Part 3

ASH AND SLAG HANDLING

3.2. Ash and slag handling systems at TPPs

3.2.2. Ash removal

3.2.2.7. Internal ash conveying plants

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Internal ash conveying plants are designed for pneumatic ash conveying from ESP hoppers to intermediate hoppers or dry ash silos at shipment of dry ash to customers or for hydraulic ash conveying to the dredging pump station in case of external wet conveying of ash and slag slurry to the disposal site (lagoon). The basic advantages and disadvantages of internal ash conveying plants are resulted further.

For internal ash conveying the following plants are used:

- gravity-flowing plants;
- aeroflow conveyor;
- vacuum plants;
- low-pressure plants with jet pumps;
- high-pressure plants with pneumatic screw and chamber pumps;
- two-stage pneumatic conveying plants;
- hydraulic conveying plants.

Gravity-flowing plants for collection of dry ash and its discharge to transport facilities directly in ash rooms of the TPP from the intermediate hoppers under ESPs, if it's possible according to ESPs configuration conditions, have obvious economic and technological advantages in comparison with ash pneumatic conveying systems with the silos removed from the main building. Such plants with shipment of dry ash to railway hoppers up to 100 thousand tons per year were under operation for a long time at Pribaltiyskaya and Estonskaya SDPPs. At some TPPs there are units for shipment of dry ash into cement trucks in the amount of several thousand tons a year. Such plants technologically can't provide shipment of dry ash to consumers in the amount of 100 % of the whole output, but can be part of ash removal system in case of their economic feasibility.

Aeroflow conveyors, applied for collecting ash from ESP hoppers, are rather reliable and effective in operation at the conveying distance up to 25 m and insignificant inclination. To provide reliable operation of aeroflow conveyors in ash collecting schemes with the conveying distance of more than 25 m, charging (overloading) units are required. Otherwise ash removal systems will work unreliably, that is absolutely inadmissible under requirements for operational characteristics of auxiliary boiler equipment, or aeroflow conveyors are to be operated in a mode of low concentration ash-air mix as traditional low-pressure pneumatic ash pipelines. It should be noted that expenses for creation and operation of low-pressure pneumatic ash pipelines are essentially less, than in case of aeroflow conveyors. In case of low-concentration ash conveying, application of aeroflow conveyors is not reasonable. At reliable operation of aeroflow conveyors, presence of the reserve ash removal system from ESP hoppers isn't obligatory.

Application of aeroflow conveyors for collecting high-calcium fine ash is undesirable, as rather fast blinding of pores of aerating elements (partitions, metal hoses, etc.) by small-fractional particles occurs, accompanied by cementation of separate sites of these elements in the presence of moisture in air.

Aeroflow conveyors have their overhaul life being the same or little longer, than low-pressure systems of pneumatic ash conveying with jet pumps or mechanical systems with screws. The eroded elements of aeroflow conveyors are air distributing partitions from filtering fabrics, metal chutes and the punched metal sheets. Aeroflow conveyors consume less energy in comparison with other ash collecting plants.

However, a low maintainability of the existing configurations of aeroflow conveyors and high labor costs on rehabilitation of their working capacity compel the majority of TPPs to stop their application and to use, as a rule, low-pressure plants of pneumatic ash conveying with different jet pumps.

Application of metal chutes and the punched metal partitions essentially raises operational indicators of pneumatic ash conveying with aeroflow conveyors, but the last with metal chutes require very careful mounting and adjustment, and manufacturing of the punched sheets in production conditions in repair sections of TPPs and power authorities is not expedient in view of their lowest adaptability to manufacture.

Vacuum plants of pneumatic ash conveying are technologically more difficult in comparison with low-pressure plants of pneumatic ash conveying with jet pumps and expensive, though they provide the best sanitary conditions in ash rooms. However, their application is restricted by the maximum conveying distance which is up to 300 m, a periodic operating mode of vacuum nozzles and necessity of performance of operations on switching and rigid observance of cyclograms «loading-unloading of hoppers». The last procedure in case there are no electrified stop valves, requires the unjustified increase in the operating staff, and reduces reliability of operation of vacuum systems of pneumatic ash conveying in connection with increase of a role of the human factor. According to the stated above, vacuum schemes are only applied at a small number of hoppers or in case the scheme of vacuum conveying is equipped with the preliminary included system of aeroflow conveyors or pneumatic ash conveying system with jet pumps.

In the majority of vacuum schemes of ash pneumatic conveying according to recommendations of Uralenergochermet, ash is accumulated in the precipitation chamber and vacuum breaking action takes place for its unloading. This reduces a possible productivity of pneumatic ash conveying systems in 2 … 4 times. Precipitation stations, applied for cleaning the waste air, with consistently set precipitation chambers and two cyclones don't provide the required air cleaning that is the reason of intensification of erosive wear of ejectors and vacuum pumps.

Low-pressure plants of pneumatic ash conveying with jet pumps are applied, as a rule, for evacuating ash from ESP hoppers or intermediate hoppers in two-stage schemes of internal ash pneumatic conveying. In most cases each plant evacuates ash from one ESP hopper. It is connected with that one plant collecting ash from several hoppers works unstable or with unfairly high power inputs. These plants are simple in manufacturing and mounting; they have a satisfactory reliability and overhaul operational life; they are simple in repair. Their drawbacks are the raised material and power ex-

penses in case of wrong estimation of parameters, as well as for any other equipment. Conveying distance of these plants makes to 400 m of the equivalent length of the line at their capacity from several hundreds kg to several tons of ash that is defined by a type of the pump and pipeline bore while estimating the parameters of the plant. For pneumatic conveying of ash from intermediate hoppers to the silos, both installations are commonly used: low-pressure plants with jet pumps as the most productive ones (at the equivalent conveying distance to 400 m and ash capacity to 20 t/h), and high-pressure pneumatic conveying plants with pneumatic screw or chamber pumps**.**

High-pressure plants with pneumatic screw pumps are used for pneumatic conveying of ash from intermediate hoppers to the silos and from the silos to customers of dry ash.

The maximum equivalent conveying distance is to 1000 m with the ash capacity to 40 t/h. The key Russian manufacturer of pneumatic screw and chamber pumps, and other equipment for pneumatic conveying of fine bulk materials is the JSC "Betsema" (Krasnogorsk town, Moscow Region). More detailed information on pneumatic conveying equipment produced by the JSC "Betsema", is placed on the site http://www.becema.ru/.

The basic drawbacks of the high-pressure plants with pneumatic screw pumps are the following:

- absence of automatic productivity control of pneumatic conveying plants;
- short capacity range of pneumatic screw pumps;
- the maximum equivalent conveying range to 1000 m;
- erosive wear of details of the screw feeder, seals and mixing chamber of pneumatic screw pumps;
- necessity of replacing screws and seals of pneumatic screw pumps after 150 … 200 hours of works at pneumatic conveying of erosive ashes from ekibastuzsky, podmoskovny and some other coals (replacement is fulfilled by a team of two persons during 8 hours).

Almost at all TPPs the operational personnel is compelled after 2…3 years to replace the factory cast-iron mixing chambers representing a serious danger to the personnel because of their possible rupture owing to erosion, with the steel welded chambers.

In power industry this equipment is not centrally repaired.

High-pressure plants with pneumatic chamber pumps are applied for ash pneumatic conveying:

- from ESP hoppers to the soils (not applied in Russia yet, but at different foreign TPPs are used rather often);
- from intermediate hoppers to the silos in two-stage schemes of internal ash pneumatic conveying;
- from the silos to dry ash customers.

The maximum equivalent conveying distance is to 1000 m with the ash capacity to 100 t/h). The possible equivalent conveying distance is 3000 m at the estimated capacity.

High-pressure plants with pneumatic chamber pumps have practically no disadvantages. In case of correct estimation of parameters and adjustment of operating modes the plants work reliably.

Capacity of chamber pumps is not practically lowered under the process of erosion during their operation, as rotating elements or strongly rubbing of ash elements are absent unlike pneumatic screw pumps which capacity essentially depends on change of the geometrical sizes of the screw and sleeve of the feeder as a result of their erosion. Besides, in installations with pneumatic chamber pumps, specific power inputs on ash conveying with other things being equal, are by 25 … 30 % lower in comparison with installations with pneumatic screw pumps. For replacement of sealing linings in pneumatic chamber pumps less than 2 hours are required for a team of two persons.

Two-stage pneumatic conveying plants represent the combinations of low-pressure pneumatic conveying installations with jet pumps and high-pressure installations with pneumatic screw or chamber pumps. Two-stage schemes of internal pneumatic ash conveying at the Russian TPP are applied more often, since the most part of ash and slag removal systems of TPPs with installations of dry ash shipment are pneumatic-and -hydraulic where ash from ESPs is supplied to the intermediate hoppers. From these hoppers the ash by the second stage of pneumatic conveying plants is fed to installation of dry ash shipment or ash-sluicing device of hydraulic ash removal plants.

The basic advantages of such two-stage pneumatic conveying plants are the following:

- reliable removal of dry ash from ash collectors to intermediate hoppers along the line of any configuration, insensibility to humidity change of the conveying air by low-pressure pneumatic conveying plants with jet pumps;
- rather long overhaul operating period of low-pressure pneumatic conveying plants with jet pumps and possibility of rehabilitation of their working capacity without stopping the boilers in case of their failure;
- reduced cost of low-pressure pneumatic conveying plants with jet pumps and insignificant operational expenses;
- conveying of dry ash from intermediate hoppers to the silos on a distance to 1000 m using pneumatic screw pumps and to 2500 m using pneumatic chamber pumps;
- optimum power inputs on ash pneumatic conveying at the second stage due to possible operation of high-pressure plants with pneumatic screw or chamber pumps in the modes of maximum ash loading.

The central failure of it is a need to clean the conveying air from intermediate hoppers.

Plants of internal hydraulic ash conveying represent, as a rule, a combination of ash-sluicing devices under ESP hoppers or intermediate hoppers and free-flow channels with incentive nozzles. They are intended for the joint hydraulic conveying of fly ash from ash collectors and bottom ash/slag from the boiler throat to the reception tank of the dredging pump station of external wet conveying. Ash-sluicing devices are not serially manufactured, but are made at factories producing boilers and auxiliaries by installation contractors or shops of the centralized repair of power equipment at TPPs. Free-flow channels of ash and slag slurry within boiler shops or ash collecting installations can represent the buried concrete channels, metal pipes or their combination, mounted with the inclination towards the reception tank of the dredging pump station.

The basic drawbacks are:

- fouling of channel walls of wet conveying systems with solid deposits at hydraulic conveying of high-calcium ash;
- inconveniences in operation and equipment repair in the rooms and in territory of TPPs where free-flow channels of wet conveying system are located;
- periodic extreme dusting in ash rooms under highly located ESPs because of ash emissions from ash-sluicing devices during volley of ash at shaking up the ESP fields.

Conclusions of § 3.3

1. At single-stage internal pneumatic conveying of ash from ESP hoppers to the silos of dry ash shipment plants the most comprehensible are high-pressure installations with pneumatic chamber pumps.

2. At two-stage internal ash pneumatic conveying:

• for evacuating ash from ash collectors to intermediate hoppers the most comprehensible are low-pressure pneumatic ash removal plants with jet pumps;

• a decision on the best scheme of conveying the ash from intermediate hoppers before dry ash shipment plants should be made according to [2] and [3] on the basis of estimation of technical and economic indicators of alternative applications of low-pressure or high-pressure pneumatic conveying plants as each pneumatic conveying system is unique and the approved technical decisions on creation of pneumatic ash removal system at TPPs can't be applied at the specific thermal power plant without taking into account its features.