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CALCULATION OF THE EFFICIENCY AND POWER RESERVE OF AN ELECTRIC VEHICLE PRODUCED ON THE BASIS OF AN INTERNAL COMBUSTION ENGINE TRACKER VEHICLE

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Abstract

This article discusses the work being done to reduce the environmental impact of motor vehicles.

Also, the theoretical foundations for calculating the efficiency and power reserve of an electric vehicle developed on the basis of the Tracker car with an internal combustion engine are presented.

Keywords

Tracker, electric vehicle, internal combustion engine, environment, air pollution, electric engine, efficiency, power.

Аннотация

В данной статье рассматривается работа, проводимая для снижения воздействия автотранспортных средств на окружающую среду.

Также представлены теоретические основы для расчета эффективности и запаса мощности электромобиля, разработанного на базе автомобиля Tracker с двигателем внутреннего сгорания.

Ключевые слова

Трекер, электромобиль, двигатель внутреннего сгорания, окружающая среда, загрязнение воздуха, электродвигатель, эффективность, мощность.

Introduction

Paragraph 9 of the Resolution of the President of the Republic of Uzbekistan No. PQ-4477 dated October 4, 2019 “On approval of the Strategy of the Transition of the Republic of Uzbekistan to a ‘Green’ Economy for 2019–2030” sets the task of expanding the production and use of vehicles, electric vehicles, hybrid engines and gas-powered vehicles that meet Euro-4 and higher standards, have improved energy efficiency and environmental performance. This resolution is aimed at expanding the use of environmentally friendly energy sources and vehicles in the republic.

Today, the increase in the world's population and the number of vehicles is leading to an increase in demand for various energy resources. The adequacy of energy supply in terms of resources and affordability is the basis of production activities and an important condition for

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economic growth. The development of the world economy demonstrates the inextricable link between the energy base and scientific and technological progress. At each stage of the development of society, technical and technological means appropriate to that time are created and existing resources are used.

Currently, the largest consumer of energy resources is the transport sector. It accounts for about 29 percent of the total energy resources consumed. Oil occupies a leading position in this direction, accounting for 97-99 percent of the energy resources consumed by all types of vehicles. In order to reduce the environmental impact of exhaust gases, theoretical and practical calculations were carried out to determine the efficiency and power reserve of an electric vehicle created on the basis of the Tracker car with an internal combustion engine (ICE) produced in our republic.[1-3]

Technical parameters of the Tracker car

Table 1.1

The armored mass of the vehicle, m_{as}, kg	1260
The mass of the IUD, m_{iyd}, kg	105
Total mass of fuel, m_{ymm}, kg	35
Aerodynamic drag coefficient, $C_{ad.q}$	0,45
The cross-sectional surface of a car body, S, m^2	2,91
The transmission efficiency, η_{tr}, %	0.9
The number of gears of a mechanical transmission, i	4.7
Wheel diameter, D_m	0.86
Mass of the electric motor, med, kg;	45
Mass of the control inverter, m_{ni},, kg;	6
The slope of an asphalt road α, grad	20

The mass of a vehicle's internal combustion engine, without its components and fuel sources, is determined using the following formula:

$$m = m_{as} - m_{iyd} - m_{ymm}, \quad kg \qquad (1)$$

here: Values: m_{as} - 1260 kg armored mass of the vehicle;
m_{iyd} - 105 kg mass of the internal combustion engine;
m_{ymm}- 35 kg mass of fuel and lubricants

$$m = 1260 - 105 - 35 = 1120 \quad kg$$

We calculate the weight of the battery as follows.

Assuming that the average energy consumption of electric vehicles is e=0.16–0.18kWh/km, and the driving range is L=300 km, the battery capacity is calculated as follows, taking the reserve driving distance into account.[4]

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$$E = L \ \ e, \ Wh \qquad (2)$$

here: L is the total travel distance of the electric vehicle.

$$E = 300 \ \ 0{,}17 = 51, \quad kWh$$

Therefore, when choosing a battery, a battery with a capacity of 55-60 kWh is selected.
The mass of the battery is calculated using the following formula.

$$m_{akb} = \frac{E}{\varepsilon}, \ \ Mkg \qquad (3)$$

here: ε - is the specific energy density of a battery, which represents the amount of energy per 1 kg of battery mass, and for electric vehicles it is as follows:

ε=160 Wh/kg

$$m_{akb} = \frac{60000}{160} = 375, \quad kg$$

The combined mass of an electric vehicle based on the Tracker car with a full-wheel drive mechanical transmission and powertrains is determined as follows:

$$m_{em} = m + m_{akb} + m_{ed} + m_{ni}, \qquad kg \qquad (4)$$

Here:
- m - mass of the 1120 kg vehicle platform without the IYOD, its components, and fuel sources;
- m_{akb} - 350 kg mass of the battery;
- med - 45 kg mass of the electric motor;
- m_{ni} - 6 kg mass of the control inverter.

$$m_{em} = 1120 + 350 + 45 + 6 = 1521 \quad kg$$

α = The calculation for the speed of the electric vehicle V, km/h, when moving on an asphalt surface with a longitudinal slope of 0°, is carried out as follows.

When the speed of the electric vehicle is V km/h, the rotation frequency of the electric motor is determined as follows:

where: V-120km/h linear speed of the electric vehicle;
i- 4.7 number of gears of the mechanical transmission;
D-0.86m wheel diameter.

$$n_{ed} = \frac{60 \ \ V \ \ i}{3{,}6 \ \ \pi \ \ D}, \ \ ayl/daq \qquad (5)$$

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$$n_{ed} = \frac{60\ \ 120\ \ 4{,}7}{3{,}6\ \ 3{,}14\ \ 0{,}86} = 3481\ \ ayl/daq$$

The air resistance force, depending on the speed of the car (V=120), is found by the following formula:

$$F_{havo} = \frac{C_{ad.q}\ \ S\ \ \rho\ \ V^2}{2}, \quad N \qquad (6)$$

here: $C_{ad.q}$-0,45 aerodynamic drag coefficient;
S- 2.91 m² cross-sectional area of the car body;
V- 120 km/h = 33.3 m/s linear speed of the electric car. Calculations are made by converting from km/h to m/s.
ρ - air density, ρ=1,29 kg/m³.

$$F_{havo} = \frac{0{,}45\ \ 2{,}91\ \ 1{,}29\ \ 33{,}3^2}{2} = 937{,}5 \quad N$$

The frictional resistance to wheel rolling is determined as follows:

$$F_{ishq} = f\ \ (m_h + m_{em})\ \ g\ \ \cos\alpha,\ N \qquad (7)$$

Here: f is the coefficient of rolling friction on asphalt roads, f=0.018;
m_h-mass of the driver, 80 kg;
g-free fall acceleration, 9.81 m/s².

$$F_{ishq} = 0{,}018\ \ (80 + 1921)\ \ 9{,}81\ \ 0{,}99 = 350 \quad N$$

All resistances to the movement of an electric vehicle at a constant speed are determined by the following formula.

$$F_{em} = F_{ishq} + F_{havo},\ N \qquad (8)$$

$$F_{em} = 350 + 937{,}5 = 1287{,}5 \quad N$$

The value of the torque required by an electric motor to travel at a given speed (V=120) is determined by the following expression:

$$M_{em} = \frac{F_{em}\ \ D}{2\ \ \eta_{tr}\ \ i},\ N\ \ m, \qquad (9)$$

$$M_{em} = \frac{1287{,}5\ \ 0.86}{2\ \ 0{,}9\ \ 4{,}7} = 130{,}9 \quad N\ \ m,$$

here: η_{tr} -transmission utilization coefficient.

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The power output from the power unit for driving at a given speed (V=120) is determined by the following expression:

$$P_{chiq} = F_{em} \quad V, W \quad (10)$$

$$P_{chiq} = 1287,5 \quad 33,3 = 42873,75 \quad W$$

The power output from the battery pack for driving at a given speed (V=120) is determined by the following expression:

$$P_{akb,chiq} = \frac{P_{chiq}}{\eta_{ed} \quad \eta_{inv}} \quad W \quad (11)$$

$$P_{akb,chiq} = \frac{42873,75}{0,9 \quad 0,98} = 48609,7 \quad W$$

here: η_{ed} -efficiency of an electric motor, η_{ed} =0,9;

η_{inv} -inverter utilization factor, η_{inv} =0,98.

The reserve range of an electric vehicle with a single electric motor without a recuperation system is calculated as follows: [5]

here: $W_{akb} = 50kW$ - total battery capacity.

We accept.

$$L_{zax,yo'l} = \frac{W_{akb} \quad V}{P_{akb,chiq}}, km, (12)$$

$$L_{zax,yo'l} = \frac{50000 \quad 120}{48609,7} = 123,4 \quad km$$

Conclusion. In order to reduce the impact of exhaust gases on the environment, theoretical calculations were carried out using formulas for calculating the efficiency and power reserve of an electric vehicle based on the Tracker car with an internal combustion engine (ICE), which is produced in our republic. The following results were achieved using formulas 1-12:

$L_{zax,yo'l}$ =123,4 km

$P_{akb,chiq}$ =48609,7 W

P_{chiq} =42873,75 W

M_{em} =130,9 Nm

F_{em} =1287,5 N

F_{ishq} =350 N

F_{havo} =937,5 N

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n_{ed}=3482 *ayl / daq* , the calculation results fully meet the requirements.

Based on the results obtained, it can be concluded that the internal combustion engines on the Trakker and similar vehicles can be considered as initial data for adapting vehicles with exhausted or low-efficiency internal combustion engines to electric vehicles.

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