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# ALTERNATIVE FUELS AND ENVIRONMENTAL EFFICIENCY

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***Abstract:*** This article examines the analysis of hydrogen fuel cells as an alternative to their use in automobiles (electric vehicles, hybrid vehicles). The authors cited the types and characteristics of alternative fuels, made an analysis in relation to the traditional type of fuel. The authors paid the main attention to the use of hydrogen fuel as a generator of electricity as a fuel cell. Made some calculations from which it is obvious that the use of fuel cells in cars gives positive results in the economic and environmental parameters of cars.

***Key words:*** *Alternative fuels, hydrogen, alcohol, alternative energy, fuel cells, carcinogenic substances, aldehydes.*

## Introduction

"The development and well-being of the city, the success of the nation, the progress of the entire human race is determined by the available energy. We should not be satisfied with simply improving steam engines or inventing new batteries. We have something better to work for, a greater challenge. We must develop methods of obtaining energy from sources that are inexhaustible, improve methods that do not require the consumption and expenditure of any materials "Nikola Tesla" Mission of Science ", 1900. [1].

In most countries of the world, the problem of finding fuel substitutes is being solved at a time when fuel reserves are declining sharply and demand for them is growing. In recent years, the world's total energy balance has increased by 4.2 times the consumption of hydrocarbon fuels.

The use of alternative fuels can significantly help solve this problem, as well as the problem of environmental pollution from cars. In this regard, in all industrialized countries of the world, work is underway to find effective alternatives to petroleum-derived fuels.

Analyzing the state of engine fuel, we came to the conclusion that in the near future there may be such fuels: ethanol, methanol, canola oil, biogas.

All alternative fuels can be classified according to the following criteria:

- by composition - hydrocarbons, hydrocarbon acids, hydrogen, alcohols, coal powder, etc.;
- by state of aggregation - liquid, gaseous, solid, mixed;
- in terms of calorie intake - high calorie, medium calorie, low calorie;

- by method of application - in the form of additives to petroleum fuel;

- by sources of raw materials - coal, peat, shale, biomass, water, etc.;

- for production processes - pyrolysis, hydrogenation, catalytic conversion, gasification, electrolysis, etc.

Alternative fuels are available in two versions:

- partial replacement, i.e., use as additives;

- complete replacement of the main fuel.

In addition to gases, alcohol and hydrogen are being studied as substitutes for hydrocarbon fuels. Methyl alcohol (methanol) and ethyl alcohol (ethanol) are promising fuels. [2].

Alcohol additives to gasoline are already widely used in a number of countries, which can significantly reduce their consumption. Research is underway on the production of synthetic gasoline from coal, shale and petroleum sands, as well as the possibility of using the gasoline mixture as a stabilizer with 15% methanol and 7% isobutyl alcohol. being carried out.

The use of methyl tert-butyl ether (MTBE) as a supplement to gasoline instead of toxic tetraethyl lead is promising.

Gaseous fuel was first used as an alternative to conventional fuel as motor fuel. In Russia, there are several types of alternative fuels that can and should be used as automotive fuel: petroleum gas, natural gas, generator gas, hydrogen, biogas, ethanol, and rapeseed oil.

| Indicators | Measurement | Gasoline | Natural Gas | Biogas | Hydrogen | Ethanol | Methanol | Rapeseed Oil |
|---|---|---|---|---|---|---|---|---|
| Ccombustion temperature | Kdj /$m^3$ | 44500 | 32186 | 32300 | 120000 | - | 26230 | 39500 |
| Combustion limit of the mixture according to the coefficient of excess air | - | 0,29-1,18 | - | 0,65-1,88 | 1-3,72 | 0,9-1,1 | 0,7-2,0 | - |
| Spontaneous ignition temperature | $^0$C | 467-527 | 640-680 | 685-747 | 510 | 423 | 464 | 329 |
| Theoretically the amount of air needed to burn fuel | $m^3$/kg | 12,35 | 9,52 | - | 5,3 | 6,53 | 6,45 | 12,6 |
| Boiling point | $^0$C | 33-168 | - | -161,3 | −252,87 | 365 | 338 | - |
| Density | kg/$m^3$ | 700-760 | 0,717 | 0,71-0,74 | 0,0000899 | 0,75 | 0,791 | 0,877 |
| Octane number | - | 76-98 | 110 | 126 | 114 | 125 | 125 | - |

1-Table. Characteristics of the most promising alternative fuel compared to conventional fuel.

## Materials and methods

Petroleum gas (butane-propane mixture) is mainly used in liquefied form (LPG). Its octane number is 90-100 units, its net caloric value is 24800 kJ / kg. Using it instead of gasoline reduces the number of harmful substances in car CO exhaust 2 times, $C_nH_n$ 1.3 ... 1.9 times, $NO_x$ 1.2 times.

Automakers produce a large proportion of natural gas-powered vehicles. This is primarily due to the fact that modern internal combustion engines that switch to natural gas require only minor structural changes in the fuel supply system, the mixture preparation system. The vehicle must first be compressed (CTG) or liquefied (STG) to ensure an adequate gas supply. The octane number of natural gas is 100-110 units, the pure calorific value is 32-36 mJ/kg. When using engines in natural gas, 4-6 times, $C_nH_n$ significantly reduces CO - 1.3-1.9 times, $NO_x$ - 1.3 times; in gas diesel - 50-70%, less than in dry diesels, 5-7.5 times, NOx remains in diesel fuel reduce the number of carcinogens, but gas diesel contains more $C_nH_n$ and aldehyde emissions.

A large number of experimental works are devoted to the use of hydrogen in internal combustion engines as a composite gasoline-hydrogen fuel, carried out by both Russian and foreign authors. [3]

Some countries, in particular, the German government decided to pursue an active industrial policy and on June 10 approved the long-prepared "National Hydrogen Strategy" for 9 billion euros. Its ultimate task is to combine the further industrial development of the country and the protection of the global climate.

When 1 kg of hydrogen is burned, up to 140 MJ of energy is released, which makes hydrogen the most energy-intensive source of chemical energy. However, the density of hydrogen (1 kg of hydrogen takes 11.2 $m^3$ of volume) does not allow us, at the current level of development of hydrogen technologies, to use it as an unconditional energy carrier in transport, etc. Even liquefied hydrogen is practically not used. In terms of weight and size energy characteristics, it is 4 times inferior to gasoline.

From the point of view of "green" energy, hydrogen fuel cells have an extremely high efficiency - 60%. For comparison: the efficiency of the best internal combustion engines is 35-40%. For solar power plants, the coefficient is only 15-20%, but highly dependent on weather conditions. The best plate-type wind farms are up to 40% efficient, which is comparable to steam generators, but wind turbines also require suitable weather conditions and costly maintenance.

## Results and discussing

A hydrogen-oxygen fuel cell with a proton exchange membrane (for example, "with a polymer electrolyte") contains a proton-conducting polymer membrane separating two electrodes - anode and cathode; each electrode is usually a carbon plate (matrix) with a supported catalyst - platinum or an alloy of platinoids and other compositions.

| Fuel cell type | Reaction at the anode | Electrolyte | Cathode reaction | Temperature, °C |
|---|---|---|---|---|
| FC with proton exchange membrane | $2\,H2 \rightarrow 4\,H+ + 4\,e-$ | Proton exchange membrane | $O2 + 4\,H++ 4\,e- \rightarrow 2\,H2O$ | 80 |
| Methanol fuel cell | $2\,CH3OH + 2\,H2O \rightarrow 2\,CO2 + 12\,H++ 12\,e-$ | Proton exchange membrane | $3\,O2 + 12\,H++ 12\,e- \rightarrow 6\,H2O$ | 60 |

2- Table The main types of fuel cells

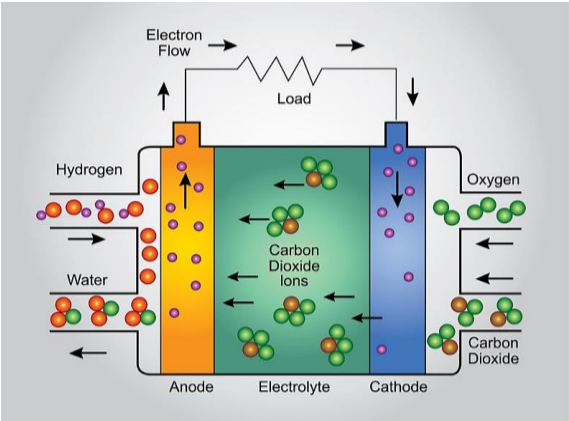


Fig. 1. Molten carbonate fuel cell. [5]

With a hydrogen consumption of 2 kg/h, it generates 30 kWt/h of electrical energy. Since one cubic meter of hydrogen gas weighs 90 g, then 2 kg of liquid hydrogen contains 2/0.09 = 22.2 $m^3$ of gaseous hydrogen. Considering that to obtain 1 $m^3$ of hydrogen, the best industrial electrolysers consume 4 kWt/h and taking this energy value as 100%, we obtain the energy efficiency of the fuel cell;

$$\frac{30 \cdot 100}{22{,}2 \cdot 4} = 33{,}8\% \qquad (1)$$

The efficiency of third generation fuel cells with solid electrolyte is close to 50% and that the use of fuel cell technology can increase the efficiency of electricity up to 75%, and taking into account the heat generated by them - up to 90-95%

One refueling per vehicle averages 4.7 kg (average fuel tank volume), which is 52.2 $m^3$ of hydrogen. With this volume of hydrogen, 208.8 kWt of energy can be obtained. Electricity for industrial use is 450 sums per kWt /h.

$$52{,}2\ m^3 \cdot 4\ \text{kWt/h} = 208{,}8\ \text{kWt} \qquad (2)$$

$$208{,}8 \cdot 450 = 93\,960\ \text{sums} \qquad (3)$$

Taking into account the fact that the mileage of a car with a fuel cell is 600 km at one hydrogen refueling, 156.6 sums are spent per kilometer. A liter of AI-80 gasoline is 4500 sum, and AI-91 - 5800 sum. A car consumes an average of 7-8 liters of gasoline per 100 km. Gasoline consumption per one kilometer is 315 sums. The savings are obvious and are almost half the price. If hydrogen is obtained from renewable energy sources, the economic and environmental performance of the car will improve several times.

According to statistics, a developed economy and the level of well-being of the people is the equivalent of electricity generated. The transition to green energy (renewable) will solve the problem with electricity generation and environmental issues that need to be addressed today.

Uzbekistan generates 85% of its electricity from thermal power plants. With increased use of renewable energy sources, the country will be able to reduce its dependence on natural gas and coal, and will also contribute to electricity production, which is projected to grow from 65,000 gigawatt-hours (GW/h) in 2019 to 103,000 GW/h by 2030 for meeting the rapidly growing demand across the country.

Decree from January 1, 2020, the President of Uzbekistan: a third of the costs of installing solar photovoltaic stations in their homes (but not more than 3 million sums), solar water heaters (not more than 1.5 million sums), as well as energy-efficient gas burners (no more than 200 thousand sums) at the expense of the state budget of the country. It also provides for the provision of compensations to individuals and legal entities to cover interest costs on loans from commercial banks taken for the purchase of renewable energy sources, energy-efficient gas burners and boilers, as well as other energy-efficient equipment. Below is a diagram of energy development in Uzbekistan until 2030. [4]

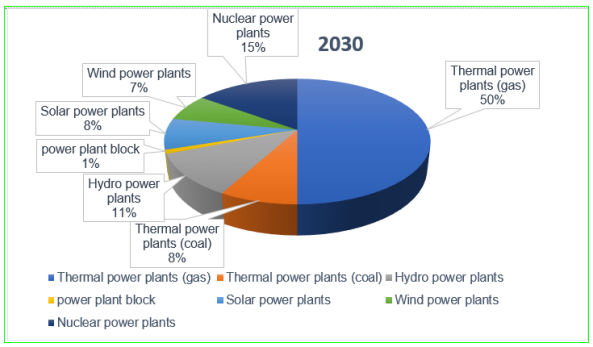


Fig. 2. Electric power generation structure [4]

## Consolation

Alternative fuels will reduce the relative harmful effects of existing cars on earth, thereby preventing the inevitable crisis of ecology, nature, humanity.

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