Oriental Renaissance: Innovative, educational, natural and social sciences
Scientific Journal Impact Factor
Advanced Sciences Index Factor

VOLUME 2 | ISSUE 11
ISSN 2181-1784
SJIF 2022: 5.947
ASI Factor = 1.7

WAYS TO REDUCE HARMFUL IMPACTS EXHAUST GASES OF INTERNAL COMBUSTION ENGINES

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ABSTRACT

The purpose of this study is to analyze the components of exhaust gases of internal combustion engines of cars for their toxicity, environmental impact and ways to reduce their emissions. Information is given on the use of catalysts for exhaust gases of internal combustion engines, which contain platinum, palladium and rhodium group metals. In addition, the calculation of the heat flow transmitted to the environment through the body of the catalytic converter is given.

Keywords: *exhaust gas, carbon monoxide, nitrogen oxides, aldehydes, soot, catalytic converter, platinum, palladium, rhodium, exhaust gas components, ecology.*

АННОТАЦИЯ

Целью данного исследования является анализ компонентов выхлопных газов двигателей внутреннего сгорания автомобилей на их токсичность, воздействие на окружающую среду и пути снижения их выбросов. Приведены сведения об использовании катализаторов выхлопных газов двигателей внутреннего сгорания, в состав которых входят металлы группы платины, палладия и родия. Кроме того, приведен расчет теплового потока, передаваемого в окружающую среду через корпус каталитического нейтрализатора.

Ключевые слова: *выхлопные газы, угарный газ, оксиды азота, альдегиды, сажа, каталитический нейтрализатор, платина, палладий, родий, компоненты выхлопных газов, экология.*

INTRODUCTION

The main normalized toxic components of engine exhaust gases are carbon, nitrogen and hydrocarbon oxides. In addition, with exhaust gases, marginal and unsaturated hydrocarbons, aldehydes, carcinogenic substances, soot and other components enter the atmosphere. When the engine is running on leaded gasoline, lead is present in the exhaust gases, and soot is present in diesel engines.

Carbon monoxide (CO – carbon monoxide). Transparent, odorless poisonous gas, slightly lighter than air, poorly soluble in water. Carbon monoxide is a product of incomplete combustion of fuel, it burns with a blue flame in the air with the formation of carbon dioxide (carbon dioxide).

Nitrogen oxides (NO, NO2, N2O, N2O3, N2O5, hereinafter – NOx). Nitrogen oxides are among the most toxic components of exhaust gases. Under normal atmospheric conditions, nitrogen is a very inert gas. At high pressures and especially temperatures, nitrogen actively reacts with oxygen. In the exhaust gases of engines more than 90 % of the total amount NOx is nitrogen oxide NO, which is still in the exhaust system, and then in the atmosphere is easily oxidized to dioxide (NO2). Nitrogen oxides irritate the mucous membranes of the eyes, nose, and destroy human lungs, since when moving through the respiratory tract, they interact with the moisture of the upper respiratory tract, forming nitric and nitric acids. As a rule, poisoning of the human body NOx does not manifest itself immediately, but gradually, and there are no neutralizing agents

Aldehydes. In diesel engines, aldehydes are formed during the course of cold-flame fuel oxidation reactions. Both in diesels and gasoline Internal combustion engine aldehydes can be formed in cold wall-mounted (near the surfaces of the walls of parts that limit the inner-cylinder volume) layers of the fuel-air mixture at low temperatures of the working fluid in the cycle, as well as when engines are running on over-compacted mixtures, in particular, in engines with layered mixing

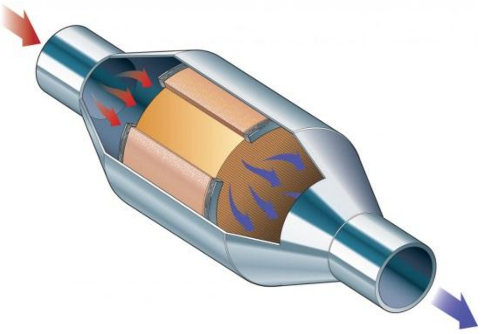
Soot. The soot formed in the engine cylinder and entering the exhaust gas of the internal combustion engine is a solid dispersed carbon product containing more than 90% by weight of pure carbon, as well as 1-3% by weight of chemically or physically bound hydrogen. The formation of soot is a process of volumetric pyrolysis (decomposition under the action of a high temperature of the working fluid in the cycle) of fuel hydrocarbons in a gaseous state (in the vapor phase), occurring under conditions of a significant shortage or complete absence of an oxidizer, in particular, air oxygen.

Exhaust Gas components	Content by volume, %		Note
	Engines		
	petrol	diesel	
Nitrogen	74,000 - 77,00	76,000 - 78,000	non-toxic
Oxygen	0,300 - 8,000	2,0 - 18,000	non-toxic

Water vapor	3,000 - 5,500	0,5 - 4,000	non-toxic
Carbon dioxide	5,000 - 12,000	1,0 - 10,000	non-toxic
Carbon monoxide	0,100 - 10,000	0,01 - 5,000	toxic
Hydrocarbons are not carcinogenic	0,200 - 3,000	0,009 - 0,500	toxic
Aldehydes	0 - 0,200	0,001 - 0,009	toxic

Table 1. Exhaust gas composition

Improvements in fuel economy and reduction of emissions of harmful substances can be achieved by the introduction of design solutions aimed at reducing the specific energy of the vehicle movement, such as weight reduction, improved aerodynamic performance, improvement of transmission structures and other components associated with a reduction in energy losses (increase in efficiency), reduction of cyclic energy losses in the process of vehicle movement (energy recovery), improvement of existing energy sources, both traditional internal and external combustion engines and electrochemical, creation of promising systems combining various energy sources (hybrid power as the same measures aimed at the development of fundamentally new energy sources (fuel and fuel cells). Catalytic converters, in general, are technical devices of varying degrees of complexity located in the exhaust system of the engine, and contain the following main functional components: the material itself (directly a catalyst for certain chemical reactions), having chemical activity and under certain conditions capable of activating the oxidation (or reduction) of incomplete oxidation products of fuel, not changing, at the same time, substantially their physical and chemical properties and characteristics; the inert base on which the catalytic material is placed; the housing. In many cases, catalytic converter devices also perform the functions of exhaust noise silencers. The catalytic converter of a diesel engine is not used to reduce emissions of nitrogen oxides in exhaust gases. This function in a diesel engine is performed by an exhaust gas recirculation system or a more advanced selective catalytic neutralization system



Pic 1. Selective catalytic neutralization system

DISCUSSION AND RESULTS

Calculation of the heat flow transmitted to the environment through the body of the catalytic converter. The heated body of the catalytic converter is cooled, giving thermal energy to the environment. Since the considered process of heating the Catholic neutralizer housing is non-stationary, the jointly occurring process of heat transfer from the housing to the surrounding atmosphere is also non-stationary. Case temperature 206 varies from large to smaller in the direction of movement of the exhaust gas flow inside the neutralizer, The steady-state heat flux emanating from the heated entire surface of the KN body dissipated in the atmosphere is calculated in accordance with the law Newton-Richman equation

$$Q_{CIRCUM} = \alpha_B F_{ENCLOSURES} \Delta T$$

where: α_B the coefficient of heat transfer from the catalyst body to the environment; ΔT the average temperature difference between the surface of the catalyst body and the surrounding air, deg.

To determine the heat transfer coefficient Q_{CIRCUM} , as well as when calculating heat losses from the catalyst body to the atmosphere, we assume that heat transfer from outside the neutralizer occurs under conditions of free movement into the surrounding unlimited space. The coefficient is found by empirical criteria formulas.

$$\alpha_B = \frac{Nu_d * \lambda_B}{d_{ENCLOSURES}}$$

where: Nu_d is the Nussle number. We calculate using the criteria equations. The regularity of the number change The Nussle for calculating the average heat transfer for horizontal pipes located in the air (I. M. Michael's formula) has the form

$$Nu_d = 0.46 Gr_{d.f}^{0.25}$$

where: $Gr_{d.f}^{0.25}$ Grashof number.

$$Gr = \frac{g d_{ENCLOSURES}^2}{v_{\frac{2}{B}}} \frac{1}{T_B} \Delta T$$

where: ΔT the temperature difference of the housing wall and the ambient air

Calculating the Nussle number and substituting its value into the formula (3), we determine the heat transfer coefficient α_B characteristic for a specific temperature pressureΔT After that, substituting the coefficient value into the formula (2), it is possible to calculate the heat loss Q_{CIRCUM} from the catalytic converter housing to the surrounding atmosphere

CONCLUSION AND RECOMMENDATION

In spark-ignition engines, in order to reduce the formation of harmful substances (incomplete oxidation products), it is advisable to influence the working processes occurring in their cylinders in the following main directions:

-providing the widest possible range of engine operation on

depleted mixtures;

-improvement of the quality of mixing (including an increase in the degree

of homogenization of the fuel-air mixture, an increase in the uniformity and uniformity of the

distribution of the combustible mixture across cylinders and cycles, etc.);

-reduction of the negative effect of flame extinguishing zones on the nature

of the combustion (oxidation) gorenje processes;

-reduction of inter-cycle instability and fluctuation of work processes;

-improving the quality of gas exchange processes.

In diesel engines, the main toxic components of exhaust gases are nitrogen oxides and soot. Therefore, the methods of influencing the processes of the working cycle of engines of this type consist mainly in a local decrease in the concentration of the oxidizer (air oxygen) in the combustion zone (with a decrease in nitrogen oxide toxicity), as well as in carrying out measures aimed at reducing the formation of soot, and improving the conditions for its burnout during the expansion of the working bodies in a cylinder.

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