P a r t 1

AIR PROTECTION FROM POWER INDUSTRY EMISSIONS

1.2. Ash collecting at TPPs

1.2.2. Fly ash collecting technologies at TPPs

1.2.2.1. Inertial ash collectors

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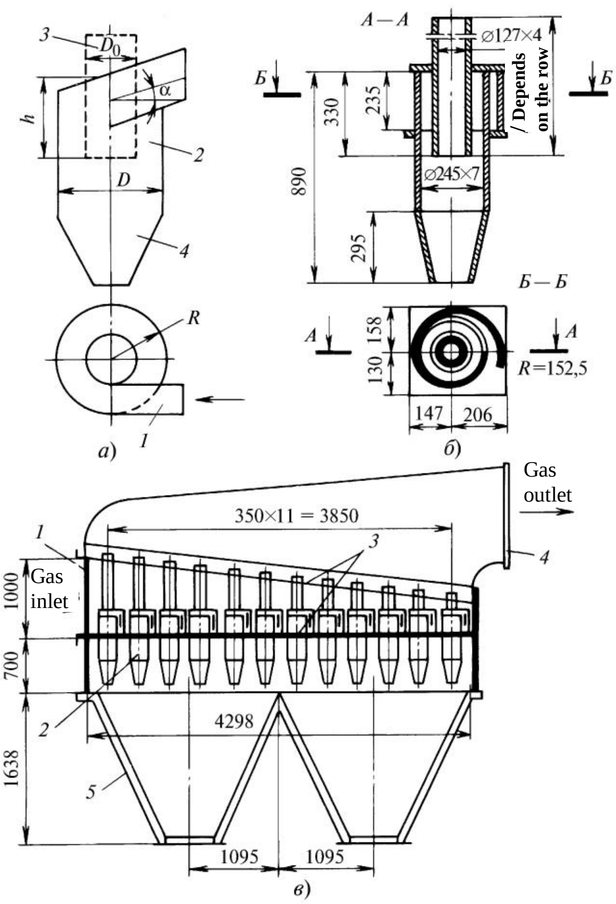

Fig. 1.24. Cyclone ash collectors:
a – schematic diagram of the cyclone, where 1 is an inlet fitting for dusty gas, *2* - the cyclone case (ash collection surface), 3 - outlet fitting of the purified gas, 4 – ash hopper; *б* - an element of the battery cyclone of "Energougol" type, *в* - the battery cyclone, where 1 is an inlet fitting for dusty gas, *2* - the cyclone element; *3* - pipe boards, 4 – outlet fitting of the purified gas, *5* - ash hopper.

Cyclones are widely used as inertial ash collectors at TPPs, in which the ash is precipitated due to centrifugal forces at rotative movement of the stream. A layout of the cyclone is shown in Fig. 1.24 a.

Gas enters the cyclone tangentially and moves around the circle in the channel formed by the outer and inner cylindrical surfaces of the cyclone. Under centrifugal forces the ash is pushed aside to the outer wall of the cyclone and under gravity it is poured down into the conical hopper and then into the general bin.

The purified gas is removed through the inner cylinder upwards.

Ash collection parameter for cyclones is determined by the equation [1]:

$$\Pi = \frac{\tau_p''}{R} \frac{2\pi n}{1-\bar{D}_0} \qquad (1.11)$$

where $\tau_p = \rho_p d^{\,2}/(18\mu)$ is a relaxation time, s (particle acceleration time from zero to the drift speed); ρ_p — particle density, kg/m^3; d — particle diameter, m; R — radius of the cyclone, m; μ — dynamic viscosity of gas, Pa·s; u — gas velocity, m/s; $\bar{D}_0 = D_0/D$; D_0 — diameter of the inner cyclone cylinder; n — gas flow speed before the cyclone outlet.

From (1.11) follows that the ash collecting parameter, and, consequently, the ash collection efficiency in the cyclone increases with the relaxation time (size of ash particles and their density), gas velocity, and decrease in the cyclone radius. Moreover, there is a squared relationship between the ash collection parameter and diameter of ash particles, i.e. the ash collection efficiency in the cyclone sharply decreases with reduction of the size of ash particles. The second fraction in (1.11) is determined by the cyclone shape - a relative diameter of the outlet hole, a depth of the pipe immersion and an angle of setting the inlet branch to the cyclone. To increase the cyclone efficiency, multicyclones, as a rule, are currently applied at power plants, when inside one body a large number of small diameter cyclones are installed.

Formula (1.11) allows to evaluate an impact of various factors on the cyclone efficiency. Practical calculations of the cyclone efficiency are made using the empirical formula, obtained in experimental studies of the operating cyclones:

$$\Pi_i = k\sqrt{\frac{u}{4{,}5}}\,\sqrt[3]{d_i^2}\ , \qquad (1.12)$$

where k is a factor, considering the cyclone type, k = 0,3 for the socket-type multicyclones, k = 0,5 for the cyclones with cochlear-type inlet; u is the gas velocity, referred to the cyclone cross-section, m/s. It is recommended to take u = 4,5 m/s.

Ash collection efficiency in multicyclones does not exceed 0,92, therefore, they are used at the power plants in boilers of small and medium capacity. Hydraulic resistance of multicyclones may be of 500 ... 700 Pa. The multicyclone consists of a body with a hopper, cyclones, lower support grid, upper tube sheet and the dust discharge canal (Fig. 1.24 *в*). Multicyclone sizes are standardized. A body of the multicyclone is usually performed partitioned. Multicyclones with the tangential cochlear gas inlet of "Energougol" type with an inner diameter of 231 mm are the most widely used at power plants. Multicyclones are not recommended for application at high ash adherence, which can cause them to clog.