воздействия радиации на людей и окружающую среду и заканчивая долговременными изменениями в экосистемах. Последствия Чернобыля до сих пор ощущаются, и полная картина масштаба трагедии и её последствий продолжает формироваться по мере проведения исследований и анализа накопленных данных.

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УДК 504.06

METHODS OF REDUCING EMISSIONS OF SOLID PARTICLES DURING COMBUSTION OF LOCAL FUELS

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An analysis of methods of reducing emissions of solid particle during combustion of local fuel was conducted. It is shown that the amount of emissions depends on factors such as composition, ash content, fuel combustion conditions, and the efficiency of gas cleaning equipment used at enterprises.

Key words: local fuels, emissions into the atmosphere, solid particles, gas cleaning equipment, biomass, composite fuel.

The utilization of solid fuels to generate thermal and electrical power is a significant contributor to environmental issues. When fossil fuels are burned, their mineral component (inorganic impurities) is transformed into ash, which is then released from the boiler along with flue gases in the form of fly ash. The concentration of solid particles in dry flue gases, categorized as undifferentiated dust, shall not surpass 50 mg/m^3 under standard conditions.

It is important to highlight that environmental concerns are mainly linked to particles smaller than 10 µm, as they have the ability to remain in the atmosphere for extended periods. The dispersion of solid dust particles is influenced by their physical characteristics and prevailing weather conditions. Factors such as shape, size, and density determine the rate at which particles settle. Larger particles, with a diameter exceeding 10 microns, tend to settle more rapidly and have a noticeable impact in close proximity to the emission source. Particles smaller than 10 µm in diameter have the ability to travel long distances, sometimes hundreds of kilometers, before they settle. These fine aerosols play a role as condensation nuclei in the formation of clouds and are eventually removed from the atmosphere by rain [2].

The presence of solid particles in emissions resulting from fuel combustion is influenced by the fuel's composition and ash content. Among local fuels, the combustion of peat produces the highest amount of solid particle emissions, followed by biomass.

To reduce the formation of dust emissions from solid fuel combustion, various methods can be employed, such as using composite fuel with lower ash content. One approach is to mix biomass with peat to create such fuel. In this context, utilizing plants obtained from phytoremediation of saline soils, like rapeseed straw and grain crops, as biomass is suggested.

There has been conducted a research on changing the main fuel characteristics (ash content, combustion heat) when using peat-based composite fuel containing various types of biomass in amounts of 10, 30 and 50 mass% (Table 1).

Research has been conducted on altering the primary fuel used in combustion processes. The fuel characteristics of individual components (peat, rapeseed straw and grain straw) of composite briquettes have been accepted based on the results of previously conducted experimental studies [3].

Table 1 – Main fuel characteristics of composite briquettes based on peat and biomass

Name of biomass type of in the composition of composite fuel	Biomass content in composite briquettes, wt.%	Heat of combustion of working fuel, MJ/kg	Ash content, %
Rapeseed straw	10	13,89	11,8
	30	14,30	10,4
	50	14,71	9,0
Grain straw	10	13,85	12,0
	30	14,20	11,0
	50	14,54	10,0

When peat-based composite fuel is combined with various types of biomass at 10%, 30%, and 50% mass proportions, changes occur in its characteristics such as ash content and combustion heat. The fuel properties of peat, rapeseed straw, and grain straw in composite briquettes were determined through prior experimental studies. The data in Table 1 illustrates that increasing the biomass content in the fuel, which is primarily peat, results in a reduction in ash content. For instance, incorporating rapeseed straw from 10% to 50% leads to a 23.7% decrease in ash content, while using grain straw in the same proportions causes a 16.7% decrease.

Moreover, specific emissions of solid particles were analyzed based on a study [4], and the findings are depicted in Figure 1.

Lowering the ash content in the fuel is essential for selecting an appropriate emission control system. In order to reduce expenses, it is important to consider cost optimization strategies.

Currently, various types of equipment are utilized to eliminate emissions from solid particles, including both dry and wet dust collection systems.

These systems consist of single cyclones, battery cyclones, scrubbers, bag filters, electrostatic precipitators, and other gas cleaning units with different designs and configurations. The operational principles of these systems are based on different methods of particle collection:

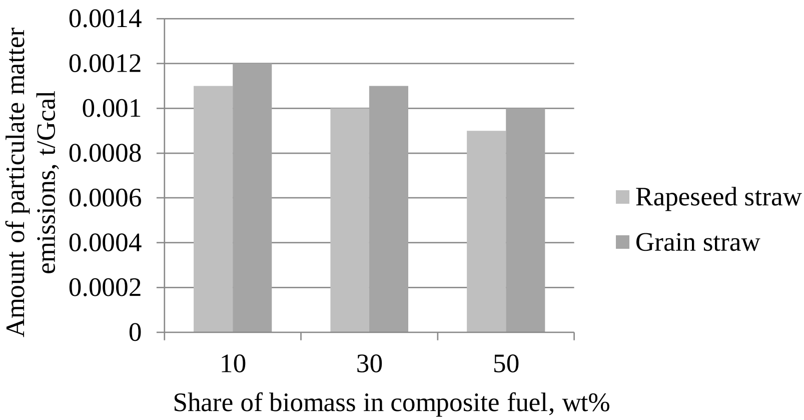

Figure 1 - Change in solid particles emissions when using composite fuels

1. Gravitational settling: This method involves the settling of solid particles from the flue gas flow through gravity. To achieve this, it is essential to establish a suitable dust flow movement within the equipment, considering factors such as particle size and density.

2. Inertial settling: Inertial settling relies on the varying inertia of particles and the suspending medium due to their differing densities. Aerosol particles are separated from the gas medium as they move by inertia. The settling process, driven by centrifugal force, occurs during this separation. The contaminated air-gas flow moves in a curvilinear path. Due to centrifugal forces, solid particles are pushed towards the edges of the device and settle there.

3. Trapping effect, where particles in the air or gas are captured in narrow channels and pores within the filter materials.

4. Wet cleaning, where the device's surfaces are moistened with water or another liquid to retain solid particles.

5. Settling in an electric field: particles can be settled in an electric field by acquiring a charge and then being attracted to electrodes with an opposite charge.

It should be stressed that cyclones are commonly used as inertial ash collectors, where solid particles settle due to centrifugal forces generated by the rotational flow. The efficiency of dust collection in a cyclone improves with larger particle sizes, higher particle densities, and increased gas velocities. A reduction in the cyclone radius leads to an increase in ash collection efficiency. Currently, battery cyclones are utilized to achieve higher ash collection efficiency. This involves installing numerous small-diameter cyclones within a single body. Battery cyclones can collect solid particles with an efficiency of up to 92-93%. They are commonly employed in boilers with low to medium steam capacity or as initial cleaning devices for highly dusty flue gases entering electrostatic precipitators. Cyclones offer advantages such as a simple design, cost-effectiveness, and reliable operation. However, they exhibit drawbacks like high hydraulic resistance and low efficiency in capturing particles smaller than 5 microns [2].

Of special importance is the fact that, depending on the ash and gases' physical and chemical properties, the cleaning requirements, and the desired cleaning level, various types of wet ash collectors are used. These collectors vary in their operational mechanisms and efficiency levels. The operating principle and design features of effective gas cleaning devices vary. One example is scrubbers with Venturi tubes, which are equipped with a spray pipe containing nozzles to introduce liquid for treating contaminated gas. However, a drawback of this equipment is the inability to produce dry ash.

For the removal of particles smaller than 5 microns from gas-air emissions, the most expedient method is to use electrostatic filters. These filters can achieve a purification efficiency of 99–99.8% with a low hydraulic resistance not exceeding 200 Pa. Their key advantages include the ability to collect ash in a dry state, low hydraulic resistance (no more than 0.4 kPa), reliable operation, easy maintenance, ability to handle large volumes of flue gases (up to 1,000,000 nm^3/h), and cost-effectiveness.

It is also worth noting that cyclone bag filters are recognized as efficient devices for cleaning gas from boiler emissions. These filters are categorized as "dry" type dust collectors. The equipment utilizes pulse regeneration through compressed air for filtering. The selection of filter material, filtration, and regeneration parameters is customized for each unit based on the emission source characteristics. In cyclone bag filters, initial cleaning targets large dust particles through the cyclone effect. Subsequent filtration takes place as the gas-dust mixture moves through the filter bags, trapping dust particles on the bag walls. This process guarantees a high level of purification, reaching 99.9% [5].

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УДК 504.06

ТЕХНОЛОГИЧЕСКИЕ МЕРОПРИЯТИЯ ПО ЗАЩИТЕ АТМОСФЕРЫ ПРИ ПРОИЗВОДСТВЕ ЦЕМЕНТА

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В данной статье рассмотрены сухой и мокрый способы производства цемента. Проанализированы основные проблемы, возникающие при производстве цемента. Предложены мероприятия по уменьшению пылеобразования при производстве цемента.

Ключевые слова: цемент, способ производства, пыль, газы, вращающиеся печи, электрофильтры, рукавные фильтры.