



SOME POSSIBLE APPLICATIONS OF ELECTRIC DRIVES IN MILITARY VEHICLES

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Abstract: The major advantages of electric propulsion compared to conventional power transmission drive of diesel engine to the wheels are presented and explained. It is briefly showed development of some electrical vehicles in our country. The analysis of the electric drive showed some advantages of electric propulsion, such as operation without thermo emission of the vehicle, improved maneuvering and noiseless operating of the vehicle and saving fossil fuel. For any applications, hybrid vehicles have some good features of electric drive and vehicles with IC engines. Some military applications in the world of electric vehicle will be shown in this paper

Key words: electric vehicles, hybrid vehicles, TAM 2001-E, military EV, Military HEV.

1. INTRODUCTION

Electric vehicles (EV) are motor vehicles fitted with an electric motor for propulsion and electrochemical energy source which carries with it[1]. Energy from electrochemical sources supplies and other support consumers in the car. Batteries may be charged from the power grid, the recuperative braking as well as through photovoltaic panels[2] installed on the vehicle or in the station to refill.

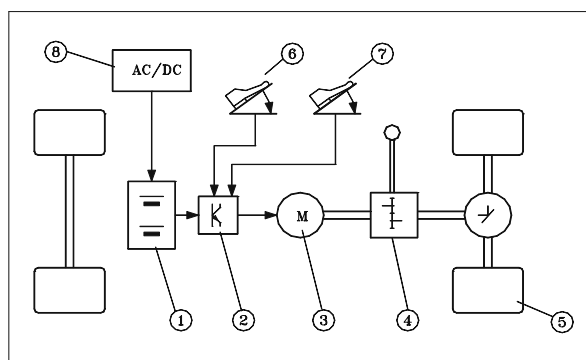
The main advantage of EV compared to vehicles with internal combustion (IC) engines, is that they are environmentally friendly since they have no emissions, they do not use fossil fuels which are less and less available, to have high efficiency and low cost propulsion system. The main drawback is poor "reservoir of power" in that it can store much less energy compared to liquid fuels.

In addition to the degree of usefulness of EV significantly higher than the equivalent cars with internal combustion engine, one can not ignore the fact that the tank cars with internal combustion engine is over 40 times more energy than in the battery for EV. To date this is still the main reason why there has been no large scale production and use of EV.

The EV's have been designed, since the beginning of the present on the same principles (Picture 1). Rechargeable battery (1), through speed controller (2) supply an electric motor (3) which, through mechanical transmission (4)

turn on wheels (5). There are two pedals, for acceleration (6) and braking (7) as battery charger. Recharging the battery pack is done through the EV charger (8) which also carries with it.

If the vehicle has a small engine with internal combustion engine (IC) equipped with a generator, this vehicle is called hybrid electric vehicle (HEV).



Picture 1. The basic components of the electric battery pack drive

Advantages of EV are well known [3,4,5]:

- There is no need for petroleum derivatives
- It is, absolutely the environmentally accepted
- It does not produce exhaust gases

- It has a quiet operation
- Vibrations are in operation at the minimum
- It is easy to manage
- There are no problems with starting, in the winter time
- It is immediately ready for operation at full power
- Operational characteristic of the electric motor is very good
- There are possibilities of overloading, especially by accelerating
- Recuperation of electric energy by breaking regime
- It has a high efficiency
- It requires a little maintenance and
- Operating costs are low.

It is normal that electric drive has a certain disadvantages, compared to existing vehicles: reducing speed, reducing the autonomy of operation without recharging, possibly increasing the mass of the drive device, and vehicle batteries and recharging problems.

The main problems in the application are rechargeable batteries. It is expecting, that significantly greater improvement.

2. BEGINNING OF EV IN THE WORLD AND OUR COUNTRY

The first transport vehicles with a mechanical drive were driven by electric power [6]. Electric vehicles (EV) appeared well before the vehicles with internal combustion (IC), so that throughout the nineteenth century EV was dominant on the roads, so even in the first race of motor vehicles won other types of cars with steam and internal combustion engines [7].

In the early production EV's were finished manually. 1910th began the mass production of internal combustion motorized vehicle assembly line. Infrastructure for EV recharge did not exist outside of urban areas so that their driving was limited.

In the early 20th century EV could not withstand the competition of much more vibrant and robust vehicles that owned internal combustion engine. The main reason lay in the fact that in the tank that has a combustion engine weight 50kg could store approximately 600kWh of energy and in electric vehicle batteries in the battery now only about 2-10kWh [8] and early 20th century, it was much less.

This has prompted that with the end of World War II production EV stops and they become just a technical vehicles - serving as a taxi, small trucks, vans and trolleys for transportation of cargo. In the late sixties and early seventies, there has been a rebirth of EV driven by concerns about air and oil embargo by OPEC. Recognizing that the EV is still not eligible to apply for its performance vehicles with internal combustion driven primarily by the big automakers have turned to the

beginning of this century, the development and sale of hybrid vehicles (HV). This reduces fuel consumption in city driving [9] and carbon emissions.

In Our country (treba koja zemlja – ne znam kome saljes ali ako nije srbin..) beginning development of EV is related to "TAM 2001" and the Bureau of autonomous electric vehicles the Institute of Technical Sciences of SANU, during mid-seventies of the twentieth century [10]. Fixed price of oil and the first "oil shock" caused the creation of the first EV in the former Yugoslavia and the Balkans, which is called the "Delivery autonomous electric vehicle." This Evis created in 1976th under the supervision of Academician Aleksandar Despić [11].

Only a few years later, the first passenger EV was created which the designer used for some period of time for driving on the streets of Belgrade. Vehicle "Trabant" reconstructed in 1979. By The prof. Stojiljkovic [12] and registered, working at the Center for chemical power sources, of the Institute for Chemistry, Technology and Metallurgy. In Zagreb, Zastava 750 car with electric drive was rebuilt

After that, there were a few successful attempts of making passenger EV by individuals and companies, such as "Gosa" and the "Red Flag". In The company "Gosa" in light vehicle with plastic superstructure, Poly-type producer "Polyester" - from Priboj inserted.



Picture 2. Commercial autonomous electric vehicle TAM 2001-E

Interest in the EV rose sharply in our country during the sanctions and the severe shortage of oil and oil products. The first and only series of EV designed for commercial use are reconstructed vehicle "Lada Niva-E." The cars were made since 1995. And they were used The number of years daily for municipal purposes in Belgrade. Early 1998. Were made "Quick Black Lada" [13]. Further working on the development of EV in the country The two autonomous electric vehicles Yugo-E were rebuilt in 1996. [14], for the purposes of the Electric Company Beograd.

At the end of the 20th century begins making EV with alternate engines. The company "Raskovnik" made some very interesting and light EV with electric capacity of 2 - 4kW. In cooperation with the fonds "Crvena zastava" and "Sever", Faculty of Electrical Engineering under the

direction of Professor Vukosavić [15], reconstructed vehicle Yugo Elektra-operating with AC electric motor 7.5 kW. EV development in our country has been gradual, according to the "step by step." Although there were a number of smaller and larger efforts on land and water to making EV, the only program that has found commercial application are the so-called "Black Lade". Work on the development of EV in our country in practically stopped in this century..

3. FACTORS IN EV DEVELOPMENT

As the main means of mass transport of the individual, the internal combustion powered cars marked the twentieth century. Modern transport with conventional (IC) engine has contributed to overall economic progress but also caused problems and environmental pollution problems and energy supply - particularly in times of energy crisis.

3.1. The population of the world's energy needs

In the early 19th century, the world was about 1 billion people. In that century the population increased by 68% and the next by 270% and reached the value of 6 billion. UN Study [16] estimate that the worldwide population would increase by 2050. to about 8.9 billion. Statistical overview of the total consumption of primary and general energy and the world since 1990. to date, as well as forecast by 2035. The point [17] to be due to increasing consumer demands, and especially because of increasing demands for the transportation of goods and people, energy demand increased by about 1.5 up to 2 % per year. It is believed that in the period from 2000. To 2050. The demand for energy will be more then doubled. Estimated share of global electricity consumption was in 2006.around 15.700TWh [18].

3.2. The use of petroleum products

Although the share of oil in total primary energy percentage decreases, production and consumption of oil is generally increasing. Efforts have been made In finding new sources but inexorable facts indicate that this type of energy is slowly drained and scientists expect that for some time sources of energy will dry up. Forecast of growth in consumption of liquid fuels for end users, according to U.S. Energy Information Administration (EIA) [19], shows that the liquid fuel consumption in this period increased from around 86.1 million bpd in 2007. to 110.6 million barrels in 2035. year or by 28.5. Oil prices reached a maximum value of 147 \$ for a barrel 2008th years and although there are forecasts that it will not exceed the value of 133 \$ to 2035 years, possibly less optimistic forecasts indicate that it may reach a value over \$ 200.

3.3. Environmental pollution

Air pollution from engines using petroleum derivatives is not limited to the immediate environment, but also has global significance. In terms of impact on global atmospheric pollution and problems associated with it, the most important effect is the increase in global mean

temperature. From the standpoint of global warming is the greatest danger represents carbon dioxide, an unavoidable component of the combustion products of petroleum derivatives [20]. In addition to air pollution in violation of the environment and space as an important part of the natural resources is oil waste, and uncontrolled release of oil [21], which pollute surface and ground water . In contrast to the natural greenhouse effect, an additional effect caused by human activity contributes to global warming and may have serious consequences for humanity. The temperature rise of this magnitude would also have impacted on the entire Earth's climate, and would be manifested as more frequent rainfall, more tropical cyclones and natural disasters every year in certain regions, or on the other hand, in other regions such as long periods of drought, which would all overall have a very bad effect on agriculture. Entire ecosystems could be severely threatened extinction of species that could not be fast enough to adapt to climate change [22].

3.4. Transport and use of EV

With the growth of population in the world there is a need to increase transportation of people, goods and raw materials as a prerequisite for the growth of production and consumption, and living standards. This constant growth is a natural and expected process of development of civilization and one of the most important indicators of development of society and humanity so that it is today a life without road traffic considered unthinkable. The world in 2010. year, according to OICA [23], produced 58,305,112 cars. China topped the list with nearly 24% produced, followed by Japan, Germany and South Korea.

Development of motor vehicles will in future be primarily dictated by the necessity of satisfying the increasing and more stringent requirements in terms of preserving natural resources and energy, as well as demands for environmental protection. The further development of motor vehicles should find solutions to basic and very important problems:

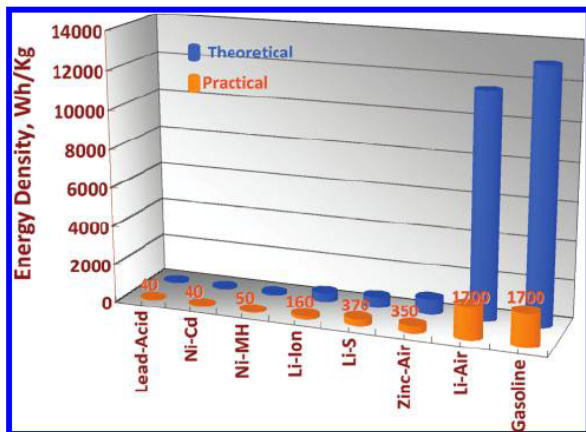
- Reduction of energy consumption to drive the vehicle;
- Saving non-renewable and renewable resources and conservation of other natural resources, including when and how the application of energy and materials for higher capacity, and their recycling and other technological processes of this type, and
- Emission reduction and other environmentally unacceptable pollution to the minimum or the extent permitted by the regulations.

3.5. New battery development

Great advantages of using electricity to power the vehicle related primarily to the fact that this type of energy can be provided from different sources. Basic and very restrictive barrier to wider application of this type of drive motor vehicles is still not well perfected system of accumulation of electricity, which is essential to drive the motor vehicle. The existing, and even the best and for this purpose specially developed batteries, have a large mass (per unit of energy), allow a relatively small capacity of

the accumulated energy, and small action radius of the vehicle, they are quite expensive and have relatively small lifetime (few cycle of charge / discharge).

If, however, find significantly better batteries, the EV in many different forms, have a great future. Since in this direction are investing a large research and development efforts are grounds to state that in the coming decades elektrovozila increasingly used, which can substantially contribute to alleviating the crisis will be a shortage of oil caused by the middle of this century. In this regard, currently the most promising Li-air batteries.



Picture 3 Specific energy of different types of batteries and gasoline [24]

4. EV WORLD DEVELOPMENT

Habits and lifestyles and work car drivers cause the corresponding technical features and characteristics of the car. EV does not yet have enough energy to be able to apply to existing vehicles with internal combustion engines. That means you do not have enough energy to consumers such as air conditioners, for example. Reservoir of energy in the EV can not be amended quickly and there are no filling stations for the distribution of electricity.

Tests EV made in our country show that reconstructed EV with 300kg of batteries with electricity from specific 35Wh/kg can cross the 50km and to develop a top speed of 75km / h. With quality, Li-ion batteries EV that is now available on the market, have external dimensions of 3.5 x1, 5m and alternating with the 35kW electric motor that can develop a maximum speed up to 130km / h [25] and cross the 150km road.

Given the inability of the previous rate of expenditure of fuel, some countries, like Italy, France and Japan, as a wise public policy, reduce the average fuel consumption in motor vehicles to 6.5 l/100km on the path in the period since 1994. to 2004. The [26], due to better internal combustion engines, lighter vehicle structures and switching from gasoline to diesel engines are more economical in the consumption of fossil fuels. Some countries, notably the United States have maintained an average consumption of liquid fuels via the path 11l/100km. That was the reason that President Obama has said 2009th The [27] that the "status quo is no longer

acceptable." Under the new standards for passenger vehicles, the average fuel consumption by 2016. year should be reduced to a level of 35.5 miles / gallon (6.62 l/100km).

If, however, the opportunity to meet the existing types of EV driving habits with conventional drive vehicles is not to be found, and vehicles with conventional drive to meet certain environmental requirements, motor vehicle manufacturers have resorted to the interim solution, so called. hybrid drive and hybrid vehicles (HV). If this vehicle has a large quantity of batteries, called "plug in" hybrid vehicles PHV. Hybrid vehicles are vehicles in which a combination of internal combustion engines (gasoline or diesel) and electric drive, but has limited features of the electric drive mode and can be supplemented from the power grid. "Plug in" HV vehicles that can move a distance of 15 to 60km with a charged battery pack and then the batteries needs to be supplemented from the power grid or by combustion engines.

The main differences between HV and "Plug in" HV Prius becomes obvious if one looks at the range or increase the radius of the vehicle in electric mode, approximately 2 km (Prius) to 23.4 km (PHV) [30]. In addition, the improved specific fuel consumption in the hybrid mode. Studies have shown that in Japan, 90% of drivers exceed the average daily distance below 50km, a 60km and 75km in the EU and the U.S. respectively. In this case, the expected cost of vehicles greatly influences the price of electricity during the day in Japan is about 20 cents/kWh and late at night around 8 cents/kWh. It should be noted that the average price of electricity in Serbia amounts to only 5 EU cents/kWh.

The best-selling hybrid car in the U.S. "Toyota Prius", has the highest demand when fuel prices rise. The state encourages the producer price of \$ 6.400, so that the standard model sells for just U.S. \$ 21.610), in [28].

Consumption per kilometer of distance traveled for this vehicle is around 48mpg (4.9 l/100km) in city driving and 45mpg (5.2 l/100km) on the open road. The global leader in HV, the Japanese company Toyota, sold over a million vehicles Toyota Prius type in the world [31].

5. POSSIBLE APPLICATIONS IN THE ARMY

Possible applications of electric drives in vehicles for military purposes are many. Primarily relate to the military vehicles that can move silently, without the thermal image with the electric drive. Equipped with internal combustion engines, as well as HV, the vehicle could move as vehicles with conventional drive when necessary and as EV, virtually noise-free.

It is known to have existed up to now certain special purpose vehicles to move through the region where there is the dominant environmental protection and the inability to use the ICE-wheel drive vehicles. Such vehicles could easily be restated to plants with AC motors and batteries much better characteristics could improve vehicle performance.

Various types of delivery vehicles with limited daily

movements magnitude are often more favorable and cost effective if they have a pure electric propulsion. To move around the polygons or dangerous places for people are the most suitable vehicle with electric drive, which would possess the extraordinary maneuverability and performance.

The range of affordable pure electric land vehicles is short at only 160 km today. Top of the market ones have many hundreds of miles range and that will permeate down to mainstream land vehicles over the next decade as many improvements are made. However, a long range car, bus or truck has to be hybrid for now. Although a hybrid bus costs up to 100% more than a conventional one, governments and fleet operators buying them tolerate a poor payback of six years or so in some cases in order to burnish their green image and increase ridership. The quieter, more comfortable ride in buses increased ridership in the Netherlands by 13% for example



Picture 4. General Dynamics Land Systems Shadow hybrid electric vehicle [29]

6. CONCLUSION

The first motor vehicle driven by mechanic power were electric. They could not stand the competition with vehicles with internal combustion engines, which marked the entire 20th century. Environmental pollution and the depletion of existing oil wells again placed in the foreground EV's. EV doesn't have emissions and do not make noise. Powered by electricity stored in batteries, and not expensive crude, which is less available in the world and therefore have certain advantages over existing vehicles with internal combustion engines.

EV with their performance remains inferior to vehicles with internal combustion engines and in relation to the current driving habits. Because of this EV are made for city driving done as a daily ride, mostly going to work in larger cities. Such vehicles have a maximum speed below the normal radii 130km/h and autonomous movement on a single charge of batteries less than 150km.

As an interim solution to a pure EV that will be able to fully replace the existing internal combustion vehicles, now are being developed HV and PHV. In urban areas these vehicles operate as an EV with a weaker performance of a van used by embedded IC engine power or recharge batteries.

It is believed that the future and the past belong to the EV. This is a positive step towards the introduction of ecological vehicle operation. However, since no definitive solution is made, experiments are to be carried out with pure electric and hybrid solutions. Despite the turbulent development of EV and HV, some experts believe that vehicles with internal combustion engines will dominate for 15 years more, but even after that won't completely disappear [30,31], primarily due to a reduction in fuel consumption per kilometer of distance. At the meeting of the Competitiveness Council in San Sebastian, in 2010, President ACEA [32] was clear: The question is whether the diesel and petrol is to be replaced by electricity and hydrogen as the dominant means of car fuel. The only question is when? Our armed forces need time to welcome the ready.

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