]. Thus, ecological and hygienic problems of water quality on board of seagoing ships and in the ocean corresponds to the problem of safe use in the transport of polymeric materials. It corresponds, in particular, with use aboard ships antifouling paints [21].

2. Polymers — a new era in the creation and implementation of modern materials and in the field of vehicles construction

About 40 years ago the World Health Organization drew the attention of the national government and public organizations to the facts of the problem of the danger of plastic containers and packaging for food, containers for transportation and storage of drinking water. It is not only polymers that are in contact with water, but a general trend towards the replacement of traditional construction materials, decoration and equipment of vehicles and stationary objects industry. Plastics have transformed everyday life of the entire population of the planet. Usage is growing and the annual world production in 2010 exceeded 300 million tons. Approximately 4.0 % of world oil production is used as feedstock for the production of plastics. This is the same quantity as is used for energy generation [11]. Providing safe water and food supply of crews and passengers of aircraft and ships, railway passenger wagons, personal and public transport, even when it comes to bottled water, largely depends on the applied for this purpose polymeric materials [13]. Not by chance, more than 16 % of the synthesized annually polymers is used in transport sector (Fig. 2) .

As it can be seen from the data in the figure, the proportion of the total weight of polymers in modern vehicles reaches 20-25 % with a progressive trend towards steady growth. Moreover, the small vessels, for example, are made entirely of plastic. So, naturally, that the total weight of the synthesized and produced polymeric materials (300 million tons per year [22]) , more and more significant part in the construction of automobiles, airliners, ships and another vehicles.

Nomenclature (range) of used plastics and their ratio is extremely dynamic and, unfortunately, at the present time is not the subject of toxicological studies and hygienic assessment [23]. So, olefins are present in about 40,0, PVC — 15,0, polyamides — 12,0, polycarbonates and carbon-composites — 9,0 (ich) , — ABS-plastics 7,0, rubbers — 6,0 and other — 11 %

As it is shown by long-term studies from different laboratories, there is significant complexity of toxicological and hygienic assessment of the potential risk and a need for an integrated approach to the solution of this important in scientific and practical terms problem. Over the past two decades it has changed not only the product range, technology and application of polymers and composition made of them in the transport sector, but also the conditions and the degree of contact of people with this dangerous chemical factors. However, approaches to hygienic standards were justified in the 70-ies of the last century, as well as the laws and mechanisms of the combined effect of the components of such complex systems and are studied not enough, and many aspects are not been investigated at all. Therefore, the study of general toxic and specific effects, the cellular mechanisms of the combined action of the components, that migrate from the polymeric materials in the process of continuous operation, the justification of methods of hygienic regulation of the operation of polymeric materials in normal and

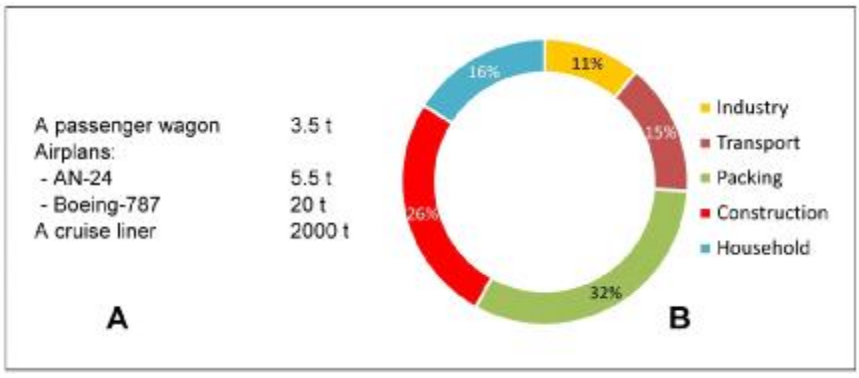

Fig. 2. Specific consumption of polymeric materials in different areas of the economy (A); amount of plastics in various vehicles (B).

emergency situations (eg, fire on board) is an actual problem of hygiene and toxicology of polymers in transport branch.

Serious concern cause some innovations in matters of hygiene regulation of polymer materials and products, primarily transportation purposes. An example is the cable production, which is known [24] as a critical link among the causes, and more than 50 % of cases of fire and the development of large-scale such kinds of emergent situations. However, in Ukraine, as in very few other countries, certification of fire hazard and, in particular, the toxicity of the combustion products of the cable production and polymer materials (its constituents) is voluntary [25]. Add to this the variety of methodological approaches to the assessment and chemical safety requirements of cable products in the countries, supplying it to the Ukrainian market, and the position of the fire risk and chemical safety acquire new meaning.

Certainly, it should be considered productive "step by step" strategy as a methodology of polymers hygiene and toxicology, which is common to the national preventive toxicology, in general, and for this direction is formulated by YS Kagan and VO Sheftel. In our laboratory, such methodology has been developed in relation to the purpose of objective polymers on transport assignment study (Fig. 3) . It allows standardizing the methods used for the purpose of examination of new materials and, simultaneously, to create materials with predetermined hygiene properties. Moreover, not only takes into account the properties of individual migrating to the environment components, but also to forecast the behavior of materials and products in normal operational and emergency situations on transport.

Using this methodology allowed for a comprehensive toxicological and hygienic assessment and promote to the transport industry hundreds of new materials. This has also contributed to the improvement of working conditions, optimizing of vehicles

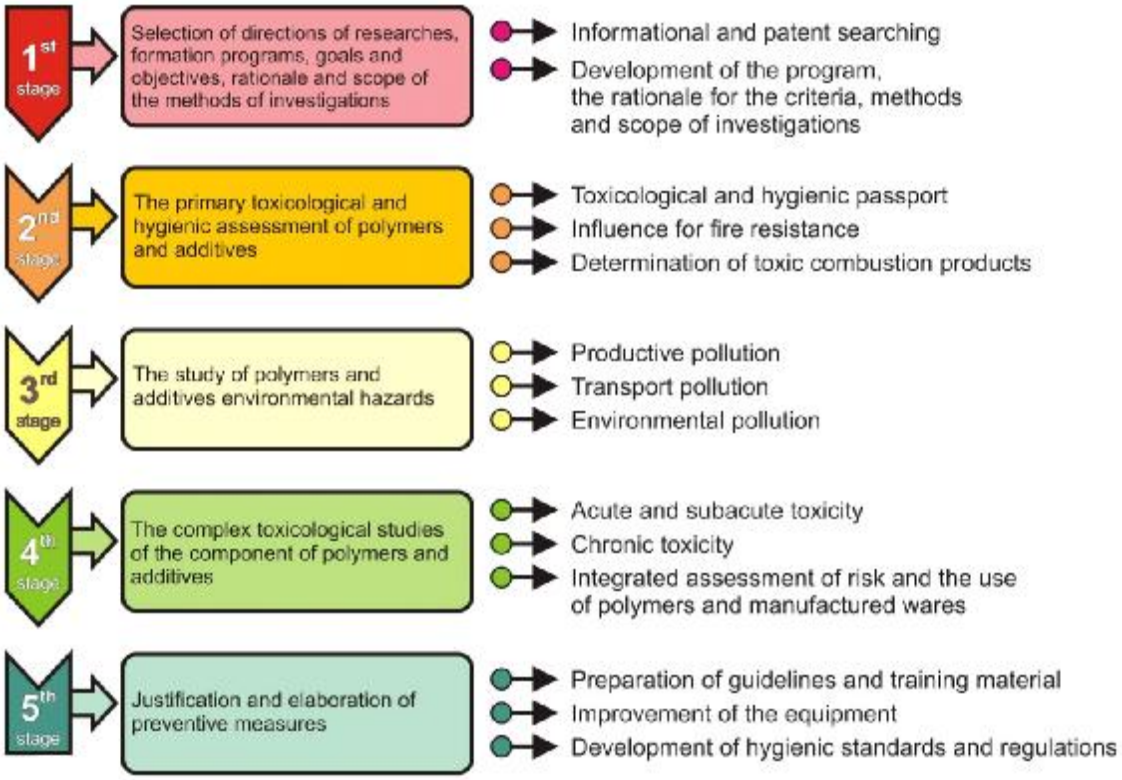

Fig. 3. The general scheme of toxicological and hygienic examinations of polymers and auxiliary substances (components) of the transport purpose

habitability and the preservation of the health of seafarers, railway workers, drivers of motor vehicles, shipbuilding repairing plants workers.

Widespread use of polymers in transportation, changes in technology and producing the composition, placing on the market of plastics derived, for example, with the use of nanoparticles, requires a change in the dominant paradigm of toxicological and hygienic safety control of large-tonnage production becomes a priority, together with the safe transport of dangerous goods.

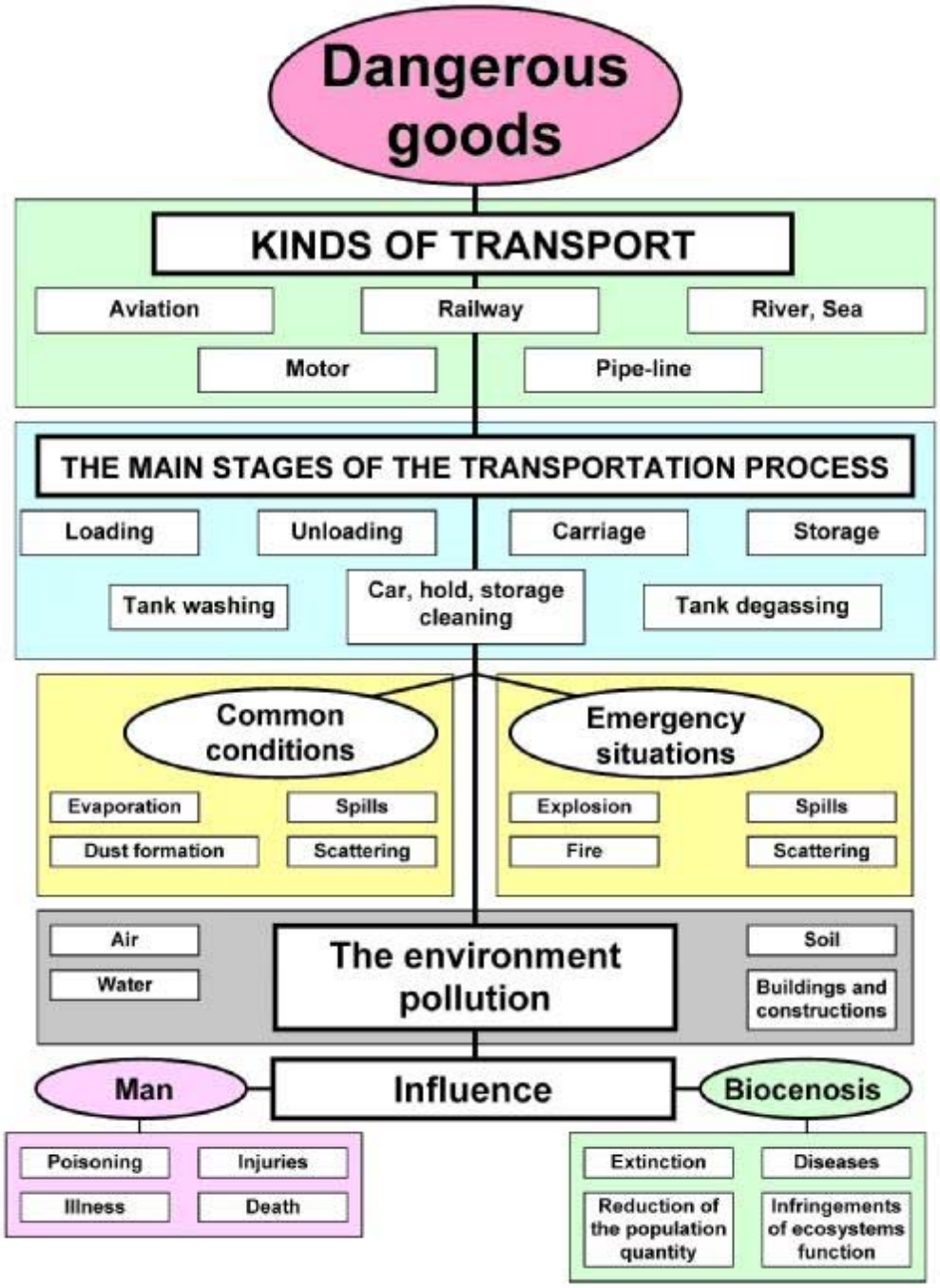

Fig. 4. Characteristics of the stages of dangerous goods transportation and the assessment of their potential impact on people health and the environment

3. Dangerous goods: a new paradigm of optimization the transportation process and security providing

The most important task of transport, along with the transportation of people (mainly passengers and tourists) , is the delivery of raw materials to processing plants and to ensure the market with finished products, i.e. transportation of goods. As it is shown by the results of author's own researches and of the analysis of hygienic aspects of the transport services market, the dangerous goods remains a leading sector for the automobile, railway communications, domestic ports and water transport on a global scale, which accounts for about 80 % of the international transport of goods. Their a potential hazard to human health and the environment illustrates the diagram in Fig. 4.

In the last few years clearly reveal two important trends in the hygienic term: on the one reversal occurs containerization as a major new technology. Transport of dangerous goods in containers, in most cases, significantly reduces the degree of danger. On the other hand, transportation of bulk cargoes in bulk significantly reduces freight rates, facilitates the current quality control, improves the efficiency of pest management supplies, including quarantine. Not coincidentally, the number of bulk carriers (ships for the transportation of goods in bulk) grows faster pace and more than 35 % in terms of tonnage in the overall composition of the marine transport fleet.

In Ukraine, a priority in this regard is the transportation of grain cargoes, especially in view of the collection of more than 60 million tons grain in 2015. Almost all exports of grain is carried by sea, as a rule, in fumigated state. This suggests the presence in the air of ship holds of phosphine, which refers to the toxicant 1st hazard class (extremely hazardous substances) [26]. However, according to the domestic legislation, fumigated goods are not classified as hazardous, even though the number of poisonings, including fatalities, they dominate in the national statistics. Occasionally, on a voluntary basis, implemented training the members of fumigation units on chemical safety, hygiene and toxicology. And other contingents, which are in contact with fumigated goods during the process of transportation, are practically out of the training. These examples are convincing arguments in favor of the implementation of national programs, realization of which will contribute to solving the problems of sustainable transport development in the national and international scale with the main task and the maximum contribution to the process of transport medicine.

Conclusion

From the standpoint of sustainable transport development it is necessary to define the place of the problem and ways of further development of transport medicine. These tasks are closely connected with the development of basic and applied sciences, reforming the health maintenance of transport workers, their reliable and safe operation. An important aspect of transport medicine is ecological because transport makes a significant impact on the environment, accounting for example about 25 % of global energy consumption and carbon dioxide emissions. Not by chance, sustainable transport will be paid a great attention to the Paris France Sustainable Innovation Forum 2015 to be held from 30 November to 11 December 2015. It will be made a new international agreement to reduce emissions into the atmosphere (COP 21) in addition to the Kyoto Protocol (CRP- eleven) . Medicine Transport and in solving these problems has an important role. The integrated circuit further development of activities and relationships medical transport is shown in Fig. 5.

Presented in Fig. 5. positions and relationships allow discover the diversity and complexity of the relationships that unite the medical, socio-economic and industrial aspects of sustainable transport. Simultaneously, they allow more clearly articulate the strategic objectives of Transport Medicine for the next decade and beyond per-

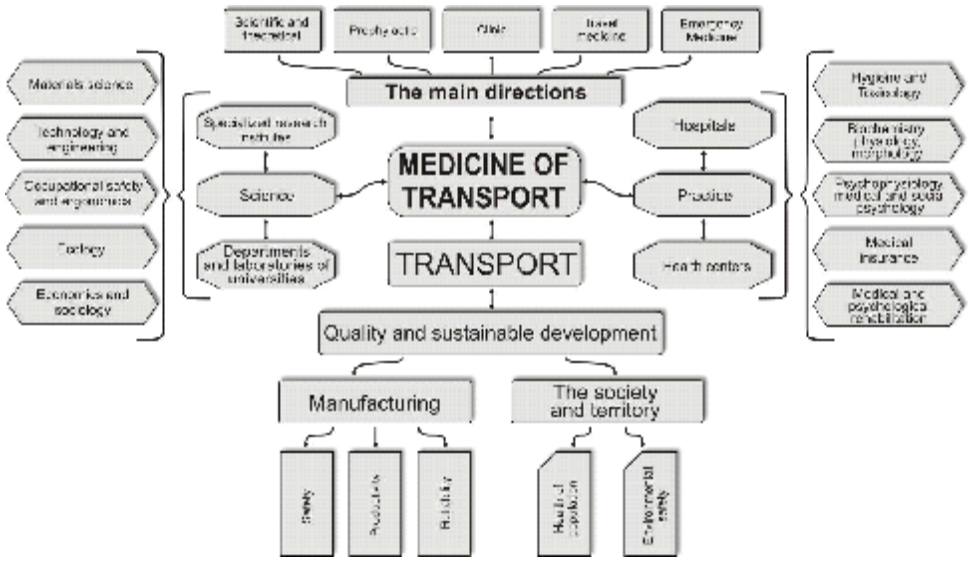

Fig. 5. Logistic Model: Medicine of transport in the sustainable development of the transport industry

spective. These include the following:

- Creating of a new concept of the transport medicine functioning in the conditions of changing the main paradigm of the organization of transport sector, taking into account different forms of ownership, the new dominant technologies of transportation of goods and passengers;
- Development of the theoretical foundations of transport medicine taking into account the characteristics of the working conditions, the labor process, regimes of work and rest of operators, persons in driving professions and other categories of transport workers for sustainable development of transport, preserving the workers health and the environment protection;
- Justification a new criterion and methodological framework of integrated dangerous goods safe transporting system using advanced technologies of chemicals, food, dusty, fumigated goods carriage under the principles of the transport toxicity;
- Establishing a system of social and hygienic monitoring, evaluation and control of occupational and environmental health risks of transport workers and people living in areas of intense transport activity;
- Improvement the epidemiological protection of borders and territory against the importation of extremely dangerous and rare tropical infectious and parasitic diseases, the hygienic control of state borders crossing by different goods, food and raw materials, and in the later stages of their itransport;
- To substantiate the hygienic, medical and physiological criteria and methods for the objective evaluation of the quality of professional training, formation and maintenance of an occupational dynamic stereotype as an integral indicator of safety, occupational health and competence of representatives of the main groups of transport workers in the secondary and higher vocational, postgraduate education, to develop the tools and methods for optimizing the learning process.

The solution to these strategic tasks allows you firmly hold the important role of transport medicine for sustainable transport development in the modern era of crisis and reformation of the industry, preserving socio-economic status of our country.

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Резюме

УСТОЙЧИВОЕ РАЗВИТИЕ ТРАНСПОРТА В НАЧАЛЕ XXI СТОЛЕТИЯ: ГИГИЕНИЧЕСКИЕ, ТОКСИКОЛОГИЧЕСКИЕ И ЭКОЛОГИЧЕСКИЕ АСПЕКТЫ

Шафран Л.М., Бадюк Н.С., Третьякова Е.В., Голикова В.В., Сидоренко С.Г.

Концепция устойчивого развития доминирует в большинстве документов ООН, ВОЗ, МОТ, ЕС и других международных организаций, определяющих пути и перспективы реформирования социально-экономической базы, ее технологической, организационной, эколого-гигиенической составляющих на период до 2030 и последующие годы. Их характерной особенностью является опережающее развитие транспортной отрасли, среди аспектов обеспечения безопасности которой авторами данной работы выделены: водообеспечение и защита Мирового океана от антропогенных загрязнений, полимерные материалы на транспорте и перевозка опасных грузов. На основе системного подхода построены интегральные схемы развития каждого направления. В заключении показано место, основные составляющие и взаимосвязи медицины транспорта с другими фундаментальными и прикладными научными дисциплинами, что позволяет активно участвовать в решении глобальной межотраслевой задачи — устойчивом развитии транспорта в XXI столетии.

Ключевые слова: *транспорт, водообеспечение, полимерные материалы, опасные грузы, окружающая среда*

Резюме

СТАЛИЙ РОЗВИТОК ТРАНСПОРТУ НА ПОЧАТКУ XXI СТОЛІТТЯ: ГІГІЄНІЧНІ, ТОКСИКОЛОГІЧНІ ТА ЕКОЛОГІЧНІ АСПЕКТИ

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Концепція сталого розвитку домінує в більшості документів ООН, ВООЗ, МОП, ЄС та інших міжнародних організацій, які визначають шляхи і пер-спективи реформування соціально-економічної бази, її технологічної, організаційної, еколого-гігієнічної складових на період до 2030-го і подальші роки. Їх характерною особливістю є випереджальний розвиток транспортної галузі, серед аспектів забезпечення безпеки якої авторами даної роботи виділені: водозабезпечення і захист Світового океану від антропогенних забруднень, полімерні матеріали на транспорті та перевезення небезпечних вантажів. На основі системного підходу побудовані інтегральні схеми розвитку кожного напряму. У висновку показано місце, основні складові та взаємозв'язки медицини транспорту з іншими фундаментальними і прикладними науковими дисциплінами, що дозволяє її фахівцям брати активну участь у вирішенні глобального міжгалузевого завдання — сталому розвитку транспорту в XXI сторіччі.

Ключові слова: *транспорт, водозабезпечення, полімерні матеріали, небезпечні вантажі, навколишнє середовище*

Впервые поступила в редакцию 26.09.2015 г. Рекомендована к печати на заседании редакционной коллегии после рецензирования