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DEPENDENCE OF THE AMOUNT OF EMISSIONS FROM THE SOLID FUEL COMPOSITION

ЗАЛЕЖНІСТЬ КІЛЬКОСТІ ВИКИДІВ ШКІДЛИВИХ РЕЧОВИН В НАВКОЛИШНЄ СЕРЕДОВИЩЕ ВІД СКЛАДУ ТВЕРДОГО ПАЛИВА

Rindyuk D.V. / Риндюк Д.В
c.t.s., as.prof. / к.т.н., доц.
ORCID: 0000-0001-7770-7547
Sheleshey T.V. / Шелешей Т.В.
senior lecturer / ст.викл.
Bednarska I. S. / Беднарська І.С.
assist. / асист.
ORCID: 0000-0002-5558-4467
Bednarska Ya. S. / Беднарська Я.С.
student / студент
Kachkivsky D. O. / Качківський Д.О.
student / студент
National Technical University of Ukraine
"Igor Sikorsky Kyiv Polytechnic Institute", Kyiv, Politechnichna, 6, 03056
Національний технічний університет України
«Київський політехнічний інститут імені Ігоря Сікорського», Київ, Політехнічна, 6, 03056

Abstract. *The main task of this study is to determine the quantitative characteristics of harmful emissions into the atmosphere depending on the composition of solid fuels. The study calculated the emission of carbon oxides and nitrogen, sulfur dioxide and particulate matter. For the calculation, the types of solid fuels most often used in Ukraine at thermal power plants were taken into account.*

Key words*: harmful emissions, emission index, nitrogen oxides, sulfur dioxide, ash content, carbon dioxide.*

Introduction. There is a revolution in the world of approaches to the functioning of the energy sector of each country. Attitudes of opponents and supporters of renewable and alternative energy sources are changing. However, thermal power plants and industrial enterprises on fossil fuels remain. In the process of development, thermal power plants still play an important role in electricity generation.

The desire to diversify the paths of electricity is also characteristic of the production and bringing energy production to a fundamentally new level of development for Ukraine. However, the structure of electricity production remains virtually unchanged. Its maximum part is associated with nuclear power plants (about 55%). The share of thermal power plants is also high (35%).

The structure of electricity production in Ukraine indicates a focus on traditional production by thermal power plants (TPPs). This production depends on a stable supply of coal. The development of heat energy requires a proper assessment of the possibilities of its development, recovery and its future prospects in the face of changing economic, industrial and natural potentials.

The development of its own coal base in the field of material production, which ensures energy security of the country, is the subject of constant attention from the

Ukrainian government, as evidenced by the adoption of a number of large-scale policy documents on development and reform of the domestic coal industry [1-2]. The Ukrainian black gold industry accounts for almost 4% of the world's strategic reserves. This allows the state to enter the top ten in terms of coal reserves in the world. As of 2019, according to scientists, 70% of all is thermal coal and 30% for coking coal. The main part of fossil fuels is located in the Lviv-Volyn field and Donetsk [3].

The main text. Thermal power plants run on coal, gas, or fuel oil. Mostly use solid fuel, because gas is not a cheap pleasure. As of today, gas is more often used only to ignite the boiler, and not as energy fuel.

About 45% of Ukrainian TPP power units (at installed capacity) operate on anthracite coal, about 35% on gas group coal, and about 20% (in Kyiv and Kharkiv) on natural gas [3]. There are also stations with the ability to work on brown coal. The main part of the reserves of such coal is extracted at the Alexandria lignite complex.

During the combustion of energy fuel, a huge amount of pollutants, such as sulfur dioxide and nitrogen oxides, heavy metals and solid particles, enter the atmosphere. Also, a large amount of carbon dioxide enters the air, which, as everyone knows, affects the thermal balance of the planet and creates a greenhouse effect. We must not forget about the harmful substances that get into the ground and spoil the natural landscape. Sulfur dioxide is a suffocating colorless gas. At a significant concentration of sulfur dioxide in the air, a person experiences irritation of the mucous membranes. This is exactly the gas that causes acid rain and fog. In the presence of oxygen, SO2 is converted to SO3 and forms sulfuric acid upon interaction with water. The end product of this reaction is an aerosol of sulfuric acid in the atmosphere. When it falls with the rain, it oxidizes the soil and adversely affects the environment and people. Scientists believe that this precipitation is one of the most important causes of forest degradation. NOx and its compounds accelerate the formation of the greenhouse effect and destroy the ozone layer. For humans, this gas is harmful by accelerating the inflammatory processes of the mucous membrane, reduces muscle performance. Carbon dioxide, formed as a result of fuel combustion in power plants, has a negative effect on the air. The reason for the increase in ambient air temperature by 1 degree is the presence of greenhouse gases in the atmosphere.

The direct thermal effect of the above harmful substances can be determined by calculating the dependence on the volume of the burned resource.

The main task of this study is to determine the quantitative characteristics of harmful emissions into the atmosphere depending on the composition of solid fuels.

In the course of the study, according to [5], the emission values of carbon oxides and nitrogen, sulfur dioxide and solid particles were calculated. The calculation took into account the types of solid fuels that are most often used in Ukraine at thermal power plants (Table 1).

The results of the calculations are summarized in Table 2.

Given the results of the calculations, it is established that the fuel composition does not affect the emissions of nitrogen oxides. The main factor influencing the emission of sulfur dioxide is the percentage of sulfur in the elemental composition of

the fuel: the most harmful emissions are formed during the combustion of Alexandria brown coal and coal from the Trostyanets basin. Emissions of particulate matter into the environment are influenced by the ash content in the fuel: the lowest emission of particulate matter during the combustion of the Donetsk long-flame and anthracite-type Donetsk basin.

Table 1

Solid fuel composition [4]

Occurrence	Mark	Composition as a percentage by weight						
		H^p	C^p	S^p	N^p	O^p	W^p	A^p
Donetsk	АШ	3,7	50,6	4	1,1	8	13	15,6
Donetsk	Г	2,8	72,3	2	1,1	1,3	5,5	15
Donetsk	Д	1,5	76,4	1,7	0,8	1,3	5	13,3
Alexandria	Б	1,9	21,1	2,6	0,2	7,1	53	14,1
Trostyanetsky		2,3	28,2	3,6	0,4	9,6	37	18,9
Kolomyia		3,1	37,8	3,6	0,6	10,9	20	24
Mukachevsky		1,8	19,6	0,4	0,3	8,1	45	24,8
Lviv-Volyn		3,5	54	1	0,9	7,7	10,5	22,4

Table 2

The results of the calculations.

Occurrence	Mark	Emission indicator			
		Solid particles	CO_2	SO_2	NO_x
Donetsk	АШ	5472,01	91315,59	3751,23	116,05
Donetsk	Г	3934,99	97700,7	1402,73	116,05
Donetsk	Д	3473,64	102827,7	1187,06	116,05
Alexandria	Б	14501,16	111153,9	7149,06	116,05
Trostyanetsky		13259,1	101332,7	6752,22	116,05
Kolomyia		11943,86	96396,56	4789,92	116,05
Mukachevsky		28064,28	112778	1210,19	116,05
Lviv-Volyn		7682,81	95163,97	916,99	116,05

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It was also found that the largest share of the above substances are carbon dioxide emissions. With this in mind, it was decided to analyze the impact of fuel composition on CO2 emissions. The main factors influencing the emissions of this gas are the content of carbon and ash in the fuel. Therefore, it is advisable to establish the effect of the above components on the amount of carbon dioxide emissions into the atmosphere depending on the type of fuel.

During the calculation study, it was found that the amount of ash in the fuel does not affect the value of carbon dioxide emissions. However, the value of k (CO2) is significantly affected by the amount of carbon in the elementary fuel composition.

Figure 1 shows the effect of carbon and ash in the fuel on the quantitative indicators of carbon dioxide emissions into the atmosphere.

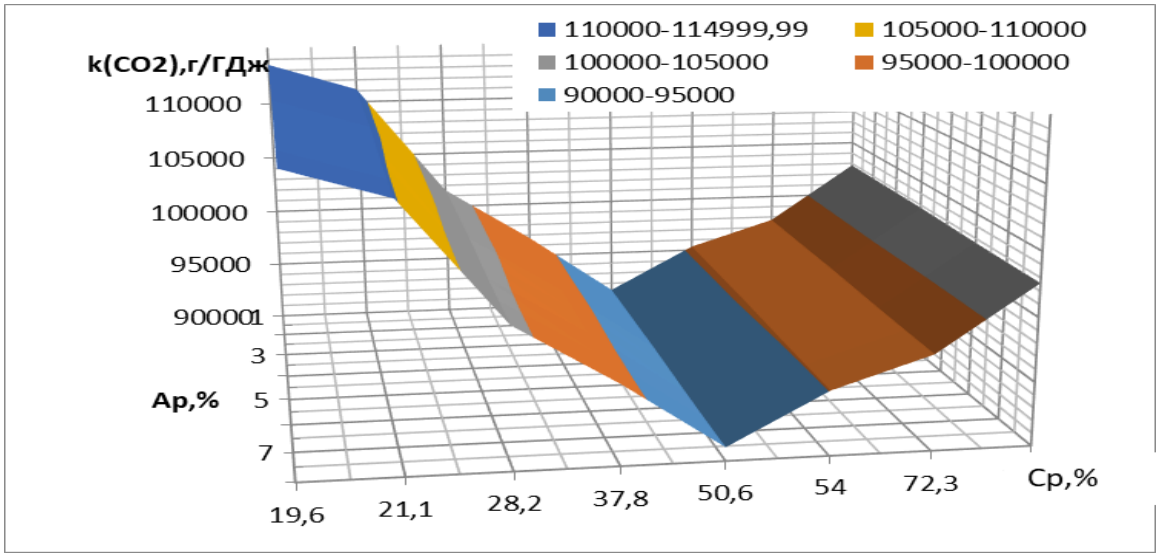

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Figure 1. Graph of the dependence of carbon monoxide emissions on the content of carbon and ash in the fuel: *k (CO_2) - carbon dioxide emission, g / GJ; C^p - carbon content in the fuel,%; A^p - ash content of fuel: 1 – A^p =13,3; 2 - A^p =14,1; 3 - A^p =15; 4 - A^p =15,6; 5 - A^p =18,9; 6 - A^p =22,4; 7 - A^p =24; 8 - A^p =24,8.*

Figure 1 shows that the lowest value of carbon dioxide emissions when using fuel with a carbon content of about 50%. This fuel is anthracite shield of the Donetsk basin (Table 1). The highest values of k (CO2) are observed when using fuels with a carbon content of about (19-22) %. These are Alexandria brown coal and coal from the Mukachevo basin.

Conclusions. Therefore, the main results of this study are: the composition of the fuel does not affect the emissions of nitrogen oxides. Most harmful emissions are formed during the combustion of Alexandria brown coal and coal from the Trostyanets basin. The lowest emission of solid particles during the combustion of the Donetsk long-flame and anthracite-type Donetsk basin. The amount of ash in the fuel does not affect the value of carbon dioxide emissions. However, the value of k (CO2) is significantly affected by the amount of carbon in the elementary fuel composition. The lowest value of carbon dioxide emissions when using anthracite-type Donetsk basin (Table 1). The highest values of k (CO2) are observed when using Alexandria brown coal and coal from the Mukachevo basin.

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Анотація. *Основним завданням даного дослідження є визначення кількісних характеристик шкідливих викидів в атмосферу в залежності від складу твердого палива.В ході дослідження розраховані показники емісії оксидів вуглецю та азоту, сірчистого ангідриду та твердих частинок. Для розрахунку брали до уваги види твердого палива, що найчастіше використовуються в Україні на теплових електричних станціях.*

Ключові слова: *шкідливі викиди, показник емісії, оксиди азоту, сірчистий ангідрид, зольність, діоксид вуглецю.*

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