Influence of Hybrid Vehicles on the Environment

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Abstract: Transport is an essential infrastructure element and a necessary condition for the functioning of 
modern society, without which life cannot be imagined. Cars are the most significant integral part of the 
transport system and are characterized by the agility, high-speed delivery of goods, providing transportation 
directly from shipper to consignee, mobility that gives quick response to changes in passenger and freight 
traffic. The negative properties are high marginal costs, low productivity and adverse impact on the 
environment due to noxious emissions. Motor transport is the main source of pollution, which accounts for 
more than 70% of the overall damage. Recently there has been a steady increase in fuel and energy resources, 
which leads to rise in oil prices, energy crisis and environmental degradation. The reduction the negative 
influence on the environment can be achieved by using of hybrid cars, the development of which, currently, 
goes through a new stage.

Key words: Hybrid car · Exhaust gas emissions · Motor transport · Fuel efficiency · Environmental safety

INTRODUCTION

Transportation is the most important sector of the country and the largest integral part of infrastructure; it has a significant impact on the efficiency and dynamics of the socio-economic development both of separate regions and the state as a whole. Motor transport is the largest source of CO₂ emissions, the amount of which exceeds 70% [1]. In recent years we have achieved great results in reducing the content of harmful substances in the vehicles exhaust gas emissions. According to the data, the economic growth in region has not accompanied by the parallel increase in CO₂ emissions any more [2]. Implementation of the modern power systems of gas engines, use of catalyst converters and prohibition of the leaded gasoline allows decreasing dangerous anthropogenic impact of transport on the environment and human health significantly. Hybrid cars play an important role in this achievement due to their environmental compatibility and fuel efficiency in comparison with the vehicles equipped with an internal combustion engine (ICE). Fuel efficiency of a vehicle with hybrid electric propulsion (GEMs) has been significantly improved by reducing the time of ICE operating; now this figure reaches 60%. Hybrid electric propulsion allows decreasing soot emissions into the atmosphere up to 90-95%, nitrogen oxides emissions up to 40-50%. The lower an engine load, the higher gain in fuel economy while reducing engine capacity in ICE [3]. It makes no sense to consider cars with GEMs as a solution of all problems. It is rather an intermediate step on the way to a future car with zero emissions.

Essence: A significant increase, observed in recent years, in the consumption of energy resources leads to raise cost of raw oil, threat to the energy crisis and has a bad influence on the environmental situation. Environmental degradation is caused by harmful exposure of the vehicles exhaust gas emissions. Therefore, the main objective in the design of new cars is to improve fuel efficiency and reduction of emissions [4]. Therefore, the main objective in the design of new cars is the improvement of the fuel efficiency and reduction of emissions [4]. Automobile development trends research shows that the most promising direction in solving energy and environmental problem is considered to be an implementation of combined power propulsion on the cars that provides the required improvement in energy and environmental performances.
Hybrid car is a vehicle driven by means of the hybrid power propulsion. A distinctive feature of the hybrid power propulsion is the use of two or more sources of energy and corresponding engines that convert energy into mechanical work. Despite the diversity of energy sources, such as petrol, diesel, gas, solar energy, etc., the combination of internal combustion engine and electric motor is implemented on hybrid cars in industry. The main advantage of a hybrid car is a significant reduction both of fuel consumption and emissions, which is achieved by:

- Coherent internal combustion engine and an electric motor;
- Using a large capacity battery;
- Using braking energy regenerative braking, i.e., converts kinetic energy of motion into electrical power.

At the same time, hybrid cars use a lot of other innovations that can help save the fuel and protect the environment, including:

- Variable valve timing system;
- Stop-start system;
- EGR.

Table 1 shows the time to tighten the standards of the UNECE, including the solid particles in the period from 1992 to the present time for the most massive cars with petrol and diesel engines.

To estimate the emission production of serial cars and trucks with GVW up to 3.5 tons the European countries use the new European test cycle NEDC (New European Driving Cycle) in accordance with the Rules of Procedure of the UN # 83-05 [5]. The first part is an urban driving cycle UDC (Urban Driving Cycle) with a maximum speed of 50 km/h; it includes four consecutive driving cycles and simulates driving conditions in the city. The second part is an extra-urban cycle speed EUDC (Extra Urban Driving Cycle) with a maximum speed of 120 km/h; it simulates the movement of the car on the highway. On the whole the cycle is characterized by the following parameters: time is 1220 sec, mileage is 11007 km, average speed is 32.5 km/h, average speed excluding idling is 44 km/h, the maximum speed is 120 km/h and proportion of idling is 26.2 %.

In the last twenty years the quantity of cars has tripled and reached 36.9 million by the beginning of 2013 in Russia. At the same time the proportion of machines in operation for over 10 years (totals 18.42 million units) still remains high, it is about 49.9 %. One cannot solve the problem by bringing into service new vehicles, satisfying modern standards of emissions level, without disposal of the obsolete machines. There are two ways to reduce the transport environmental impact. The first one is calculated to the nearest future, it is a development of measures to accelerate the replacement of old vehicles by the modern ones, relevant to current level of Euro 5 requirements; this will reduce emissions to 60 % approximately. The second way is forward-looking decision, but it requires action on the program design just right now; this is a design of a comprehensive state program for the development of vehicles using alternative energy sources [6].

Ground transportation problems are associated with the operation of urban passenger transport, which plays a big role in the negative impact on the environment. Transportation of passengers in the modern city is a part of the economic turnover, being failed it can paralyze production and stop the trade. When transporting a passenger by a public transport we require from 5 to 10 times less territory and energy resources, while air emissions has from 5 to 25 times less pollutants than when transporting by the individual vehicles. The life of settlements without public transport is impossible due to

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Table 1: Exhaust emissions standards for of cars, UNECE Regulation # 83
the basic advantages: speed, comfort, accessibility [7]. To increase the safety of passenger transport and road safety in general one need to improve the reliability of drivers and provide them with the best working conditions. One way is to update a city bus fleet [8].

As a promising direction of the hybrid vehicles development we can specify the production of buses for public transport; on the one hand, the bus fleet in Russia is rather big, but on the other hand it needs to be almost full updated. Hybrid buses in this segment will not be more expensive than usual, while their sizes and dimensions allow placing the batteries without compromising the performance properties and maintenance system allows their replacement and charging [9]. As for the terms of mobility, the hybrids surpass the trolleys.

Another advantage associated with the environment is that during the idle a car with GEM generates no emissions due to battery operation. The electric motor provides instant starting and stopping, has no need for idling, which gives another important advantage—the absence of the clutch mechanism. Fuel economy in the urban cycle is 25-35 %. Economy class hybrid can travel up to 80 km and accelerate to 50-60 km/h, using only one electric drive. Due to the fact that there are two engines in a vehicle, less powerful engine can help to achieve sufficient capacity of the non-hybrid analogue. Both electric motor and internal combustion engine are activated at the time of high load operation. This provides redistribution and accumulation of power generated by the internal combustion engine, allows operating in the most favorable mode most of the time [10]. As a rule, the economy reaches 30-50 % of the capacity of traditional modification. For example, two-liter capacity is achieved in hybrid vehicle by the operation of the 1.5-liter engine together with an electric motor, the efficiency of which is 90-95 %. The sum of these factors results in less fuel consumption, a hybrid uses no more than 5-6 l/100 km in a city drive, while the vehicle equipped only by gasoline engine needs in average 11-12 l/100 km.

Fuel efficiency is determined by speed and load modes of the engine. Small load modes have low values of the mechanical and indicator coefficient of performance (COP) of the engine, because the low load increases the proportion of mechanical losses in the overall energy balance. Indicated efficiency of the spark ignition engine decreases from 0.35-0.4 to 0.2-0.25 in accordance with the load reduction. Thus, the fuel economy of a vehicle with GEMs can be significantly improved by reducing the time of the engine operation under these modes. The lower an engine load, the higher gain in fuel economy while reducing engine capacity. Reduction in fuel consumption entails reduction of harmful substances emissions into the atmosphere. Hybrids emit 90 % less soot and hydrocarbons and 50 % less nitrogen oxides. However, this effect is achieved only under the "average" operation of the vehicle, i.e. at a speed of up to 70-80 km/h in urban and not more than 120-130 km/h on the highway.

**CONCLUSION**

Currently, due to the need in radical improvement of the environmental situation the active researches of the GEMs vehicles wide use opportunities are carried on all over the globe. We can assume that hybrids will supersede the classic cars in the coming years. We also should mention the fact that electric motor generates far less noise and vibration in comparison with internal combustion engine, because the sound energy of a production process makes the certain proportion of the total energy produced by machines that has a positive effect on the environment [11]. Considering the aforesaid, we can suggest that now GEM cars are the most promising direction in solving energy and environmental problems.

The future of hybrid cars is determined by factors both similar to universal and specific. The advantages of hybrids that define a positive trend are as follows:

- Fuel efficiency of hybrids.
- Eco-friendly operation.
- Excellent handling characteristics.
- Increased driving range.
- Refilling carbon fuel in a conventional petrol station.

At the same time a number of considerable disadvantages is characteristic for the hybrid cars both from the point of view of manufacture/seller and consumer:

- Rather high price of model.
- Difficulties in batteries use: weight, transportation, charging, recycling, etc.
- Underdeveloped network of specialized stations to recharge, refuel and service, lack of qualified specialists.

Save the power, speed, acceleration and bring the rate of fuel use to a minimum at the same time is the main goal of the development and subsequent modifications of the hybrid propulsion.
REFERENCES