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THE PROBLEM OF FINE DUST IN THE PRODUCTION PROCESS AND METHODS OF DETERMINING ITS CONCENTRATIONS

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ABSTRACT

The article talks about the device for determining the concentration of dust, the intensity of light radiation, devices and methods of optical measurement of the concentration of dust particles in the air, and new measuring elements.

The device for determining the concentration of dust is a device designed to measure the mass concentration of dust in the exhaust gases of combustion devices, in work and living areas, in the ambient air. A certain type of device should be used for each task.

Today, there are several methods of dust measurement: optical (photometric), gravimetric, piezobalance, triboelectric, radioisotope [1]. The optical principle of the technological process is to determine the attenuation of the intensity of light radiation when passing through a dusty environment. The concentration of dust particles is proportional to the optical density value, which is determined automatically [3]. The main disadvantages of these measuring devices are as follows:
- Low sensitivity when measuring low concentrations of aerosol particles (less than 30 mg/m³), as well as the inability to control high concentrations (more than 10 ... 12 g/m³);
- High impact of physico-chemical properties of aerosols on the measurement result (aerosol size, composition and color). To reduce the measurement error, it is necessary to calibrate the device for a specific type of aerosol or enter a correction factor;
- There is always a need for periodic cleaning of optical elements (optics, reflectors, etc.) Fig. 1 [1].

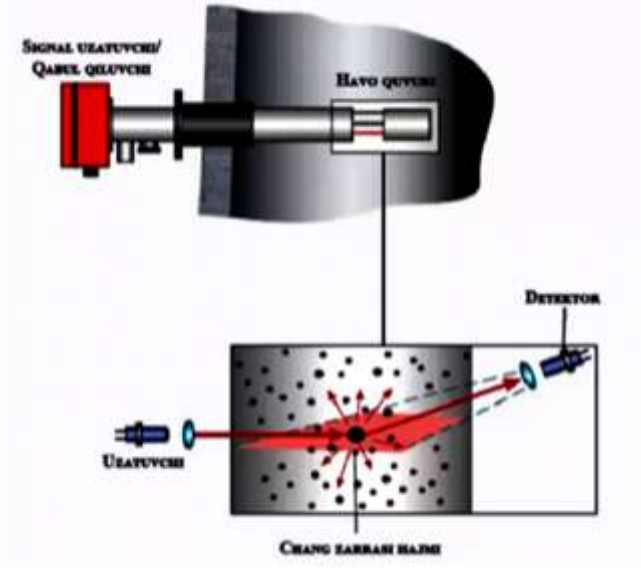

Figure 1. The principle scheme of devices for optically measuring the concentration of dust particles in the air

Dust particles in the air are circulated through a special pipe. The signal transmitting sensor sends an IK type signal. This light signal reaches the detector with a certain intensity change from the dust particles. Information is formed based on the information received through the detector. The nephelometric method, based on the registration of direct, laterally backscattered light radiation, is much more effective in measuring low concentrations of aerosol particles [96]. This method is performed on SICK, AEROKON (NPO EKO-INTECH LLC), Cassela CEL 712, Kanomax 3443 devices and TM-data, TM-digital, TM-F and TM-M (HUND) devices.

The nephelometric method works on the basis of monitoring the weight concentration of industrial dust aerosols with a wide composition. The disadvantage of the nephelometric method is a sharp loss of sensitivity when measuring the concentration of particles with a diameter of more than 8 μm. Industrial enterprises mainly consist of dust particles of 10 microns, and the use of such devices significantly reduces or even excludes the possibility of use in many areas. Therefore, these devices are mainly used in places where fine aerosol particles are released and at the exit of filters of gas treatment plants to control their efficiency [3].
The gravimetric method of measuring aerosols (GOST 17.2.4.05-83) consists in separating particles from dust and gas flow, then placing them on an analytical filter and drying them. The weight gain on the filter, taking into account the sample volume, is used to determine the mass concentration of the aerosol. In this case, the dust concentration is calculated using mathematical expressions [98].

Advantages of the Gravimetric Method
- The advantages of this method are measurement accuracy, because there is a direct measurement of the aerosol, and the results are not affected by physicochemical properties,

Disadvantages of the Gravimetric Method
- The difficulty of this method,
- Duration of the process,
- Use of additional equipment.

Today, the complicated gravimetric method has been replaced by a new piezo-balance method of weighing the settled dust sample. This method was first used in KANOMAX dust meters models 3521 and 3522. Later, Russian companies such as

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"NTM-PROTECTION" LLC began to master this measurement method and implemented it in the Atmas device. The piezo-equilibrium method of measuring the performance of the device consists in periodically taking a sample of aerosol particles through an impactor, which separates the receiving fractions (up to 10 μm) from the total mass of particles, then charges them with the help of a corona electrode and is deposited on the surface of the collecting electrode. A piezoelectric element (quartz) is used as such an electrode. Sampling is carried out by the internal pump of the device. A quartz piezoelectric element is included in the circuit of the generator of electric vibrations. When dust falls on its surface, the weight of the piezoelectric element changes its vibration frequency. The linear variation of the frequency depends on the mass of dust deposited on the element and is the value of the measured weight concentration of the aerosol.

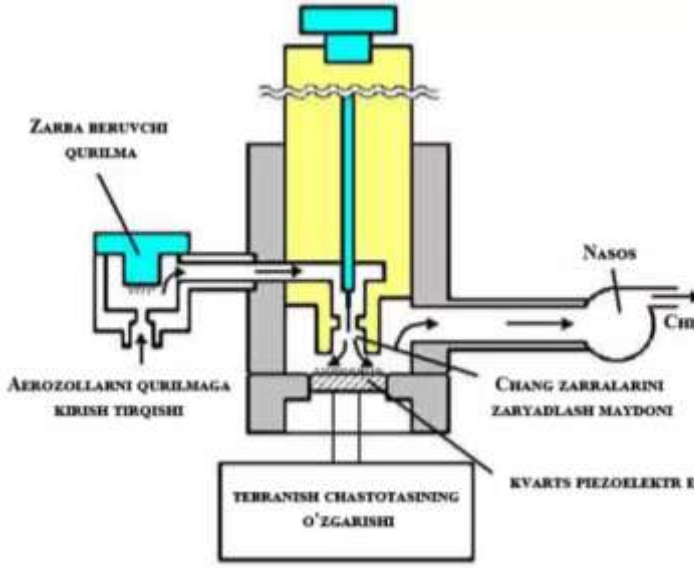

Figure 2. A view of the principle scheme of Gravimetric Measuring Devices

Advantages of the Piezo-Balanced Measuring Method

-Quick measurements, no need to use a large fleet of additional equipment;
-Reliability of instrument readings, physico-chemical properties do not affect measurements;
- Small dimensions of the measuring tool (the tool is usually delivered in a portable box, the total weight of the tool does not exceed 4 kg).

Disadvantages of the Piezo-Balanced Measurement Method

- Measurement is carried out only in places of work and residence;
- The price of the equipment is high;
-Must be handled with care (the sensitive element of the device is very delicate, it should not be allowed to fall, and the prevention device must be carried out strictly according to the instructions).

The triboelectric measurement method is based on measuring the induced charge on an insulated measuring electrode located in a metal gas channel through which dust and gas flows. The induced charge results from the interaction of moving aerosol particles with the electrode surface, and its value is proportional to the aerosol mass concentration over a wide measurement range. These devices are called triboelectric. They can be divided into devices that measure the DC (digital signal) component of the triboelectric signal and devices that measure the AC (Analog signal) component of the triboelectric signal (electrodynamically induced charge). DC-type measuring devices include Auburn, FilterSense, Babbit and Bindicator (USA). AC type measuring devices include S300 series electrodynamic devices (S301 / S303 / S304 / S305) [4].

Advantages of the Triboelectric Measurement Method

-Vibration at the installation site does not affect the indicators;
- Does not have nodes that can be contaminated, which allows the devices to be used for a long time in harsh conditions, and there is an opportunity to use the signals in harsh conditions due to the fact that the nodes of the initial operation are located outside;
- The device has a low chance of losing its resources over time. The devices are durable, so their maintenance is simple and cheap Figure 1.12.

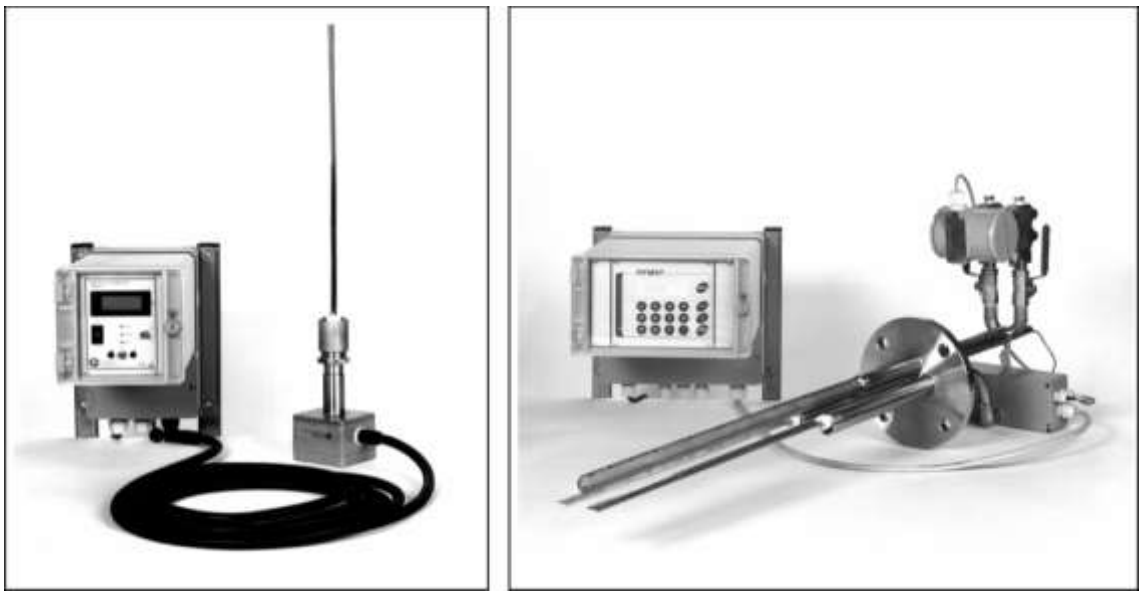

Figure 3. Measuring Devices of Triboelectric Type

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The radioisotope method of measuring dust concentration is based on the absorption of radioactive radiation (usually β-radiation) by dust particles. The mass of trapped dust is determined by the degree of attenuation of radioactive radiation when it passes through the accumulated dust layer. The results of measuring the dust concentration by the radioisotope method depend to a certain extent on the chemical and dispersed composition, which is due to the specificity of the interaction of radioactive radiation with the substance and depends on the nonlinearity of the dependence on the level of absorption. [4]

Practice shows that the fields of application of dust meters are different and they are divided into two groups: the first - used in workplaces, the second - production industrial waste.

For workplace certification, devices with a smaller measurement range are used to achieve more accurate results. It is necessary to control the concentration of dust in this area, because a large amount of dust in the workplace can adversely affect the health of employees working in such conditions and cause a number of respiratory diseases. Recently, more and more large factories have begun to think about the exhaust gases they produce. In addition to environmental monitoring, dust emissions are monitored using stationary gas analysis stations.

SUMMARY

Modernization of existing dust collection systems of primary cotton processing plants is often complicated by the lack of space required to accommodate new dust collection systems. Thus, primary cotton processing plants continue to use outdated and inefficient dust collectors, which has serious environmental consequences. Existing devices are only designed to determine the concentration of dust in the air under laboratory conditions. Therefore, there is a great need to create mini-stations for continuous monitoring of the amount of dust in the enterprise, and mechatronic devices for determining and monitoring the concentration of dust in the primary cotton processing enterprises.

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