http://www.moderntechno.de/index.php/meit/article/view/meit21-01-068
DOI: 10.30890/2567-5273.2022-21-01-068

УДК 536.24:621.184.5

# QUANTITATIVE EMISSIONS OF SUSPENDED SOLID PARTICLES AT DIFFERENT COMBUSTION TECHNOLOGIES

## КІЛЬКІСНІ ПОКАЗНИКИ ВИКИДІВ СУСПЕНЗОВАНИХ ТВЕРДИХ ЧАСТИНОК ПРИ РІЗНИХ ТЕХНОЛОГІЯХ СПАЛЮВАННЯ

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***Abstract.*** *The main problem of all thermal power plants is the impact on the environment. After all, with all available technologies for reducing emissions and disposing of waste, the damage to the environment is quite large. Emissions from boiler exhaust gases (including thermal pollution), fuel waste, combustion products (ash and slag), emissions of polluted water into natural reservoirs (lakes, rivers, etc.).*

*Changes in combustion technology can affect many factors and can also be used as primary means to reduce emissions of fly ash, SO2, NOx and other fuel components. Due to calculations and comparison of quantitative characteristics with the help of graphs, it is noticeable that the change in the emission index of particulate matter k is influenced by: fuel ash content; heat of combustion; combustion technology; particle removal rate αvin. There are some relationships between the above indicators and the emission factor. According to calculations, the best in terms of emission reductions is combustion in a cyclone furnace (with a horizontal pre-furnace). Note the disadvantages of this method of combustion, namely: increased NOx emissions due to high combustion temperature; increase in loss in the boiler q6 - heat loss of slag; increase of own expenses of the electric power for increase of draft and work of blowers.*

*So, we see that the introduction of such technologies is a complex issue. There are many factors to consider, but saving on the environment is like saving on yourself. In the future. After all, our procrastination is reflected not only now and not only on us. But also in the future of our descendants. And it is our current actions that will determine what their future and ours will be.*

***Keywords:*** *Environmental energy problems, harmful emissions, combustion technologies, solid suspended particles*

## Introduction.

The entire energy sector of Ukraine is united in the UES - the United Energy System. It has 8 hydropower plants and 3 hydroelectric hydropower plants (PSPs), 4 operating nuclear power plants, 15 thermal power plants, 43 thermal power plants - thermal power plants, many solar power plants and many wind farms. However, thermal power plants have become the most widespread.

Thermal power plant (TPP) - a power plant that uses the chemical energy of fossil fuels (coal, peat, fuel oil, natural gas, etc.) to heat the working fluid (usually water) in the boiler furnace, bringing steam to certain parameters and using its kinetic energy to develop turbine torque. The torque of the turbine rotor is transmitted to the stator of the generator, where an electric current is produced by the phenomenon of electromagnetic induction.

The main problem of all thermal power plants is the impact on the environment. After all, with all available technologies for reducing emissions and disposing of waste, the damage to the environment is quite large. Emissions from boiler exhaust gases (including thermal pollution), fuel waste, combustion products (ash and slag), emissions of polluted water into natural reservoirs (lakes, rivers, etc.).

Therefore, during the development of thermal energy, many ways and solutions have been found to reduce the harmful effects of the operation of the plant. Such as: installation of filters and technologies for catching flue gas cleaning (electrostatic precipitators, bag filters, scrubbers, cyclones, etc.); improving fuel preparation; change of boiler design; changing the combustion process and new combustion methods.

**Main text**

Changes in combustion technology can affect many factors and can also be used as primary means to reduce emissions of fly ash, SO2, NOx and other fuel components. Measures to modify the combustion process include: reducing power; modification of burners; modification of the combustion process in the middle of the furnace; modification of the fuel and air mixing system (eg flue gas recirculation, pre-mixing of fuel with air, use of additives, fuel mixing, drying, fine grinding, gasification, pyrolysis).

When burning fossil fuels, its mineral part (inorganic impurities) are converted into ash and partially come out of the boiler in the form of volatile ash with flue gases. Particles in the flue gases, such as fly ash, enter the equipment to control particulate matter. The characteristics and amount of fly ash depend on the fuel, such as the mineral composition of the coal and the type of combustion. Consider the basic technologies of coal combustion on the example of the design of furnaces and their upgrades.

Boiler plants with solid slag removal or TSHV operate at a temperature below the melting point of ash near the walls of the furnace or heating surfaces. The highest temperature is set in the core of the torch in the central part of the furnace, located approximately at the level of the burners. As a result of heat transfer to the furnace screens, an isotherm with a relatively low temperature is located near them. As the ash melted in the core of the torch moves to the periphery and enters the region of relatively low temperature ash particles are cooled and solidified. Thus, the ash particles when heated in the core of the torch and then cooled near the furnace screens twice undergo all stages of change of physical state from solid to liquid (or softened) and back. On the way up, the ash particles are also cooled together with the gases and must be carried out of the furnace in a granular (hardened) state.

In furnaces with liquid slag removal or RSHV, the temperature in the lower part of the combustion chamber is maintained so as to ensure not only complete melting of the slag but also their reliable removal in liquid form from the furnace.

The disadvantages of the furnace with liquid slag removal include increased losses with the physical heat of the slag. For multi-ash fuel, these losses can reach 2-3%. However, it should be noted that the heat of the liquid slag and the slag itself can be used for various technological processes.

The main disadvantages of cyclone furnaces include: problems with burning coal with a low yield of volatile, as well as highly humid coal; increase in heat loss with physical heat of slag (more than 2%); increased energy consumption for blasting; relatively high yield of nitrogen oxides due to the high temperature in the cyclone chamber.

Combustion in a fluidized bed takes place in a hot fluidized bed, in which combustion air is introduced into the lower part of the furnace. As CFC systems appeared for the combustion of coal and lignite, they became predominantly used in industrial combustion plants. Sand is usually used as the fluidized bed material, especially during start-up. The layer, which includes fuel (1 to 3% of the layer material), ash and sorbents, is fluidized with air coming from the bottom up, and the temperature of the layer provides fuel combustion.

Therefore, we will calculate and demonstrate the value of the coefficient k for each type of fuel for different combustion technologies. Here are some graphs.

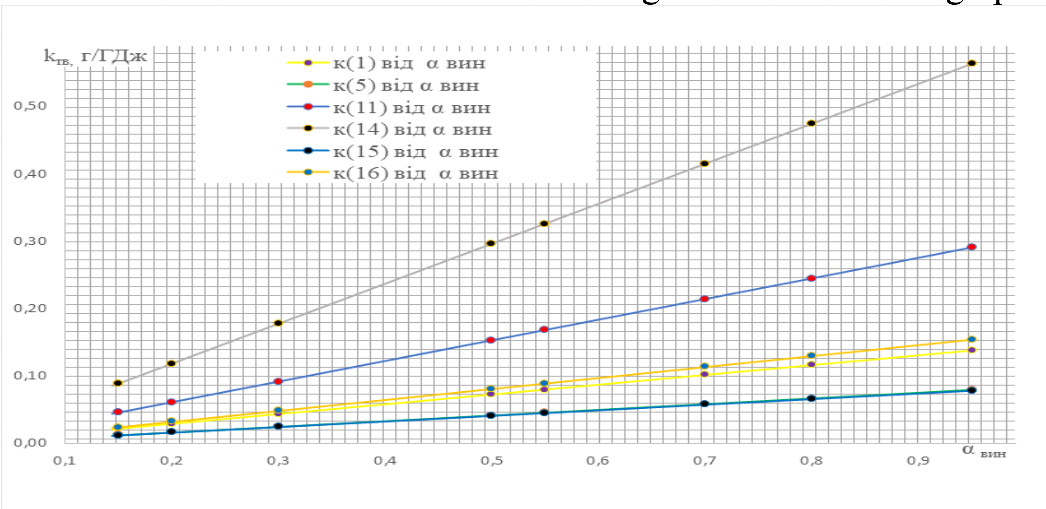


**Figure 1 - dependence of the emission index k (g / GJ) on the indicator $\alpha_{win}$**

Figure 1 shows the dependence of the emission factor k on the removal rate of particles $\alpha_{vin}$. There is a noticeable tendency that for all types of fuel the value of the emission indicator k increases linearly with increasing α value.

It is noticeable that the fuel from the Mukachevo field has the greatest value of emission. It is noticeable that this fuel has the highest content of AP ash - 24.8%, but the lowest value of carbon $C^P$ - 19.6% and sulfur $S^P$ - 0.4%.

At the same time, the lowest indicator of particulate matter emissions k has a fuel - coke breeze (note also that this fuel has the lowest percentage of hydrogen hydrogen - 1.4% and the lowest ash content of $A^P$ - 12%).

The graph above shows the dependence of the emission index of particulate matter k and the heat of combustion of fuel Qp. The schedule tends to decline. That is, regardless of the combustion technology with increasing heat of combustion of fuel, the emission of particulate matter is reduced.

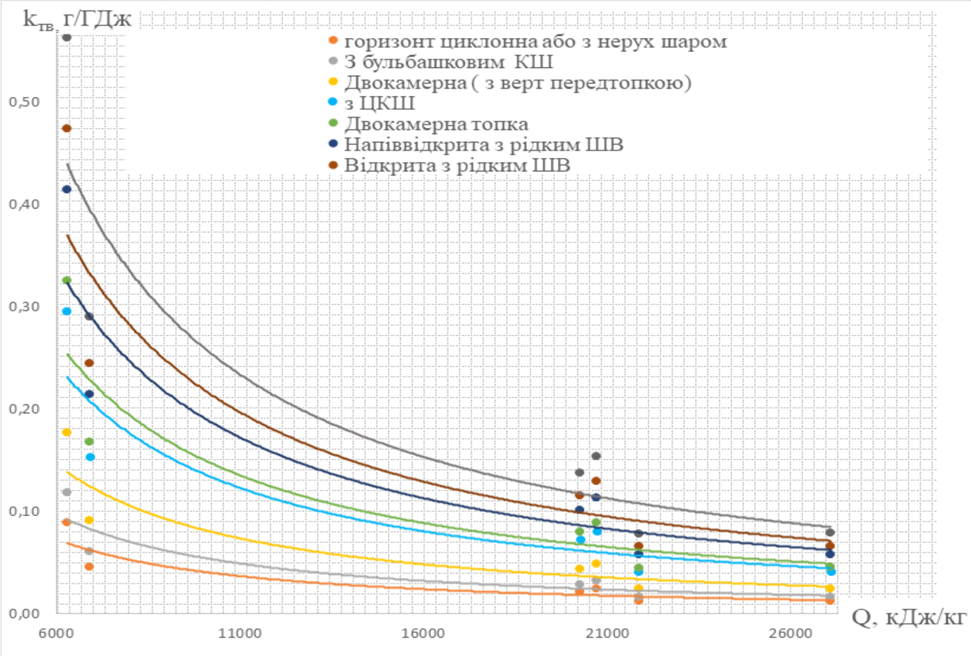


**Figure 2 - the dependence of the emission of particulate matter emissions to g / GJ on the heat of combustion Q kJ / kg**

**Conclusions.**

Due to calculations and comparison of quantitative characteristics with the help of graphs, it is noticeable that the change in the emission index of particulate matter k is influenced by: fuel ash content; heat of combustion; combustion technology; particle removal rate αvin.

There are some relationships between the above indicators and the emission factor. According to calculations, the best in terms of emission reductions is combustion in a cyclone furnace (with a horizontal pre-furnace). Note the disadvantages of this method of combustion, namely: increased NOx emissions due to high combustion temperature; increase in loss in the boiler q6 - heat loss of slag; increase of own expenses of the electric power for increase of draft and work of blowers.

Therefore, this method is not an ideal solution from an environmental point of view. However, combining it with other methods such as: installation of additional filters (fabric and electric filters); use of modern technologies of fuel preparation and storage; inclusion in the fuel-air path of scrubbers (wet Venturi scrubber), cyclones, etc.

So, we see that the introduction of such technologies is a complex issue. There are many factors to consider, but saving on the environment is like saving on yourself. In the future. After all, our procrastination is reflected not only now and not only on us. But also in the future of our descendants. And it is our current actions that will determine what their future and ours will be.

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***Анотація.*** *Головною проблемою всіх теплових електростанцій є вплив на екологію. Адже за всіх наявних технологій зменшення викидів та утилізації відходів шкода для навколишнього середовища доволі велика. Викиди з вихідними газами котла (включаючи теплове забруднення), відходи паливного господарства, продукти згорання (зола та шлак), викиди забрудненої води в природні водоймища (озера, річки і тд).*

*Зміни в технології спалювання можуть вплинути на безліч факторів та можуть також використовуватись як первинні засоби для зниження викидів леткої золи,* $SO_2$*,* $NO_x$ *та інших складових палива. Завдяки проведенню розрахунків та порівняння кількісних характеристик за допомогою графіків помітно, що на зміну показника емісії твердих частинок к впливають: зольність палива; теплота згорання; технологія спалювання; показник виносу частинок* $\alpha_{вин}$*. Помітні певні залежності між наведеними вище показниками та коефіцієнтом емісії. Згідно розрахунків найкращим з точки зору зменшення викидів є спалювання в циклонній топці (з горизонтальною передтопкою). Відмітимо і мінуси цього способу спалювання, а саме: підвищений викид* $NO_x$ *через високу температуру спалювання; збільшення втрати в котлі* $q_6$ *– втрати з теплотою шлаку; збільшення власних витрат електроенергії на підвищення тяги та роботидутьових вентиляторів.*

*Отже, бачимо, що впровадження таких технологій – питання комплексне. Потрібно врахувати багато факторів, проте економити на екології це все одно, що економити на собі. На своєму майбутньому. Адже наше зволікання відображається не лише зараз і не лише на нас. Але і на майбутньому наших нащадках. І саме від наших* *теперішніх дій буде залежати,яким саме буде їхнє та наше майбутнє.*

***Ключові слова:*** *Екологічні проблеми енергетики, шкідливі викиди, технології спалювання, тверді суспендовані частинки*

Статья отправлена: 25.06.2022 г.