

EXPERIMENTAL RESEARCH OF POWER CHARACTERISTICS CAR TOYOTA PRIUS IN THE MODE ELECTROMOBILE

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Abstract. It is spent experimental researches of power characteristics of the hybrid car of Toyota Prius in a car mode. It was produced by the calculation consumed electric energy, that consumes the Toyota Prius at 1 km run at different speeds. The basic purpose of the traction storage battery as part of hybrid power-plant of Toyota Hybrid System is defined.

Keywords: Toyota Prius, high-voltage battery, electric traction, electric, hybrid power plant Toyota Hybrid System, power characteristics.

ЭКСПЕРИМЕНТАЛЬНОЕ ИССЛЕДОВАНИЕ ЭНЕРГЕТИЧЕСКИХ ХАРАКТЕРИСТИК АВТОМОБИЛЯ TOYOTA PRIUS В РЕЖИМЕ ЭЛЕКТРОМОБИЛЯ

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Аннотация. Проведено экспериментальные исследования энергетических характеристик гибридного автомобиля Toyota Prius в режиме автомобиля. Проведен расчёт потребляемой электрической энергии, которую Toyota Prius расходует на 1 км пробега при различных скоростях движения. Определено основное назначение тяговой аккумуляторной батареи в составе гибридной силовой установки Toyota Hybrid System.

Ключевые слова: Toyota Prius высоковольтная аккумуляторная батарея, электрическая тяга, электромобиль, гибридная силовая установка Toyota Hybrid System, энергетические характеристики.

ЕКСПЕРИМЕНТАЛЬНЕ ДОСЛІДЖЕННЯ ЕНЕРГЕТИЧНИХ ХАРАКТЕРИСТИК АВТОМОБІЛЯ TOYOTA PRIUS У РЕЖИМІ ЕЛЕКТРОМОБІЛЯ

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Анотація. Проведено експериментальні дослідження енергетичних характеристик гібридного автомобіля Toyota Prius у режимі електромобіля. Проведений розрахунок споживаної електричної енергії, що витрачає Toyota Prius на 1 км пробігу при різних швидкостях руху. Визначено основне призначення тягової акумуляторної батареї у складі гібридної силової установки Toyota Hybrid System.

Ключові слова: Toyota Prius, високовольтна акумуляторна батарея, електрична тяга, електромобіль, гібридна силова установка Toyota Hybrid System, енергетичні характеристики.

Introduction

The main condition that faces developers of vehicles, is search of ways for decrease in emis-

sions of polluting substances and minimisation of negative influence on environment. Therefore in motor industry for today the special attention is given to questions creation of ecologically

safe vehicles. Perspective and priority direction of development of motor industry is working out and creation of electromobility.

But for today electromobility in comparison with cars with internal combustion engines concede behind cost, technical characteristics and convenience to operation. Energy sources of electromobility is traction high-voltage battery which can compete to gasoline behind energy density. The first step to working out of a non-polluting vehicle is application on it of a hybrid power-plant. It harmoniously unites positive properties of an internal combustion engine and electric cars on different modes movements.

Analysis of researches and publications

Comparatively non-polluting car is the hybrid car with a power-plant which includes in itself an internal combustion engine, a traction electric motor, energy storage and a control system. Therefore at the present stage it is necessary to develop road vehicles with hybrid power-plants which the engine unites positive qualities of an internal combustion engine and electric [1].

The most mass hybrid car in the world of Toyota Prius which enters into ten cars changed the world. Toyota Prius car has possibility to move only on electric draught without internal combustion engine application, therefore dynamic properties of this movement directly depend on condition high-voltage battery. Condition high-voltage battery of hybrid cars and electromobility is their basic indicator economic and dynamic characteristics [2-3].

Purpose and problem statement

Research objective is increase of ecological compatibility and profitability of cars for the account of introduction of hybrid power-plants which can work in an electromobility mode. Object of research - process of research of power characteristics of cars of Toyota Prius without internal combustion engine connection. The core is the condition and operating modes high-voltage battery which works as a part of a hybrid power-plant of Toyota Hybrid System. For an adequate estimation of condition high-voltage battery it is necessary to spend an experimental research by definition of dependence of currents of discharge high-voltage battery on various speeds of movement of the car in an electrodraught mode. Results of real experiment will

form base for carrying out of calculation by electric base for carrying out of calculation of electric energy which spends Toyota Prius car for 1 km of run at different speeds of movement. It will allow to formulate corresponding conclusions concerning profitability of hybrid cars in a mode of an electromobility and defines basic purpose high-voltage battery as a part of a hybrid power-plant of Toyota Hybrid System. This data will be useful by working out of a hybrid power-plant of new type.

Experimental researches of the Toyota Prius

Hybrid car of Toyota Prius 2001 p was used for experimental research which is located in laboratory of hybrid cars of chair of automobile electronics KhNAHU. The basic technical characteristics of the car are resulted in the tabl. 1.

Table 1 Characteristics Toyota Prius

Basic characteristics		Prius-1
Traction battery	Capacity, A·hour	6
	Weight, kg	57
	Voltage, V	288
	Power W_{HVB} , kW·h	1,73
Motor power, kW		30
ICE	Capacity, kW	43
	Max. revs, r/min	4000
	Amount, cm ³	1498
Total capacity, kW		58
The maximum speed / on the drive, km/h		160/40
Acceleration from 0 to 100 km/hour, s		15,5
Weight, kg		1240
Blowout CO ₂ , g/km		108
Average fuel waste, l/100 km		5,1

On chair of automobile electronics KhNAHU the information-measuring complex which is appointed for registration of key parametres that characterises functioning high-voltage battery, the generator, an electric motor and Toyota Prius internal combustion engine is developed. For definition of a condition of blocks high-voltage battery it is applied mobile universal software and hardware to diagnosing of an electric equipment of cars on the basis of motor-tester MODIS.

At the beginning of the experiment the battery is charged to 54% power with a battery voltage of 15.58 V to 15.67 V. Then automatically connected internal combustion engine to charge high voltage battery. When the battery is charged to 70% of ICE is automatically disabled.

Experiment was spent as follows. For the account of a bias of a highway, a direction and a strength of wind, the car at first moved at first with constant speed in one direction. The current of category high-voltage battery was defined. Then movement was carried out in the opposite direction with the same speed and registration of a current of the category of the battery. Results of the spent real experiment on operation of the car of Toyota Prius-1 in an electrodraught mode on the horizontal section a road in the street Pushkinska of Kharkiv, in the form of dependence of arithmetic-mean current high-voltage battery on speed of the car, It is shown in tab. 2

Table 2 Dependence of a digit current of the storage battery, power and electric energy on speed of the car

V, km/h	10	20	30
\bar{I} , A	5,86	10,07	13,65
P, kW	1,69	2,9	3,93
W, W·h/km	167	145	131

In an electromobile mode on one electric energy of Toyota Prius can accelerate momentum to 40 km/hour, but in real movement it was possible to support speed more than 30 km/hour. It is connected by that at the further dispersal of the car there is an automatic inclusion of an internal combustion engine. Thus voltage on blocks high-voltage battery has made from 14,98 V to 15,09 V. It means that condition high-voltage battery of the experimental hybrid car of Toyota Prius, satisfactory, and voltage its stable. The control system of a hybrid power-plant of the car of Toyota Prius supports an optimum level of a charge and optimum temperature high-voltage battery. Both these functions support long service life of the battery.

Calculation of the consumed electric energy on 1 km of run of the car. Let's accept that voltage high-voltage battery it is equal 288 V. The initial current of a charge of the battery from an internal combustion engine has made 16,4 A. The current falls on exhibitor dependences at the further discharge. Let's spend calculation of electric energy W which spends high-voltage battery Toyota Prius for 1 km of run in a mode of an electromobile with switched off by an internal combustion engine, W -hour/km

$$W = \frac{\bar{I} \cdot U \cdot t}{S},$$

where U – voltage battery, V; t – time, h;
 $S = V \cdot t$ – distance, km; V – speed, km/h.

High-voltage battery Toyota Prius spends for 1 km of run in electromobile mode

$$W = \frac{I \cdot U}{V} = \frac{13,65 \cdot 288}{30} = 131 \text{ W} \cdot \text{h/km}.$$

Profitability of the hybrid car of Toyota Prius in a mode of an electromobile and full of power consumption traction high-voltage battery according to passport data has made 1,73 kW·h/km. The maximum distance which can overcome the car on electric draught has been received

$$S_{electro} = \frac{W_{HVB}}{W} = \frac{1730}{131} = 13,2 \text{ km}.$$

Given the fact that the car can overcome the Toyota Prius in electric traction distance of 2 km, the traction high-voltage battery energy is used for movement in electric mode less than 15 %.

Conclusion

The control system of hybrid propulsion car Toyota Prius constantly ensures that during the high-voltage battery is not discharged below 50% of its capacity and not charged for using the internal combustion engine more than 70% in basic. High-voltage battery consisting of hybrid propulsion Toyota Hybrid System is designed not to move the car on electric traction and damper is power, and is designed to collect excess energy released when the engine of internal combustion and electric generator when braking energy recuperation car.

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