TOSHKENT DAVLAT TRANSPORT UNIVERSITETI
Tashkent state transport university

Issue 2, 2024

INTERNATIONAL JOURNAL OF TRANSPORT AND TECHNOLOGICAL MACHINES

ISSN: 3030-363X



THE SCIENCE OF TODAY IS THE TECHNOLOGY OF TOMORROW

INTERNATIONAL JOURNAL OF TRANSPORT AND TECHNOLOGICAL MACHINES

Published since 2023

Editorial Council:
Mukhitdinov A.A., Ziyayev K.Z., Rustamov K.J, Abdurazzakov U.
Editorial team:
Chief Editor – Rustamova N.R.
Deputy Chief Editor – Rustamov K.J.

Members of the editorial board:
Mukhitdinov A.A., Ziyayev K.Z., Rustamov K.J., Abdurazzoqov U.A., Saman M. Almufti., Habibollah Haron., Gai-ge Wang., Jayson A. Dela Fuente., Ahmad A. AlRabab'ah., Rami Hikmat Fouad AL-Hadeethi., Emad Kamil Hussein., Ayman Abu-Rumman.

TASHKENT STATE TRANSPORT UNIVERSITY

Founder of the scientific and technical journal, “International Journal of Transport and Technological Machines” – Tashkent State Transport University (100167, Republic of Uzbekistan, Tashkent, Temiryulchilar str., house No. 1, office: 379, tel Tel.: +998 97 156 94 21 E-mail: k.j.rustamov82@gmail.com).

In the International Journal of Transport and Technological Machines publishes the most significant results of scientific and applied research carried out in universities of transport and information technology profile, other higher educational institutions, research institutes and centers of the Republic of Uzbekistan and foreign countries.

The journal is published 4 times a year and contains publications in the following main areas:

- Automotive engineering
- Civil Engineering
- Construction Engineering and Management
- Instrumentation technology
- Environmental Engineering
- Environmental Sciences
- Green production
- Industrial Safety
- Mechanical Engineering Technology
- Mining
- Mechatronics

CONTENTS

1. Shermukhamedov A.A., Ergashev N.T., Frimpong J.A. EXPERIMENTAL INVESTIGATION OF RESPONCE TIME FOR LARGE TRACTOR TRAILER BRAKE SYSTEM..... 4
2. Alimova Z., Madrahimov Sh., Mengliev Sh. SPECIFICATIONS FOR APPLYING HIGH OCTANE ADDITIVES TO THE MOTOR GASOLINE IN HOT CLIMATE ……..... 8
3. Sushko A.A.., Bakhanovich A.G., Mukhitdinov A.A. THE ROLE OF PERSONAL (INDIVIDUAL) MOBILITY IN IMPROVING THE QUALITY OF ROAD TRAFFIC…… 14

TOSHKENT DAVLAT TRANSPORT UNIVERSITETI
Tashkent state transport university
International Journal Of Transport And Technological Machines
Tashkent 2024, issue 2, https://ijttm.uz/

EXPERIMENTAL INVESTIGATION OF RESPONCE TIME FOR LARGE TRACTOR TRAILER BRAKE SYSTEM

Shermukhamedov Abdulaziz Adilkhaqovich, DSc, professor Tashkent State Transport University, sheraziz@mail.ru
Ergashev Nurillo Tokhirbek ugli PhD candidate Tashkent State Transport University, Tashkent, Uzbekistan, *ergashevnurillo657@gmail.com*
Frimpong Justice Alex, PhD, Associate professor Wuhan University of Technology, alexua45@whut.edu.cn

Abstract. The article discusses determining reasonable places for installation of accelerating valve (AV) in pipelines of different lengths of a large tractor trailer (LTT), determining the starting time of the pipeline of the trailer brake system using modern pressure sensors, the theoretical and experimental comparison of the rational location of installation of AV in LTT brake system, and also using AV in LTT brake system increases the traffic safety, and the effective use of the possibilities of multi-articulated tractor trailers (MATT).

Key words: Large tractor trailer, large-capacity, pipelines, brake system, accelerating valve, pressure sensors, multi-articulated tractor trailers, drive, pneumatic brakes, line.

Introduction

The increase in labor productivity in the production and transportation of agricultural products is significantly dependent on the level of mechanization of transport products, which is a link related to the entire technological process of the product. Improving the efficiency of harvesting agricultural products, transporting goods from the fields to the preparation points and from the preparation points to processing plants depends on the transported load and its mass, size and speed. Therefore, the increase in labor productivity aimed at saving fuel and lubricants, labor and other consumables is directly related to the production of large tractor-trailers [1].

Wheeled tractor trailers designed for the transportation of scattered and mass agricultural products (cotton, grain crops, roots, potatoes, mineral and organic fertilizers, hay, silage and other products) can carry loads from 2 to 14.5 tons [2, 3, 4]. Statistics show that the share of costs associated with the transportation of goods amounts to 25-30% of the total cost of agricultural production.

Along with developed countries, large capacity tractor trailers for the transportation of cotton and large light-weight agricultural products are being implemented in Uzbekistan.

In this regard, after a detailed analysis of the constructions and characteristics of modern tractor-trailers produced in the world's developed countries, in the framework of the innovation project number IL-462106970 - in cooperation with the engineers of "Design and Technology Center of Agricultural Machinery" LLC and scientists of Tashkent State Transport University A tractor trailer with a large capacity (40 m^3) designed for transportation of light agricultural cargo adapted to work with modern cotton picking was created.

However, the load capacity and speed of such tractor trailers often significantly reduce the effectiveness of the braking features.

The growing use of MATT requires an expansion of measures aimed at increasing active traffic safety, which largely depends on the speed of operation of braking systems.

The brake drive of MATT is characterized by long control lines, a large number of tracking devices, brake chambers and, in connection with this, ensuring the speed of brakes within the specified limits for each link of the trailer is a rather complex task.

One of the main parameters for assessing the braking properties of MATT's drives is the speed of brake response.

Methodology

One of the effective ways to speed up the response time of the brake drive is to install an (AV) in the control lines of the two-wire brake drive LTT.

Using the mathematical model previously developed in [5, 6], research was conducted on the effect of the distance from the AV installation site to the brake valve on the driving speed.

Laboratory - field tests were conducted to verify theoretical studies. Laboratory - field tests provided an opportunity to fully simulate the performance of pneumatic brakes of large tractor trailers.

Laboratory-field tests were carried out with the help of pressure sensors - SS302 model diaphragm sensor of "Sendor Sensor" company (Fig. 1), accuracy level is 0.5%, measurement range is 0-40 MPa [7].

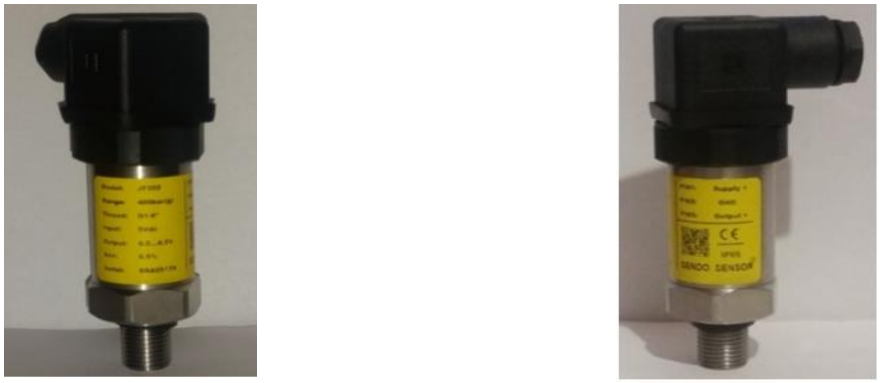


Figure 1. SS302 model pressure sensor of "Sendor Sensor" company

In the calibration of pressure sensors, calibration was carried out using the manometer IP40 with the calibration certificate "UZ-14/200-2023" dated March 27, 2023, accepted as a standard model at KTB "AVTOSOZLASh" LLC (Fig. 2). The error of manometer IP40 is 0.5% [8].



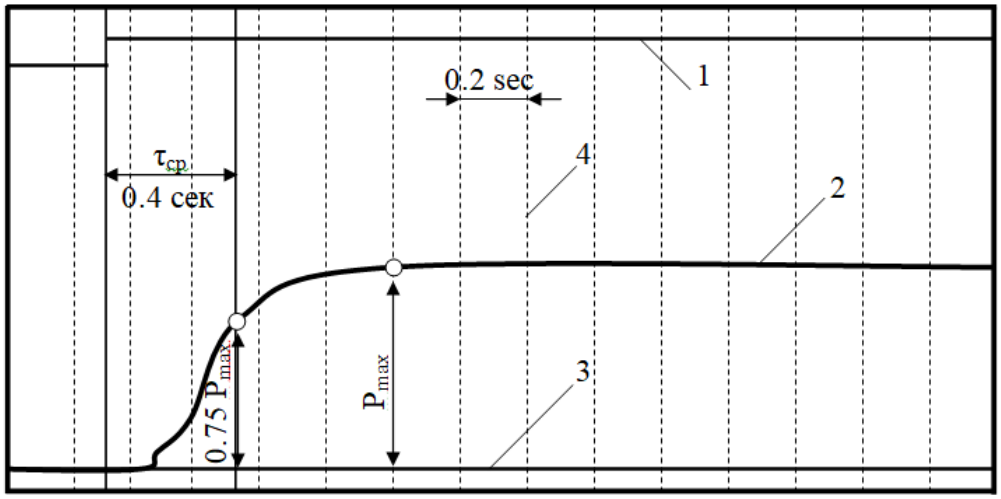
Figure 2. Process of calibration of pressure recording sensors using a piston-loaded manometer IP40

Separation of calibration errors, addition of sensor and galvanometer errors, as well as power supply voltage instability also cause errors. The error caused by voltage instability does not exceed 0.1%. Therefore, the margin of error of the record Δe depends on

measurement and measurement errors, according to the first rule that recommends the largest error [9, 10], the largest error is assumed to be 4 %.

Results and discussion

Before the start of the research, the following were carefully checked: the tightness of the brake drive, the pressure in the receivers, the stroke of the brake chamber rod, and several test braking cycles were carried out. The temperature regime of the measuring and recording equipment was also checked. For the planned research, the recording was repeated 4 times for each experiment, the research results were averaged. An example of a pressure change recording is shown in Fig. 3.

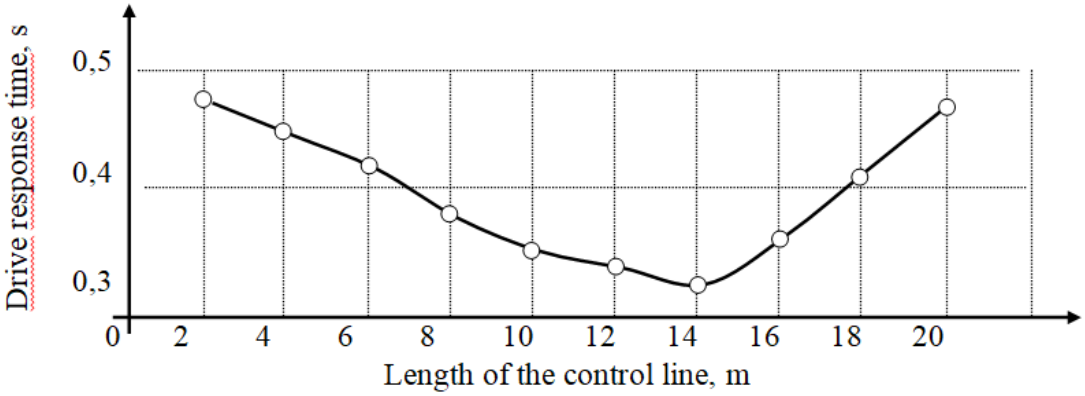


1- braking start marker; 3- base line;
2- SS302 pressure sensor signal; 4- time marker;

Figure 3. Sample oscillogram recording the process of pressure change in the control line of the trailer brake drive

The pressure sensor was installed on the pipeline at the entrance to the air distribution valve. The response time of the control line was measured when the trailer air distribution valve reached 0.45 MPa. (i.e. when the air distribution valve is fully triggered).

Fig 4 shows the change in the time τ_{cp} of the actuation of the control line of the brake drive of the ADV, depending on the AV location. Similarly, rational places for installing the AV in control lines of different lengths were determined. The theoretical determination of the rational location of the AV installation in the pneumatic line of the TT brake drive, in this case with one trailer, showed good convergence with experimental studies, within 5%.



○ places of installation of the control unit in pneumatic drive.

——— experimental characteristics of the drive

Figure 4 Determining the rational location for installing the control unit in the control line of the pneumatic drive of the trailer brake

Conclusion

Thus, the approximation of the results of theoretical studies with experimental data showed that it is usually quite high, from 5 to 8%. The convergence of theoretical and experimental results in determining the reasonable location of the AV installation on the control line for the minimum response time does not exceed 5%.

This proves the correctness of the choice of the mathematical model of a typical section of the pneumatic brake line and the transformations and clarifications carried out in it.

The use of high-speed brake drives LTT will improve traffic safety, effectively use the capabilities of MATT.

References

1. Шермухамедов А.А., Тогаев А.А., Астанов Б.Ж. Выбор конструктивных параметров тракторных прицепов категории О3. // Вестник ТАДИ. -2012 №1-2 С. 60-65
2. Перчаткин, Ю.В. Развитие сельскохозяйственных тракторных транспортных средств [Текст]: монография / Ю.В. Перчаткин, Е.П. Шилова. – Орск: Издательство Орского гуманитарно-технологического института (филиала) ОГУ, 2012. – 182 с.
3. Шилова, Е. П. Инновационное развитие мирового сельскохозяй-ственного машиностроения: научн.-анал. обзор [Текст] / Е.П. Шилова [и др.]. – М. : ФГНУ «Росинформагротех», 2006. – 180 с.
4. Шилова, Е.П. Тенденции развития сельскохозяйственной техники: научн.-анал. обзор [Текст] / Е.П. Шилова [и др.]. – М.: ФГНУ «Росинформаг-ротех», 2006. – 164 с.
5. Расчет быстродействия тормозов автопоезда. В А.Топалиди, К.К.Ходжиев – Автомобильная промышленность, 2000, №4, 19-20.
6. Shermukhamedov, A., Ergashev, N., & Azizov, A. (2021). Substantiating parameters brake system of the tractor trailer. In E3S Web of Conferences (Vol. 264). EDP Sciences. https://doi.org/10.1051/e3sconf/202126404019
7. http://www.sendo-sensor.com
8. Манометры избыточного давления грузопоршневые. Общие технические требования ГОСТ8291-83
9. Шермухамедов А.А. Разработка научных основ моделирования рабочих процессов в гидравлических приводах грузовых мобильных машин, эксплуатируемых в экстремальных условиях. дисс... д-ра. техн. наук. док.дисс., – Т., ТАДИ.– 2000г. – 265 с.
10. Борисов Б.П. Объемные гидромашины. –МГТУ им. Н. Э. Баумана. 2018. – 240 с.

TOSHKENT DAVLAT TRANSPORT UNIVERSITETI
Tashkent state transport university
International Journal Of Transport And Technological Machines
Tashkent 2024, issue 2, https://ijttm.uz/

SPECIFICATIONS FOR APPLYING HIGH OCTANE ADDITIVES TO THE MOTOR GASOLINE IN HOT CLIMATE

Zebo Alimova[1], Sherzod Madrahimov[2], Sherzod Mengliev[3]

[1]Tashkent State Transport University, Uzbekistan
[2]Texas A&M University, Qatar, Doha, Qatar
[3]Tashkent institute of chemical technology, Uzbekistan
Corresponding author: e-mail: zeboalimova7841@mail.ru

Abstract. Currently, to improve anti–knock properties and increase resources, high-octane components - oxygen-containing compounds - are added to the composition of gasoline. The article analyzes the application of high-octane additives to automotive gasoline used in hot climatic conditions. We have studied anti-knock additives as an additive to improve the octane number of gasoline. An alcohol-based additive octane Booster was used as such additives. Laboratory studies were carried out on the physico-chemical parameters of gasoline AI-80 and AI-92 with the addition of an anti-knock additive.

The results of the conducted studies show that when gasoline is used in hot climates, the addition of high-octane alcohol-based components increases the octane number, but at the same time the boiling point of the light gasoline fraction decreases. Taking into account all the experimental data obtained, we propose adding a percentage of this additive of no more than 3%, which shows the optimal value of the octane number and the distillation temperature of 10% gasoline for a hot climate.

Keywords: gasoline volatility, starting qualities, combustion completeness, high-octane components, octane number, engine, anti-knock additive, distillation temperature.

Introduction

One of the main indicators of the quality of automobile gasoline is their detonation resistance, on which reliability, increased power, efficiency and duration of operation of the car engine depend to the greatest extent. The internal combustion engine is not designed to work with gasoline with an octane number below a certain value set by the compression ratio of the combustible mixture in the combustion chamber. Low-octane fuel is capable of self-ignition in the combustion chamber before the desired moment, determined by sparking in the spark plug, which causes dangerous detonation.

The discrepancy between the octane number of gasoline and the engine parameters can cause detonation combustion of the fuel mixture, accompanied by a characteristic metallic knock, an increase in exhaust smoke and temperature in the engine cylinders. Detonation entails emergency breakdowns of engine parts: burnout of valves, destruction of pistons, breakdown of the cylinder head gasket.

Currently, to improve anti–knock properties and increase resources, high-octane components - oxygen-containing compounds - are added to the composition of gasoline. Ethyl and methyl alcohols (ethanol and methanol) can be used as oxygen-containing high-octane additives. The use of alcohol components in the form of additives to gasoline is promising not only in terms of preserving oil resources, but also improving the environmental properties of motor fuels. The amount of alcohols introduced reduces the concentration of undesirable aromatic hydrocarbons. Alcohols have a high octane number (90÷94) than gasoline, a latent heat of evaporation, which reduces the thermal stress of engine parts (Table 1).

Table 1. Chemical composition and performance characteristics of alcohols and gasoline

Chemical composition and	Methanol	Ethanol

performance characteristics			Gasoline
Chemical formula	CH_3OH	C_2H_5OH	C_5-C_{12}
Carbon (wt.%)	38	52	86
	12	13	14
	50	35	0
Hydrogen (wt.%)	798	794	690-740
Oxygen (wt.%)	65	78	35÷200
Liquid Density (kg/m^3)	0,74	1.2	
Boiling temperature	109	109	86-100

From an energetic point of view, the advantages of alcohols lie mainly in their high detonation resistance. By adding 10 percent ethyl alcohol, gasoline type AI-92 can easily be upgraded to AI-95. Alcohol, by increasing the charge density, simultaneously reduces the detonation rate and the effect of high temperatures on the engine. During trial operation of vehicles using a gasoline-methanol mixture containing 3-5% methyl alcohol, gasoline savings amount to 1.5-3%.

Along with the positive environmental efficiency of using alcohol additives, negative phenomena should also be noted, such as increased emissions of aldehydes and evaporation of hydrocarbon compounds. When using alcohols, the content of aldehydes in the exhaust gases increases by 2–3 times. The content of aldehydes increases with increasing concentration of alcohols in the fuel mixture.

Methanol produces formaldehyde emissions, and combustion of ethanol produces acetaldehyde. On average, aldehyde emissions when running on alcohol are approximately 2–4 times higher than when the engine is running on gasoline. Disadvantages of alcohol additives are also low hydrolytic stability, low anti-wear and anti-corrosion properties. Alcohols penetrate into the material of the hoses and seals of the car's fuel system, which disables them, breaking the tightness.

It is possible to increase the octane number of gasoline and reduce the risk of detonation by adding an additive to the fuel called an octane corrector, which is a mixture of ethanol. Octane corrector (octane booster) increases the octane number of fuel by 3-6 units. Thus, gasoline with an octane number of 92, after adding an additive, will be equivalent in its anti-knock properties to gasoline with an octane number of 98. Its operating principle is based on changing the chemical structure of the fuel, which allows increasing combustion efficiency and improving the quality of the fuel.

Materials

The purpose of this work is to study the performance characteristics of motor gasoline used in hot climates with the addition of the anti-knock additive Octane Booster. To achieve this goal, we selected samples of motor gasoline AI-80, AI-95 and anti-knock additive and were analyzed according to main quality indicators. The physicochemical properties of motor gasolines AI-80 and AI-95 without additives were previously determined for comparison. Laboratory physical and chemical analyzes were carried out according to established methods and are shown in Table 2.3.

Table 2. Basic physical and chemical indicators of AI-80 gasoline

Quality indicators	AI-80	
	According to GOST	In fact
1. Knock resistance: octane number	80	80

2. Fractional composition:		
temperature at the beginning of distillation of summer gasoline, °C,	35	37
boiling point of 10% gasoline, °C	70	69
boiling point temperature of 50% gasoline, °C	115	112
boiling point temperature of 90% gasoline, °C	185	184
end of boiling point of summer gasoline, °C,	205	195
residue in flask,%,	1,5	1,9
balance and losses,%,	4,0	4,2
3. Saturated vapor pressure of summer gasoline, kPa	66,7	66
4. Acidity, mg NMH per 100 cm^3 of gasoline	1,0	1,1
5. Water-soluble acids and alkalis	Absence	
6. Density at 20 °C, kg/m^3	690-760	760

Table 3. Basic physical and chemical indicators of AI-92 gasoline

Quality indicators	AI-92 According to GOST	In fact
1. Knock resistance: octane number	92	92
2. Fractional composition:		
temperature at the beginning of distillation of summer gasoline, °C	35	37
boiling point of 10% gasoline, °C	70	70
boiling point temperature of 50% gasoline, °C	115	115
boiling point temperature of 90% gasoline, °C	185	184
end of boiling point of summer gasoline, °C,	205	198
residue in flask,%,	1,5	1,7
balance and losses,%,	4,0	4,1
3. Saturated vapor pressure of summer gasoline, kPa	66,7	65
4. Acidity, mg NMH per 100 cm^3 of gasoline	1,0	1,05
5. Water-soluble acids and alkalis	Absence	
6. Density at 20 °C, kg/m^3	690-760	755

Subsequently, laboratory tests were carried out with an anti-knock additive separately for AI-80 and AI-92 gasoline. The recommended concentration of this additive in gasoline is 3–7%. Based on this, we prepared samples with 3–7 percent concentrations of AI-80 and AI-92 gasoline and then determined the main physical and chemical indicators of the fuel (Table 4.5).

Table 4. Basic physico-chemical parameters of AI-80 gasoline with octane-Booster additive

Quality indicators	AI-80 +3%	AI-80 +5%	AI-80 +7%
1. Knock resistance: octane number	83	86	86
2. Fractional composition:			
temperature at the beginning of distillation of summer gasoline, °C	37	37	36
boiling point of 10% gasoline, °C	68	65	58

boiling point temperature of 50% gasoline, °C	108	105	105
boiling point temperature of 90% gasoline, °C	178	175	175
end of boiling point of summer gasoline, °C,	195	193	193
residue in flask,%,	1,9	1,9	1,9
balance and losses,%,	4,2	4,2	4,2
3. Saturated vapor pressure of summer gasoline, kPa	66	70	75
4. Acidity, mg NMH per 100 cm^3 of gasoline	1,1	1,1	1,1
5. Water-soluble acids and alkalis		Absence	
6. Density at 20 °C, kg/m^3	760	758	752

Table 5.Basic physical and chemical parameters of AI-92 gasoline with octane-Booster additive

Quality indicators	AI-92 +3%	AI-92 +5%	AI-92 +7%
1. Knock resistance: octane number	95	98	98
2. Fractional composition:			
temperature at the beginning of distillation of summer gasoline, oC,	37	36	35
boiling point of 10% gasoline, °C	68	65	61
boiling point temperature of 50% gasoline, °C	108	110	105
boiling point temperature of 90% gasoline, °C	180	180	178
end of boiling point of summer gasoline, °C,	195	195	195
residue in flask,%,	1,9	1,9	1,9
balance and losses,%,	4,2	4,2	4,2
3. Saturated vapor pressure of summer gasoline, kPa	65	68	70
4. Acidity, mg NMH per 100 cm^3 of gasoline	1,05	1,05	1,05
5. Water-soluble acids and alkalis		Absence	
6. Density at 20°C, kg/m^3	755	753	750

Results and discussion

As a result of the research, it is clear that with an increase in the percentage of additives added to gasoline, the octane number of the fuel increases, but at the same time, the boiling point of the light fraction of gasoline and the density of the fuel decrease.

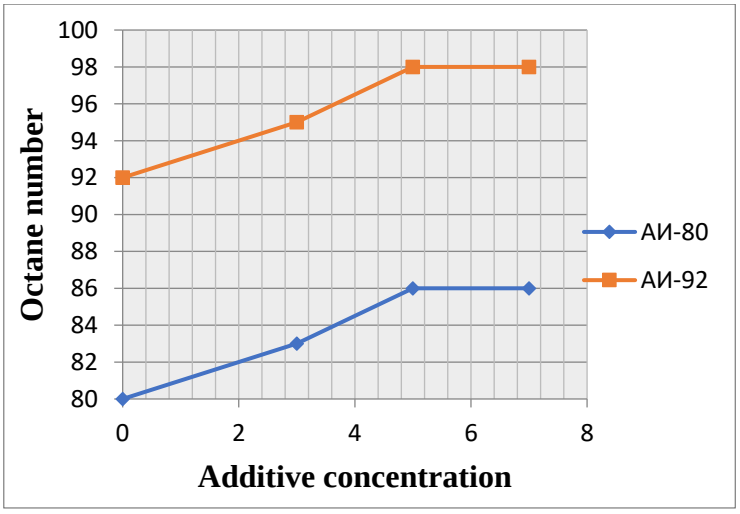


Fig-1. Change in fuel octane number depending on additive concentration.

The volatility of gasoline must ensure the optimal composition of the air-fuel mixture in all engine operating modes.

The starting temperature ($t_{н.к}$) of summer and winter gasoline is standardized at 35°C. The boiling point of 10% ($t_{10\%}$) gasoline to ensure optimal engine operating conditions should be: for summer gasoline - not lower than 70°C, for winter gasoline - not lower than 55°C. At values below those indicated, the formation of steam and steam-air plugs in the fuel system is possible. In the summer, a decrease in this temperature inevitably leads to large losses from the evaporation of gasoline, as well as the occurrence of an explosion and fire hazard during the operation of such gasoline.

Boil-off of 10% of summer gasoline should occur at a temperature not lower than 70°C. In our example, when adding a 3% additive to AI-80 fuel, the boiling point of 10% gasoline decreased by 68°C, respectively, at 5% - 62°C, and when adding 7% additive, the boiling point decreased by 58°C. The boiling point of 10% AI-92 gasoline decreased from 70°C to 68,65,61°C (Fig. 1)

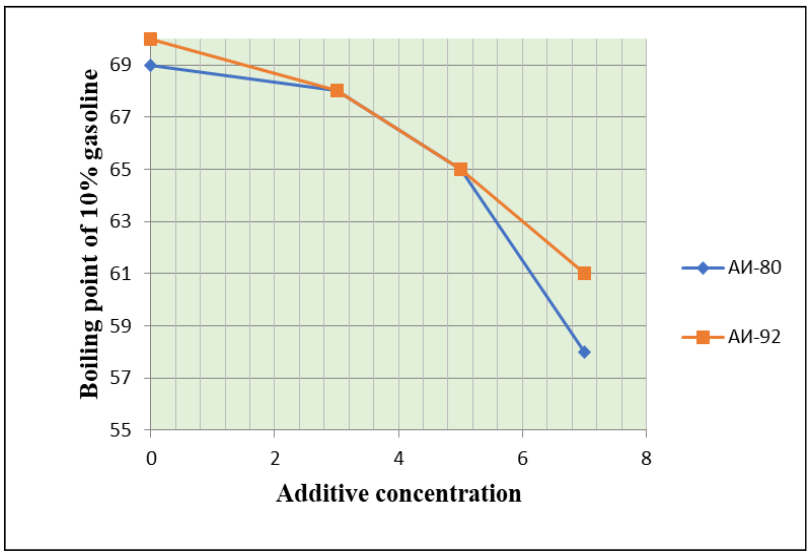


Fig-2. Change in boiling point of 10% fuel depending on additive concentration.

It is undesirable to have too many light fractions in the fuel, which easily evaporate. The use of very light gasolines causes other operational difficulties, such as the formation of vapor locks in the power system, especially in the summer. At a low temperature of the light fraction of gasoline, especially in hot weather, vapors are formed in the power system, the volume of which is 150–200 times greater than the volume of gasoline, which causes interruptions or engine shutdown. In this case, vapors become clogged in the fuel pipes of gasoline engines, as a result of which the engine does not operate normally (overheats, loses power, sometimes stops, and cannot be started without cooling).

For the southern regions of the country in the summer, at an ambient temperature of +40°C ÷ +50°C, if gasoline begins to boil at 35°C, then vapor locks form in the power system, which can lead to disruption of the fuel pump.

Maximum evaporation can be controlled in one of two ways:

– the maximum temperature at which the vapor-liquid ratio equals 20;

- volatility index or vapor lock index, which is a function of saturated vapor pressure and the amount of fuel in% evaporated at 70°C:

$I_{PP} = 10 \cdot D_{svp} + 7 \cdot V^{70}$,

Where: D_{svp}– saturation vapor pressure, kPa,

V^{70} – amount of fuel evaporating at 70°C, %

Conclusion

Thus, to ensure optimal engine operating conditions in hot climatic conditions, we suggest that the boiling point of gasoline at the beginning of distillation should be no lower than 40°C ÷ 45°C, and the distillation temperature of 10% of gasoline should be no lower than 70°C. The results of the studies show that when gasoline is used in hot climates, the addition of high-octane components based on alcohols increases the octane number, but at the same time the boiling point of the light fraction of gasoline decreases. With an increase in the percentage of additive, the boiling point of the light fractions reached 58°C. Taking into account all the experimental data obtained, we suggest adding a percentage of this additive of no more than 3%, which shows the optimal octane number and distillation temperature of 10% gasoline for hot climates. With a further increase in concentration to 5%, the octane number increases, but at the same time the distillation temperature of 10% gasoline sharply decreases, which can lead to engine malfunctions. When the concentration increased above 5%, the octane number did not change.

In conclusion, to ensure optimal engine operating conditions in hot climatic conditions, we suggest ensuring that the boiling point of gasoline at the beginning of distillation is not lower than 40°C ÷ 43°C, and the distillation temperature of 10% gasoline is not lower than 70°C.

The quality of motor gasoline can be improved by dividing gasoline by fractional composition and saturated vapor pressure into classes, taking into account the operating season of the vehicle and the ambient temperature characteristic of a specific climatic zone. The presence of classes allows us to produce gasoline with properties that are optimal for real ambient temperatures, which ensures engine operation without the formation of vapor locks at air temperatures up to +55°C.

References:

1. Jerichov V B 2009 Automobile maintenance materials A training manual p 256 St. Petersburg

2. Maharramov A. M, Akhmedova R. A., and Akhmedova N. F. 2009 Petrochemicals and Oil Refining Textbook for Higher Education p. 660

3. Makushev Y. P. 2006 Automobile maintenance materials Omsk, SibADI Publishing House p. 58

4. Stukanov V. A. 2002 Automotive Maintenance Materials Textbook, Laboratory workshop. Moscow p. 208

5. Syrbakov A. P., Korchuganova M. A. 2015 Fuel and lubricants Allowance. - Tomsk: Publishing House of Tomsk Polytechnic University.

6. Alimova, Z. Kh., Akhmatzhanov, R. N., & Usmanov, I. I. (2021). Study of the influence of the vaporization temperature of gasoline under hot climatic conditions on the wear of engine parts.

7. Alimova, Z., Kholikova, N., & Kholova, S. (2020, July). Improvement of properties of oils used in hydraulic systems of road-construction equipment. In *IOP Conference Series: Materials Science and Engineering* (Vol. 883, No. 1, p. 012167). IOP Publishing.

8. Alimova Zebo, & Usmanov Ilkhomjon. (2022). The dependence of the wear of engine parts on the evaporation temperature of gasoline. *The American Journal of Interdisciplinary Innovations and Research*, *4*(03), 7–11.

9. Alimova, Z. (2023). Effect of activation of alkaline additives in oils for wear of engine parts. *Scienceweb academic papers collection*.

10. Alimova, Z. X., Kholikova, N. A., Kholova, S. O., & Karimova, K. G. (2021, October). Influence of the antioxidant properties of lubricants on the wear of agricultural machinery parts. In *IOP Conference Series: Earth and Environmental Science* (Vol. 868, No. 1, p. 012037). IOP Publishing.

THE ROLE OF PERSONAL (INDIVIDUAL) MOBILITY IN IMPROVING THE QUALITY OF ROAD TRAFFIC

Sushko A.A.[1)], **Bakhanovich A.G.**[2)], **Mukhitdinov A.A.**[3)]

[1)]Associate Professor of the Department of Administrative Activities of Internal Affairs, Educational Institution "Academy of the Ministry of Internal Affairs of the Republic of Belarus"

[2)]First Deputy Minister of Education of the Republic of Belarus, prof. BNTU

[3)] Professor of Vehicle engineering department, Tashkent state transport university

Annotation. The issues of terminology and classification of mobility aids for pedestrians participating in road traffic are considered.

Key words: Traffic rules, means of individual (personal) mobility, means of increased danger.

Introduction

From the moment of his awareness as a pedestrian, man sought to move across the surface of the earth faster than on foot. This is inherent in human nature: the speed of movement greatly influenced the survival of humans as a species. For this reason, man rode an animal, created a wheel, a cart, and a car. In fairy tales, with the help of magical power, without the strain of human effort, a stove, sleigh and other objects, such as running boots, move.

The need for a compact mobile device, with the help of which a pedestrian who has it, with the expenditure of almost the same physical strength, can move faster than other pedestrians participating in road traffic, led to the appearance of skis and skates, including roller skates, scooters and other sports equipment . The speed of movement was determined by the success of the design and the physical characteristics of the pedestrian who moved on them. A completely logical continuation of the development of the design of vehicles on which pedestrians moved was the integration of small engines, both internal combustion and electric motors, into their wheeled and other propellers. The internal combustion engine used in certain propulsion designs for moving pedestrians was not widely used and was inferior to the electric motor, which was powered by a compact energy source. We can say that progress in the design of the battery as a source of electricity has predetermined the widespread use of electric scooters and other means of pedestrian transportation.

Methods

The increase in the number of pedestrians on mechanical vehicles (hereinafter referred to as MPV), who became road users, quite naturally led to their conflict with other road users. The appearance of a “semi-finished product” (no longer a pedestrian in terms of speed of movement, and not yet a vehicle in terms of the means of transportation) on the roadway led to a conflict with vehicle drivers, and on the sidewalk - with pedestrians.

Without dwelling in detail on the designs of MSPP, it should be noted that, for example, an electric scooter can transport an individual weighing up to 100 kg and reach

speeds of up to 40 km/h. The natural question is how dangerous it is for an individual who is traveling on it both in the flow of pedestrians and in the flow of vehicles.

It is convenient to characterize a moving object by an impulse of force, the modulus of which is equal to the product of the mass of the body and its speed or the product of the force and the time of its action. If the body is at rest, the momentum is zero. Any moving body, including a motor vehicle controlled by a pedestrian, has a non-zero impulse. Force impulse is a measure of how great the force must be, acting over a certain time, to stop or accelerate a pedestrian from a place to a given speed. We are interested in the impulse of force now of collision. So, a pedestrian weighing 60 kg when moving at a speed:

- 5 km/h (walking) when colliding with a stationary object, is exposed to a force impulse of 83.3 kg*m/s;
- 12 km/h (running) when colliding with a stationary object, it is exposed to a force impulse of 200.0 kg*m/s;
- 25 km/h (driving on a motor vehicle) when colliding with a stationary object, it is exposed to a force impulse of 416.0 kg*m/s.

The impact of an impulse on the human body at a speed of more than 12 km/h will lead to a combined injury. With combined trauma, the patient receives numerous injuries to different parts of the body: head, chest, abdomen, sprains and ruptures of limb ligaments, hematomas, dislocations of joints, damage to knee joints [1, 2].

Experienced pedestrians on MSPPs most often suffer serious injuries because they have long felt like fish in water on this vehicle. Experienced riders love speed, brake sharply, and perform various pirouettes, which can result in a fall. Most hoverboards or motorcycles can reach speeds of up to 15 km per hour, and some even more. The risk of injury greatly increases self-confidence. Often a person: drives at maximum speed; does not pay attention to pedestrians or vehicles, and as a result may collide with them; turns while driving fast; takes an incorrect, insufficiently stable position on the board; drives while intoxicated (even a small dose of alcohol, which is not subjectively felt, significantly impairs coordination of movements and the ability to maintain balance); moves on a slippery surface[3].

The question is natural: - a pedestrian moving on a MCPP controls a source of increased danger or not, and MCPP a vehicle or not. Since the appearance of MCPPs, they have been outside the legal field for a relatively long time, causing harm to the health of both pedestrians moving on them and pedestrians with whom a collision occurred. Isolated cases of collisions were considered in the plane of hooliganism. However, in the second half of 2022, almost simultaneously in Russia and the Republic of Belarus, the terms “personal mobility device (hereinafter referred to as PMD)” appeared in the legal field. This is a device or appliance that is not a vehicle (hereinafter referred to as a TS), driven by an engine and intended for individual or joint (in the case of the presence of specially equipped seats) use by pedestrians (electric scooter, gyro scooter, segway, unicycle, etc.) clause 2.601 of the Traffic Regulations [4] and “individual mobility device (hereinafter referred to as SIM)” is a vehicle with one or more wheels (rollers), intended for individual human movement using an engine (engines) (electric scooters, electric skateboards, gyro scooters, segways, unicycles and other similar means) [5]. It should be noted that "other" in the term SPM includes any device or appliance driven by an engine, which a pedestrian uses individually or jointly for his/her movement. At the same time, a pedestrian operating a SPM is not a driver, and the person moving together with him/her is not a passenger. This follows from the thesis that a SPM is not a vehicle. At the same time, a vehicle is a device intended for movement on the road and for the transportation of passengers, cargo or equipment installed on it, paragraph 2.69 of the Traffic Regulations.

If, to reveal the meaning of the term, we substitute the definition of a vehicle into the term SPM, we get: SPM - a device or device that is not (a device intended for driving on the road and for transporting passengers, cargo or equipment installed on it), driven by an engine and intended for individual or joint (in the case of specially equipped seating) use by pedestrians (electric scooter, hoverboard, Segway, unicycle, etc.).

The construction of the definition of the term SPM as a device or device, through the exclusion of the term vehicle, led to the emergence of a contradiction (in the case of substituting the concept of vehicle into the term SPM): at the same time it is a device or device and not a device intended for ... transporting passengers and, at the same time, this is a device ... intended for individual or joint (in the case of specially equipped seating) use by pedestrians. At the same time, the use of SPM involves its movement with the help of an engine, and the presence of specially equipped seating areas so that the pedestrians who sit on them are passengers. At the same time, the pedestrian who drives the SPM is not vested with legal responsibility as a driver.

The construction of the definition of SIM in the traffic rules of the Russian Federation through the term TS is also not without drawbacks, for the following formal reasons. Thus, a vehicle in the traffic rules of the Russian Federation is a device intended for transporting people, goods or equipment installed on it along the roads.If we substitute the definition of a vehicle into the term SIM, we get: SIM is a device designed for transporting people, cargo or equipment installed on it on roads, having one or more wheels (rollers), intended for individual movement of a person using an engine (motors)) (electric scooters, electric skateboards, hoverboards, Segways, unicycles and other similar means) A person riding on a SIM is not a road user because “road participant” is a person directly involved in the process of movement as a driver, pedestrian, passenger of a vehicle, and not a person. If:

- a person driving a SIM driver, then the responsibilities of the driver are fully extended to him, including legal liability;

- A SIM is a vehicle, then it is subject to a list of malfunctions and conditions under which operation of the vehicle is prohibited (annex to the basic provisions for the admission of a vehicle to operation and the responsibilities of officials to ensure road safety) as far as it concerns.

The presence of additional requirements in Section 24 of the Traffic Regulations of the Russian Federation does not mean that a person traveling on a SIM should be guided only by these provisions. It is subject to all the requirements of the Russian Federation Traffic Regulations, as far as they are concerned, but there is ambiguity in the application of a number of points. For example, in the section “traffic controller signals” ... Persons using personal mobility devices for movement must be guided by traffic controller signals for pedestrians. At the same time, clause 24.2 allows the SIM to move along the right edge of the roadway. When driving on a SIM along the edge of the roadway, a pedestrian, as a vehicle driver, must be guided by the traffic controller’s signals for the vehicle, and at the same time, persons using the SIM for movement “must be guided by the traffic controller’s signals for pedestrians.” Note that not all traffic controller permitting signals for the pedestrian and the driver are the same.

The key factor in determining the means of mobility of a pedestrian, as an individual participating in road traffic, is the concept of a vehicle. In one case (traffic regulations of the Russian Federation) the mobility device is classified as a vehicle, and in the other (traffic regulations) it is not, but in both cases there are problematic issues.The way out of the current situation is seen in preserving the essence of the term TS as a device for movement with the exclusion of its features for SIM-SPM as MSPP. Electric scooters, electric skateboards, gyro scooters, segways, unicycles and other similar means of pedestrian mobility do not exclude

other means and devices that, using any engine operating on any physical principle, will allow a pedestrian to move (participate in road traffic) at a speed greater than when walking. For example, back in 1976, "seven-league boots" with an internal combustion engine were developed and manufactured at the Ufa Aviation Institute [6]. The described design has neither rollers nor wheels for movement. Thus, it is quite possible to implement a design when a pedestrian participates in road traffic and does not even touch or minimally touches the road surface. The author believes that a careful study of existing patents will provide a wide range of devices that can be classified as SIM-SPM. Tomorrow they may appear on the road and make their negative contribution to the state of road safety.

Taking into account the above, the term SIM-SPM should include the following:

- it is a controlled self-propelled object, specially designed, adapted or used for moving a pedestrian;
- a pedestrian on a SIM-SPM participates in road traffic;
- at the maximum speed of the SIM-SPM, in a collision with a pedestrian, the resulting bodily injuries will not go beyond minor injuries.

The issue of the permitted maximum speed of the SIM-SPM should be considered in the plane of the speed of the pedestrian. Thus, when walking quickly, the average pedestrian takes 120-140 steps per minute, which corresponds to a speed range of 5.6 - 6.5 km / h. The speed advantage of a pedestrian moving on a SIM-SPM, taking into account safety requirements in a collision, should not exceed 1.5-1.75 times. Thus, it is advisable to set the speed limit at about 10 - 12 km / h.

As for SIM-SPM that are used by pedestrians together (in the case of specially equipped places for sitting), it is necessary to consider such a parameter as the power of the drive electric motor. Currently, the power of the electric motor installed on the SIM-SPM fluctuates in a wide range: from several hundred to a thousand watts or more. At the same time, the minimum power in the long-term load mode (more than 0.25 kW) is defined only for a moped, paragraph 2.27 of the Traffic Regulations. A power of 250 W can be defined as the upper limit for vehicles equipped with an electric motor. This category will include bicycles with an electric motor and SIM-SPM.Taking into account the proposed upper speed limit for SIM-SPM of 12 km/h, a speed range for bicycles equipped with an electric motor can be justified as 12-25 km/h.

Thus, the term SIM-SPM can be stated in the following wording: - this is a controlled self-propelled (using any engine) object, specially designed, adapted or used to move a pedestrian participating in road traffic at a speed of no more than 12 km/h. If equipped with an electric motor, the rated maximum power in continuous load mode is up to 250 W.

As for vehicles that go beyond the speed limits established in the definition of the term for SIM-SPM, including electric bicycles, their classification is necessary by analogy with the classification of vehicles. Depending on the degree of harm caused and the severity of the consequences when participating in SIM-SPM traffic, a certain part of them can be classified as vehicles with all the ensuing consequences for their design. So, if the maximum speed is:

– up to 12 km/h and the rated maximum power in continuous load mode up to 250 W should be classified as SIM-SPM;

– up to 25 km/h and rated maximum power in continuous load mode up to 250 W should be classified as bicycles;

– up to 50 km/h – for mopeds, clause 2.27 of the SDA, regardless of the type of engine;

– 50 km/h and above – for motorcycles, clause 2.28 of the Traffic Regulations, regardless of the type of engine.

SIM-SPM for sports and other special purposes, which should not participate in road traffic, can be classified into a separate class.

Decisions

As for the classification of SIM-SPM as a source of increased danger, by default the driver of the vehicle is considered and treated as a person managing a source of increased danger. However, the current legislation does not define the term “source of increased danger.” There is only a “source of increased danger to the environment” [7]. Analysis of this term allows us to identify key points in its definition: these are objects of activity; objects carrying out activities; objects with a high level of potential danger.

In the legislation of the Russian Federation [8], a source of increased danger is recognized as any activity, the implementation of which creates an increased likelihood of causing harm due to the impossibility of full control over it by a person, as well as activities for the use, ... and other objects of production, economic or other purposes , having the same properties.From the definition of the owner of a source of increased danger, which is understood as a legal entity or citizen who uses it (a source of increased danger) by virtue of their property rights, the right of economic management, operational management or on other legal grounds (for example, under a lease, rental agreement, by proxy for the right to drive a vehicle, by virtue of an order from the relevant authority to transfer to him a source of increased danger)” [9] it follows that: the vehicle is a source of increased danger.

Conclusion

The term “harm” means injury or damage to human health, equipment or the environment [10,11], and probability is a quantitative measure of the possibility that a certain random event will occur. Trauma is traumatic damage: wounds, bruises, sprains, broken bones, dislocated joints.

The analysis shows that the source of increased danger is an object that creates an increased likelihood of causing harm due to the impossibility of complete human control over it, and this is not only the vehicle. SIM-SPM, as a MSPP, undoubtedly fully meets the stated criteria: there is no complete control on the part of the pedestrian; Even at speeds up to 12 km/h, damage is caused. A pedestrian does not undergo a medical examination to participate in road traffic and does not receive (after training) the right to drive a SIM-SPM. The amount of harm depends on the object with which the collision occurred (a child pedestrian, an elderly pedestrian, or other objects) and the mechanism of the collision itself.

In relation to road traffic, a source of increased danger should be understood as: an object (not only a vehicle) that creates an increased likelihood (the possibility of what will happen) of causing injury (wounds, bruises, sprains, broken bones, dislocated joints), due to the impossibility full control over it by the road user [12-14].

To summarize the above, we note that: in the legal field, it is advisable to consider SIM-SPM as a controlled self-propelled object (if equipped with an electric motor with a rated maximum power in continuous load mode of no more than 250 W), specially designed, adapted or used to move a pedestrian participating in road traffic at a speed of no more than 12 km/h, while it creates an increased likelihood of causing injury due to the inability of the pedestrian to fully control it.

Reference

1. https://temryuk.ru › presscenter › news › padenie-s-giro.
2. http://streetracing.ru/auto/3264-travmy-na-giroskutere-prichiny-i...

3.https://auto. rambler.ru/other/40340608/? utm_content = auto_media&utm_medium =read_more&utm_source=copylink

4. On measures to improve road safety Decree of the President of the Republic of Belarus dated November 28, 2005 N 551.

5. About traffic rules. Resolution of the Council of Ministers-Government of the Russian Federation of October 23, 1993 N 1090

6. Technology for youth 1976 issue No. 9 p.2. (magazine of Technology for Youth No. 2 1983)

7. Resolution of the Interparliamentary Assembly of Member States of the Commonwealth of Independent States No. 27-8 “On the Model Environmental Code for Member States of the Commonwealth of Independent States (General Part)” (Adopted in St. Petersburg on November 16, 2006).

8. Resolution of the Plenum of the Supreme Court of the Russian Federation dated January 26, 2010 N 1 “On the application by courts of civil legislation regulating relations regarding obligations resulting from harm to the life or health of a citizen.”

9. Resolution of the Plenum of the Supreme Court of the Russian Federation dated January 26, 2010 N 1 “On the application by courts of civil legislation regulating relations regarding obligations resulting from harm to the life or health of a citizen.”

10. Decision of the Board of the Eurasian Economic Commission N 173 “On approval of the Rules for the classification of medical devices depending on the potential risk of use” (Adopted in Moscow on December 22, 2015).

11. Kapsky, D. V. Some aspects of the use of personal (individual) mobility devices / D. V. Kapsky, E. N.Cat // Automotive and tractor engineering and road transport: Collection of scientific papers of the International Scientific and Practical Conference. In 2 volumes, Minsk, May 25–28, 2021. Volume 2. – Minsk: Belarusian National Technical University, 2021. – P. 160-165. – EDN SPKLIZ.

12. Sustainable urban mobility: theory and practice of development / A. O. Lobashov, E. N. Kot, D. V. Kapsky [etc.]. – Vologda: Publishing House “Infra-Engineering”, 2023. – 236 p. – ISBN 978-5-9729-1491-3. – EDN ADEWPO.

13. Planning for sustainable urban mobility / I. N. Pugachev, A. O. Lobashov, S. S. Semchenkov [etc.]. – Khabarovsk: Far Eastern State Transport University, 2023. – 147 p. – ISBN 978-5-262-00939-8. – EDN DOUXSG.

14. Pugachev, I. N. Development of plans for sustainable urban mobility and digital transformation in the field of traffic management, the path to further development of cities and the country as a whole / I. N. Pugachev, D. V. Kapsky // World of transport and technological machines . – 2023. – No. 3-2(82). – P. 92-99. – DOI 10.33979/2073-7432-2023-3-2(82)-92-99. – EDN AYPAQF.