EFFECTIVE ASPECTS OF APPLYING HYDROGEN GENERATOR UNITS IN AUTOMOBILES

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Abstract: This thesis highlights the scientific and practical significance of installing hydrogen generator (HHO) units in internal combustion engines (ICE) of automobiles. The impact of introducing hydrogen gas mixed with traditional fuel into the combustion chamber on engine efficiency, fuel economy, and the environment is analyzed.

Keywords: Hydrogen generator, HHO gas, Brown's gas, internal combustion engine (ICE), fuel economy, environmental safety, electrolysis.

Working Principle of the Hydrogen Generator

Hydrogen generators used in automobiles are essentially compact devices that produce HHO gas (Brown's gas – a mixture of two parts hydrogen and one part oxygen) through the electrolysis of water.

The process occurs as follows:

- Distilled water and a conductivity-enhancing electrolyte (usually KOH or NaOH) are poured into the device.
- The electrolysis process is carried out using electric current obtained from the vehicle's electrical system (battery and alternator).
- The separated HHO gas is directed into the vehicle's air intake manifold.
- The gas burns inside the cylinder together with the main fuel (petrol, diesel, or methane/propane) and air mixture.

Effective Aspects of Application

The application of a hydrogen generator in automobiles offers a number of economic, technical, and environmental advantages:

Fuel Economy (up to 15-30%) According to the laws of thermodynamics, the energy required to extract hydrogen from water is greater than the energy obtained from its combustion. However, the secret of the HHO generator is that it does not act as an independent fuel. Hydrogen burns very quickly and at a high temperature. It acts as a "catalyst" inside the cylinder, ensuring the complete combustion of the main fuel (petrol or diesel). Typically, 20-30% of the fuel in ICEs does not burn completely and is emitted as exhaust waste. Hydrogen minimizes this indicator, thereby saving fuel.

Environmental Cleanliness and Reduction of Harmful Emissions The combustion of hydrogen produces only water vapor (H2O). Due to the complete combustion of the main fuel, the amount of harmful gases emitted into the atmosphere is drastically reduced:

- Carbon monoxide (CO) – reduced by up to 50%.
- The amount of hydrocarbons (HC) and nitrogen oxides (NOx) decreases significantly. This feature is especially important in solving the smog problem in large cities.

Extension of Engine Service Life (Decarbonization) During the operation of an ICE, soot (carbon deposits) accumulates on the cylinder walls, piston rings, and spark plugs. When HHO gas burns at a high temperature, it burns off and cleans the old carbon deposits inside the engine. As a result:

- The engine's traction (power) is restored.
- The engine runs smoother, without noise and vibrations (knocking).
- The service life of the engine oil is extended because, with complete combustion inside the cylinder, unburnt fuel residues do not mix with the oil.

Adaptability to Any Type of Fuel Hydrogen generators can perfectly synchronize not only with petrol engines but also with diesel and gas (methane/propane) engines. Its economic efficiency is particularly high in heavy commercial trucks (diesel) and agricultural machinery.

Existing Problems and Solutions

Along with the advantages of the technology, there are also aspects that require attention:

- **Load on the electrical system:** The electrolysis process requires additional power from the car's alternator. Therefore, the HHO system must be adjusted correctly, and the amperage must be selected according to the engine size.
- **Working with modern sensors:** The lambda probe (oxygen sensor) of modern cars detects increased oxygen in the exhaust, assumes the fuel mixture is "lean," and commands the injection of more petrol. To prevent this, it is necessary to adjust the ECU (Engine Control Unit) or use "spoofers" (EFIE - Electronic Fuel Injection Enhancer) and chip-tuners.
- **Safety:** HHO gas is highly explosive. However, the generator does not store the gas but sends it to the engine as soon as it is produced (on-demand system). To prevent flashback in the hoses, it is mandatory to install special water bubblers or dry check valves.

Conclusion. In conclusion, the application of hydrogen generator units in automobiles is one of the effective and affordable solutions to today's most pressing problems: environmental pollution and the fuel crisis. This technology allows for increasing engine power, reducing fuel costs by up to 15-30%, and protecting nature.

In the future, the factory integration of these systems by automakers or their promotion through state-level environmental programs will bring immense benefits to the country's economy and ecology.

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