Regulator settings effect for high-current electronics on functional efficiency of gas cleaning system filters

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Abstract. The article considers different methods of influence and algorithms of gas-cleaning equipment operation used to capture particles from dust-gas flue gas streams of power plants operating on solid fuels. The article proves that if there is feedback then it is possible to achieve the highest performance indicators for gas cleaning filters of various types used in modern and modernized thermal power plants.

1. Introduction
The use of Ekibastuz coal of the Republic of Kazakhstan as the main fuel type at the power plant causes serious problems in constant tuning of operating modes of the gas cleaning equipment, bringing the degree of flue gas cleaning to design values. Thermal power plants use electrostatic precipitators as gas cleaning equipment, but, recently, bag filters have been introduced. Electrostatic precipitators operate due to two basic electro physical processes: charging the particles of the cleaned flue gas with corona ions and moving the charged particles to the precipitation electrode under the electrostatic force. With a certain voltage value applied to the inter electrode gap, the field intensity near the discharge electrode becomes enough to fill the outer part of the inter electrode gap, mainly with negative ions, which under the electric field forces action move from the corona electrodes to the precipitating electrodes. Ash or dust particles, when meeting ions, adsorb them, are charged, and under the field forces action move to the precipitation electrodes, where they precipitate. The electrodes are periodically shaken, the layer of precipitated dust is destroyed, and the dust falls into the bins of the electrostatic precipitator, and the dust is periodically or continuously removed from there. There are special cassettes with filter material used in bag filters to trap micro particles of ash and dust from flue gases, the particles get stuck in its pores. Periodically, with the directed compressed air jet, the accumulated particles are shaken into the filter hoppers, and the dust is also periodically removed from there. The purpose of the article is to show that feedback on the dust content of the output streams using special dust meters is necessary to detune the regeneration systems of both types of gas cleaning systems filters.

2. Study subject and experiment methods
A problem in electric gas purification is gas cleaning from dust with high specific resistivity; the last is the Ekibastuz coal ash, the Republic of Kazakhstan. Such flue gases give rise to back-corona on collecting electrodes; they decrease breakdown voltage, decrease the electric field, increase the adhesive properties of the layer on a collecting electrode, its poor cleaning, and as a result, reduce the current load due to the locking action of the dust layer. These processes lead to reduction in the degree of gas purification with electrostatic precipitators. Thus, the second problem is to reduce the reverse corona
effect. The secondary flue dust connected with the shaking electrodes operation and regeneration of the filter bag elements is a common problem for different filter types. Flue dust can be significantly reduced by implementing the optimal shaking mode and regeneration. The decrease amount in removal due to optimization of shaking and regeneration depends on the physicochemical properties of the dust and gas environment. An optimal mode of corona electrodes shaking should maintain a layer of dust on the corona elements, where the corona current provides the most effective dust trapping in the electrostatic precipitator, and the control algorithms optimization of the electrode shaking mechanisms maintains the optimal operating mode, as it is the most important task [1, 2]. To optimize bag filters operation and regeneration system efficient operation, it is necessary to determine permanently the dew point where dust particles adhere to the electrostatic precipitator element, and it makes the regeneration system operation ineffective, and important task for this electrostatic precipitator type is to solve an optimization problem of the bag filter operation temperature mode. Optoelectronic sensors (OES) to control dust and ash carryout (OES-2) were developed in FSBEE HE "Omsk State Technical University" to solve problems of setting modes dust and ash carry out equipment [2, 3], to control this equipment operating processes and qualitative assessment of the gas cleaning process as in general, as the environmental monitoring purposes. The dust meters are installed on the exhaust passes and they are electro optical sensors that constant monitor dustiness. They consist of three blocks: a radiation source, a radiation detector and a control unit. Using these devices, the efficiency of filter operation modes according to the following procedure can be determined [3, 4]:

1. Setting the sensitivity and maximum of the dust meter scale.
2. Continuous shaking or regeneration for 6 minutes.
3. Setting the test mode for 4-8 minutes.
4. Trend analysis of the dust removal at the filter outlet.
5. Repeat pp. 3-5 for other power modes of the electrostatic precipitator fields and activation of the bag filter regeneration system.

3. Results and Discussion

Pulse regeneration is applied with the gas flow being disconnected on the bag filters installed at the output of one of the boilers under consideration. Operation control of electro pneumatic valves that provide impulsive supply of compressed air to the electrostatic precipitator is completed by the control software device. The periodicity and duration of regeneration pulses depend on both as the efficiency of the gas cleaning as the durability of the filter materials operation. As the dust grows on the filter materials, it should be considered that not only the hydraulic resistance of the filters increases, but also the efficiency of the smallest particles filtration increases, i.e., not the entire dust layer is to be removed, but as much as to provide sufficient hydraulic resistance without reducing the efficiency of gas cleaning. Therefore, the regeneration process should be optimized according to the following criteria:

- hydraulic resistance of the filter section;
- cleaning efficiency;
- service life of filtering materials;
- temperature mode optimization by the dew point.

In connection with these tasks, it is necessary to examine selection, installation and maintenance of pressure sensors metrological characteristics to determine the sectional hydraulic resistance of filters. Installation of OES-2 dust meters is supposed to be at the bag filter exit. It will provide feedback for optimization of regeneration modes (periodicity and duration of regeneration pulses), and examine the effects of regeneration periodicity on the service life of different filtering materials. According to electrostatic precipitators in operation, the following was stated (figure 1):
Nature of curves for semifields proves that there is back corona on the electrostatic precipitators and it is necessary to apply intermittent power supply for these semifields and to maintain voltage on electrostatic precipitator electrodes by means of algorithms of digital voltage regulators (DVR) control near the inflection point of volt-ampere characteristics. Trends of dust meter readings, current transducers and voltage probes when passing from the mode with transmission of pulses (2/8, 2/6) to the mode of continuous supply of voltage pulses with frequency 100 Hz are shown in figure 1 graphs. When supply voltage with an intermittent forms the relative dust-ash carryover decreases twice [4].

As a result of dustmeter trend analysis, there was an increase in the dust collector from an electrostatic precipitator detected with the standard settings of shaking modes. Pauses were reduced and rapid shaking of the electrodes was carried out in the period from 9 to 14 hours. According to figure 2 dustiness decreases after time reduction [4].
There is a ratio established between the pauses of the shaking mechanisms operation and voltage change at the electrostatic precipitation electrodes, and it specifies the pause time equal to 3 minutes figures 3 and 4 [4].

![Dustmeter](image)

**Figure 4.** Output dust on the dust meter.

Thus, alternating forms of voltage were applied and it reduced energy consumption doubled, DVR algorithms were changed, new firmware was for all DVR regulators. So the ash removal was reduced 10-15% [4].

4. **Conclusion**

Use of dust meters based on electro optical sensors OES-2, installed on the exhaust passes after precipitator housings, organizes feedback on the control system and detuning the optimum operating modes of the control systems for operation of precipitators for cleaning flue gases of various types. There is an opportunity to install automated process control systems for gas purification and constant monitoring of dustiness of power plants piped gas. The quantitative results of the effectiveness of the proposed solutions can be obtained from the reference comparative measurements of the dust-and-ash carryout in the nominal and recommended modes using GRAVIMAT tool.

**References**

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