Part 1

AIR PROTECTION FROM POWER INDUSTRY EMISSIONS

1.2. Ash collecting at TPPs

1.2.2. Fly ash collecting technologies at TPPs

1.2.4. Control over operating efficiency of ash collecting plants at TPPs, burning ekibastuzsky coal

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A law of the Republic of Kazakhstan “On Environmental Protection, adopted in 1997, obliges users of natural recourses to conduct an industrial monitoring and report on the impact of their business activities on environment.

One of the anthropogenic pollutants, containing in emissions of coal-fired TPPs, is fly ash, emitted in large quantities into atmosphere in process of ekibastuzsky high-ash coal combustion even at rather high electrostatic precipitator efficiency. Ash concentration in emissions after wet ash collectors reaches 0,2 ... 0,5 g/m^3, and in case of electrostatic precipitator application it makes 1 ... 2 g/m^3

According to requirements of ecological standards ash emissions should be taken into account in grams per second and tons per year. Direct measurements of these units are not possible, therefore, they are agreed with the authorities of the Ministry of Ecology of the Republic of Kazakhstan and a method of complex measurements is already under realization. It includes separate measurements of ash concentration in emissions c_a (g/m^3) and flue gas flow rate $Q_{f.g}$ (m^3/h) for each boiler unit, and total amount of ash emissions for one year Q_{em}, t/year:

$$Q_{em} = 10^{-6} \sum_{\tau=0}^{8760} c_a Q_{f.g}$$

The first task is a continuous measurement of concentration. Optical dust meters can realize it in the simplest technical way. Devices of this class measure the optical density (or opacity) of gases, but their readings can be converted into concentration units by the calibration curve “opacity – concentration” individual for the flue, which should be updated from time to time. By this, the use of stationary devices able to operate in thermal power plants, and the availability of certified measuring techniques (CMT) are assumed. Such devices, able to realize the task at high dust content in emissions from our thermal power plants, were absent until recently.

The second task is a continuous flow rate measurement of flue gases. It could be solved metrologically. These measurements can be carried out indirectly - by pressure drop at the representative duct section or by other means. Here it’s also required to have the procedure of flow rate calibration, certified by CMT or agreed with the bodies of the Ministry of Ecology of the Republic of Kazakhstan. The calibration curve "AR – flow rate" is strictly individual for each duct and from time to time should be updated. For continuous measurement of AR there can be applied well-known instruments such as "Sapphire", used at thermal power plants.

The third task is the joint continuous processing of the above mentioned measurements. This problem is easily solved by using a standard low-capacity PC. For processing the data a special program is needed, which should include both calibration and signal processing algorithms of processing the signals from dust and flow rate meters. It should include a presentation format of returns on emissions and a set of service files for the user, agreed with the bodies of the Ministry of Ecology.

The first problem is solved, the second is in the final stage. Let’s start to address the third problem.

In the general task of monitoring the first place is taken by creation and certification of the dust meter that can satisfy the requirements of the whole monitoring chain, and specific operational conditions at thermal power plants. In addition, the use of dust meters allows to get operational information for use in industrial purposes: monitoring of the boiler operation modes, a quality of ash collectors, etc. For this purpose dust meters are to be installed at each power boiler.

To ensure the above objectives, the instrument should meet a number of the key technical requirements:

- have a long life at the flue gas temperature of 70 ... 160°C under polluted environmental conditions at occasional maintenance;
- continuous, reliable and representative recording the flue gas opacity in a range of A = 0 ... 50 (25)% with a relative error of less than 4%;
- have a optical small base, and a unit construction;
- have an effective protection and automatic compensation of the optics dusting;
- have automatic control and alarm systems of staff and emergency situations;
- allow the rapid replacement of worn parts, contacting with the flue gases.

It should be added that the instrument of this type should be placed in duct sections allowing to choose the downstream dimensional section for further calibration of concentration and gas flow rate. Unfortunately, the known types of instruments, produced in western firms and CIS, meet only part of the requirements. Therefore, in the JSC "KazNII" of power engineering there was developed an optical dust meter, maximally close to the conditions of TPP operation. As the instrument basis, the differential method of measurements with a reference comparison channel was put. Fig. 1.37 shows a diagram of the device. A special reflector, located in the duct, serves as a source of light. The instrument has an additional optic line, helping to correct the readings automatically depending on contamination of the optical surfaces.

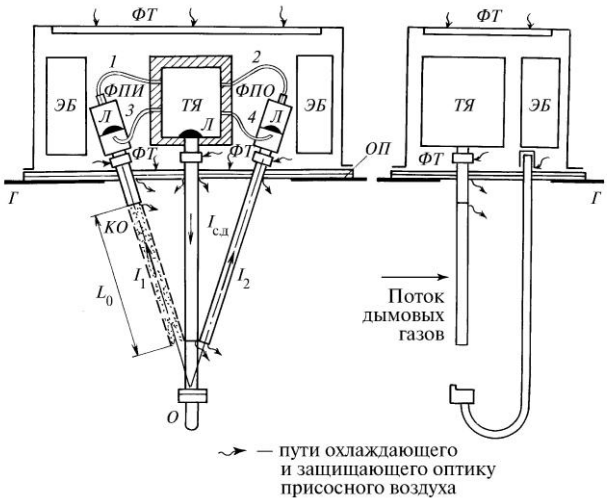

Fig. 1.37. A layout of the optical measuring device IONG-2: *ТЯ* – thermostabilized cell with the illuminating and control light emitting diodes, two photodetectors and preamplifiers of photosignals, *ФПИ* and *ФПО* - optical head of detectors, *О* - Reflector; $I_{l.d}$ and I_1, I_2 - luminous flux of light emitting diode and reflected fluxes, respectively, *КО* - controlled volume of dust flux; L_0 - optical base of the device; *Л* - optical lens; *ЭБ* – electric unit, *ОП* - base plate; *Г* - duct wall; *ФТ* - fabric filter, 1–4 – fibers

Поток дымовых газов - Flue gas flow
пути охлаждающего и защищающего оптику присосного воздуха - directions of the cooling suction air, protecting the optics

Photodetectors of the device and a part of the electronic circuit are thermostabilized. Microprocessor processes the photosignals. Suction air prevents an electron-optical part from overheating and optics dusting, for which the existing underpressure in the duct is used. The device was designed as a single unit with a size of the external part of 70×40×40 cm, and the tubes, immersed in the flow, are less than 80 cm long. Some technical data of the instrument are:

- measuring range of gas opacity A — 0 ... 50 (0 ... 25)%;
- measurement error – less than 4%;
- optical base length - 45 cm;
- microprocessor signal processing;
- automatic correction of dust optics;
- autocompensation limit of optics dusting by absorption - 50%;
- autocompensation limit of reflector dusting by absorption - 50%;
- maximum temperature in the duct - 160 ° C;
- output — controlling dial meter: current 0 ... 5 mA to an external recorder, digital (signal values) on PC.

The device and measurement procedure are certified by the State Standard bodies of the Republic of Kazakhstan. The first device is installed at Aksusskaya TPP in Pavlodar region.

In Fig. 1.38 the calibration curve of the instrument, made under CMP, is shown.

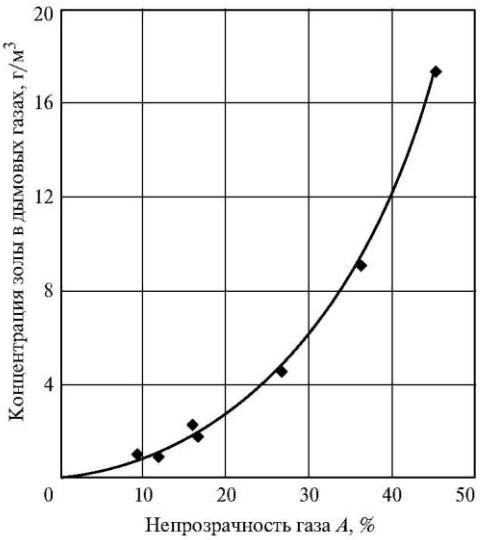

Fig. 1.38. Calibration dependence of the gas opacity A on ash concentration in gas. Device of IONG type, KK 8B, Aksusskaya power plant

Непрозрачность газа- gas opacity *A*, %

Концентрация золы в дымовых газах, г/м^3 - Ash concentration in flue gases, g/m^3

Continuous operation experience of the first unit for one year and a half has shown its sufficient reliability.

Currently two more boilers at the same TPP are being equipped with the dust meters of the same type in order to create over time a computer system for ash emission monitoring.