ТЕХНИЧЕСКИЕ НАУКИ / TECHNICAL SCIENCE

UDC 656.02 73.43.61

LOGISTIC MANAGEMENT OF ENVIRONMENTAL SAFETY OF PASSENGER TRANSPORT

ЛОГИСТИЧЕСКОЕ УПРАВЛЕНИЕ ЭКОЛОГИЧЕСКОЙ БЕЗОПАСНОСТЬЮ ПАССАЖИРСКОГО ТРАНСПОРТА

©Gogiashvili P.,
Dr., Akaki Tsereteli State University,
Kutaisi, Georgia, pridongo@gmail.com
©Гогиашвили П.,
Dr., Государственный университет Акакия Церетели,
г. Кутаиси, Грузия, pridongo@gmail.com
©Kamladze A.,
Dr., Akaki Tsereteli State University,
Kutaisi, Georgia, aleksandrekamladze@gmail.com
©Камладзе А.,
Dr., Государственный университет Акакия Церетели,
г. Кутаиси, Грузия, aleksandrekamladze@gmail.com
©Chogovadze J.,
Dr., Akaki Tsereteli State University,
Kutaisi, Georgia, jumberi54@gmail.com
©Чоговадзе Дж. Т.,
Dr., Государственный университет Акакия Церетели,
г. Кутаиси, Грузия, jumberi54@gmail.com

Abstract. Analysis of air samples taken from the dense traffic sections of urban transport of different compositions revealed that the value of NO_X, C_XH_y and CO emitted into the environment by vehicles depend on the traffic flow density and composition. It has been revealed that in those areas of the urban traffic networks where the urban passenger transport prevails in the traffic flow composition, the indicator of traffic–related air pollution is much higher, so the management of the road transport processes by using the logistical arrangements of the traffic flows should be carried out taking into account the environmental safety criteria.

The paper dwells on three different levels of management of environmental safety of vehicles as follows: the mega–level of the formation of regional transport; the micro–level of management of passenger routes, and the individual level (driver — vehicle) of traffic management.

Аннотация. Анализ проб воздуха, взятых на участках с плотным потоком городского транспорта разных составов, показал, что значение NO_X, C_XH_y и CO, выделяемых в окружающую среду транспортными средствами, зависит от плотности и состава потока движения. Было обнаружено, что в тех районах сетей городского транспорта, где преобладает городской пассажирский транспорт в составе транспортного потока, показатель загрязнения воздуха, связанного с дорожным движением, намного выше, поэтому управление процессами автомобильного транспорта с использованием логистических механизмов транспортных потоков должны осуществляться с учетом критериев экологической безопасности.

В статье рассматриваются три различных уровня управления экологической безопасностью транспортных средств следующим образом: мегауровень формирования регионального транспорта; микроуровень управления пассажирскими маршрутами и индивидуальный уровень (водитель транспортного средства) управления движением.

Keywords: passenger transport, ecology, safety, logistics.

Ключевые слова: пассажирский транспорт, экология, безопасность, логистика.

The movement of individual vehicles on roads, of course, will not have a significant impact on the environment and ecosystem, but the situation is entirely different, when considering traffic fluidity in the context of the carriage of goods and passenger traffic. In this case, the environmental impact depends not only on technical condition of the road surface and individual vehicle, but also on traffic density, speed, traffic stream composition, road network density and so on.

The pace of market economy development has diversified the directions of road transport. In the areas of intensive transport and pedestrian flows, which are characteristic for metropolitan cities and industrial centers, the carriage of goods and passenger traffic not only increase the risk of road traffic accidents, but also increase the negative impact on the natural environment [1, 3]. In this context, the reduction in the adverse impact of motor transport on human health and environment is an immediate scientific and methodological problem.

Despite extensive research investigations carried out throughout the world, air pollution problems in the industrial centers, in the areas of the intensive transport and passenger flows, remain to be resolved. The long-term program developed by leading countries of the world [2], in this respect envisages not only the development of expensive transport infrastructure, but also the formation of measures for organizing environmentally-oriented traffic on road sections. At this time, special attention should be attached to sound management of the movement of M_1 and M_2 categories of vehicles in traffic flows of metropolitan cities (M_1 and M_2 are the categories of passenger vehicles with the gross mass up to 2000 kg and in the range of 2500-3000 kg). In addition, in the case of M_1 category, the number of passengers does not exceed eight, and in the case of M_2, their number is more than eight.

In quantifying compounds emitted to the atmosphere by transport flow, two approaches may be used as follows: 1) without consideration of vehicle influence; 2) interaction between vehicles. In the first case, the amounts of compounds emitted by each vehicle are directly summarized, and in the second case, traffic is considered to comprise all vehicles.

In assessing the concentration of harmful compounds emitted to the atmosphere by the transport flow, we can use the following assumptions [4]:

1) to determine the fuel consumption of each component of the flow, and the amount of compounds attached at different speeds;

2) to determine the fuel consumption and the amount of emitted compounds for the flow, on a separate section of the road network;

3) to determine the concentration of harmful substances on-road section to be considered.

The amount of harmful substances (kg/h·kg) emitted by vehicle flow on road section is determined by formula:

$$y = \sum_{i}\sum_{\gamma}\sum_{k} W_{\gamma} \cdot P_{ki} \cdot N_{a}$$

where W_γ — is a consumption of any emitted component of fuel during the period of use of vehicle;

P_{ki} — the probability of the *k* group vehicle entering the range with *i* speed.

N_a — traffic intensity, vph.

The probability (P_{ki}) of entering of different groups of vehicles the range with a given speed of movement can be determined based on the results of calculation, or by using the movement simulation model of individual vehicle in traffic flow.

Given that in the major cities and district towns, the most significant share of traffic flow refers to the M_1 and M_2 categories of vehicles, it is easy to imagine the role of these objects in the context of environmental pollution. In accordance with the permissible levels of pollutants in internal combustion engines, based on the carried out theoretical research, it has been established that in the case of average annual kilometrage, this category of vehicles account for a total of 70–80% of city traffic pollution. In this regard, the results of studies carried in Kutaisi City (see Figure 1) clearly confirm these assertions.

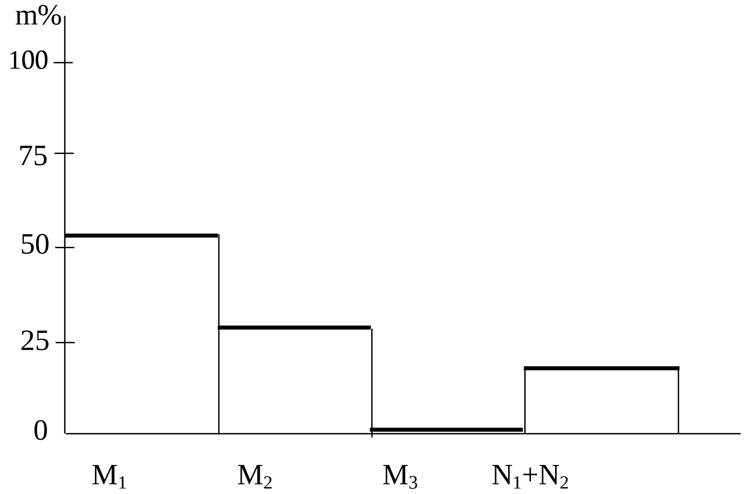


Figure 1. The dependency of environmental pollution in the city on the category of vehicles

The mass of *m* pollutants of the city, in percentage.

M_1 — passenger vehicle, the gross mass is up to 2500 kg, the number passengers does not exceed eight;

M_2 — passenger vehicle, the gross mass is 2500–5000 kg, the number passengers is more than eight;

M_3 — passenger vehicle, the gross mass is more than 5000 kg, the number passengers is more than eight;

N_1 — freight vehicle, the gross mass is under 3500 kg;

N_2 — freight vehicle, the gross mass is 3500–12000 kg.

It should be noted that in terms of the emission of CO, C_xH_y, NO_x to the atmosphere during road transport operations, the operation of obsolete motor vehicle fleet in Georgia complicates the problems of environmental security of the atmosphere. Given that the existing obsolete fleet replacement with current pace is a long period (15–20 years), an increase in the number of new environmentally clean vehicles in the transport flow cannot decrease the amount of mass of dispersed particles emitted as a result of wear of brake blocks, tires and road surface.

This reality creates the need for merging the environmentally oriented technologies in the road transport management processes in metropolitan cities on the basis of systemic-purposeful underpinnings of logistics. In such a case, the basis of logistics approach methodology is the interaction between the operation of transport and the quantities of different types of products produced during this period, which allows for optimizing these processes. A model linking the transport operation (A) and mass of pollutants (M) is a regulatory basis of the alternative implementation of transportation according to the environmental requirements. In addition, the optimization criteria are based on generalization of technical and environmental indicators.

In the process of road transport, three different levels can be distinguished as follows: the transportation process on the regional mega-level; the transportation process on the local macro-level; the transportation process on the individual micro-level.

The optimization of transportation process at each level is conducted with regard to the following criteria:

–road transport volumes in a certain *n* period should not exceed the volume of works performed in the next $n + 1$ period, i.e. $A_{n+1} > A_n$;

–the total mass of polluting substances emitted by road traffic flows (M_p) is less than the maximum permitted concentration of the mass of these substances (M_{mpc}), i. e. $M_p < M_{mpc}$.

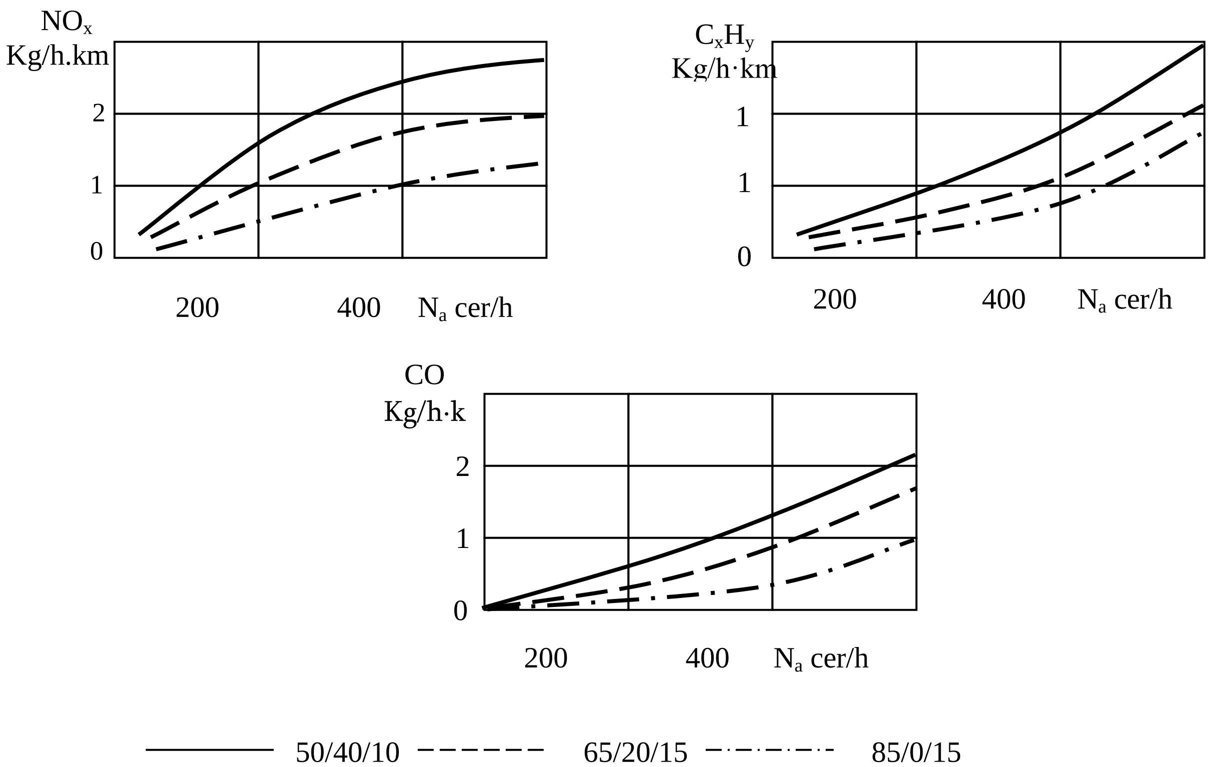
The methodology of road transport management at each level is determined with regard to the environmental criteria. For example, at the third level, we conduct the optimization of the composition of regional vehicle fleet, and modelling is carried out for those fleets, where there are quantity changes of the ratio of M_1, M_2 and M_3 categories of vehicles. In order to pursue research in this direction, to decrease the mass of pollutants emitted when carrying out transport process activities on the sections of urban sector roads, passenger routes and the group of major street crossings can be taken as the management objects.

The first situation includes replacement of the M_2 category vehicles by the M_3 category of buses with great passenger capacity, with a view to minimizing the environmental indicators. In the second case, it is advisable to regulate the vehicle density on major highways, with periodic redistribution of the M_1 category of vehicles on the adjacent road networks.

The analysis of the environmental-chemical studies carried out based on the example of Kutaisi City reveals that the main mobile source of air pollution are the vehicles, a large proportion of which were of both urban and transit passenger buses. The deterioration of qualitative indicators of the air basin is caused by a sharp increase in the number of vehicles, traffic congestion, disorder in the road network, irrational distribution of traffic flows, technical malfunction of vehicle fleet and so on.

Analysis of air samples taken from the dense traffic sections of urban transport revealed that the concentrations of nitrogen oxides, hydrocarbon and lead compounds in the atmospheric air exceed the maximum permissible value, due to which the diseases such as pneumonia, allergy, asthma, cancer and cardiovascular diseases show the growing trends.

The next phase of the study examined the dependency of the values of NO_X, C_XH_y and CO emitted into the environment by the traffic flow on the density and composition of traffic on the most congested sections of the city (2). It has been revealed that in those areas of the urban traffic networks where the urban passenger transport prevails in the traffic flow composition, the indicator of traffic-related air pollution is much higher.



Note: The designation 50/40/10 indicates the percentage the M_1, M_2, and M_3 categories of vehicles in the traffic flow composition.

Figure 2. The dependency of exhausted compounds on the composition and density of the traffic flow

In the case of first level, the optimization of the traffic condition of individual crew (driver — vehicle) should be taken into consideration, since when moving on the particular sections of urban sector roads, then the correct implementation of the processes of stopping, acceleration and braking of vehicle mostly depends on driver's qualification. From our studies carried out on these issues (in the same conditions), we have established that the upgraded driver's professional level increases vehicle's fuel economy by 10–20%, which itself obviously reduces the amount of polluting substances emitted into the environment.

In this context, during the vehicular traffic in urban areas, the environmental impact of the traffic flow is determined by the density and composition of traffic, as well as by the quality of traffic regulation quality and driver's qualification.

Therefore, in order to fulfil the set task by using the logistical arrangements, the following conditions need to be met:

1. Management of the road transport processes by using the logistical arrangements of the traffic flows should be carried out taking into account the environmental safety criteria.

2. Selection of the type of vehicles in the traffic flow and the assessment of economic efficiency should be carried out taking into account the indicators of environmental safety.

Funding: This work was supported by Shota Rustaveli National Science Foundation (SRNSF) (No 217764, Adaptation of Disabled People in the Logistics System of Passenger Transport).

References:

1. Gudkov, V. A. (2008). Quota arrangement of the number of passenger vehicles according to environmental safety criterion. *Standards and quality*, (2), 44-48
2. Transportion Demand Management Deutsche Gesellschaft für Technische Zusammenarbeit, Echborn. (2009). *Germany*, 118
3. Lozhkin, V. N., Greshnykh, A.A., & Lozhkina, O.V. (2007). Vehicle and the environment. Motor transport as a source of environmental pollution. Problems and solutions, *St. Petersburg*, 305
4. Fedotov, V. N. (2010). Selection of the object and algorithm of the neuro-programs of coordination of the road traffic management systems by criterion. *Instruments and systems. Management, control, diagnostics*, (1). 3-8
5. Vemoshkin, A. G. (2008). Theoretical bases of environmental protection. Moscow. 397

Список литературы:

1. Гудков В. А. Квотирование числа пассажирских автотранспортных средств по критерии экономической безопасности // Стандарты и качество 2008. №2. С. 44-48.
2. Transportion Demand Management Deutsche Gesellschaft für Technische Zusammenarbeit, Echborn. Germany, 2009. 118 p.
3. Ложкин В. Н., Грешных А. А., Ложкина О. В. Автомобиль и окружающая среда. Автомобильный транспорт, как источник загрязнения окружающей среды. Проблемы и решения: СПб, 2007. 305 с.
4. Федотов В. Н. Выбор объекта и алгоритма нейропрограмм координации систем управления дорожным движением по критерию риска экологического воздействия // Приборы и системы. Управление, контроль, диагностика. 2010. №1. С. 3-8.
5. Вемошкин А. Г. Теоретические основы защити окружающей среды. М. 2008. 397 с.

Работа поступила в редакцию 04.03.2018 г.

Принята к публикации 11.03.2018 г.

Cite as (APA):

Gogiashvili, P., Kamladze, A., & Chogovadze, J. (2018). Logistic management of environmental safety of passenger transport. *Bulletin of Science and Practice*, 4, (4), 262-267

Ссылка для цитирования:

Gogiashvili P., Kamladze A., Chogovadze J. Logistic management of environmental safety of passenger transport // Бюллетень науки и практики. 2018. Т. 4. №4. С. 262-267. Режим доступа: http://www.bulletennauki.com/gogiashvili (дата обращения 15.04.2018).