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TOXIC WASTE REDUCTION: EFFECTIVE METHODS, TECHNOLOGIES, AND ENVIRONMENTAL MANAGEMENT STRATEGIES

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Annotation: This article covers effective methods, advanced technologies, and environmental management strategies for reducing toxic waste. To reduce the amount of waste harmful to the environment, such ways as waste recycling, hazardous substance replacement, the introduction of waste-free technologies, and the strengthening of monitoring systems are of great importance. Sustainable development can also be achieved by increasing the environmental responsibility of manufacturers, improving legislation, and involving the public. These activities contribute to ensuring human health and environmental safety.
Keywords: Toxic waste, recycling, environmental safety, waste-free technologies, monitoring system, environmental management.
Introduction. The main source of exhaust gases (or exhaust gases) is an internal combustion engine - these are substances with different chemical and physical properties in an inhomogeneous gaseous state as a result of complete or incomplete combustion of fuel, air, aerosols, and various micro-mixtures, which enter the exhaust system from the engine cylinder. They contain more than 300 different substances, many of which are poisonous. The main toxic components that regulate exhaust gases from car engines are carbon monoxide, nitrogen, and hydrocarbons. In addition, along with exhaust gases, limited and unlimited hydrocarbons, aldehydes, carcinogens, soot, and other substances are released into the atmosphere.
Incentives for reducing the volume of toxic emissions are primarily an incentive to reduce fuel consumption. The organization of automobile traffic in cities (a significant portion of emissions occurs in traffic jams and traffic lights) has a very significant impact on the amount of emissions (excluding fuel combustion and time).
Methods. With good traffic management, it is possible to use low-power engines at lower speeds.
- Using passenger gases or natural gases as fuel can reduce hydrocarbons in exhaust gases by more than 2 times. The main disadvantage of natural gases is that they travel relatively less distance, which is not so significant in urban conditions;
- the condition and adjustment of the engine, in addition to the fuel composition, affect the toxicity of exhaust gases (mainly in diesel engines - carbon monoxide can increase up to 20 times, in the carburetor - nitrogen oxides up to 1.5-2 times);
In modern designs of engines with -injection feed systems, exhaust gases are reduced (fuel consumption is reduced). In these engines, a constant stoichiometric mixture of non-ethylated gasolines is formed, a catalyst is installed, and mixed transmissions are used for the drive and air cooling of gas engine units. But such designs lead to an increase in the cost of cars. Tests of - SAE show that one of the ways to reduce the toxicity of exhaust gases and nitrogen oxides (up to 90%) is to spray water into the combustion chamber.
The search for a technical solution to environmental problems in world practice is carried out in three directions: reducing the toxicity of fuel, engine, and exhaust gases. Each of them requires mandatory analysis, so we will underline the task with a few lines.

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Satisfaction and discussion. Meets the fuel quality requirements. One way to reduce the toxicity of exhaust gases is to use compressed and liquefied gases as fuel. In the regions of the Fergana Valley, about 90 percent of gasoline engines are converted to gas-cylinder cars, and more than 95 percent of gas-powered cars are designed for methane.

The use of hydrogen as fuel is considered the most promising. This significantly improves the engine's energy and environmental performance. The maximum heat of combustion of hydrogen is 120 MJ/kg and significantly exceeds the mass heat of other fuels: gasoline - 45 MJ/kg, and diesel fuel - 42.7 MJ/kg. However, due to the low density of hydrogen, its simple energy characteristics are lower than those of petroleum fuels. The heat capacity of the hydrogen-air mixture is 15% lower than that of the gasoline-air mixture and 10% lower than that of the alcohol-air mixture.

Hydrogen is a highly promising type of fuel for engines, as it has an inexhaustible raw material base, a very high heat of combustion (its heat of combustion is 118045 kJ/kg), does not release toxic substances (except nitrogen) during combustion, and does not deteriorate the properties of the oil.

The high diffusion coefficient of hydrogen allows for the formation of a homogeneous mixture when the fuel is fed into the cylinder by any method, ensuring its uniform distribution across the cylinders in all engine operating modes. The combustion of hydrogen does not lead to the formation of varnish, soot, and coke, which is optimal in terms of wear and service life of engine parts. However, due to the low density of hydrogen, its volumetric energy capacity is relatively low. The combustion of a hydrogen combustible mixture occurs 6 times faster than the combustion rate of a gasoline-air mixture. A working mixture of hydrogen with air in a ratio of 1:10 is considered relatively effective. Hydrogen-hydrogen mixture is characterized by a low lower ignition limit (hydrogen-air ratio 1:25) and a very low ignition energy (12-14 times less than that of gasoline). These properties of hydrogen cause flashes in the working mixture inlet conductors, premature ignition of the working mixture in the cylinders, intense combustion processes, and detonation. As a result of these conditions, the working process in the carburetor engine is disrupted. In addition, the issue of hydrogen storage and placement in the vehicle is one of the problems that need to be solved. For example, if the mass of the fuel tank is 13-15 kg for storing a sufficient amount of fuel (gasoline or diesel fuel) to cover a certain reserve mileage, then the mass of the container system for storing compressed hydrogen designed for the same mileage should be 1300-1400 kg. For these reasons, hydrogen is considered in the distant future as a substitute material for liquid fuel derived from oil. Currently, work is underway to use hydrogen as an additive to reduce the consumption of liquid fuel.

Currently, the direction of a promising and effective strategic environmental initiative is, of course, the introduction of changes in the design of engines. The widespread use of injection engines, electronic control systems, and the improvement of the engine's operating process have raised fuel efficiency and environmental performance to a new qualitative level. If we look at the concept of inventing an environmentally friendly engine, then in world practice, as a result of 30 years of research, only various shapes, interesting projects, and designs have been proposed, but all of them have been turned into metal. As an example, one can cite a rotary-piston engine, which differs from a classic ICE in the toxicity of exhaust gases. These engines are currently produced at the Volzhsk plant only for installation on special equipment.

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Currently, hybrid power plants, the most efficient in terms of cost-effectiveness and environmental parameters, are used: they operate on internal combustion engines on highways, and on electric motors in urban areas. Switching to a particular type of engine is carried out automatically depending on traffic and road conditions.

The third direction of reducing the toxicity of exhaust gases is the installation of additional devices on the exhaust pipelines, i.e., devices for additional combustion of fuel, which are neutralizers of toxins equipped with expensive catalysts. The additional device increases the cost of the car, reduces its power and economy, we did not achieve economy and environmental friendliness with the two above methods, therefore we have to use devices that reduce the toxicity of various types of exhaust gases. In addition, one of the ways to ensure the eco-norm is to increase the efficiency of the engine, reduce the resistance of the tire to vibration, reduce the weight of the car using new materials, etc.

Currently, to improve the resource-saving and environmental performance of vehicles, the cylinder shutdown method is used at idle. This method yields particularly good results in cities, as in urban conditions, there are traffic lights or pedestrian crossings every 500-1000 meters, and when cars stop, toxic gases from them have a toxic effect on surrounding enterprises and institutions. In this method, at pedestrian crossings, traffic lights, and parking lots, when the engine runs idle, one or two cylinders are automatically switched off, while the remaining two cylinders maintain the engine's power at idle. The disadvantage of this method is that the algorithm for turning off the cylinders has not been developed, therefore, some shortcomings arise in determining when to turn off the cylinders.

Analysis of the problem of resource saving and ensuring environmental safety in the motor transport complex allows us to formulate a work objective, to achieve which we will perform the following tasks:

- development of a method for improving the fuel-saving and environmental indicators of a modern car with an engine equipped with an electronic injection system;
- development of a methodology for differentiated fuel consumption rates for a vehicle, taking into account the method of controlling the engine in idle mode and operating conditions;
- development of a methodology for studying the influence of the proposed engine control method on the operational and standard fuel consumption of the vehicle, the toxicity of exhaust gases, and vibration activity;
- development of a method for controlling the engine by turning off the cylinders of modern cars at idle during operation;
- study of the influence of a rational engine idle control algorithm under operating conditions on vibroacoustic, fuel-saving, and environmental indicators.

Conclusion. One of the directions for ensuring resource saving and environmental safety in the motor transport complex is the improvement of fuel-saving and environmental indicators of motor vehicles under operating conditions.

Currently, hybrid power plants are used, which are the most efficient in terms of cost-effectiveness and environmental parameters: they operate on internal combustion engines on highways, and on electric motors in urban areas. Switching to a particular type of engine is carried out automatically depending on traffic and road conditions.

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