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ANALYSIS OF METHODS FOR REDUCING THE HARMFUL EFFECTS OF EXHAUST GASES FROM AUTOMOBILE ENGINES.

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Annotation: Cars with internal combustion engines produce a lot of harmful emissions, causing environmental problems. These emissions reduce air quality, pollute water resources, and disrupt the overall ecological balance. Air pollution harms plants and animals, and also threatens human health, causing respiratory diseases, allergies, and other health problems. In addition, vehicle emissions lead to pollution of water bodies, which seriously harms their ecosystems.
Key words: car engines, neutralizer, catalyst, exhaust gases, catalytic converters, carbon monoxide, catalytic neutralization, liquid neutralizers.
The amount of nitrogen oxides (NOx) is significantly dependent on the temperature in the combustion chamber. When the temperature increases from 2500 K to 2700 K, the reaction rate increases by a factor of 2.6, and when it decreases from 2500 K to 2300 K, it decreases by a factor of 8. The higher the temperature, the higher the concentration of NOx. The fuel injection process or high pressure in the combustion chamber also increases the formation of NOx. High oxygen concentrations further increase the amount of nitrogen oxides.
Hydrocarbons are irritating to the mucous membranes (eyes, throat, nose) and play an important role in the formation of biologically active substances that are harmful to the environment.
Exhaust smoke (smog) consists of dust particles, liquid droplets (in humid conditions) and aerosols, and occurs in industrial cities under certain weather conditions. Gases released into the atmosphere react chemically with each other, forming new, including toxic, compounds. In this process, reactions such as photosynthesis, oxidation, polymerization, condensation, and catalysis occur.

Neutralizers and catalysts are used to reduce the harmful effects of exhaust gases.
Catalytic converters are installed in the exhaust systems of cars. These neutralizers create chemical reactions in the exhaust gases, significantly reducing the release of toxic substances into the atmosphere.
Millions of cars are on the road around the world, and their engines produce large amounts of exhaust gases as a result of fuel combustion. The main components of car exhaust are nitrogen, water vapor, and carbon dioxide, which are harmless in themselves. However, excessive accumulation of carbon dioxide in the atmosphere can lead to the greenhouse effect and global climate change.
At the same time, car exhaust also contains small amounts of toxic substances such as carbon monoxide (CO), hydrocarbons, and nitrogen oxides. These gases are dangerous to humans and other living organisms. Catalytic neutralizers help reduce the release of these toxic substances.
As the name suggests, catalytic converters use special catalysts. Two types of catalysts are considered more effective in neutralizing vehicle exhaust gases: the first are oxidizing catalysts and the second are reducing catalysts. A honeycomb-shaped metal catalyst is attached to a ceramic base. This ensures that the exhaust gas flow reaches the catalyst surface area to the maximum extent.
The reducing catalyst is the first stage of neutralizing vehicle exhaust gases. In this case, a catalyst based on platinum or rhodium neutralizes nitrogen oxides, that is, decomposes them into

harmless oxygen and nitrogen: NO = N + O.
In the next stage, the oxidizing catalyst comes into play: in it, a catalyst made of palladium and platinum neutralizes unburned hydrocarbon waste and carbon oxides. In this process, the catalyst oxidizes hydrocarbon waste, breaking them down into water and CO2, and carbon dioxide is also converted into carbon dioxide. Some modern vehicles are also equipped with a third-stage exhaust gas control system, which controls the fuel delivery process to the engine by analyzing the quantitative values recorded by the sensor.
Catalytic neutralization
Many studies have been conducted using various catalysts to increase the efficiency of the oxidation of carbon monoxide (CO) and hydrocarbons (CH) in synthetic mixtures and exhaust gases. The most comprehensive results of these studies are summarized in the works of D.V. Sokolsky and P.M. Popova. Studies on the catalytic reduction of nitrogen oxides (NOx) are relatively few. To neutralize toxic substances in engine exhaust gases, it is necessary to provide two types of reactions: oxidation reactions (conversion of CO and CH to complete combustion products) and reduction reactions (decomposition of NOx to oxygen (O_2) and nitrogen (N_2)). Oxidation reactions can be carried out in two reactors, but to increase their efficiency, it is necessary to maintain a high temperature or extend the reaction time by increasing the reactor volume.
Various design schemes for catalytic converters have been developed. Catalytic decontamination of exhaust gases uses metal catalysts (platinum, palladium, monel metal, etc.) and catalysts based on metal oxides (copper, nickel, chromium, iron, etc.).
There are a number of difficulties associated with the use of catalytic converters in internal combustion engines:
1. Complexity of exhaust gases.
The main toxic components that need to be neutralized are CO, CH, and NOx. To neutralize CO and CH, an oxidizing agent and catalysts that accelerate this reaction are required. To neutralize NOx, a reducing agent and appropriate catalysts are required. In addition, the composition of exhaust gases varies significantly depending on the type of engine and its operating mode.
2. High volumetric speed.
Catalysts used in the purification of exhaust gases from automobile engines typically operate at high volumetric speeds of up to 100,000 h^{-1} (in order to reduce the volume of the neutralizer). The volumetric speed is measured in h^{-1} as the ratio of the volume of gas passing through the catalyst in one hour to the volume of the catalyst.
3. Wide range of exhaust gas temperatures.
The temperature of the exhaust gases varies over a wide range from 100°C to 700°C.
4. Maximum catalyst temperature.
During operation, especially when the spark plugs fail, the catalyst temperature can reach up to 1000°C.
5. Strict requirements for mechanical strength.
The catalyst granules must be mechanically strong under conditions of temperature changes, vibrations and friction against each other due to high gas velocity.
6. Presence of toxic substances
Exhaust gases contain substances that can damage the catalyst, such as lead and sulfur compounds.
7. Need to quickly warm up the catalyst
When starting a cold engine, the catalyst needs to be warmed up in a short time.
Diesel engines always operate with an excess air ratio (a>1). At minimum operating conditions, depending on the mixture formation method and the compression ratio of diesel, the excess air ratio is in the range of 1.3-2.2. At low load and idle, this figure can reach 6-10. The oxygen content in the exhaust gases exceeds 10%, and the content of carbon monoxide (CO) and hydrogen (H_2) usually does not exceed 0.1-0.2%. Therefore, in all modes of diesel engines, the exhaust gas environment is oxidizing, and nitrogen oxides (NOx) are practically not formed. In

catalytic neutralization of diesel exhaust, it is necessary to create an artificially reducing environment before the gas reaches the catalyst. In addition, the high content of soot in the exhaust of diesel engines creates an additional problem, since soot accumulates on the catalyst, reducing its efficiency. When a catalytic converter is installed, measures are taken to periodically heat the catalyst to a temperature above 500°C or install special ignition devices in front of the catalyst to combat soot.

Without special measures, catalytic converters are effective only in the combustion of carbon monoxide, hydrocarbons and aldehydes. Aluminum-platinum catalysts provide the following results in the processing of diesel engine exhaust: a purification level of 30-100% for carbon monoxide, 80-100% for aldehydes, and 60-80% for soot is achieved. The purification level is calculated as the ratio of the concentration of the toxic substance at the inlet and outlet of the reactor in %.

Liquid neutralizers

The principle of operation of liquid neutralizers is based on the passage of exhaust gases through a liquid of special composition and the dissolution or chemical bonding of toxic substances in this process.

Conclusion: New types of automotive catalysts are important in solving environmental problems and reducing emissions. Modern technologies and materials increase efficiency and protect the environment. Their development will help ensure the environmental sustainability of the automotive industry.

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