

CEA Guidelines for Ash Handling Plants

By
K. P. Shah

Email: kpsah123[at]gmail.com (Please replace [at] with @)

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Selected information on ash handling plants from standard design criteria / guidelines for balance of plant of 2 x (500 MW or above) thermal power project published by Central Electricity Authority, New Delhi – 110066, in September 2010 is given in this article. All information contained in this article has been assembled with great care. However, the information is given for guidance purposes only and the ultimate responsibility for its use and any subsequent liability rests with the end user. Please see the disclaimer uploaded on <http://www.practicalmaintenance.net>.

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Selected information on ash handling plants from standard design criteria / guidelines for balance of plant of 2 x (500 MW or above) thermal power project published by Central Electricity Authority, New Delhi, India – 110066, in September 2010 is given in this article.

For trouble free operation / reliability, various equipment / components of ash handling plants may be designed as per the following recommendations.

Bottom Ash Hopper

The hopper shall be made from tested quality mild steel plates of thickness not less than 10 mm (IS: 2062) and suitably stiffened with rolled steel sections. The top 1100 mm of the hopper including seal trough shall be constructed of 6 mm thick SS 316. In case of sea water application, the entire hopper including seal trough shall be 6 mm thick of SS 316. Hopper shall be lined with monolithic castable refractory of minimum thickness 230 mm.

Bottom Ash Water Impounded Hoppers Discharge Gates

Each gate shall be capable of discharging 100% of the contents of one hopper section, within the specified time. The gate size shall be minimum 900mm x 900mm. Electric drive for gate operation is not acceptable. The material of gates shall be as below:

Gates	Cast Iron IS: 210, Gr. FG-260.
Gate wear liners	6 mm thick SS 316
Housing wear plates / impingement plates	25 mm thick Cast Iron IS: 210, Gr. FG 260
Housing	10 mm thick (Min.) Mild steel IS: 226 or IS: 2062

Clinker Grinders

The clinker grinder shall be single roll / double roll type and its speed shall not exceed 40 rpm and the grinder drive motor speed shall not exceed 1000 rpm. The clinker grinders shall be provided with a reversing mechanism to reverse the direction of the grinder rolls should an obstruction stall the grinder. The clinker grinder shall crush large clinkers to suitable size [normally to (-) 25 mm] for transportation through pipeline. The material of construction shall be as under:

Grinder chamber	Carbon Steel (IS: 2062), 10 mm thick.
Wear plates	12-14% Mn. Austenitic steel plates to IS: 276, 10 mm thick
Grinder rolls & teeth	Hadfield's Manganese steel (ASTM A128, 12-14% Mn) casting shop hardened to 300 BHN at all working surfaces and work hardened to 400 BHN at site.
Grinder shaft	Stainless Steel 304/EN-8.
Shaft sleeve	Hardened stainless steel 410/416
Clinker outlet chute	10 mm thick mild steel (IS: 2062) lined with wear resistant liners as above.

Sea water applications shall have suitable materials.

Jet Pumps

The Jet pumps shall be designed so that it will convey ash at the rated capacity with a minimum of 25 mm wear margin on the diameter of the throat. The material shall be wear resistant and proven type. Typically, the material shall be as per below:

Inlet Section, Throat and Discharge/Tail piece	Alloy Cast iron as per IS: 4771 type 1 (a) minimum 4.5% Nickel with hardness of minimum 500 BHN.
Nozzle inlet	C.I. Grade FG-260 as per IS: 210
Nozzle tip	Ceramic lined Stainless Steel / Tungsten Carbide

Submerged Scraper Chain Conveyor

Scraper chain conveyors shall be 2x100% (1 working + one standby) or 4x50% (2 working + 2 standby) for each boiler. The scraper chain shall be Cr-Ni based alloy steel with minimum hardness of 750 HV (equivalent to 63 RC or 690 BHN). The upper surface of the chain shall be case hardened to a depth of minimum 3 mm to offer abrasion resistance. The size of the chain shall be provided with a factor of safety of minimum five (5) over the required chain pull during startup condition with the upper trough being filled with ash up to maximum water level. In no case the diameter of the chain shall be less than 26mm. The drive of SCC shall be provided with variable speed.

The minimum operating depth of water in the upper water filled trough of the scraper conveyor shall be 2.0 metres.

Vacuum Pumps

The vacuum pump shall be of the low speed liquid ring type driven by an electric motor.

The design shall also take into account the possibility of vacuum pumps sucking in flue gas containing SO₂ and SO₃ from the ash collection chutes.

Wetting Heads

Wetting head shall be constructed of alloy cast iron while the water nozzles shall be constructed of hardened stainless steel 400 series with minimum 500 BHN.

Intermediate Surge Hopper

The capacity of the Intermediate Surge Hopper shall be adequate to store 30 minutes of fly ash collection from a unit. It shall be complete with all other equipment needed for ash intake, ash discharge and fluidization etc. The material of construction shall be 10 mm thick M.S. to IS: 2062 with 20 mm thick abrasion resistant alloy C.I. / 10 mm thick SS liners of 300-350 BHN hardness at sloping surfaces and outlet area.

Vent Filters / Bag Filters – Pulse Jet Type

Bag Filters shall be provided in vacuum conveying line above intermediate surge hoppers and vent filters with pulse jet system at silo top. These filters shall have adequate capacity to achieve 50 mg/Nm³ air quality at filter outlet. Vent fans shall be provided complete with drive motor and accessories. The material of bag shall be suitable for 140°C continuous temperatures. Adequate “anti-static” protection will be taken (if required) in design to prevent any possibility of “dust explosion” within the silo/bag filter. The performance of the bag filter shall not get affected with 10% of the bags plugged.

Fluidizing Air Blowers

2x100% fluidizing blowers shall be provided for fluidizing ESP hoppers and intermediate fly ash silos with dedicated heating units to maintain the temperature of fly ash about 140°C for establishing free flow.

Air Lock Vessels and Valves

Material of construction for air lock vessel shall be minimum 10 mm thick MS plates to IS: 2062 and shall be designed as per ASME section VIII or IS: 2825 with a corrosion allowance of minimum 3 mm.

Ash intake / ash discharge valves shall be dome type / rotary segregating type / cone type / swing disc type. The size of ash intake / ash discharge valves shall be as per system requirements. Material of construction shall be as below:

Body	Alloy cast iron, with minimum 250 BHN hardness.
Dome /segregating slide / cone / disc:	Minimum 10 mm thick SS / alloy CI 300-350 BHN.
Seat (as applicable)	Replaceable type, alloy CI or SS smooth finished, hardened to 250 BHN minimum.

Valves shall be provided with suitably located poking port / access plug / panel if applicable.

All valves shall be subjected to cycle testing for at least 15 cycles on-off operation to ensure smooth operation.

Transport and Conveying Air Compressors

Compressors shall be screw type. At least 10% margin shall be provided on compressor capacity over and above the maximum flow requirement. 50°C ambient and a RH of 100% shall be considered for design of capacity of compressors.

Instrument Air Compressors, Air Receivers, Air Drying Plants

2x100% capacity instrument air compressors shall be provided for each unit.

Each compressor shall be provided with an air receiver of ample size so that delivered air pressure is kept within $\pm 5\%$ of rated pressure without excessive start/stop operation in the working cycle. Air receivers shall be located convenient to compressor discharge. The receivers and associated fittings shall comply with BS: 5169 and BS: 1123 or other approved standards.

Air drying plants shall provide reliable, moisture free compressed air supply.

Vacuum and Pressure Conveying Pipes for Dry Fly Ash

Following materials shall be used for dry fly ash conveying:

Vacuum conveying	Class-D cast iron pipes conforming to IS: 1536 or BS: 1211
Pressure conveying system up to 3.5 bars	Class-D cast iron pipes conforming to IS: 1536 or BS: 1211
Pressure conveying system > 3.5 bars	MS pipes to IS: 3589 of 9.5 mm wall thickness or Class-D cast iron pipes conforming to IS: 1536 or BS: 1211

BAHP, BALP and FAHP Water Pumps

The pumps shall be of horizontal, centrifugal direct driven type.

The material for the BAHP (bottom ash high pressure), BALP (bottom ash low pressure) and FAHP (fly ash high pressure) water pumps shall be as below:

Casing	2% Ni Cast Iron to IS: 210 Gr. FG 260.
Impellers	Stainless Steel to ASTM A351 Gr. CF8M / Bronze - Grade LTB1, IS: 318.
Shaft	Stainless steel type 410 hardened / Carbon Steel EN-8 / Equivalent
Shaft Sleeves	Stainless steel type 316 / 410.
Bolts/Nuts	Steel ASTM A 193/194.

Ash Slurry Pumps

In conventional lean slurry, the ash concentration (w/w) shall be as given below:

- For bottom ash slurry disposal - 25% max.
- For fly ash slurry disposal - 30% max.
- For combined slurry disposal - 28% max.

The ash slurry pumps may be required to be placed in series (maximum four) for meeting high head requirement while pumping to long distances and higher elevations. In case of excessively high head requirement of ash slurry pumping a booster station may also be required between ash slurry pump house and ash pond.

The slurry pumps shall essentially be slow rpm pumps. The rotational speed of the impeller at design point shall not exceed 1000 rpm. These shall be designed to pump the slurry up to the ash pond taking into account the distance and ultimate height of the ash pond embankment. The first stage of slurry pumps shall have a variable speed drive.

The ash disposal pumps shall be designed limiting the impeller tip speed to 28 to 30 m/sec.

The ash disposal pumps shall be constructed of materials that equal or exceed the corrosion-erosion resistance of the following materials:

Casing (inner & Outer)	Outer casing shall be of cast steel to ASTM-A216 or Spheroidal Graphite Ductile Iron to ASTM A-536, 65-45-12 Inner casing (Volute liners) shall be of chrome nickel cast iron (composition to Ni Hard-IV) of 550 BHN or 24% chromium cast iron of 550 BHN
Impeller / wear plate	Chrome nickel cast iron (composition to Ni-Hard IV) of 550 BHN or 24% chromium cast iron of 550 BHN
Shaft	Carbon steel to AISI K-1040 / EN-8
Shaft sleeves	SS 410

Alternatively, high concentration slurry disposal (HCSD) system is employed. HCSD system uses the slurry concentration between 55 % - 70 % depending on specific slurry rheology.

HCSD system design shall be based on 60% slurry concentration by weight.

The high concentration ash slurry disposal pump shall be positive displacement type.

The HCSD pump shall have variable speed drive.

Slurry Line Valves

Adequately sized motor operated or solenoid operated pneumatically actuated metal to metal seated knife edge gate valves, the valves shall strictly meet the testing requirements of MSS-SP 81 code (Manufacturers Standardization Society of USA) for seat leakages. The material of construction shall be as under:

Body / Cover	Cast iron FG-260 to IS: 210 (min. 10 mm thickness) with alloy CI/SS Deflection cone (minimum 400 BHN hardness) for knife edge gate valves or Carbon steel to ASTM A216 Gr. WCB (0.3% carbon max.) for plug valves.
Gate / Plug	Stainless steel with min. 400 BHN Hardness on wear surface for knife edge gate valves or Carbon steel to ASTM A216 Gr. WCB with hardness of 400-450 BHN suitably impregnated for low friction.
Stem	Stainless steel (SS 316) for knife edge gate valves or IS: 1875 Class C made out of ASTM A105 (forged carbon steel) and will be suitably impregnated for low friction.

Dry Fly Ash Storage Silo

The main fly ash storage silos shall be of reinforced concrete / steel construction with flat / conical bottom.

The storage silo shall be designed to provide a clear headroom of 6 m for a road tanker to come under the silo and receive the ash from the retractable chutes. It may be noted that unloading system from Silo shall be suitable for both rail wagon unloading and closed tanker/open truck unloading.

The dust loading from the outlet of the bag filters shall not exceed 50 mg / Nm³ under any operating condition with 10 per cent bags plugged.

Silo Fluidizing Air Blowers

Each main fly ash silo shall be provided with adequately rated 2x100% silo fluidizing blowers with dedicated heating units for maintaining temperature of fly ash about 140°C for establishing free flow.

Materials for Water and Air piping

The material for instrument air pipe shall be GI.

The material for conveying air pipes shall be MS.

Water piping shall be MS ERW pipes heavy grade up to 150 NB confirming to IS: 1239 and MS ERW pipes above 150 NB confirming to IS: 3589 of thickness 9.4mm.

Slurry Pipes and Fittings

Slurry piping from bottom ash hopper to slurry sump: 20 mm thick cast basalt lined MS pipe (MS shell 6 mm thickness).

Slurry piping from slurry sump to disposal area: 9.52 mm thick (minimum). MS pipes of min. 6 mm thick with 20mm thick cast basalt lining may be used for sea water applications.

Fittings for slurry pipes: Ni-chrome alloy C.I. or equivalent with minimum hardness 400 BHN. Integral wear back of minimum 20 mm thickness or 20 mm thick cast basalt lined MS fittings (MS shell 6mm thick).

The slurry line velocities shall not exceed 2.8m/sec.

The HCSD disposal pipeline shall be made from seamless steel pipe having a minimum wall thickness as per Schedule 80. Bends shall have minimum - 3D radius made from seamless steel pipe of same thickness.

In HCSD disposal pipe line, velocity should be 1.8 m/sec. maximum at 60% concentration.