INCREASING THE EFFICIENCY OF ELECTRIC MOBILITY

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Abstract

In recent years, important steps have been taken in the direction of expanding the use of electric cars in our country. Electric cars are considered environmentally friendly as they do not run on fuel. Electric cars are quiet and comfortable. There are three types of electric cars. Fully electric, hybrid and plug-in. Fully electric forms of hybrid electric cars are designed for short distances. Because their energy decreases on a long journey and it is necessary to re-accumulate energy. Some cars use solar energy to provide part of their electricity needs. Solar panels are used to power electric motors and charge batteries. They only get energy from the sun during the day. In this paper, another construction for long-distance electric vehicles is proposed. By installing piezoelectric materials in the wheels of electric cars, their long-distance movement is ensured. Unlike electric cars, where solar panels are installed, piezoelectric materials will provide additional electricity at any time when the cars are moving, not just during the day. In electric cars, since piezoelectric materials are installed on the tires, they will not need additional structural changes.

Keywords: electric car, solar panel, piezoelectric material, electric batteries, electric vehicles, wheels

I. Introduction

Electric cars are safer not only for nature, but also for passengers. Their maneuverability is higher than that of cars powered by conventional energy sources. Currently, climate change is one of the global problems that concern the world. Azerbaijan has not been left out of the influence of global climate changes. In the last 100 years, average annual temperatures in the territory of Azerbaijan have increased by 0.4-1.3^{0}C. Against the background of climate changes, Azerbaijan is experiencing floods, avalanches, storms, hurricanes, surges, strong winds, heat, droughts, melting of glaciers, salinization, land degradation, desertification, reduction of precipitation and water resources, etc. exposed to the effects of such extreme climate events. One of the main factors in environmental pollution is the transport sector [1]. The increase in vehicles is rapidly increasing the risks to the environment. One way to reduce these risks is to increase the share of electric vehicles in the transport sector. There are difficulties in the matter of power supply of electric vehicles. Works aimed at eliminating these problems will directly create conditions for reducing environmental risks. The 29th session of the Conference of the Parties to the UN Framework Convention on Climate Change - COP29, which is hosted by a different country every year, in Baku this year also means global support for Azerbaijan's green energy policy. At present, light material is mainly used in the production of electric vehicles. Thanks to the use of environmentally friendly fuels such as electricity, most urban vehicles (taxis, company and service vehicles, etc.) have no exhaust gases, which makes them promising for use in urban environments.

Currently, many well-known car manufacturing companies have started producing their own electric cars. The power of German-made electric cars has been increased to 544 horsepower. US-made electric cars have four electric motors. There are 105, 135 and 180 kWh batteries. It has a range of 370 to 660 km. These cars can accelerate from 0 to 100 km/h in about 4.4 seconds, just like internal combustion engine cars.

"National Program on Electromobility" is being prepared in our country. There is an order of the Minister of Energy of the Republic of Azerbaijan on the creation of a working group on "Preparation of the National Program on Electromobility". The working group will prepare and implement measures for the development of electromobility.

In recent years, important steps have been taken in the direction of expanding the use of electric cars in our country. From 2022, the import and sale of electric cars and level 2 and 3 electric chargers for them are exempted from VAT. More than 100 electric car charging stations have been installed in the last year. Since last year, the application of the customs duty on the import of electric motor vehicles that have passed the factory release date up to 3 years has been suspended. Statistics show that after these measures, the import of electric cars to the country has increased significantly. So, last year, 3,102 vehicles powered by an electric motor were imported to Azerbaijan worth 125 million 268 thousand US dollars, which is 7.1 times and 6.4 times compared to 2022, respectively, compared to 2021 in comparison, it is 36.2 times and 19.4 times more.

However, in order to promote the use of electric cars, it is not only the reduction of import and sales prices, but also the creation of favorable infrastructure that is important. In other words, electric cars should have a sufficient number of charging points, spare parts warehouses, and quality service should be provided to them. A lot of work has been done in Azerbaijan in the direction of creating such infrastructure.

Usually, some companies that sell electric cars say that the car can travel about 400 kilometers after charging. Experience shows that this car cannot travel even 250 kilometers with an electric engine. Solving these issues requires special attention and control in the area in question.

Electric cars are considered environmentally friendly as they do not run on fuel. Electric cars are quiet and comfortable. There are three types of electric cars. All-electric forms of electric cars in all-electric, hybrid and plug-in hybrid forms are designed for short distances. Because their energy decreases on a long journey and it is necessary to re-accumulate energy. Hybrid cars work with both gasoline and electric engines. Such cars use the electric motor when driving and driving at low speeds, and as the speed increases, the gasoline engine starts to work. The battery of a hybrid car is technically designed for long journeys, as it can collect energy by itself while driving, while the gasoline engine is running, and when it is stopped. Plug-in Hybrid cars, unlike normal hybrids, have batteries with external electrical storage capacity. Such cars can be used on long roads thanks to their powerful batteries.

Taking into account the demand for electric cars, projects related to the production and export of this type of cars are expected in Azerbaijan in the coming years. In total, 8,000 cars are planned to be produced in Azerbaijan in 2024, of which 6,000 are passenger cars, and 2,000 are trucks and buses. The price of cars starts from 17,800 manats and this figure varies up to 160,000 manats.

Due to the lgots for the use of electric cars, their importation to our country, low operating costs, and their environmental friendliness, they replace those working with traditional energy sources more and more every year.

Over the years, energy prices are rising, and it is becoming more difficult to obtain it. Clean energy is being used all over the world. The electric car market is one of the best solutions to these problems. This market has great potential for long-term growth: as expected, the vast majority of cars in the world will be electrified in the near future.

Silent operation, comfort, modern design, simple management and maneuverability of electric cars allow for their wider application.

The developers of their electric cars are working to cover longer distances with a smaller battery. In this regard, everything is simpler with regular buses - the route is known, the distance is also known. Taking all this into account, the American AEM presented to the public the latest version of the 18-seater electric bus E-Shuttle.

II. Methods

The transition to electric vehicles has not always been straightforward. One day, John Mountey, a resident of the United States, decided to completely stop burning fuel. He took the 1994 "Geo Prism" sedan, the Toyota Corolla car produced jointly with "General Motors" under his own brand, and threw the internal combustion engine into the landfill. Many components were sent for recycling: engine cooling system, exhaust pipes, catalytic converter, fuel tank, clutch basket, etc. There was a lot of free space under the hood. But it didn't take long for the new electric motor to occupy a significant part of the space. It is mated to a standard manual transmission locked in second gear. The entire bottom is covered with a large battery. More precisely, there are 50 of them: two sections of 25 12-volt lead-acid batteries.

Additional details: power steering, brake master cylinder and air conditioning system are connected to the electric motor. These are the standard items available. But the water tank with a small heater is new. Of course, heating does not always mean "free" in cars with an internal combustion engine. The gearbox has been changed to make it easier to switch between forward and reverse. A socket is installed instead of the fuel tank mouth. Charging can be done from 120 or 240 V networks. And of course the fuel sensor has been changed to a voltmeter. John Mountey left all other systems unchanged.

Let's say that the standard Geo Prism sedan consumes no more than 10 liters of fuel per 100 km. It turns out that the internal combustion engine will burn 8 liters in 80 km. While the average price of gasoline is 1 AZN/liter, it turns out that a trip of 80 km costs 8 AZN. According to John Mountey, only 12 kW of power is needed to fully charge the batteries of his electric car. The tariff in Baku is AZN 0.08 per 1 kW. If you charge the car during the day, this procedure costs AZN 0.96! In the latter case, each kilometer traveled by car is 8 times cheaper than a standard car. Such savings can only be dreamed of. The disadvantage of operating electric cars is quite obvious: the need for constant recharging. And the maximum mileage is not important here: whether you travel 50 km or 300 km from your home, it is very difficult to find a free outlet. Moreover, the charging procedure requires an average of about 8 hours! You can completely forget about traveling on such transport. It turns out that the destiny of electric vehicles is purely urban use. Here we can add that hydrogen fuel cars are exactly the same as electric cars. The only difference is in the way the electric motor is powered. In the first case, this is the charge of the batteries, and in the second, the energy of the chemical reaction of hydrogen decomposition. But filling a full tank of liquid hydrogen takes no longer than a regular tank of gasoline. The only question is infrastructure.

Solar electric buses (solar cars) are a type of electric buses that move using solar energy. It uses solar panels to power electric motors and recharge batteries. Like an ordinary electric bus, the sunmobile moves at night, and during the day it has enough energy from the sun [2].

The drawback of electric cars is quite simple: the need for constant charging. And here the maximum mileage is not important: it is very difficult to find an electric charger, whether you travel 50 km or 300 km from your home. Moreover, the charging procedure takes about 8 hours on average (15 minutes at special stations)! You can completely forget about traveling in such transport. It turns out that the fate of electric cars is purely urban use. We can add here that hydrogen fueled cars are exactly the same as electric cars. The only difference is in the way the electric motor works. In the first case, it is the charge of the batteries, and in the second case, it is the energy of the chemical reaction of hydrogen decomposition. But filling a tank full of liquid hydrogen doesn't take much longer than a regular tank of gasoline. The only question is the infrastructure.

III. Results

Some cars use solar energy to provide part of their electricity needs. Solar panels are used to power electric motors and charge batteries [3]. They only get energy from the sun during the day.

The following calculation is used when calculating the engine power of an electric car:

Required power:

$N_e = g\eta m\vartheta + C_v F\vartheta^3$, Watt

Where: $g = 9{,}8$ m/сек² - acceleration of free fall;

- η- average rolling coefficient on asphalt;
- m- full mass of the car;
- υ- speed in meters in seconds;
- C_υ- body flow coefficient;
- F- frontal area of the car.

For electric vehicles weighing 2000kg, at a speed of 30 km/h. or 8.3m/sec;
N_e=4072 Watt.
with motor efficiency 0.7, transmission 0.9 (total 0.63), then
$N_{бат}=N_e$ / Efficiency=4072 / 0.63=6,4 kW.

Discharge current:

I = N: U = 6400: 100 = 64 amperes; With a battery capacity of 150 Ah, the permissible discharge is 100 A/H, the permissible discharge time is 100: 64 = 1.56 hours or 94 minutes.

The distance from here will be 47 km. By changing the parameters of the battery, we can get the range we want, and the electric car should be as light and small as possible.

Like any technical device, the solar battery has its operational and technical characteristics, which differ for different models and different manufacturers, but with a fairly small discrepancy.

With a solar cell area of about 1.5 m2, the power of the module is about 250 W. A typical solar cell has an efficiency of 16-21%. The service life of such a solar battery is at least 25 years.

IV. Discussion

Apart from the solar panels mentioned above, electric vehicles can be energy efficient by using piezoelectric materials [4]. Piezoelectric materials are materials that generate an electric current when they are mechanically affected, even when raindrops fall on them (Kalbiyev and Jamalova, 2020).

Piezoelectric materials are used to generate electricity using the kinetic energy of raindrops [5]. The physical properties of piezoelectric materials allow them to generate electricity. This feature is known as the piezoelectric effect. When compressive or tensile stress occurs in these materials, an electric field is created in the material and a voltage difference occurs, causing current to flow. The occurrence of this stress difference is due to the asymmetry of the shape of the crystals (cells) of these materials. As can be seen from the figure, a small part of the crystalline form (cell) is positively located as a particle in the center. As shown in Fig. 2, when a certain compressive force is applied, this particle slides in a certain direction, distributing the charge and then creating an electric field. These materials come in different forms. Crystals are the most common, but substances such as plastic and ceramics are also found [6].

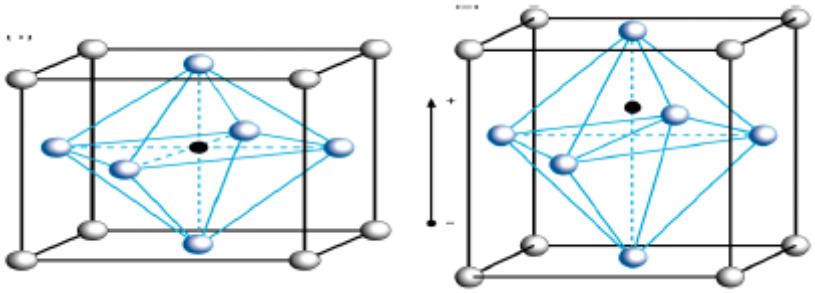

Figure 2: *Structure of the crystal lattice of piezoelectric materials*

The energy obtained by this method is stored in electric batteries and can be used in the electric batteries of electric vehicles.

As shown in Fig. 3, the electrical energy obtained during the use of piezoelectric materials [7] will be directly supplied to the electric battery.

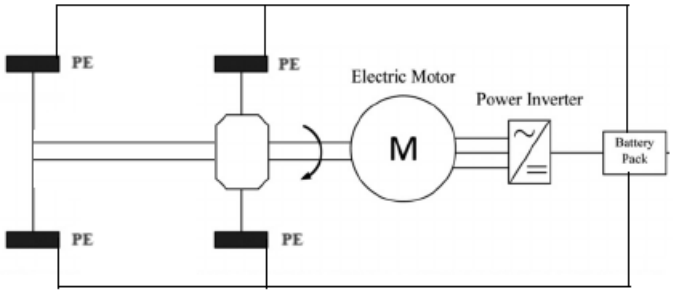

Figure 3: *Power supply and power management of electric vehicles with piezoelectric materials*

The piezoelectric material will be placed on the tires, which can be installed on the wheels, rather than directly on the wheels of the electric vehicle. It is similar to anti-skid pads on car tires. Depending on the amount of electricity consumption of electric machines, the surface area of the piezoelectric material will be determined. During the movement of the electric car, as the piezoelectric materials on the wheels are affected by the car's gravity, as a result, electric energy will be generated, and this electric energy [8] will be transferred to the battery of the electric car.

Figure 4: *Placement of piezo electric material parts on car wheel*

There is experience in using piezo electric materials in cars. There, the piezoelectric material is installed inside the wheel disc. The implementation of this proposal is quite complicated. It interferes with the structure of the disks and changes them. Our proposal does not interfere with the wheel and its other parts. Piezoelectric material parts are installed in a removable cover that is simply attached to the wheel (Fig. 4). One advantage of this offer is that the tire can be fitted to different tire sizes (wheel rims are made for specific tires).

V. Conclusion

One of the main parts of electric cars is its power supply element. Their ability to travel long distances depends on this element. Various methods are proposed to increase this period, for example, installing solar panels. In this paper, another construction for long-distance electric vehicles is proposed. By installing piezoelectric materials in the wheels of electric cars, their long-distance movement is ensured. Unlike electric cars, where solar panels are installed, piezoelectric materials will provide additional electricity at any time when the cars are moving, not just during the day. In electric cars, since piezoelectric materials are installed on the tires, they will not need additional structural changes.

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