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ІНФОРМАЦІЙНІ ТЕХНОЛОГІЇ: НАУКА, ТЕХНІКА, ТЕХНОЛОГІЯ, ОСВІТА, ЗДОРОВ'Я

Наукове видання

Тези доповідей
XXVIII МІЖНАРОДНОЇ НАУКОВО-ПРАКТИЧНОЇ КОНФЕРЕНЦІЇ
MicroCAD-2020

У п'яти частинах
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Подано тези доповідей науково-практичної конференції MicroCAD-2020 за теоретичними та практичними результатами наукових досліджень і розробок, які виконані викладачами вищої школи, науковими співробітниками, аспірантами, студентами, фахівцями різних організацій і підприємств.
Для викладачів, наукових працівників, аспірантів, студентів, фахівців.

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ЗМІСТ

DETERMINATION OF CARBON DIOXIDE EMISSIONS WITH DIESEL ENGINE EXHAUST GAS FLOW

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As is known from the analysis of studies of scientists who specialize in ensuring the ecological safety of exploitation process of power plants with reciprocating ICE, except for the legislative normalized directly indicators of its level – mass hourly emissions of particulate matter PM, nitrogen oxides NO_x, unburned hydrocarbons C_nH_m, carbon monoxide CO, exist also legislative regulated indirectly, among which emissions of carbon dioxide CO_2 should be singled out, since this pollutant is both a toxic substance and a greenhouse gas, and its emission is limited by the quota of the Kyoto Protocol [1].

To account of such emissions in the criteria-based assessment using the mathematical apparatus of the complex fuel-ecological criterion K_{fe}, the value of mass hourly emission $G(CO_2)$ and dimensionless index of the relative aggressiveness of this pollutant $A(CO_2)$ should be determined. It was found that under normal conditions the concentration of CO_2 in dry atmospheric air is 250 ... 450 ppm, physiologically normal content in the air of the room is 600 ... 800 ppm, there is a negative impact on the state of health of the person from 10^3 ppm, lethal dose LD_{50} = $90 \cdot 10^3$ mg/m^3. For Ukraine, the Kyoto Protocol's CO_2 emission quota is 922 million tonnes/year, of which 45 % remains unclaimed. $MPC(CO_2)$ = 9000 mg/m^3, so $A(CO_2)$ = 0.002. The study analyzes the features of the processes that lead to the formation of CO_2 and proposes to determine the value of $G(CO_2)$ by the formula (1).

$$G(CO_2) = G_{fuel} \cdot 3{,}20 - G(CO) \cdot 1{,}59 - G(C_nH_m) \cdot 3{,}07 - G(PM) \cdot 2{,}85, \text{ mg/h.} \quad (1)$$

Distribution of magnitude of $G(CO_2)$ by the regimes of the ESC standardized steady test cycle (UNECE Regulation No. 49) for 2Ch10.5/12 autotractor diesel and by the field of its operating regimes obtained in this study by the proposed method is illustrated in Fig. 1.

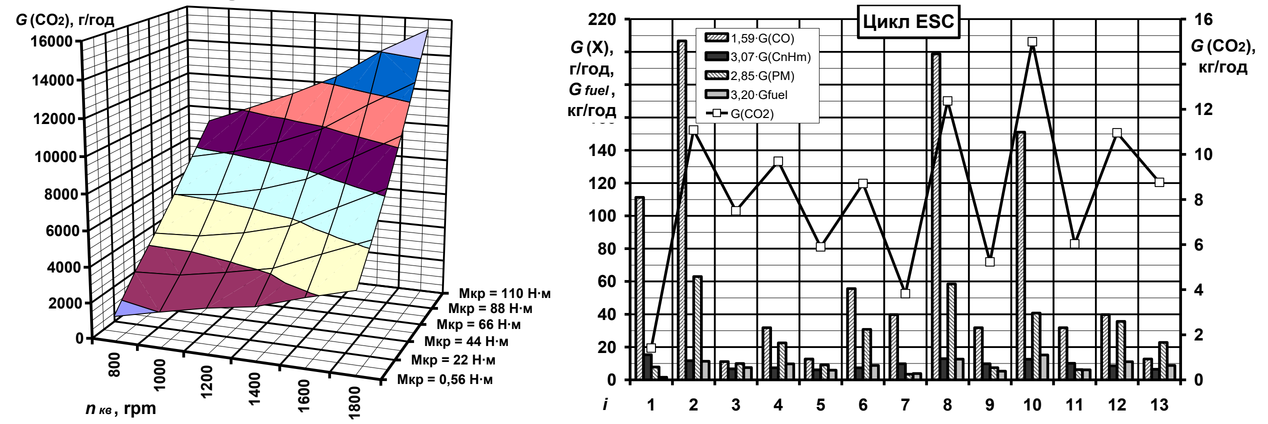

Fig. 1 – Results of the study

References:

1. Kondratenko O.M. (2019). Metrological aspects of complex criteria-based assessment of ecological safety level of exploitation of reciprocating engines of power plants: Monograph. Kharkiv. Publ. Style-Izdat. 532 p. ISBN 978-617-7738-33-5.

DETERMINATION OF WATER VAPOR EMISSIONS WITH DIESEL ENGINE EXHAUST GAS FLOW

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As is known from the analysis of studies of scientists who specialize in ensuring the ecological safety of exploitation process of power plants with reciprocating ICE, except for the legislative normalized directly indicators of its level – mass hourly emissions of particulate matter PM, nitrogen oxides NO_x, unburned hydrocarbons C_nH_m, carbon monoxide CO, exist also legislative regulated indirectly, among which the least toxic, but the most significant in volume, is the emission of water vapor H_2O as a product of complete combustion of motor fuel hydrocarbons [1]. In this case, H_2O vapor is a reagent in the formation of acid rain, increases the humidity of the atmospheric air, worsening the sanitary and hygienic conditions of work and human habitation and promotes corrosion of machine parts. To account of such emissions in the criteria-based assessment using the mathematical apparatus of the complex fuel-ecological criterion K_{fe}, the value of mass hourly emission $G(H_2O)$ and dimensionless index of the relative aggressiveness of this pollutant $A(H_2O)$ should be determined. Since there are no standards limiting the MPC of water vapor in the air, we will assume that the magnitude of this indicator is limited by the humidity standards, which, in turn, is determined by the magnitude of saturated water vapor pressure and depends on the magnitudes of barometric pressure and air temperature. Taking into account these aspects, it can be assumed that for normal conditions (φ = 80 %, t = 0 °C, P_0 = = 101325 Pa), the value of $A(H_2O)$ is $1.976 \cdot 10^{-3}$. The features of the processes leading to the formation of H_2O vapor are considered in the study and the value of $G(H_2O)$ is proposed to be determined by formula (1).

$$G(H_2O) = C_f(H) \cdot 2 \cdot \mu(H_2O) / (4 \cdot \mu(H)) = k(H_2O) \cdot G_{fuel} = 1{,}08 \cdot G_{fuel}, \text{ kg/h} \quad (1)$$

Distribution of magnitude of $G(H_2O)$ by the regimes of the ESC standardized steady test cycle (UNECE Regulation No. 49) for 2Ch10.5/12 autotractor diesel and by the field of its operating regimes obtained in this study by the proposed method is illustrated in Fig. 1.

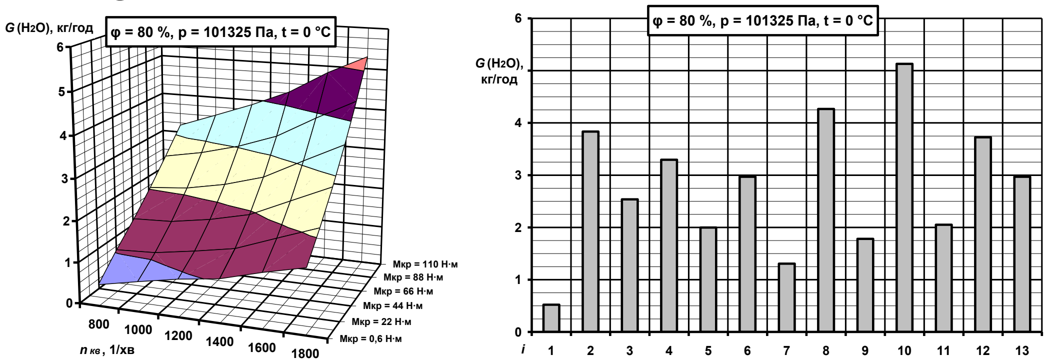

Fig. 1 – Results of the study

References:

1. Kondratenko O.M. (2019). Metrological aspects of complex criteria-based assessment of ecological safety level of exploitation of reciprocating engines of power plants: Monograph. Kharkiv. Publ. Style-Izdat. 532 p. ISBN 978-617-7738-33-5.

SUBSTANTIATION OF SELECTION OF RATIONAL UNITS OF EXPRESSION OF MONETARY COMPONENTS OF INDICATOR OF ECOLOGICAL SAFETY LEVEL OF ICE EXPLOITATION

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In order to carry out a comprehensive assessment of the level of ecological safety of exploitation process of power plants with reciprocating ICE, it is rational to use a mathematical apparatus of complex fuel and ecological criterion of prof. I.V. Parsadanov (NTU «KPI») K_{fe} [1]. One of its main advantages over alternatives is the presence in the structure of components having monetary units of expression, namely: monetary costs for consumed motor fuel $Z_f = g_e \cdot P_f$, compensation for ecological damage to the environment and human $Z_e = g_e \cdot \delta \cdot \sigma \cdot f \cdot \sum\left(A_k \cdot G_{ki} / G_{fi}\right)$, and total fuel and ecological costs $Z_{fe} = Z_f + Z_e$. In that formulas: g_e – specific effective mass hourly fuel consumption, kg/(kW·h); P_f – price per unit weight of motor fuel, \$/kg; σ – dimensionless indicator of the relative risk of contamination in different territories; f – dimensionless coefficient that takes into account the nature of the scattering of EG in the atmosphere; $\delta = P_f$ – dimension indicator that converts a score assessment into a value, \$/kg; G_{fuel} – mass hourly fuel consumption, kg/h; G_k – mass hourly emission of k-th pollutant in EG flow, kg/h; A_k – dimensionless indicator of the relative aggressiveness of the k-th pollutant in EG flow.

However, when performing a comparative calculation study for reciprocating ICE of the same and different brands and/or models, of different release dates or experimentally investigated at different time periods, or of the same engine in different technical condition or, in the rest, of are in exploitation process in the territories of different countries of the world there is a problem of bringing the units of expression Z_f, Z_e and Z_{fe} to each other. In the original mathematical apparatus at the time of its creation (2003), such units were ₴/(kW·h), in previous works, the authors proposed to switch to the use of one of the world's reserve freely convertible currencies, the history of which completely covers the history of reciprocating ICE as such – US Dollar, i.e. \$/(kWh). However, due to the extremely volatile exchange rate of the Ukrainian Hryvnia to the US Dollar, there is some ambiguity in determining the numerical values of Z_f, Z_e and Z_{fe} for different historical periods. The results of a comparative calculation study for substantiation of this choice are summarized in Table 1.

Table 1 – Results of the study

Monetary costs	**Year**	**Units of expression**					
		₴/(kW·h)			**\$/(kW·h)**		
Z_e	**2003**	2,081	2,729	2,553	0,391	0,513	0,480
	2018	27,050	35,472	33,185	0,567	0,744	0,696
Z_f	**2003**	0,574	0,685	0,899	0,108	0,129	0,169
	2018	7,463	8,903	11,681	0,156	0,187	0,245
ICE operational regime		N_{enom}	M_{max}	**idle**	N_{enom}	M_{max}	**idle**

References:

1. Кондратенко О.М. Обґрунтування вибору раціональних одиниць вираження вартісних складових комплексного паливно-екологічного критерію / О.М. Кондратенко, С.А. Коваленко // Електронна збірка наукових праць «Е-КОНОМІКА». – 2019. – № 1(3)/2019. – С. 114-118.

OBTAINING OF INDICATORS OF ECOLOGICAL SAFETY LEVEL OF DIESEL ENGINE THAT OPERATES ON TESTING CYCLE ESC

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In the study was obtained technical end ecological indicators of operation process of diesel engine D21A1 (2Ch10.5/12 in accordance with GOST 10150-2014) that operates of standardized steady testing cycle ESC (UNECE Regulations № 49) and also magnitudes of complex fuel and ecological criterion and its components. This data obtained by processing of results of motor bench tests in [1] an application of mathematical apparatus of complex fuel and ecological criterion of Prof. I.V. Parsadanov (NTU «KhPI») K_{fe} [2] and illustrated on Fig. 1 – 3.

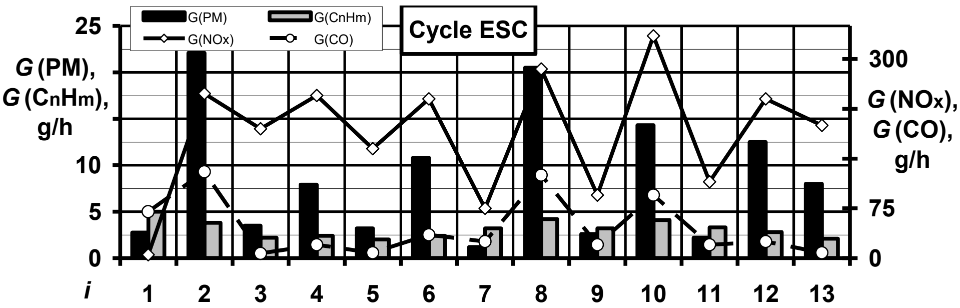

Figure 1 – Ecological indicators of 2Ch10.5/12 diesel engine

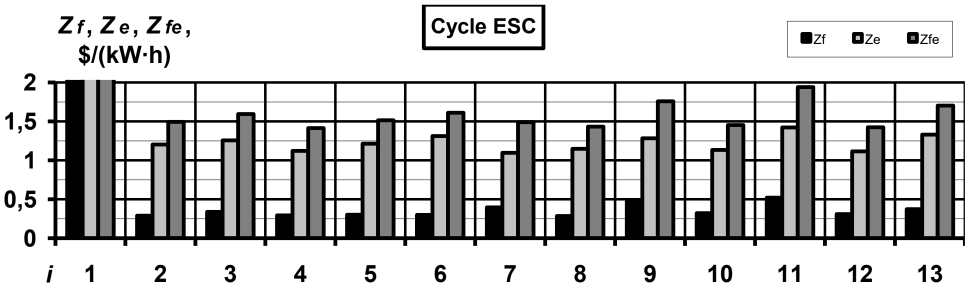

Figure 2 – Monetary components of criterion K_{fe}

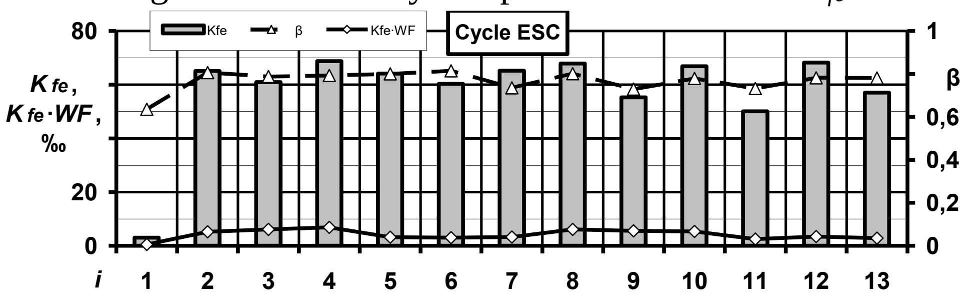

Figure 3 – Distribution of magnitudes of complex fuel and ecological criterion K_{fe}

References:

1. Kondratenko O.M. (2019). Metrological aspects of complex criteria-based assessment of ecological safety level of exploitation of reciprocating engines of power plants: Monograph. Kharkiv. Publ. Style-Izdat. 532 p. ISBN 978-617-7738-33-5. **2.** Parsadanov I.V. (2003). Improving the quality and competitiveness of diesel engines based on complex fuel and ecological criteria: Monograph. Kharkiv. Publ. Center NTU “KhPI”. 244 p. ISBN 966-593-319-1.

DETERMINATION OF SULFUR OXIDES EMISSIONS WITH DIESEL ENGINE EXHAUST GAS FLOW

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As is known from the analysis of studies of scientists who specialize in ensuring the ecological safety of exploitation process of power plants with reciprocating ICE, except for the legislative normalized directly indicators of its level – mass hourly emissions of particulate matter PM, nitrogen oxides NO_x, unburned hydrocarbons C_nH_m, carbon monoxide CO, exist also legislative regulated indirectly, among which the emission of sulfur oxides SO_x deserves special attention [1].

To account of such emissions in the criteria-based assessment using the mathematical apparatus of the complex fuel-ecological criterion K_{fe}, the value of mass hourly emission $G(SO_x)$ and dimensionless index of the relative aggressiveness of this pollutant $A(SO_x)$ should be determined. In [1] analyzed the composition of sulfur oxides in the structure of exhaust gas (EG) of an reciprocating ICE and found that they are on 94 % composed of SO_2, for which $A(SO_x)$ = 22.0. It has also been found that the sources of SO_x occurrence in the composition of EG of diesel engine are sulfur in engine fuels and engine oils, both in the free and in the chemical-bound form. Then the value of $G(SO_x)$ can be determined by the formula (1).

$$G(SO_x) = 2 \cdot G_{fuel} \cdot (C_{Sf} + C_{of} \cdot C_{So}) / 100 = G_{fuel} \cdot k_{SO2}, \text{ kg/h.} \quad (1)$$

where k_{SO2} – coefficient that converts the fuel consumption value into the SO_2 emission value; G_{fuel} – mass hourly consumption of motor fuel, kg/h; C_{Sf} – relative sulfur content of the motor fuel, % mass; C_{So} – relative sulfur content of engine oil, % mass; C_{of} – relative consumption of engine oil through burning, % mass.

Distribution of magnitude of $G(SO_x)$ by the regimes of the ESC standardized steady test cycle (UNECE Regulation No. 49) for 2Ch10.5/12 autotractor diesel and by the field of its operating regimes obtained in this study by the proposed method at k_{SO2} = 0.015 is illustrated in Fig. 1.

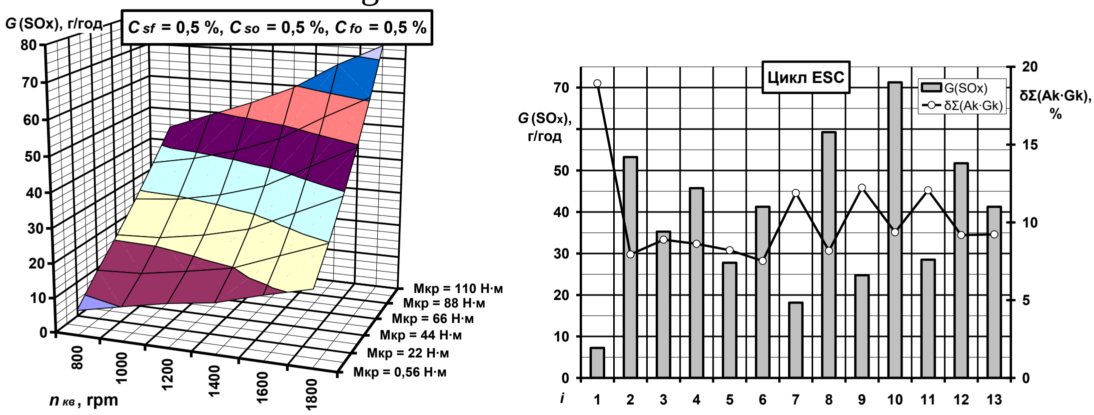

Fig. 1 – Results of the study

References:

1. Кондратенко О.М. Обґрунтування вибору раціональних одиниць вираження вартісних складових комплексного паливно-екологічного критерію / О.М. Кондратенко, С.А. Коваленко // Електронна збірка наукових праць «Е-КОНОМІКА». – 2019. – № 1(3)/2019. – С. 114-118.

Наукове видання

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У п'яти частинах
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