Part 3

ASH AND SLAG HANDLING

3.2. Ash and slag handling systems at TPPs

3.2.4. External ash and slag conveying

3.2.4.1. External ash and slag conveying plants

Putilov V.Y., MPEI(TU); Vishnya B.L., UralORGRES; Gavlitin N.V., WGC-5

For external ash and slag conveying the following plants are used:

- pneumatic conveying plants (vacuum, low-pressure and high-pressure ones with jet pumps; high-pressure plants with pneumatic screw and chamber pumps);
- hydraulic conveying installations;
- motor transport;
- conveyor transport.

Vacuum, low-pressure and high-pressure pneumatic conveying plants are applied for dry ash shipment for the own commodity output manufacture and/or to foreign customers. A decision on application of pneumatic conveying plants is made depending on the equivalent conveying distance and the required capacity of plants considering the supervising branch documents of the Open JSC "RAO UES of Russia" [2, 3].

Hydraulic conveying plants are designed for transportation of the unclaimed by customers part of dry ash and slag to ash disposal sites (lagoons) in a form of ash and slag slurry and consist, as a rule, of a reception pit of ash and slag slurry, dredging pumps, ash and slag pipelines and a unit of discharging the slurry to the lagoon. Ash pipeline inlets in the reception unit of a lagoon serve as a technological border of hydraulic conveying plants. Water-to-ash ratio in the slurry changes in the range of 10:1 to 50:1. Depending on elevation change of dredging pumps at the industrial site of TPP, and intakes of ash and slag lagoons, length and height differences along the route of pipelines, mass of the conveyed materials, the accepted configuration of ash and slag collecting, technologies of slurry preparation and other factors, there can be additionally mounted one or two intermediate dredging pump stations along the route for overcoming hydraulic resistance of pipelines in case dredging pumps of the main dredging pump station don't have the required discharge-head characteristics.

The basic disadvantages of external hydraulic ash conveying plants are:

- unjustified high power inputs on external ash hydraulic conveying because of practical noncontrollability of capacity of external hydraulic ash removal plants depending on a mass of the conveyed ash and slag;
- high operational expense on repair and replacement of ash pipelines due to erosion and corrosion;
- withdrawal of lands from their rational use for constructing ash pipelines, return water supply pipelines and intermediate dredging pump stations along the route from the industrial site of TPP to the ash lagoon;
- decrease in design capacity of hydraulic ash removal plants due to formation of solid deposits in pressure ash pipelines and pipelines of the clarified water return;
- environmental contamination at failures and repairs of ash pipelines, etc.

Especially high cost price of ash and slag removal is characteristic for TPPs with a combination of gas-oil and coal-fired power units. So, at the minimum load operation of one of three coal-fired power units by 300 MW each, specific operational costs of hydraulic ash removal system are more than 4 times higher.

Cost of construction of external hydraulic conveying plant makes 20 … 35 % of the total cost of hydraulic ash and slag removal system.

Motor transport for evacuating the whole amount of ash and slag from the industrial site of TPP to ash disposal area is used rather seldom in Russia. As a rule, motor transport is used at old TPPs with rather small ash output in case when laying of hydraulic ash lines is impossible or hydraulic resistance of slurry lines is too great.

Motor transport for evacuating ash and slag from the industrial site of TPP to dry ash landfill. For example, dry ash and slag from a boiler-house of "Krasmash" plant is pneumatically conveyed to the external hopper by vacuum system, and then to screw mixers, where ash and slag is mixed up with water to humidity of 25 … 35 %. The humidified mix is loaded into trucks and transported to dry ash landfill located on a distance of 41 km from TPP. At the landfill the mix is unloaded and leveled without consolidation.

Combination of external hydraulic ash removal and motor transport. In 1970-ties the combined ash and slag removal has been introduced at Vladivostokskaya CHPP-2. The old partitioned alluvial ash lagoon, placed nearby, has been transformed into the operative disposal site with step-by-step drying-out of the completed sections. Dehydrated ashes and slags from the drying-out section of ash lagoon were transported by motor transport to the new dry ash landfill, where they were piled layer-by-layer with consolidation by road-building technics.

External ash and slag removal is introduced since 1994 at Krasnoyarskaya TPP-2 using the same technology according to the project of "Krasnoyarskgidroproject" Institute. A part of dry ash and the dehydrated slag from the industrial site of TPP is shipped to customers, but its most part in a form of ash and slag slurry is hydraulically conveyed to operative ash lagoon, located on a distance of 400 m from TPP in limestone open cast mine. In working sections of the operative ash lagoon step-by-step stockpiling, dehydrating and loading of ash and slag by excavator to motor transport for evacuation to the permanent bulk dry ash landfill, located on a distance of 1,5 km from TPP in the other limestone open-cast mine “Blossoming ravine”. Water from ash and slag slurry is drained into intermediate section and through purification basin self-flowing water returns to TPP.

Evacuation of ash by motor transport in a form of high-concentration slurry. On such technology since 2000 ash from hoppers near the main building of Abakanskaya TPP is loaded into transit-mix trucks where water is added up to water-to-ash ratio of 0,5 … 0,8. At conveying high-concentration slurry is formed, which pours out in the prepared sections of ash lagoon. The general designer is "UralVNIPIenergoprom" Institute.

Conveyor transport is widely enough used at TPPs in EU member-states and other countries world-wide. The automated plants for conveying ash from ESP hoppers to the stockpiling sites of landfills in areas with severe winter and

minimum temperature of –30 …–42°C (Fortune 1, Canada; Elbistan, Turkey) are successfully applied. One of the world known manufacturers of such plants is a firm "Beumer", conducting a full complex of works on designing, manufacturing, setting-up and commissioning of the automated conveying plants of ash and others lumpy and fine materials for various branches of economy:

- power industry (coal, ash, slag, gypsum, etc.);
- cement production (transportation of lime, slag, cement, secondary fuel, wastes, etc.);
- metallurgy (ore);
- extraction of nonmetallic materials (sandy and gravel open-cast mines);
- production of fertilizers (phosphates and processing factories);
- transportation of other materials (fertilizers, forage for animals, grain, dust, wood chips, wastes, etc.).

For conveying of the mentioned materials tube and open belt conveyors with horizontal bends are applied (fig. 3.10).

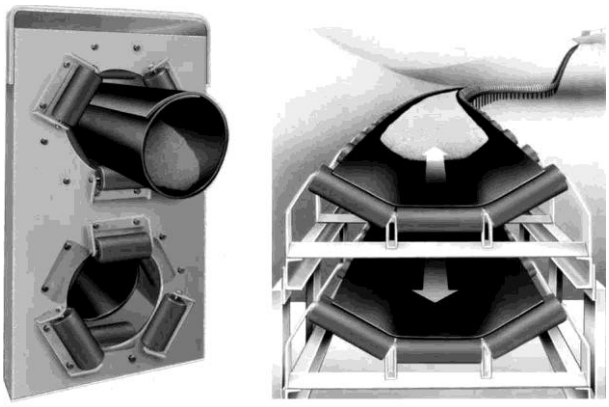
For conveying of dusty materials that is ash, and less - slag, in the Russian climatic conditions, tube belt conveyors are the most applicable.

Advantages of conveyor transport are:

- applicability almost in any landscape;
- environmental soundness;
- low cost of investments;
- low cost of operation;
- low specific power inputs on transportation of materials.

The basic technical characteristics of tube belt conveyors:

- a level of filling with fine-grained material — to 75 %;
- a level of filling with granular material — to 60 %;
- maximum size of a lump of material is less than 1/3 of pipeline bore D_{pipe};



а) *б*)

Fig. 3.10. Belt conveyors:
а — tube belt conveyor; *б* — open conveyor with horizontal bends

- a length of the pipe forming section — $30D_{pipe}$;
- a length of the unloading section — $30D_{pipe}$;
- minimum radius of a bend for the textile belt $R_{min} = 300D_{pipe}$;
- minimum radius of a bend for the belt from steel wire $R_{min} = 1000D_{pipe}$.

One of the basic elements of tube belt conveyor is a flexible belt, rolled up in a pipe by directing rollers of the pipe forming section at the outlet of the conveyor loading unit. Capacity of tube belt conveyors depending on diameter of a pipe is presented in tab. 3.3.

As an example in tab. 3.4 technical characteristics of one tube belt conveyor are resulted.

In fig. 3.11 a scheme of the combined conveyor installation is shown (Ciments Vigier S.A., Reuchenette, Switzerland).

Table 3.3. **Maximum capacity of tube belt conveyors, t/h, at transportation of fine bulk materials in the filling level of 75 %**

Speed of the belt, m/s	Diameter of a pipeline, mm								
	100	150	200	250	300	350	400	500	600
1,0	21	46	84	132	189	260	337	529	761
1,5	31,5	69	125	198	284	390	506	794	1142
2,0	42	92	168	264	378	520	674	1058	1522
2,5	52,5	115	210	330	473	650	843	1323	1903
3,0	63	138	252	396	567	780	1011	1687	2283

Table 3.4. **Technical characteristics of the tube belt conveyor**

Pipeline diameter, mm	350
Width of the belt, mm	1350
Length of the conveyor, m	750
Lift, m	82
Angle of ascent, deg.	22,2
Number of horizontal bends	2
Radius of horizontal bends , m	> 150
Number of vertical bends	2
Radius of vertical bends, m	> 525
Maximum conveyor speed at the load of 850 t/h, m/s	3,1
Frequency drive capacity, kW	3x160

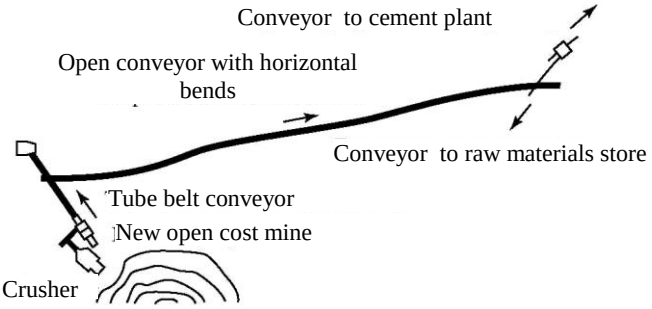


Fig. 3.11. A scheme of the combined conveyor installation:
total distance — 2645 m; height difference — 280 m; capacity — 800 t/h; maximum capacity — 1400 t/h