

- Електроніка. Сучасні Технології. – ХНАДУ. – Харків. – 2013. – №4. – С. 15 – 18.
4. Гибридный автомобиль [Электронный ресурс] // Системы современного автомобиля. – Режим доступа: <http://systemsauto.ru/engine/hybrid.html>.
5. Электромобиль-гибрид с возможностью подключения к электросети – машина будущего? (дополнительные и ионные батареи) [Электронный ресурс] // Авто Релиз.ру. – Режим доступа: <http://autorelease.ru/articles/automobile/347-gibridnyj-elektromobil-s-vozmozhnostyu-podklyucheniya-k-elektroseti-mashina-budushhego.html>.
6. Гибридный автомобиль [Электронный ресурс] // Словари и энциклопедии на Академикe. – Режим доступа: <http://dic.academic.ru/dic.nsf/ruwiki/72359>.
- Рецензент А.В.Бажинов, профессор, д-р техн. наук, ХНАДУ.
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## PRINCIPLES OF CONSTRUCTION HYBRID POWER INSTALLATIONS

O. Smyrnov, associate professor, cand. eng. sc.,  
S. Klymenko, student, KhNAHU

**Abstract.** A new classification of the hybrid power plant, that defines of their creating at the main decisive principle: economic, energy and ecological. At creating hybrid vehicles in the budget segment, the most promising is the economic principle of the hybrid power plant.

**Keywords:** hybrid vehicle, hybrid electric, hybrid power plant, construction principle, internal combustion engine, electric motor, traction battery.

## ПРИНЦИПИ ПОБУДОВИ ГІБРИДНИХ СИЛОВИХ УСТАНОВОК

О.П. Смирнов, доцент, к.т.н., С.І. Клименко, студент, ХНАДУ

**Анотація.** Запропонована нова класифікація гібридних силових установок, яка визначає їх побудову за основним вирішальним принципом: економічним, енергетичним або екологічним. При створенні гібридних транспортних засобів у бюджетному сегменті самим перспективним є економічний принцип побудови гібридних силових установок.

**Ключові слова:** гібридний транспортний засіб, гібридний електромобіль, гібридна силова установка, принцип побудови, двигун внутрішнього згорання, електричний двигун, тягова акумуляторна батарея.

## ПРИНЦИПЫ ПОСТРОЕНИЯ ГИБРИДНЫХ СИЛОВЫХ УСТАНОВОК

О.П. Смирнов, доцент, к.т.н., ХНАДУ, С.И. Клименко, студент, ХНАДУ

**Анотация.** Предложена новая классификация гибридных силовых установок, которая определяет их построение по основному решающему принципу: экономическому, энергетическому или экологическому. При создании гибридных транспортных средств в бюджетном сегменте самым перспективным является экономический принцип построения гибридных силовых установок.

**Ключевые слова:** гибридное транспортное средство, гибридный электромобиль, гибридная силовая установка, принцип построения, двигатель внутреннего сгорания, электродвигатель, тяговая аккумуляторная батарея.

## Introduction

Research development adverse effects a motor transport complex allows to determine two ways influence of motor transport on the environment it is not enough considering the high level of eco-technology excellence. Firstly, motor transport consumes a significant amount natural materials and raw primarily non-renewable and deficit energy carriers such as oil or gas, and secondly - polluting. These problems can be complex addressed at the expense the development and introduction hybrid vehicles and electric cars.

At synthesis of new hybrid vehicle designer, foremost, must decide a number questions. What to be a car? What purpose it has to perform? On what principles it being built power plant? Therefore propose a new classification of hybrid power plant that correspond various principles of constructing: economic, energy and ecological.

## Analysis of researches and publications

For today no single concept concerning construction of hybrid power plants, each manufacturer inculcates its own version hybrid technology. Hybrid power plants are classified by the method connection of engines and storage to drive: sequential, parallel, sequential-parallel. Automobile Corporation General Motors inculcates a sequential hybrid circuit in the electric hybrid Chevrolet Volt. International industrial company Honda Motor Co., Ltd. develops hybrid vehicles Honda Insight, Honda Civic Hybrid, Honda CR-Z and others for parallel circuit. Automobile building Corporation Toyota Motor Corporation lets out hybrid vehicle lineup of Toyota Prius, Lexus RX400h, Lexus GS450h and others on sequential-parallel technology [1-3].

## Purpose and problem statement

Research purpose – conduct is a new classification formation of hybrid vehicles, which takes into account decisive principle of creating a hybrid power plant.

Object of research - the process of designing hybrid vehicles. The new classification of hybrid power plants still in the early design allows you determine the decisive principle of construction: economy, energy, ecological.

## Economic principle of construction hybrid power plants

Economic principle implies construction of a hybrid power plant in the budget segment. This means that electric drive will cost no more than 30% of the value of basic automobile. Traction electric motors realize the maximum moment on the start at small frequency of rotation, so they, unlike ICE, demonstrate high energy economical at sustainable speed 6,94...8,33 m/s (25...30 km/h.) (fig. 1).

Dependence relative distance run on the speed of the car with ICE received from the typical fuel characteristics of sustainable car movement [4], %

$$D = \frac{Q_{min}}{Q_n} \cdot 100\% , \quad (1)$$

where  $Q_{min}$  – minimum fuel consumption, l/100 km;  $Q_n$  - current fuel consumption, l/100 km;

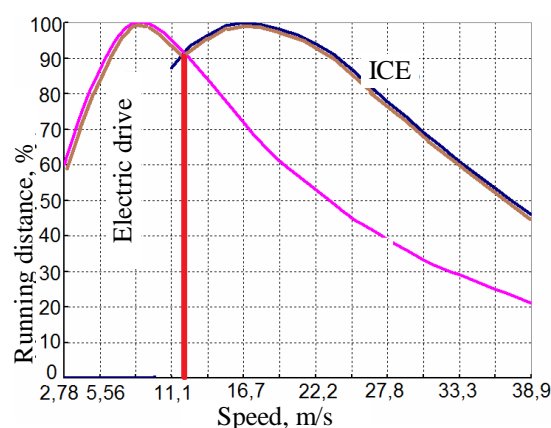


Fig. 1. Illustration economic principle of building hybrid power plants

According fig. 1 movement on electrical drive

hybrid vehicles, which created for economic principle, occurs approximately to a speed of 11,1 m/s (40 km/h.). The further overlocking expedient to using ICE. At this ratio of the power of the electric motor to the power ICE is within 1/3...1/2. Positive qualities of a hybrid vehicle, such as the movement on electrical drive, charge unit traction battery from stationary electrical grid are stored.

The economic principle of construction of hybrid power plants optimal use economic opportunities a traction electric motor and internal combustion engine and is the most promising when creating of hybrid vehicles in the budget segment. By the economic principle built a few hybrid vehicle concepts which are creat at the department of automotive electronics KhNAHU based Tavria Pickup and Lanos Pickup [1,2,5].

### Energy principle of construction hybrid power plants

The energy construction principle of hybrid power plants considering the motion a hybrid vehicle from point view of optimal consumption energy (fuel and electric power) considering coefficient of efficiency of electric motor and ICE. Calculations of effective energy ICE released at the combustion of gasoline, carried out on formula, kW·h.

$$Q_e = \eta \cdot \frac{H_u \cdot V \cdot \rho}{1000}, \quad (2)$$

where  $\eta=0,3$  – effective efficiency ICE;  $H_u=44,0$  MJ/kg=12,22 kW·h/kg – lower combustion temperature gasoline AI 95;  $V$  – the volume of spent gasoline, l;  $\rho=750$  kg/m<sup>3</sup> – the specific density gasoline AI 95.

The point of intersection dependence fuel consumption ICE of a speed that is built with the typical fuel characteristics sustainable car movement considering recalculating formula (2) and dependence, obtained by results of mathematical modeling in economical vehicles mass of 1200 kg which apply traction electric drive and considering coefficient of efficiency of the electric motor ( $\eta_{EM}=90\%$ ) corresponds to the speed of the vehicle about 22,22 m/s (80 km/h.) (fig. 2).

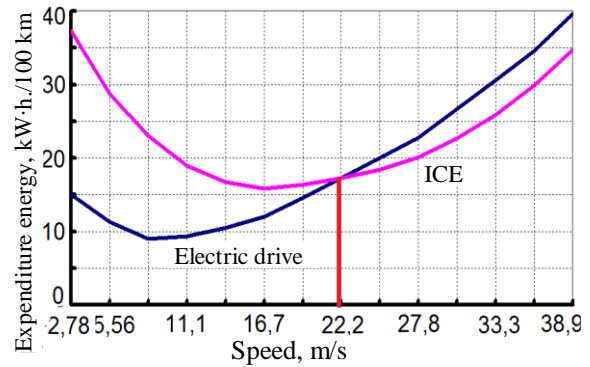


Fig. 2. Illustration energy principle of building hybrid power plants

According to the energy principle of building hybrid power plants appropriate to apply traction electric drive at speeds up to 22,22 m/s (80 km/h.), and at higher speeds apply ICE. The ratio power an electric motor to power the ICE is within 1/2...1/1. To the car built by the economic principles can be attributed Toyota Prius versions 2 and 3 in which the maximum speed on electric drive reaches 16.67 m/s (60 km/h.).

### Ecological construction principle hybrid power plants

In constructing hybrid propulsion system for the ecological principle movement vehicle throughout the speed range is exclusively on electric drive and system ICE - generator sets connected in the exhaustion of energy block traction battery for its charge (fig. 3).

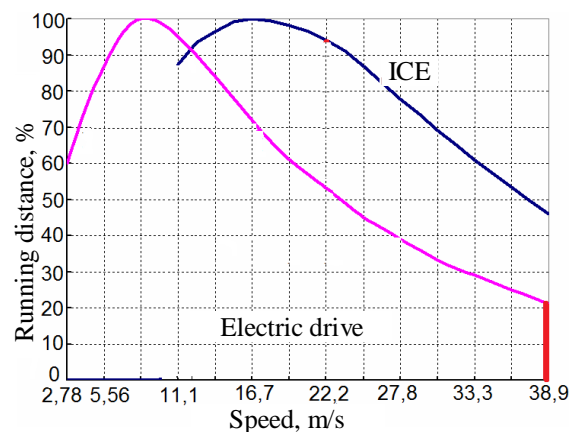


Fig. 3. Illustration economic principle of building hybrid power plants

To implement the ecological principle of construction of hybrid power plants must use electric motors to high power, so the power of the electric motor should be more power ICE,

and the ratio of these power can be within 1/1...2/1. A typical example a car that is built on ecological principles a hybrid electric Chevrolet Volt.

### Comparison construction principles hybrid power plants

Work hybrid power plants on different principles can be demonstrated for example to overcome the hybrid vehicle European driving cycle (fig. 4).

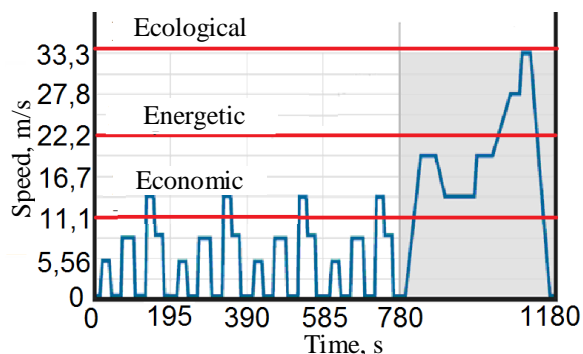


Fig. 4. Example connection ICE

Part of the range speed is overcome the help of electric motor, and the other part by means of ICE. When reaching the appropriate speed for the realization of economic or power principle construction of hybrid power plants connected ICE.

### Conclusion

For the purpose of increase competitiveness and economic attractiveness ecologically friendly vehicles they should be realized in the budget segment, and the functional capabilities and performance characteristics exceed the best foreign analogues, example, such as, the Toyota Prius. In the formation of hybrid vehicles in the

budget segment the most promising is economic principle of construction of hybrid power plants that implements all the main positive qualities of hybrid vehicles such as the movement in mode electric, charge traction battery from of stationary electricity network and others.

### References

1. Бажинов О.В. Синергетичний автомобіль. Теорія і практика: моногр. / О.В. Бажинов, О.П. Смирнов, С.А. Серіков, В.Я. Двадненко; – Х.: ХНАДУ, 2011. – 236 с.
2. Бажинов О.В. Гібридні автомобілі: моногр. / О.В. Бажинов, О.П. Смирнов, С.А. Серіков С.А. та ін. – Х.: ХНАДУ, 2008. – 327 с.
3. Смирнов О.П. Аналіз схемних рішень побудови автомобіля з гібридною енергетичною установкою. / О.П. Смирнов // Вестник ХНАДУ. – 2006. – № 32. – С. 41–43.
4. ГОСТ 20306-90 «Автотранспортні засоби. Паливна економічність. Методи випробувань».
5. Смирнов О.П. Гибридная силовая установка для транспортных средств / О.П. Смирнов, А.Б. Богаевский, А.О. Смирнова // – Вісник Харківського національного технічного університету сільського господарства імені Петра Василенка. – 2013. – № 139 – С. 207-211.

Reviewer: O.V. Bazhynov, professor, Ph.D., KhNAHU

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