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PROSPECTS OF APPLICATION OF GAS-OIL BLOCKS WITH THE PURPOSE OF REDUCING HEAVY METAL EMISSIONS

ПЕРСПЕКТИВИ ЗАСТОСУВАННЯ ГАЗОМАЗУТНИХ БЛОКІВ З МЕТОЮ ЗМЕНШЕННЯ ВИКИДІВ ВАЖКИХ МЕТАЛІВ

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Abstract. *During the combustion of fuel oil at the power plant, heavy metal compounds are formed. Vanadium compounds are the main components of fuel oil ash, so the amount of vanadium emissions is taken as a control parameter of the harmful effects of fuel oil on the environment. The study calculated vanadium emissions from the combustion of high-sulfur fuel oil grades 100 and 200, given that these two types of fuel oil differ in fuel oil content, and all other brands have the same content as high-sulfur fuel oil grade 100. Also for the calculation took into account the use of the above ash traps, which have the following characteristics. The dependence of the vanadium emission index on the brand of fuel oil and ash trap installation was established.*

Key words: *harmful emissions, emission index, vanadium, fuel oil ash, brand of fuel oil, ash trap.*

Introduction. Energy consumption is related to all human activities, which in turn it receives from the energy system. The power system of Ukraine includes TPPs, NPPs, PSPs, HPPs, SPPs, WPPs, etc. The share of thermal power plants is quite high and is 35%. Electricity at thermal power plants is produced by burning fossil fuels (coal, natural gas, fuel oil). In Ukraine, pulverized coal stations are more common, where the main fuel is coal, and fuel oil is also presented, which is used as a reserve fuel. At the same time, gas-oil units are widely represented, in which the main fuel is natural gas and the reserve fuel is fuel oil. Since fuel oil is used in all thermal power plants, it is worth paying attention to it and investigating its impact on the environment. During the combustion of fuel oil at the power plant, heavy metal compounds are formed. Vanadium compounds are the main components of fuel oil ash, so the amount of vanadium emissions is taken as a control parameter of the harmful effects of fuel oil on the environment. At present, fuel power plants that burn fuel oil are not equipped with modern dust and gas capture equipment. Therefore, 70-80% of ash residues enter the atmosphere without purification, and the remaining part is deposited in the flues, on the heating surfaces, the economizer and the regenerative

air heater. Depending on the combustion conditions of fuel oil, the location of particles in the boiler and its design, the content of vanadium oxide (V) varies widely - from 1.5 to 35% V2O5, which is hundreds of times higher than its content in the ore. In addition, the ash residues contain toxic heavy metals: Nickel - 1-4.5% Ni; chromium - 1-3% Cr2O3 and manganese - 1-2.5% Mn.

According to the impact on humans and the environment, vanadium pentoxide belongs to the first class of danger, ash residues of thermal power plants that burn fuel oil - to the second class of danger. Once in the environment, vanadium chemical compounds can stay in it for a long time, accumulate, enter into chemical interactions between themselves and the components of the biosphere, affect the fauna, flora and humans. When developing the technology of utilization of TPP ash residues and economic evaluation of their further use as vanadium-containing raw materials for many industries, it is important to determine the ratio of vanadium in different types of waste and the amount of each type of secondary raw materials.

The main text. The TPP uses fuel oil of various brands, the composition of which is summarized in table 1.

Table 1

Composition of fuel oils [4]

Indicator	Brand of fuel oil				
	High sulfur			Low-sulfur	
	40	**100**	**200**	**40**	**100**
S^{daf}, %	2,50	2,70	3,00	0,40	0,40
C^{daf}, %	85,50	85,70	85,90	87,50	87,50
H^{daf}, %	11,20	10,60	10,20	11,50	11,10
$(O + N)^{daf}$, %	0,80	1,00	0,90	0,60	1,00
Q^{daf}, МДж/кг	40,40	40,03	39,77	41,24	40,82
A^d, %	**0,15**	**0,15**	**0,30**	**0,15**	**0,15**
Fuel ash (V_2O_5), mg / kg	**600**	**600**	**1200**	**600**	**600**
W^r, %	2,00	2,00	1,00	2,00	2,00

Gross emissions of pollutants and greenhouse gases are determined by the industry control document [4] by continuous measurements of pollutant concentrations in flue gases of power plants and calculation methods based on data on fuel consumption and composition and characteristics of power and gas treatment plants. According to the above document, the vanadium emission index is affected by the content of fuel oil ash (V_2O_5) in fuel oil and the efficiency of the ash trap.

The main ash traps include: electrostatic precipitator, wet scrubber and battery cyclone. Electrostatic filter or electrostatic precipitator - a technological device for capturing and removing dust suspended in a gaseous medium. The essence of the process of electrostatic purification of gases is based on the ionization of the gas, ie the splitting of its molecules into positively and negatively charged ions. Wet dust collectors are designed to clean gases from dust when passing the dust-gas mixture through a layer of water. Battery cyclone - air or gas cleaning device of centrifugal action, designed to release dust up to 5 microns.

In the course of the study, according to [4], the vanadium emission values were calculated during the combustion of high-sulfur fuel oil grades 100 and 200, given

that these two types of fuel oil differ in fuel oil content, and all other grades have the same content as high-sulfur fuel oil brand 100. Also for the calculation took into account the use of the above ash traps, which have the following characteristics, presented in table 2.

Table 2

Values of the empirical coefficient f_V for calculating the efficiency of vanadium capture by an ash trap [4]

Ash trap installation	Empirical coefficient
Electrostatic filter	0,6
Wet scrubber	0,5
Battery cyclone	0,4

The results of the calculations are summarized in table 3.

Table 3

The value of vanadium emissions depending on the brand of fuel oil and ash trap

Brand of fuel oil / Ash trap installation	High sulfur 100	High sulfur 200
Electrostatic filter	15,099664	30,3967589
Wet scrubber	27,87630277	56,1170933
Battery cyclone	34,84537847	70,1463666

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Based on the results of the calculations, a graphical dependence is constructed, which is presented in Figure 1.

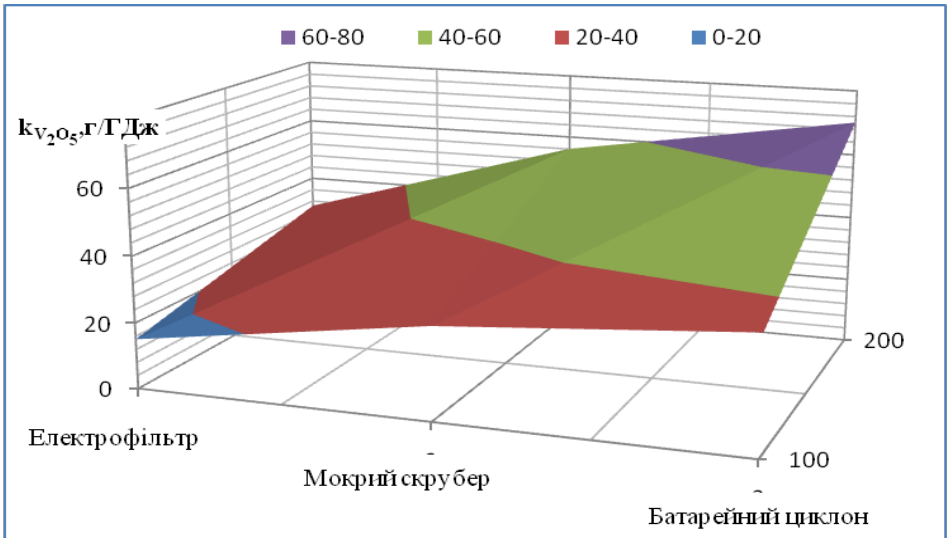

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Figure 1. Graph of the dependence of vanadium emissions on the brand of fuel oil and ash trap.

It is established that the lowest value of the emission index when burning high-sulfur fuel oil grade 100 using an electrostatic precipitator. Instead, the highest rates of vanadium emissions are observed when burning high-sulfur fuel oil grade 200 and installing at the TPP such an ash trap as a battery cyclone.

Conclusions. Therefore, the main results of this study are: the quantitative indicators of vanadium emissions into the environment during the combustion of fuel oil are affected by the content of fuel oil ash (V_2O_5) in fuel oil and the efficiency of the ash trap. The lowest value of the emission index when burning high-sulfur fuel oil brand 100 using an electrostatic precipitator. The highest rates of vanadium emissions were obtained during the combustion of high-sulfur fuel oil brand 200 and the installation at the TPP of such an ash trap as a battery cyclone.

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Анотація. *Під час спалювання мазуту на енергетичній установці утворюються сполуки важких металів. Сполуки ванадію відносяться до основних складових мазутної золи, тому кількість викиду ванадію прийнято за контрольний параметр шкідливої дії мазутної золи на довкілля. В ході дослідження розраховані показники емісії ванадію при спалюванні високо сірчистого мазуту марок 100 та 200 з огляду на те, що ці два види мазуту відрізняються за вмістом мазутної золи, а всі інші марки мають такий же вміст як і у високо сірчистого мазуту марки 100. Також для розрахунку брали до уваги використання вищевказаних золовловлювальних установок, які мають наступні характеристики. Встановили залежність показника емісії ванадію від марки мазуту та золовловлювальної установки.*

Ключові слова: *шкідливі викиди, показник емісії, ванадій, мазутна зола, марка мазуту, золовловлювальна установка.*

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