TOSHKENT DAVLAT TRANSPORT UNIVERSITETI
Tashkent state transport university

International Journal Of Transport And Technological Machines
Tashkent 2024, issue 3, https://ijttm.uz/

TOSHKENT DAVLAT TRANSPORT UNIVERSITETI
Tashkent state transport university

Issue 3, 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 2024

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

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. Z.T. Maksudov, A. Sungatollakyzy, A.X. Sarmonov. OPTIMIZATION OF THE USE OF COMPLETE TECHNOLOGICAL MACHINES.....4
2. Sushko A.A., Bakhanovich A.G., Mukhitdinov A.A., A THE ROLE OF PERSONAL (INDIVIDUAL) MOBILITY IN IMPROVING THE QUALITY OF ROAD TRAFFIC.....14
3. Kadirshayev.T., Valiyev.J., Ashuraliyev E., Doliyeva D.
ANALYSIS OF PROBLEMS IN THE MAINTENANCE AND OPERATION OF ELECTRIC VEHICLES…….22

TOSHKENT DAVLAT TRANSPORT UNIVERSITETI
Tashkent state transport university
International Journal Of Transport And Technological Machines
Tashkent 2024, issue 3, https://ijttm.uz/

Optimization of the use of Complete Technological Machines

Z.T. Maksudov[1], A. Sungatollakyzy[2] A.X. Sarmonov[1]

[1]Tashkent State Transport University, Tashkent, Uzbekistan

[2] Karaganda Technical University, Karaganda, Kazakhstan

Abstract: The article presents methods and solutions to improve the efficiency of using technological machines in a set by optimizing their main operating parameters: such as the cost of transportation and loading and unloading excavation machines; productivity of technological machines in a set; the required number of machines; machine downtime during operation, etc.. The article presents a developed block diagram of the algorithm for optimizing the performance of interconnected operating technological machines in a set. The results of calculating optimization indicators for interconnected working single-bucket excavators and vehicles in the set are presented. A graph has been developed for the dependence of the cost of loading and transporting soil on the number of vehicles, which allows us to determine the optimal values for the use of working machines in the set.

Key words: technological machine, excavator, indicator, set of machines, optimization, cost, transportation, dump truck, soil.

Introduction

Optimization of technological machines in a set of machines and determination of the optimal number of vehicles in an excavator-transport set, when transporting soil for the construction of a roadbed, is a technical and economic task, the solution of which must take into account the duration of downtime of all links of the set and its impact on the productivity of the set and the cost of road works performed during the transportation of soil (in this case, loading and transportation of 1,0 m^3 of soil).

The problem under consideration pertains to the type of problems of mass servicing and operation of technological machines in closed systems. The source of service requirements is a single-bucket excavator, and the service is performed by a DOOSAN W 210 dump truck. Depending on the number of dump trucks in the set, the duration of their downtime t_{ac} and the excavator $t_{эк}$ will change, which, in turn, will affect the cost of transporting 1,0 m^3 of soil. Minimum cost value and determine the optimal number of dump trucks in the set.

The cost of loading and transporting 1.0 m^3 of soil can be determined as follows:

$$C_e = \frac{\gamma}{2GK_{ИП}K_{ИГ}}\left[C_{м-ч.ас}\left(T_{ца}+t_{ас}\right)+2C_к L\right]+\frac{C_{м-ч.эк}}{П_э}+P_п+C_{ц.м}, \quad (1)$$

where γ – bulk density of the asphalt-concrete mixture, kg/m^3; so

$\gamma = 1540$ кг/м^3;

G – dump truck load capacity, kg; $G = 16{,}0_{\text{Т}}$;

$K_{ИG}$ – coefficient of utilization of the load-carrying capacity of a dump truck;

$K_{ИП}$ – coefficient of mileage utilization of a dump truck;

$C_{м-ч.ос}$ – costs per machine hour of operation of a dump truck, independent of its mileage, sum/hour;

$T_{ца}$ – duration of the working cycle of a dump truck, h;

$t_{ас}$ – Duration of downtime of a dump truck, h;

$C_{к}$ – Costs per 1.0 km of a dump truck, sum/km;

L – дальность транспортировки грунта, км;

$C_{м-ч.эк}$ – costs per 1.0 machine-hour of excavator operation for loading soil, sum/hour;

$П_{э}$ – operational capacity of the set of machines , m^3/h;

$P_{п}$ – wages of auxiliary workers per 1.0 m3 of soil, sum/ m^3;

$C_{ц-м}$ – cost of 1.0 m3 of soil, sum/ m^3.

The operational performance of an excavator-transport set of machines for loading and transporting soil, taking into account the downtime of excavation machines, can be determined from the expression:

$$П_{э} = \frac{GK_{Т}K_{орг}K_{ИG}}{\gamma\left(T_{цэ} + t_{эк}\right)}, \qquad (2)$$

where is $K_{Т}$ coefficient that takes into account time losses due to technical reasons (due to restrictions and malfunctions, maintenance, etc.); $K_{орг}$- coefficient taking into account time losses due to organizational reasons (due to the lack of a work front, fuel and lubricants and other materials.); $T_{цэ}$- excavator duty cycle for loading soil, h; $t_{эк}$- duration of excavator downtime while waiting for the arrival of a dump truck, h.

The optimal number of dump trucks should ensure maximum productivity of the set with minimum cost of loading and transportation of 1.0 m^3 of soil. The problem can be solved using two methods: statistical modeling (Monte Carlo method) and the graphical analytical method.

When determining the optimal number of dump trucks in a set using the statistical modeling method, sequential multiple calculations of the set's productivity and the cost of loading and transporting soil are determined for various values of downtime $t_{эк}$ and t_{ac}.

The values of the variables $t_{эк}$ and t_{ac} are selected in accordance with the known distribution laws of these quantities.. The type of distribution laws for $t_{эк}$ and t_{ac} is adopted based on the results of chronometry or by analogy with previously conducted studies.

Thus, the number of dump trucks N in a set of machines that ensures the minimum cost of C_e loading and transporting soil is considered optimal..

To simplify calculations during optimization, they operate not with random values of indicators (for example, the duration of the cycle of a dump truck), selected in accordance with the law of their distribution, but with mathematical expectations of these indicators. The random nature and type of distribution law of random variables are taken into account when determining the boundaries of the interval of optimal values of the sought indicators: the number of machines, the productivity of the set and the cost of 1.0 m^3 of soil. The calculation of the values of $П_э$ and C_e is performed for $2 \div 10$ arbitrary values of N. Based on the calculation results, graphs of the dependencies are constructed:

$$П_э = \varphi(N_i) \quad (3)$$

$$C_e = \varphi(N_i). \quad (4)$$

The graph $C_e = \varphi(N_i)$ determines the minimum value of Ce and the number of dump trucks corresponding to this value. $N_{опт}$.

The calculation of the optimal number of dump trucks using the graph-analytical method is performed in the following sequence.

1. The duration of the working cycle of a dump truck is determined without taking into account the loading time using the formula:

$$T_{цс} = \frac{L}{V_{ср}} 2 + t_в, \quad (5)$$

where $t_в$ – auxiliary time for unloading, turning, etc., $t_в = 0{,}05$ ч;

$V_{ср}$ – capture length, km/h;

2. The duration of the dump truck cycle is compared with the total time it spends under unloading.

$$\frac{t_{П}N}{n} \vee T_{цс}, \qquad (6)$$

If $T_{ца} \langle \frac{t_{П}^{ср} * N}{n}$, the excavator is idle, i.e. the excavator is waiting for demands for loading dump trucks $t_{эк}$. In this case, it is determined as follows:

$$t_a = T_{ца} - \frac{t_{П}^{ср} N}{n} \qquad (7)$$

When $T_{ца} \langle \frac{t_{П}^{ср} * N}{n}$ dump trucks are idle waiting for unloading $t_{ас}$.

$$t_{ас} = \frac{t_{П}^{ср} N}{n} - T_{ца} \qquad (8)$$

3. The formula determines the productivity of the excavator-transport kit.

4. The formula determines the cost of loading and transporting 1.0 m^3 of soil.

5. Performance Calculations $П_э$ and the cost of loading and transporting 1.0 m^3 of soil C_e are produced for 2 ÷10 arbitrary values N_i.

6. Based on the calculation results, dependency graphs are constructed. $C_e = \varphi(N_i)$ и $П_э = \varphi(N_i)$.

7. According to the constructed schedule $C_e = \varphi(N_i)$ the minimum value is determined C_e and the corresponding number of dump trucks $N_{ОПТ}$. Increasing the efficiency of using excavation machines and motor transport in a set of machines by optimizing their work during the construction and operation of highways is a very urgent task. The efficiency of operation of interconnected excavator-transport machines in a set in the technological process is determined by ensuring the continuity of their joint operation, completed on the basis of calculation of the main output parameters of the machines. Based on the obtained results of the conducted research, the operational productivity of the set of machines taking into account the downtime of the single-bucket excavator tэк is determined by the obtained research formula

$$П_э = \frac{7{,}752}{0{,}018 + t_{эк}} \quad \ldots\ldots\ldots\ldots\ldots\ldots (9)$$

where $t_{эк}$ is the idle time of a single-bucket excavator, determined by research, h.

Calculation of the cost of loading and transportation C_e, taking into account the downtime of motor vehicles during transportation and unloading of 1.0 m^3 of soil, they are produced according to the formula obtained as a result of the study:

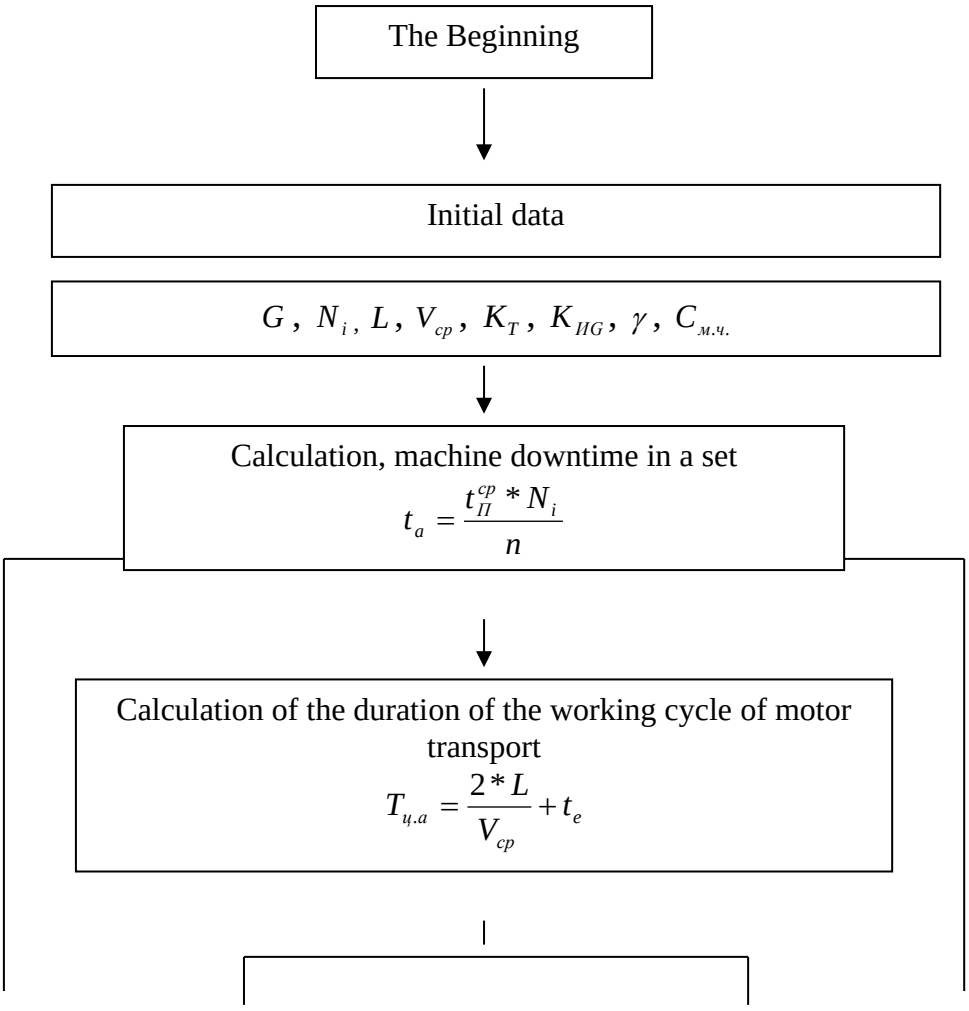
$$C_e = 135{,}3 + 6{,}55 * t_{ac} + \frac{98{,}6}{П_э} \quad \ldots\ldots\ldots\ldots\ldots\ldots (10)$$

where t_{ac} - is the idle time of motor transport determined by the results of the study.

The optimal number of vehicles in a set of machines should ensure maximum productivity of the set with minimum cost of transportation and unloading of soil.

To simplify calculations during optimization, they operate not with random values of indicators (for example, the duration of the cycle of a dump truck), selected in accordance with the law of their distribution, but with mathematical expectations of these indicators.

To solve the planned tasks, a graph-analytical research method is considered, for which a block diagram of the algorithm for optimizing the indicators of excavator-transport set of machines was developed, which is presented in Fig. 1.



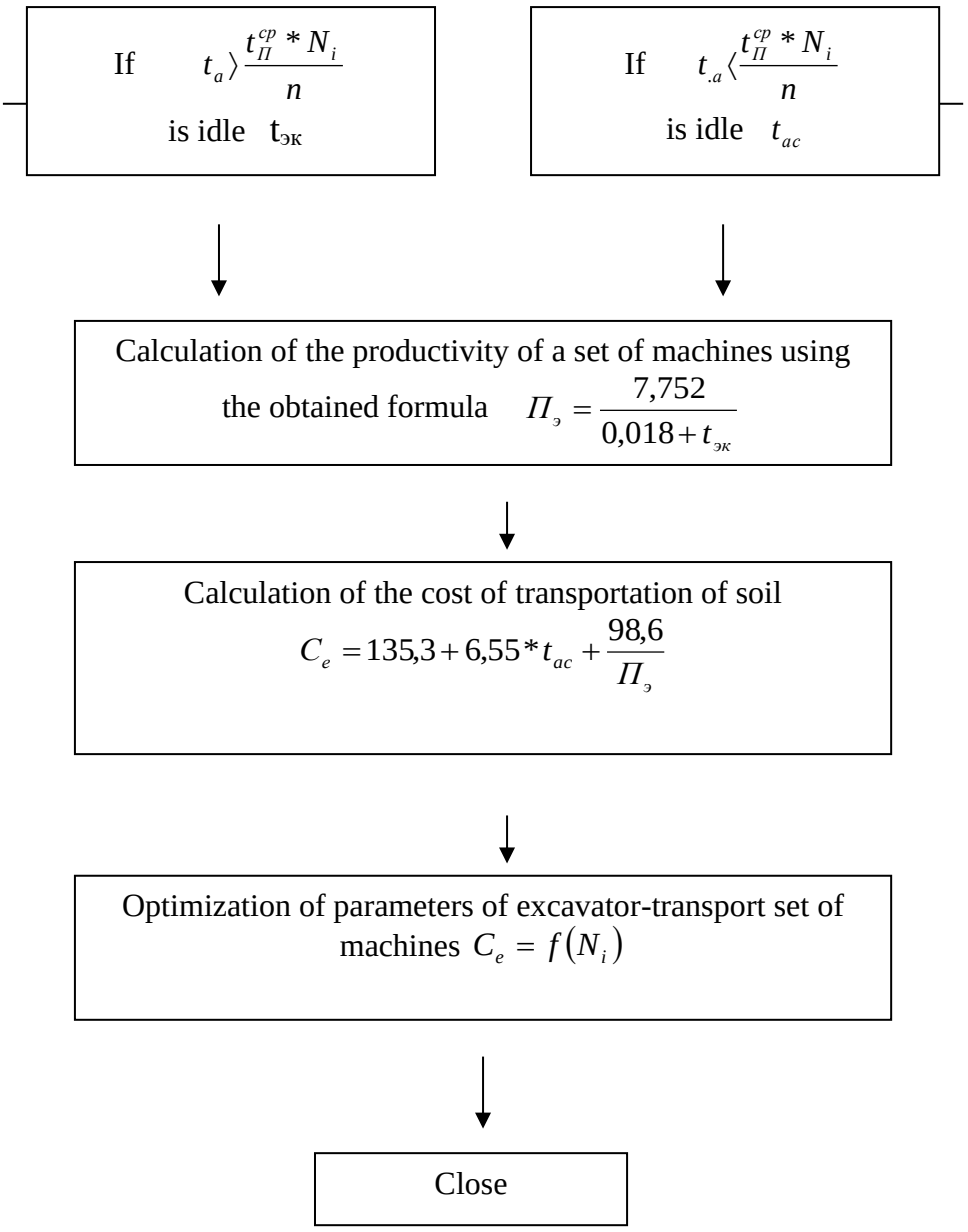


Fig. 1. Block diagram of the algorithm for optimizing the indicators of the machines in the set.

The results of calculating the optimization indicators of the machines in the set are presented in Table 1.

Results of calculation of optimization indicators of machines in a set.

Table 1.

№ п/п	Number of dump trucks	Operating productivity of a set of	Excavator downtime duration	Duration. of dump truck downtime	Cost of transportation of materials

		machines			
	N_i	$П_э$, m³/h	tэк, h	t_{ac}, h	C_e тыс.сум/м³
1	2	23,63	0,31	0	141,50
2	3	41,23	0,17	0	138,80
3	4	133,65	0,04	0	136,30
4	5	430,67	0	0,10	136,18
5	6	430,67	0	0,23	137,04
6	7	430,67	0	0,36	137,89
7	8	430,67	0	0,50	138,81
8	9	430,67	0	0,63	139,66
9	10	430,67	0	0,77	140,47

Thus, according to the obtained results of the experimental study of this research work, which are presented in Table 1, draw up performance graphs for a set of machines $П_э$, cost of loading and transportation from the number of vehicles N_i:

$$П_э = f(N_i) \text{ и } C_e = f(N_i) \text{.....(11)}$$

Graph of the productivity of a set of machines $П_э$ from quantity N_i DOOSAN W 210 dump truck is shown in Fig. 2

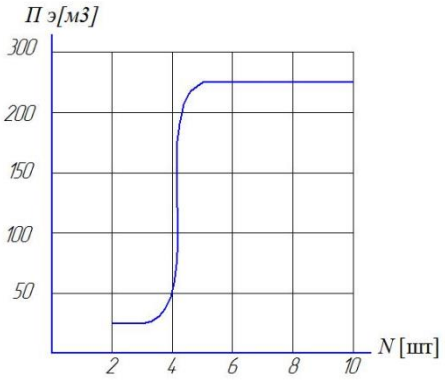


Fig. 2. Graph of the dependence of the productivity of the Pe machine set on the quantity Ni of the DOOSAN W 210 dump truck.

Analysis of the dependence graph $П_э = f(N_i)$ shows that the productivity of the excavator-transport kit, as well as the operational productivity of the excavator, depending on the number of vehicles, changes significantly, from the graph it is clear that the productivity of the excavator increases sharply to $N = 5$, and with increase $N_i \rangle 5$ The performance of the DOOSAN W 210 excavator remains unchanged, i.e. $П_э = const$ This is explained by the fact that during the operation of the machines in the excavator-transport kit, the downtime of the main machine of the DOOSAN W 210 tэ excavator is minimized, and a further increase in the number of transport only leads to an increase in the downtime of vehicles t_{ac}, i.e. a dump truck.

Thus, based on the obtained results of the experimental study, we draw up graphs of the dependence of the cost of loading and transportation of soil C_e from quantity N_i dump truck included

$$C_e = \varphi(N_i) \qquad (11)$$

.

Next, we draw up a graph of the cost dependence (C_e) loading and transportation of soil from the amount (N_i) dump truck of the MAN TGL 16.270 brand in an excavator-transport kit, which is shown in Fig. 3.

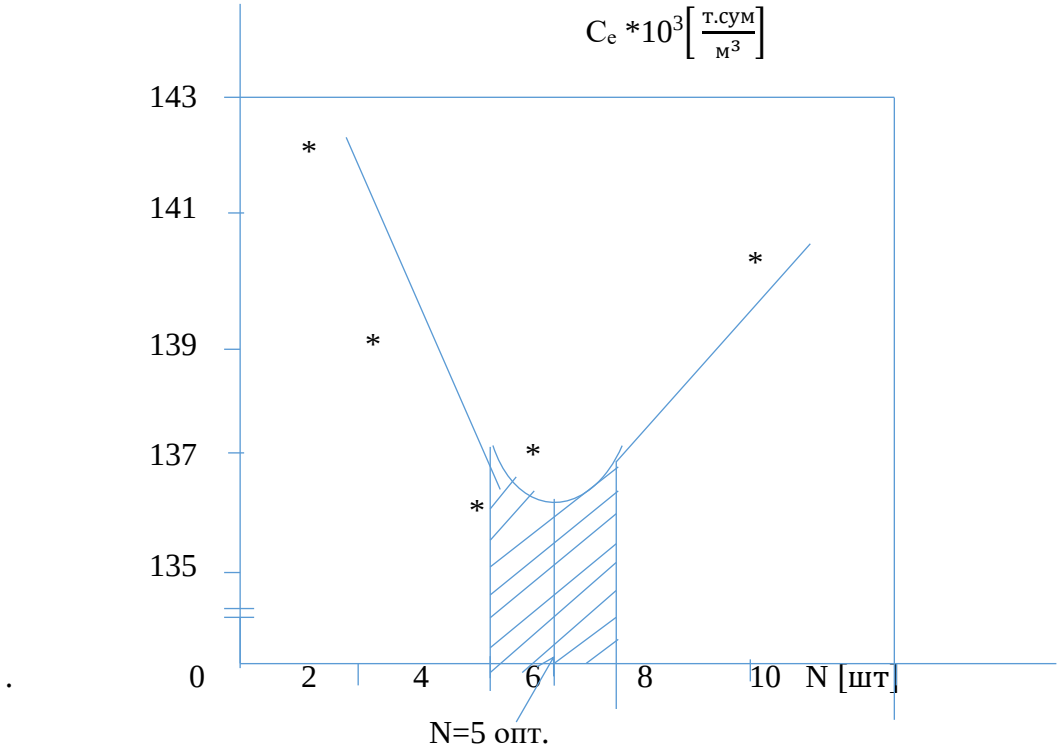


Fig. 3. Graph of the dependence of the cost of loading and transportation of soil on the number of dump trucks

MAN TGL 16. 270. From the dependence graph in Fig. 3. $C_e = f(N_i)$ it is clear that the optimal value of the number of vehicles in the set is equal to $N_{onm} = 5$.

Conclusion.

However, the reduction in the number of vehicles is lower $N\langle 5$ leads to a sharp increase in the cost of work of excavator-transport machines, as well as a decrease in the productivity of the excavator, this circumstance is associated with an increase in downtime $t_{эк}$ excavator, i.e. excavator brand DOOSAN W 210.

Thus, the optimal number of MAN TGL 16.270 dump trucks for the operating conditions of the excavator-transport kit, required for the uninterrupted operation of the kit, should be within the range $N = 4 \div 6$, this leads to minimization of downtime of machines of the excavator-transport set, i.e. $t_{эк} \to \min$ и $t_{ac} \to \min$, these circumstances lead to an increase in the efficiency of use and operation of excavator-transport machines and the entire set of machines interconnected in the technological process.

References

1. Zakir Maksudov, Kamoliddin Rustamov, Samandar Komilov Research of The Performance Indicators of Reliability of The Excavator of The Brand «DOOSAN» Problems in the textile and light industry in the context of integration of science and industry and ways to solve them: (ptlicisiws-2022) https://doi.org/10.1063/5.0145531
2. Zakir Maksudov, Mavlyan Kudaybergenov. Research on the creation of a joint filler on the basis of a trailed tractor E3S Web of Conferences 419, 01032 (2023) https://doi.org/10.1051/e3sconf/202341901032 WFCES 2023
3. Zakir Maksudov, Mavlyan Kudaybergenov Research on methods for effective use of machines in kit in construction and repair of asphalt concrete pavement E3S Web of Conferences 401, 02054 (2023) CONMECHYDRO – 2023 https://doi.org/10.1051/e3sconf/202340102054
4. Z.T.Maksudov S.M. Mirkholikov Studies of the periodicity of the service maintenance of the bulldozer “SHANTUI SD 32” on fuel consumption and workout of machines E3S Web of Conferences https://doi.org/10.1063/5.0166186
5. Tavbay Khankelov[1], Zokir Maksudov[1]*, Nafisa Mukhamedova[1] and Shavkat Tursunov[2] Crushing and screening complex for the production of compost from organic components of municipal solid waste E3S Web of Conferences 264, 01026 (2021) https://doi.org/10.1051/e3sconf/202126401026

6. Z.T.Maksudov, M.S.Kudaybergenov, K.J.Rustamov, N.B.Mukhamedova Issues of Development of an Industry Standard for Mechanized Costs of Single-Bucket Excavators in the Construction of Roads Nexus : Journal of Innovative Studies of Engineering Science (JISES)
7. Z.T.Maksudov, M.S.Kudaybergenov, K.J.Rustamov, N.B.Mukhamedova. Industry-specific cost standards for mechanized work of road equipment for the flight maintenance of highways Procediaof The oreticaland Applied Sciences
8. Tavbay Khankelov, Tulkun Askarkhodzaev, Norqul Aslanov. (2023).Modeling of segmental excavator working tool for soil compaction.E3S Web of Conferences 401(826), 1-11, doi: https://doi.org/10.1051/e3sconf/202340102052
9. Tavbay Khankelov, Nafisa Mukhamedova.(2023). Choice of garbage trucks with rational parameters according to criterion of minimum operation cycle time.E3S Web of Conferences, 401,02053 (2023) CONMECHYDRO-2023,doi: https://doi.org/10.1051/e3sconf/202340102053
10 Tavbay Xankelov, Aziz Sarmoov, Anvar Kadirov. (2023).The analytical dependence of the resistance force to digging with a bulldozer blade on the main influencing factors. E3S Web of Conferences, 458, 10001 (2023) EMMFT-2023, doi: https://doi.org/10.1051/e3sconf/202345810001

TOSHKENT DAVLAT TRANSPORT UNIVERSITETI
Tashkent state transport university
International Journal Of Transport And Technological Machines
Tashkent 2024, issue 3, https://ijttm.uz/

The Role of Personal (Individual) Mobility In Improving The Quality of Road Traffic

Sushko A.A. 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"

Bakhanovich A.G., First Deputy Minister of Education of the Republic of Belarus, prof. BNTU

Mukhitdinov A.A., professor of Vehicle engineering department, Tashkent state transport university

Abstract: 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.

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.

TOSHKENT DAVLAT TRANSPORT UNIVERSITETI
Tashkent state transport university
International Journal Of Transport And Technological Machines
Tashkent 2024, issue 3, https://ijttm.uz/

Analysis of Problems in the Maintenance and Operation of Electric Vehicles

[1]Kadirshayev.T., [2]Valiyev.J., [3]Ashuraliyev E., [4]Doliyeva D.

Tashkent state transport university, Uzbekistan, Tashkent

[1] A candidate of technical sciences, professor of the department «Automobile and automotive industry» Toshkent state transport university, Tashkent, 100109, Uzbekistan

kadirshaevt@gmail.com

[2] A PhD, Wuhan University of Technology, China

[3]A PhD candidate, department of «Automobile and automotive industry» Tashkent state transport university, Tashkent, 100109, Uzbekistan, eldorjonashuraliyev1998@gmail.com

[4] A Master candidate, department of "Automobile and automotive industry" Tashkent state transport university, Tashkent, 100109, Uzbekistan, gulielectra1@gmail.com

Abstract: Electrical vehicles (EVs) can have significant emission benefits over conventional vehicles. All EVs produce zero tailpipe emission, so they have been widely used because of their high efficiency and zero emission. It is becoming more important that to understanding, maintenance and exploitation EVs. In this paper, the general structure of electric vehicles, the electric motors and batteries used in them, and the impact of electric vehicles on the climate will be examined. The shortcomings in the technic exploitation of electric vehicles are analyzed and suitable solutions are proposed.

Key words: electric vehicle (EV), exploitation, battery, electric motor, converter, maintenance.

Introduction

With the rapid development of electronic commerce, EVs have been widely used. In Uzbekistan in January-September 2024, 16,209 electric cars were imported from abroad. Cars powered by internal combustion engines emit large amounts of particulate matter into the atmosphere, which in turn causes climate change and the development of various human diseases. The development of EVs with the advantages of high efficiency, and low energy consumption, especially zero−emission can alleviate the current social environment and energy problems. In Uzbekistan new vehicles are moving on the streets of the capital in more than 1,000 directions. As a result, the amount of toxic gases emitted into the atmosphere will be reduced by an average of 1.2 thousand tons per year.

In recent years many researches have done on electrical vehicle design, power system parameters, batteries, battery management systems, thermal management systems and control systems. There are some problems with the design and maintenance of electric vehicles, and solutions to these problems have been proposed. There is lack of research on how to exploitation

and maintenance of EVs and it will be important to improve maintenance of EVs that helps to drive without being shortcomings and making the life of EVs long.

1. **Electrical vehicles types and structures**

2.1 EVs type

Battery Electric Vehicle (BEV)- EVs with only batteries to provide power to the drive train are known as BEVs. BEVs have to rely solely on the energy stored in their battery packs; as result of that the range of such vehicles depends directly on the battery capacity. Most of this type vehicles have the problem to refill their battery and it takes nearly 24 hours when slow charger is used. However, nowadays EVs are being charged with fast charger. EVs can be charged 28 minutes. Charging times depends on various factors that are charger configuration, its infrastructure and operating power level. BEVs do not produce any green house gases and do not create any noise that is why very beneficial for the environment. Research shows that about 20%–50% or more of the driving energy is lost during the braking process. In urban areas the result of traffic congestion and traffic lights drivers have to brake. Most of the energy is spent on this process.

Hybrid Electric Vehicle (HEV)- HEVs employ both an ICE and an electrical power train to power the vehicle. The combination of these two can come in different forms. An HEV uses the electric propulsion system when the power demand is low. It is a great advantage in low speed conditions like urban areas;

Plug-in Hybrid Electric Vehicle (PHEV) The PHEV concept arose to extend the all-electric range of HEVs. It uses both an ICE and an electrical power train, like a HEV, but the difference between them is that the PHEV uses electric propulsion as the main driving force, so these vehicles require a bigger battery capacity than HEVs.

Fuel Cell Electric Vehicle (FCEV) also go by the name Fuel Cell Vehicle (FCV). They got the name because the heart of such vehicles is fuel cells that use chemical reactions to produce electricity. Hydrogen is the fuel of choice for FCVs to carry out this reaction, so they are often called ‘hydrogen fuel cell vehicles’.

Structure of EVs

The structure of electric vehicles (EVs) encompasses various components that work together to provide energy-efficient and eco-friendly transportation. Below is an outline of the key systems and components:



1. Battery system
2. Power electronics
3. Electric drive system
4. Chassis and body
5. Thermal management system
6. Control systems
7. Auxiliary systems
8. Sensors and communication systems

Figure 1. the systems of EVs

In EVs power is supplied from EVs' source to the motor through a power electronics. According to the position of the accelerator pedal, the power converter controls the power supplied to electric motor. When the vehicle is accelerating or decelerating, flo flow of power is controlled by the power converters.

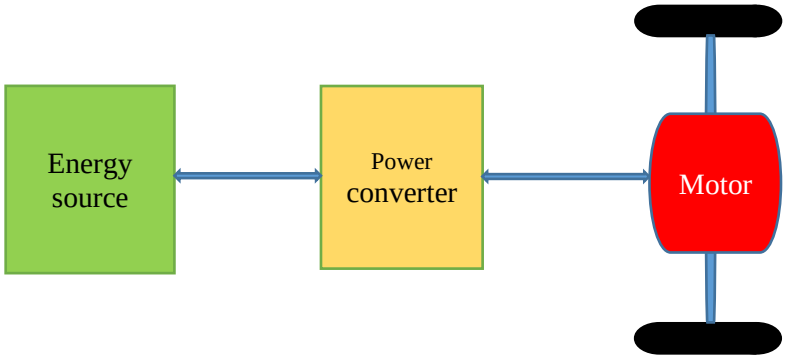


Figure 2. Basic Electric Vehicle Structure

As shown in Figure 1 the shaft of electric motor is turned by the electrical power supplied to the electric drive motor. The wheels of the vehicle is coupled to the shaft that causes movement either forward or reverse, depending on the direction the shaft is turning.

Motors on EVs

In internal combustion engine the heart of the vehicle is an engine. However, the heart of an EV is the electric drive system, and the motor is the main part of the system. In EVs, electric motor operates at all of its operating (torque/speed) ranges. The electric motor converts electric energy that is taken from the battery into mechanical energy which satisfy different driving conditions such as acceleration and deceleration rates, frequent stop-go etc., thereby motor needs to operate at its high torque density and efficiency over all speed ranges. During regenerative action, the motor works as a generator and sends energy back to the energy source. There are

various of motors are used in EVs, namely, Brushed DC motor, Brushless DC motor (BLDC), Permanent Magnet Synchronous Motor (PMSM), Induction Motor (IM), Switched Reluctance Motor (SRM), Synchronous Reluctance Motor, Axial Flux Ironless Permanent Magnet Motor etc. Axial Flux Ironless Permanent Magnet Motor is the modern one in which using metal are avoided, so the motor has less mass then others. However, complexity while producing and controlling it are being problem to use them in modern EVs.

The mechanical efficiency μ_m of electric motor is calculated as ratio of motor output power, $P_{m,chiq}$ to input power, $P_{m,kir}$

$$\mu_m = \frac{P_{m,chiq}}{P_{m,kir}} \quad (1)$$

The output power of electric motors is:

$$P_{m,chiq} = \mu_m P_{m,kir} \quad (2)$$

The output power can be calculated as:

$$P_{m,chiq} = M_m V_m \quad (3)$$

where, M_m is motor torque and V_m is motor speed

Batteries on EVs

Presently among the EV energy storage devices such as Ultracapacitor, Flywheel, battery etc., rechargeable batteries are used most of current EVs' market. Many of the type of the battery are used in EVs , however Lithium-ion batteries have a high power-to-weight ratio, high energy efficiency, good high-temperature performance, long life, and low self-discharge. Most of today's EVs are using lithium-ion batteries which can be recycled. The cost of the batteries is still becoming challenging. In terms of safety, it ranks high among the lithium-ion batteries that are currently widely used. LFP (lithium, iron, phosphate) batteries have a life cycle of 5000 cycles, and this figure can be even higher if the battery is properly operated. LFP batteries also differ from other batteries in their low cost, and this also increases the charging time of the batteries to a very high level. Generally, the amount of electric charge that a battery can store is the battery capacity. Theoretical battery capacity can be expressed as:

$$C_{T,b} = 0.278 n_b F_b z_b \quad (4)$$

Where, F_b =96.485 C/mol is Faraday constant, n_b is the amount of substance ("number of moles")

Usable capacity, $C_{U,b}$ of battery is the electric current $i(t)$ integrated over time:

$$C_{U,b} = \int_{t_0}^{t_{cut}} i(t)dt \quad (5)$$

Most of battery maker companies are giving guarantee for their batteries 8-10 years or 160000 km to keep 75% battery health.

Problems in the maintenance of electric vehicles

The main reasons for the mass adoption of electric vehicles in Uzbekistan may be the lack of technical support, long service times, and insufficient service stations. If an electric vehicle malfunctions, there are problems finding spare parts. Also, the fact that not all regions of the republic are provided with stable electricity can create problems with charging electric vehicles. The infrastructure is not yet formed. There are few charging stations. Not everyone has the conditions for charging at home (including those living in apartment buildings). There are still few auto masters who understand electric vehicles. You have to wait 1-2 months for spare parts, if your EV has been crashed or has disruption. Battery degradation. You cannot sell an electric vehicle that you have been riding for 1-2 years for the price you paid. The price can drop by 10-20 percent.

Providing the maintenance of EVs

Electric vehicles (EVs) require less maintenance than internal combustion engine (ICE) vehicles, but they have specific needs. Electric vehicles (EVs) are easier and more cost-effective to maintain than traditional internal combustion engine (ICE) vehicles due to their simpler design and fewer moving parts. Key maintenance tasks include regular battery health checks, ensuring proper charging practices, and keeping the battery management system updated. Electric motors require minimal maintenance but should be monitored for unusual noises or vibrations. Tires may wear faster due to high torque, so routine checks for pressure and tread are essential. Regenerative braking reduces wear on brake pads and rotors, but occasional inspections are still necessary. Cooling systems for the battery and motor should be checked and coolant levels maintained. Regular software updates ensure optimal performance, while periodic diagnostics and inspections of suspension, steering, and lighting systems help catch potential issues early. EVs eliminate the need for oil changes, exhaust system repairs, and other engine-related maintenance, making them highly efficient and reliable for long-term use.

Conclusions

The main reason of why EVs have been widely used is their high efficiency and zero emission. In this paper the basic structure of EV is established and the main part of the EVs are discussed. The type of EVs are introduced and their differences from each showed. The main problems on the technic exploitation of electric vehicles are analyzed and suitable solutions are

proposed. In the real time most EVs are new and have less problems with their technic conditions, however charging infrastructure are becoming main problem especially the places far from urban cities.

References

1. Electric and Hybrid Vehicles: Technologies, Modeling and Control: A Mechatronic Approach, First Edition. Amir Khajepour, Saber Fallah and Avesta Goodarzi. 2014 John Wiley & Sons, Ltd. Published 2014 by John Wiley & Sons, Ltd
2. Ashuraliyev Eldorjon Shamsiddin o‘g‘li.; Kadirshaev Turgunbay.; Valiyev Jamshid.; 5 tonnalik yuklarni samarali tashish qobiliyatiga ega bo’lgan elektr yuk mashinalari uchun elektr motorlarning tahlili. talqin va tadqiqotlar.2024, https://doi.org/10.5281/zenodo.10929242
3. Ashuraliyev Eldorjon Shamsiddin o‘g‘li.; Kadirshaev Turgunbay.; Valiyev Jamshid.; 5 tonnalik yuklarni samarali tashish uchun elektr yuk avtomobillarining batareyasini optimallashtirish. Zenodo.2024, https://doi.org/10.5281/zenodo.11493242
4. Ashuraliyev Eldorjon Shamsiddin o‘g‘li.; Kadirshaev Turgunbay.; Temperaturaning elektromobillarga va ularning qismlariga ta’siri. Zenodo.2024, https://doi.org/10.5281/zenodo.13951011
5. Fuad Un-Noor.; Sanjeevikumar Padmanaban.; Lucian Mihet-Popa.; Mohammad Nurunnabi Mollah.; Eklas Hossain.; A Comprehensive Study of Key Electric Vehicle (EV) Components, Technologies, Challenges, Impacts, and Future Direction of Development. Energies 2017, 10, 1217; DOI: 10.3390/en10081217
6. Ma, J.; Gu, F.; Feng, Z.; Zhang, S. Parameter Matching of Power Systems and Design of Vehicle Control Strategies for Mini-Electric Trucks. World Electr. Veh. J. 2023, 14, 207. https://doi.org/10.3390/wevj14080207
7. Yong, J.Y.; Ramachandaramurthy, V.K.; Tan, K.M.; Mithulananthan, N. A review on the state-of-the-art technologies of electric vehicle, its impacts and prospects. Renew. Sustain. Energy Rev. 2015, 49, 365–385. [CrossRef]