Mine back filling with ash slurry at TTPS.-Key Challenges.

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Abstract:

Power Sector in India is witnessing a period of rapid expansion of capacity to meet the increased load as a consequence of rapid industrialization and rising consumer demands. The evolving scenario is forcing power plant owners and operators to optimize the operation and maintenance costs and reduce the risk of equipment failures that could cause costly unplanned outages of the units. Power Generating plants in our country are facing numerous challenges in today's volatile market such as rising fuel costs and increased environmental regulation.

Ash disposal in thermal power plants is one of the highly environmentally sensitive issues in the operation of such plants. Our country is currently producing in excess of 200 million tonnes of Coal Ash. Out of this, approximately 80% is Fly ash and remainder Bottom-ash. Thus, the management of coal ash is one of the challenges that the power plant management will have to solve. In view of the importance of this problem, there has been a sustained effort to utilize the coal ash as much as possible. There has been a significant improvement in the utilization of coal ash during the last decade.

In spite of this substantial improvement in the utilization of coal ash in recent years, a major portion of the ash produced needs to be transported for safe disposal and storage at the ash ponds. Currently, in majority of plants, both types of ash are being mixed together and transported hydraulically to ash ponds.

Talcher Thermal Power Station, the best performing unit of NTPC have adopted an unique mode of ash disposal system by mine back filling. The ash generated in this plant are taken into the abandoned mines of Talcher coal fields of MCL. Team TTPS carefully manages with the limited land availability for laying the ash disposal lines and IR issues linked with the surrounding villages to carry out and maintain this unique project to ensure unit availability ,sustainable generation and an effort to protect environment.

Background:

- The TALCHER THERMAL POWER STATION is located in the hinterland of Talcher Coalfield.
- Talcher-Angul area is the major industrial region of Orissa with good transport and communications facilities.
- The Plant was established as a public sector unit of Govt. of Orissa. It has the distinction of being the first thermal power plant in the state.
- The plant has four identical units of 60MW each two units of 110MW each. Thus the installed capacity of the power station at present is 460MW.
- The Station was taken over by NTPC in the year 1995 .
- The main features of TTPS, Talcher are as under:

Electricity generation capacity : 460 MW (4X60 + 2X110)
Plant load factor : 92.68%
Source of coal : Mahanadi Coalfields Limited (MCL)
Percentage of ash in coal : 38.50%
Yearly ash generation : 1161369 MT (approx)
Ash utilization : 100%

MOU signed between Dir.(OPN), NTPC & CMD, MCL for allocation of South Balanda Open Cast Mine for ash back filling on 17.01.2002 .

Contract awarded to M/s. CMPDIL, Ranchi for conducting following studies i.e. (required for NOC by Pollution Control Board):

a) Hydro-geological investigation of South Balanda area.

b) Ash characterization and Baseline data.

c) Feasibility report (Environmental Impact Assessment)of ash disposal in mines.

The South Balanda coal mine is an opencast mine located adjacent to the Jagannath open cast mine which supplies coal to the TTPS.

- The South Balanda mine has three quarries namely Quarry-1, Quarry-2 and Quarry 3
- The mining activities in Quarry-1,Quarry-2 and Quarry-3A & 3B are stopped from April, 2004
- The ground level at the top of end wall towards the Jagannath mine varies between RL (+) 125-135 m
- The deepest point in Quarry-2/3 is about RL (+) 75m
- The average depth of the quarry is varying from 40 m to 50 m
- The quarry area has been measured based the survey drawing & the details are as under:

Quarry no. 2 : 41.00 ha

Quarry no. 3A : 18.50 ha

Quarry no. 3B : 11.25 ha (Abandoned Mine in MCL)

COAL ASH CHARACTERISATION:

The coal ash when dumped in the mine voids, would come in contact with mine water, under ground water and also be exposed to rains and other surface water bodies.

- During compaction and in course of time the leachates will get generated.

These leachates may contain harmful heavy metals. Mine sump water has definite characteristics of pH and presence of trace metals. These affect the leachability characteristics and consequent toxicity of the leachate.

- As the aquifers are exposed in the mine voids the PFA and the leachates, if any, will come in direct contact with groundwater present in the exposed aquifers. Then there is a possibility of contaminants finding their way into groundwater.

- As the mine voids have sump water, the toxicity characteristic leachate procedure (TCLP) of fly ash with mine sump water is recommended to simulate the actual conditions in de-coaled pits to be stowed with coal ash.
- To achieve the objective of the study, physical, engineering and chemical properties of the fly ash of the TTPS along with the leaching behavior of the fly ash and bottom ash have been studied.

PHYSICAL CHARETERISTICS OF ASH:

SAMPLE ID	FA U1-1	FA U1-3	FA U1-4	FA U2-5	FA U2-6
Sp. Gravity	2.12	2.15	2.18	2.16	2.10
Optimum Moisture Content (%)	32	31	33	32	30
Mean Mass Density (Gm/cc)	1.13	1.12	1.10	1.12	1.09
Bulk Density (Gm/cc)	1.49	1.42	1.41	1.415	1.51
Permiability (cm/cc)	1.22	1.30	1.10	1.14	1.16
Unconfined Compression (kgf/cm2)	0.209	0.190	0.200	0.170	0.20
Direct shear (kg/cm2)	0.16	0.22	0.25	0.18	0.19
Angle of repose (degree)	17.5	18.2	17.6	19.10	19.80
California Bearing Ratio (%)	2.6	2.5	2.1	3.8	2.4
Consolidation compression index (C_C Value)	0.08	0.05	0.06	0.065	0.058

FA-U1-1 denotes fly ash sample from Unit 1 of Stage I and so on.

CHEMICAL CHARETERISTICS OF ASH :

Sample ID	FA-U1-1	FA-U1-3	FA-U1-4	FA-U1-5	BA-U1-1	BA-U1-2	BA-U1-3	FA-U2-6
Pb	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0
Cd	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
Cr	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
Cu	<0.4	130	67.7	<0.4	<0.4	<0.4	<0.4	<0.4
Zn	<0.4	116.3	48.7	<0.4	9.8	13.7	9.4	11.1
Ni	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4
Hg	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5
Mn	208.8	152.7	215.4	142.7	59.8	253.1	88.2	117
Be	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02
Li	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3
Al	3255.6	3756	4907.4	2626.9	2593.7	3268.7	3181.5	2774
Mg	195.4	196	250.4	121.3	180.5	304.1	194.9	124.3
Ba	69.4	49.7	70.9	47.5	37.2	73.4	74.7	42.4
As	<20	<20	<20	<20	<20	<20	<20	<20
Se	<20	<20	<20	<20	<20	<20	<20	<20
Co	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
V	70.0	100.0	90.0	40.0	60.0	50.0	130.0	90.0

Elements in PFA samples analysed by XRF (ppm)
FA-U1-1 denotes fly ash sample from unit 1 of Stage I and so on
BA-U1-1 denotes bottom ash sample from Unit-1 of Stage 1 and so on

Ash Transportation Mode:

Various ash transportation modes/alternatives have been considered. The various modes of ash transportation includes the following:

Dry Transportation:

In this method, ash may be transported to the mine site in a dry form. For this purpose, either a dedicated rail system or a belt conveyor system or trucks may be used. Dedicated rail or belt conveyor has to be constructed, which may be cost prohibitive. For road transportation, a road has to be constructed. Dry transportation can also be accomplished pneumatically through pipe lines.

- Ø Truck transport
- Ø Belt conveyor
- Ø Custom built special railway wagon
- Ø Dry pneumatic transport through pipelines
  - · Lean phase dry pneumatic(flyash to air ratio::<10:1)
  - · Medium phase dry pneumatic (flyash to air ratio::20:1-30:1)
  - · Dense phase dry pneumatic (flyash to air ratio::>50:1)

Wet Transportation:

In this method, ash may be transported to the mine site through a pipeline in the slurry form. Depending on the level of concentration of ash in slurry form, this method may be further divided into three categories as follows:

- Ø Low concentration slurry (fly ash to water ratio:: 1 : 6 to 8)
- Ø Medium concentration slurry (fly ash to water ratio:: 1 : 1.5)
- Ø High concentration slurry (fly ash to water ratio:: 3:1)

Low Concentration Slurry Disposal : In this method, centrifugal type of slurry pumps would be used to pump slurry through the pipelines. Depending on the head requirement, number of pumps would be used in series. The normal range of ash concentration is approximately 10-15 % by weight (5-8% by volume). At present, this method is by far the most widely used method of ash transportation in the existing thermal power plants in the country. As such the technology is well proven and tested in our country.

Medium Concentration Slurry Disposal (MCSD): The normal range of ash concentration is in the range of 40 -50% by weight. In this method of transportation, centrifugal pumps are used. At present, sufficient field data on the performance and reliability of this method are not easily available, since it is not in use in the power plants in India

High Concentration Slurry Transportation: In this method, the concentration of ash is in the range of 60% or above by weight. The slurry is in the form of a paste. The transportation of this highly viscous and non-Newtonian fluid would need special type of pumps. Although this system has been used abroad on a limited scale, there is little experience in India.

Design and Selection Criteria:

The various factors that would guide in selection of appropriate mode of transport include:

- Ø Availability of proven technology
- Ø Environmental considerations
- Ø Techno-economic viability

Ø Availability of infrastructure

Some additional factors to be taken into account for selection of appropriate mode of transportation are as given under:

Ÿ The distance between the plant and the mine void is about 10 km

Ÿ Strip of lend sufficient void laying pipeline needed for slurry transportation is available with plant.

Ÿ The road connecting the plant with mine void is a public road and there is considerable traffic on it

Ÿ Large quantity of ash are likely to be transported through the proposed system. It is important that the proposed system should be reliably designed taking account of the proportion of fly ash. A poorly designed system based on insufficient field data may result in repeated system shut down with significant loss of revenue and problem arising out of interruption in evacuation of ash from plant premises. With such a high rate of ash production, it is essential that it is reliably and efficiently evacuated from the plant Additional land would be required for laying either a dedicated railway line or road for ash transportation.

Medium concentration slurry disposal mode and high concentration slurry disposal mode are new concept. Availability of field data on operational and maintenance aspects are rather limited. Moreover, it is not a proven technology. In the Indian context, a couple of medium concentration slurry disposal system have been installed recently. High concentration slurry disposal system has so far been not used in India.

Low concentration slurry disposal mode is a popular system that uses conventional hard wares. It is a proven and reliable technology for which sufficient field data are available in its operational and maintenance aspects. Hence it is easier to design, construct and maintain

Technology for dry transportation is a proven technology. Equipments/Hard wares are readily available as such its design, construction and maintenance may not be sufficient.

The capital cost for dry transportation system would be the highest. Amongst the three wet slurry system, the costliest is high concentration slurry disposal system and cheapest would be medium concentration slurry disposal system.

In absence of field data the maintenance and running cost in respect of high concentration slurry and medium concentration slurry disposal system, comparison is not possible.

Environmental Consideration:

Air pollution :-There may not be any air pollution in wet transportation system. But use of dry system would cause air pollution in courses of various activities.

Water pollution: Wet system particularly low concentration slurry disposal system require high quantity of water. Medium concentration slurry disposal system and high concentration slurry disposal system uses comparatively low quantity of water. The leaching test conducted on fly ash have concluded that leaching of trace elements are rather low and leachate are within the limits prescribed for effluents. Hence possibility of water pollution are rather limited. The volume of water requirement may be reduced for low concentration slurry disposal system if appropriate

treatment by recycling arrangements are made. In this scheme three facilities are proposed to be installed.

Land Requirement : Land requirement for creating transport facilities for all systems would be more or less same. However, for the project under consideration no additional land has to be acquired

Preferred Mode of Disposal : In view of the facts stated above, it may be concluded that under the given circumstances, the adoption of low concentration slurry disposal system would be most optimal.

(ASH DISPOSAL IN SOUTH BALANDA MINE)

Recirculation of decanted water:

- Three centrifugal dewatering pumps of capacity 500m3/hr installed over barge.
- Pumps are in parallel operation throughout the year.
- Average water inflow from plant =20,000m3/day
- considering 40% evaporation and sippage loss water proclaimed to Quarry-2 is 12,000 m3/day
- Average water outflow from quarry-2, considering 20 running hours/day and 80% pump efficiency =16,000m3/day
- The decanted water is partly circulated back to plant for make water and major part is given to the near by villages for irrigation purpose.

Clean water after settling of ash

Pumping of return water

Issues and hurdles

- Ash pipe laid along the coal conveyor with in limited space, very difficult to carry out maintenance work.
- Due to space constraint the lines are laid in earth in many places.
- These lines are going through villages on the way to mines hence little pipe failure are leading to pollution issues and very difficult to resolve.
- Watch and ward of NTPC property is very difficult in this area due to non-cooperation and support.
- Piping laid on ground without pedestal.
- No of diversions are more.
- Gradient difference is high.
- Over lapping of pipe due to space constraints.
- Horizontal centrifugal pumps installed for decantation purpose are suffering with frequent breakdowns.

Challenges ahead:

- Removal of critical diversions & under ground ash pipes .Making proper lay out with pedestal and trestle.
- Procurement and Installation of high capacity submersible pumps for decantation of mine water in place of centrifugal pumps which suffers with breakdowns.
- Development and maintenance of decantation pump house area in order to minimize theft and disturbance by local people.

Activities going on…

- As part of our efforts to bring the ash pipe lines to a level above earth ,to minimize the critical diversions and make the pipes accessible to work, a detailed plan has been prepared.
- A contract has been awarded in this regard to go for a comprehensive thickness survey of pipe line, replace all the MS bends with cast basalt bends, bringing the pipe lines to pedestals and road crossing of pipes are to be made in RCC hume pipes.
- The procurement of new MS pipes are done, we are getting the stock of pipes as per our requirements.
- Thickness survey of the pipelines are completed and on the basis of the survey areas are identified for replacement.
- Replacement of all MS bends are in progress with cast basalt bends.
- Fabrication of pedestals and bringing the pipes to the pedestals is going on.

Conclusion:

- This project of mine back filling with ash slurry has been taken up by ministry of environment as pilot project for implementation of the same in nationwide. The report in this regard as received is also attached herewith for reference.
- NTPC is monitoring the quality of decanted water and also the dug well situated near the mine to evaluate the leachate effect of wet ash slurry deposition in the quarry.
- The ash dumping in the quarry has benefited environment in the following ways:
  Avoiding further acquisition of land for NTPC ash dumping.
  Reduction in make up water in TTPS due to reuse of decanted water.
  The decanted water which conforms the discharge standards of CPCB is being utilized for irrigation by local village community thereby increasing the crop harvesting thrice in a year.
  Reclamation of quarry by filling with ash for future plantation.

A **leachate** is any liquid that, in the course of passing through matter, extracts soluble or suspended solids, or any other component of the material through which it has passed.

Leachate is a widely used term in the environmental sciences where it has the specific meaning of a liquid that has dissolved or entrained environmentally harmful substances that may then enter the environment. It is most commonly used in the context of land-filling of putrescible or industrial waste.

In the narrow environmental context leachate is therefore any liquid material that drains from land or stockpiled material and contains significantly elevated concentrations of undesirable material derived from the material that it has passed through.