Part 1

AIR PROTECTION FROM POWER INDUSTRY EMISSIONS

1.2. Ash collecting at TPPs

1.2.2. Fly ash collecting technologies at TPPs

1.2.2.2. Fly ash scrubbers

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The simplest type of scrubber ash collector is a centrifugal scrubber (Fig. 1.25 a), in which a water film runs down the wall, so the ash, separated due to inertial forces, is better removed from the scrubber into the hopper, and ash re-entrainment from the walls by the gas flow is reduced. Scrubbers have the ash collection efficiency of 0,82 ... 0,90.

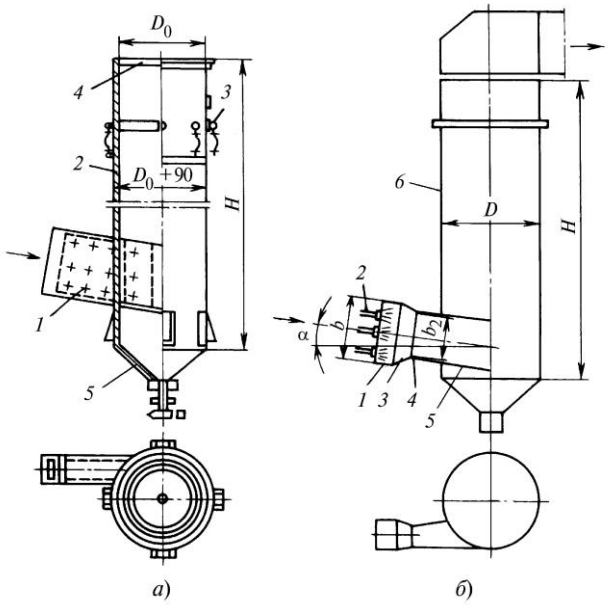

Fig. 1.25. Fly ash scrubbers: *а* — centrifugal scrubber, where *1* — inlet fitting of the dusty air; *2* — ash collector body; *3* — irrigation nozzles; *4* — purified gas outlet; 5 — hopper; *б* — ash collector with Venturi coagulator, where *1* — inlet fitting of the dusty air; *2* — water supply through the irrigation nozzles; *3, 4* and *5* — confusor, neck and diffuser of Venturi coagulator; *6* — scrubber-drop catcher

Higher collection efficiency can be obtained by using the devices with pre-wetting of ash. Currently the widest application received the ash scrubbers with pre-included coagulator in the form of Venturi tube. In Fig. 1.25, *б* a diagram, including the coagulator in the form of Venturi tube, is shown. Water is injected through special nozzles into the gas flow at the inlet of Venturi tube. In the confusor of Venturi tube there is an acceleration of the powder-gas flow up to speeds of 50 ... 70 m/s; in the neck breaking of water droplets in contact with a fast-moving stream, occurs, and in the diffuser there's a brake of the powder-gas flow and the clash of ash particles with water droplets. After Venturi tube, the flow is tangentially introduced into the scrubber, the walls of which are irrigated with water, and the coagulated particles are removed to the hopper. A capture of small ash particles by large water drops occurs due to the following reasons:

- ash particles are moving in Venturi tube almost at a gas rate, and large water drops do not have time to accelerate to the flow rate. Due to the speed difference, collision between ash particles and water droplets occur;
- small ash particles are involved in the turbulent fluctuations, and collide with water drops, almost not involved in the turbulent fluctuations.

Ash collection parameter for ash scrubbers with coagulator in the form of Venturi tube is determined as follows:

$$П = \sqrt{q_{liq} u_g} \qquad (1.13)$$

where q_{liq} is a specific consumption of the irrigation liquid, kg/m^3; u_g is a gas velocity in the throat of Venturi tube, m/s. q_{liq} is usually taken within 0,12 ... 0,20 kg/m^3, and u_g is of 50 ... 70 m/s.

Thus, the efficiency of ash scrubbers with the pre-included Venturi tube depends on the specific consumption of the irrigation liquid and gas velocity in the throat. This is the only type of ash collectors in which the cleaning efficiency does not depend on the particle size. In the first approximation it could be assumed that all particles from large to small ones are collected with the same efficiency, and their size distribution could be not taken into account.

From (1.13) follows that the cleaning efficiency can be improved by increasing the irrigating fluid consumption in excess of the recommended limits, but at that hydraulic resistance of the ash collector will increase, and the purified gas temperature should also meet the following condition:

$$t_{flue} \geq t_d + 21, \qquad (1.14)$$

where t_d is a dew point temperature of the vapor, °C.

An increase in gas velocity in the throat of Venturi tube also increases the hydraulic resistance of ash collector. At the recommended values of q_{lig} and u_g the hydraulic resistance of the apparatus is typically in the range of 800 ... 1100 Pa.

Ash scrubbers with the pre-included coagulator in the form of Venturi tube may have the ash collection efficiency of 0,95 ... 0,97. They are used in boiler of steam capacity to 670 t/h. Ash scrubbers are not recommended to apply for fuels, containing more than 15% CaO in ash, and in case they have the reduced sulfur content above 0,3 %/MJ. Hardness of the irrigation water should not exceed 15 mg-eq/liter (meq/L).