ASH MANAGEMENT AT GIPCL's SURAT LIGNITE POWER PLANT

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Abstract

In India thermal power plants share about 72% of the total installed capacity of power plants. 90% of thermal power plants uses coal/lignite as primary fuel due to abundant coal/lignite reserves. The available coal used for power generation is of inferior quality with high ash content where as lignite is having high sulphur and moisture content. Coal/lignite based thermal power plants release number of pollutants like particulate matter, oxides of carbon, sulphur, nitrogen, heavy metals, etc. These pollutants affect the environment causing air pollution and other pollution viz water, noise and land. In setting up of power plants the various pollution control measures need to be adopted during concept to commissioning stage including selection of environmental friendly technology. Some additional control measures for controlling pollution are also being included in the system based on operational experience. Air pollution in thermal power plants is mainly due to dust emission during transportation, handling, re-handling of primary fuels, additives (in CFBC technology), secondary fuels, emission of flue gas and particulate matters during combustion process and disposal of ash.

Ash and its utilisation have become a national issue of power generating units in India. Many of the initiatives taken by MOEF, pollution control authorities, ash generators and ash users resulted in improved ash utilisation.

Surat Lignite Power Plant (SLPP) of Gujarat Industries Power Company Limited (GIPCL) is operating 2 x 125 MW lignite based power plant near Surat. SLPP has taken many initiatives from concept stage itself for utilisation and pollution free disposal of ash generated at SLPP. Currently SLPP is one of the very few power generators with 100% ash utilisation.

This paper discusses briefly the need of effective flyash management & utilisation including safe storage, handling, transportation and disposal. Paper also presents a brief of experimentation done at SLPP for achieving 100% ash utilisation by means of using ash for road construction (as sub-grade material, as surface material, as FALG, as base course and surface material) and dry-ash disposal in to mines void filling using truck mounted closed containers. Brick manufacturers in the vicinity of SLPP have also contributed to a greater extent for 100% ash utilisation at SLPP. Problems faced and issues in achieving and sustaining total ash utilisation at SLPP has also been discussed.

Introduction

Ash and its utilisation/disposal have become a national issue as majority of power generating units in India are using coal. Indian coals in general have high ash content. Many of the initiatives taken by pollution control authorities and ash generators resulted in improved ash utilisation. Surat Lignite Power Plant (SLPP) has also initiated many actions for utilisation and pollution free disposal of ash generated at SLPP. SLPP, a power plant of Gujarat Industries Power Company Ltd promoted by Gujarat public sector undertakings viz. Gujarat Electricity Board (presently Gujarat Urja Vikas Nigam Ltd.) ,Gujarat State Fertilizers and Chemicals Ltd , Gujarat Alkalies and Chemicals Ltd. and Govt.of Gujarat. Initially the Company has set up a 145 MW gas based Power Plant at Vadodara basically to cater to the power requirement of promoting companies and subsequently ventured into IPPs of 160 MW Naphtha based power plant at Vadodara besides the existing unit and a 250 MW lignite based Power Plant at village Nani-Naroli , taluka Mangrol, Dist.Surat. The lignite based Power plant at Surat comprises of 2 x 125 MW units with boilers of 390 Tonne/hr capacity .Boilers of SLPP are of CFBC technology.

Technology

CFBC is a class of Fluidized Bed Combustion (FBC) technology. FBC initially used in the chemical and process industries was applied to the electricity industry because of its perceived advantages over competing combustion technologies.

The project of GIPCL at Mangrol, Surat Lignite Power Project (SLPP) has two 390 tph CFBC boilers. These are the biggest CFBC boilers in India as well as Asia. These are the first CFBC boilers used in India in a commercial power utility.

FBC technology can effectively use a wide range and quality of coals improving combustion efficiency and environmental emissions. Fuel for combustion is admitted as particles upto 10 mm size in CFBC boilers. Combustion takes place at lower temperatures of 800 – 900 deg C resulting in reduced NOx formation compared with Pulverized Coal Combustion (PCC). SO_2 emissions can be reduced by the use of lime as sorbent.

A fluidized bed that is operated at velocities in the range of 4 to 6 m/s is referred to as a Circulating Fluidized Bed (CFB).

The CFB system is a highly efficient gas-solids process initially developed and patented by M/s.Lurgi of Germany for the calcination of alluminium trihydrate. This technology has been successfully used in a number of applications to carry out endothermic and heterogeneous gas-solids reactions.

PRINCIPLE OF OPERATION

A fluidized bed is composed of lignite fuel and bed material (ash, sand, and/or sorbent) contained with in an pessurized chamber called the combustor. The bed becomes fluidized when air (Primary Air) flows upwards at a velocity sufficient to expand the bed. As fluidizing velocity increased smaller particles are entrained in the gas stream and transported out of bed. The bed surface becomes diffused and solid densities are reduced in the bed.

The bed material is fluidized by primary air introduced through a nozzle grate at the bottom of the bed and by combustion gas generated which flows upwards with a relatively high fluidizing velocity. The entire combustor contains suspended solids having a high concentration, which decreases continuously towards the top of the combustor. The combustion gases flows upwards with a considerable portion of the solids which are separated from the gas in cyclone separator and recycled back to the combustion chamber through a recycle loop. Individual particles may recycle any where from 10 to 50 times depending on their size and how quickly the particles burns away. Residence time during one pass is very short. Flue gas that leaves cyclone loses its heat to water and steam flowing in tubes of super heater, re-heater and economiser and finally to primary & secondary air in the air pre-heater. Flue gas passes through ESP for separating all ash particles in flue gas. 99.9% of ash particles get collected in ESP and only flue gases goes to atmosphere. Flue gas is discharged to atmosphere at higher level with the help of a stack

Bottom ash is extracted intermittently from combustor maintaining the required bed height inside the combustor. This ash is cooled in ash coolers and transported to ash silo from where it is conveyed to ash silos. Fly ash that moves along flue gas gets collected in ESP and is pneumatically transferred to fly ash silos.

ADVANTAGES OF CFBC TECHNOLOGY

- **Environment Friendly**

  Sulpher emissions are effectively controlled by adding lime stone to the fluidized bed, eliminating the need for an external desulfurization process such as SO_2 scrubbers, which are costly. Because of reduced combustion temperatures, Nox emissions are inherently low or negligible.

- **Fuel Flexibility**

  FBC units were touted as being “fuel flexible”, with the capability of firing a wide range of solid fuels with varying heating value, ash content, and moisture content.

- Combustion in FBC units takes place at temperatures below the ash fusion temperatures of most fuels. Consequently, tendencies for slagging and fouling are greatly reduced with FBC.

- **Simplified Fuel Preparation And Feeding**

  Normally crushers are sufficient for fuel preparation. A top size, in the range of 5 – 12 mm is required for sub-bituminous coals. Pulverizes and associated maintenance are eliminated.

<u>Ash generation and Quantities:</u>

SLPP(2x125 MW) generates Fly ash quantity of about 700 MT/day and bottom ash quantity of 300 MT/day. Lignite being used at SLPP has ash content to the extent of 12%. Though the ash content is less, use of lime for controlling sulphur in lignite is contributing to an enhanced ash content of 8%. Total ash generation contributed by both ash in lignite and lime is about 20%.

Ash quality: Ash quality varies depends on the quality of lignite burnt in terms of ash content and sulphur. The ash analysis at GIPCL is as under:

Constituents	NAME OF LABORATORY								
	CFRI	NCCB		CGCRI			GIPCL		
	1	1 FA	2 BA	1 FA	2 FA	3 BA	1 FA	2 FA	3 FA
SiO2	26.20	**22.60**	35.82	25.58	24.30	36.89	**40.11**	35.05	32.00
Al2O3	14.63	**11.62**	19.9	15.01	13.11	12.34	**31.23**	30.07	22.05
Fe2O3	12.77	10.82	22.64	16.50	17.16	**30.60**	8.82	17.80	**4.45**
TiO2	1.82	1.51	2.98	1.92	2.51	**4.52**	**0.90**	1.01	1.10
P2O5	**0.33**	**0.06**	0.12	ND	ND	ND	ND	ND	ND
SO3	7.96	7.57	3.98	**9.80**	9.50	**3.43**	ND	ND	ND
CaO	31.88	29.35	9.29	17.50	27	9.92	9.01	**7.26**	**35.77**
MgO	2.82	**3.24**	2.09	0.50	**0.32**	0.40	1.03	2.00	0.86
Na2O	1.42	0.88	1.17	**1.80**	1.05	1.07	0.30	0.24	**0.17**
K2O	0.15	**0.12**	0.24	**0.90**	0.16	0.32	NIL	NIL	NIL
LOI	ND	**10.69**	0.95	8.77	4.78	**0.41**	1.78	2.26	1.45
CL	ND	**0.39**	**0.59**	ND	ND	ND	ND	ND	ND
FREE SILICA	ND	**1.44**	**0.07**	ND	ND	ND	ND	ND	ND
LI2O	NIL	NIL	NIL	NIL	NIL	NIL	NIL	NIL	NIL
R2O3	ND	ND	ND	ND	ND	ND	**40.95**	48.88	**27.60**

FLY ASH RANGE:

SIO2: 24.30 TO 35.05

AL2O3: 11.62 TO 31.23

FE2O3: 4.45 TO 17.80

TIO2: 0.9 TO 2.51

P2O5: 0.06 TO 0.33

SO3: 7.57 TO 9.80

BOTTOM ASH:

SIO2: 35.82 TO 36.89

AL2O3: 12.34 TO 19.9

FE2O3: 22.24 TO 30.60

TIO2: 2.98 TO 4.52

P2O5: 0.12

SO3: 3.43 TO 3.98

CaO: 7.26 TO 35.77	**CaO: 9.29 TO 9.92**
MgO: 0.5 TO 3.24	**MgO: 0.40 TO 3.24**
NA2O: 0.17 TO 1.24	**NA2O: 1.07 TO 1.17**
K2O: NIL TO 0.90 `	**K2O: 0.24 TO 0.32**
LOI: 1.45 TO 10.69	**LOI: 0.41 TO 0.95**

Ash handling System at SLPP :

SLPP is having Dry ash collection system in silos with facilities for loading from underneath the silos and also provision of wet ash disposal system in slurry form to ash dyke. There are 02 nos of bed ash silos of each 250 MT capacity and 02 nos.of fly ash silos of each 500 MT capacity for collection of dry ash. SLPP has abandoned the ash dyke and wet ash disposal system since June 2003.

Dry ash stored from silos is evacuated on day to day basis through truck mounted closed containers and disposed off for backfilling of mines voids.

Ash Utilisation :

The major utilisation of ash is in the area for mines voids filling in our captive lignite mines. Other areas of ash utilisation are for manufacturing of bricks, ash blocks, paver blocks, AC sheets and tiles, construction of road sub grade in mines areas and construction of road with FAL-G as surface course, FAL-G concrete for making level platforms and controlling grass and for construction of RCC road.

The major use of bottom ash is for filling low lying areas in surrounding villages as per the need of villagers, basement filling, partly in construction of roads etc.Remaining quantity is used for backfilling in Mines.

Area of ash utilisation	**Year 2004-05**	**During April 2005**
Manufacturing of ash based products such as Fly ash bricks, Paver blocks, tiles, blocks etc.	20%	37%
Backfilling of mines voids.	79%	58%
Misc.work like concrete work, approach road, filling iin low lying areas etc.	01%	05%
Total ash utilsation	100%	100%

The ash off take by brick manufacturers has increased substantially during last six months. This is due to the stringent measures taken by Pollution Control authorities, effect of fly ash notification and increased pressure on implementation of the norms. With all out efforts and also awareness among users and also the better strength of fly ash bricks, the interaction sessions done with brick manufacturers, the utilisation of ash in fly ash bricks manufacturing improved to an extent of 37%.

Dry ash transportation through truck mounted closed containers and disposal into captive lignite mines for backfilling of voids.

As per MOEF guidelines, the mine voids filling come under Class 'C' category ash utilisation. GIPCL envisaged the mine voids filling with ash right in the begining . Hence GIPCL constructed an ash dyke of smaller capacity. The ash transportation through truck mounted closed containers was commenced in the year June 2002 with back up system of wet ash disposal system into ash dyke. Initially it was thought that ash will be disposed into ash dyke during monsoon during which time it was difficult to transport ash to mines due to slippery black cotton soil. From Feb 2003, almost 100% dry ash transportation and disposal was achieved and then from June 2003 , ash dyke was completely abandoned and ash disposal was continued with dry ash transportation into mines. Necessary roads were constructed with use of ash. Inspite of continuous rains during monsoon period of 2003 , ash transportation was done successfully and 100% ash disposal was achieved at SLPP.

The total utilisation of ash at SLPP is100% by way of disposal of ash in dry form to mines voids backfilling, Construction of roads, off take by brick manufacturing industries.

Difficulties / Problems in sustaining 100% Ash utilisation :

Ash off take by brick manufacturers is not consistent. During monsoon, the off take is negligible, during which period SLPP have to rely on 100% ash disposal into Mines. There was also not much demand for bottom ash except captive consumption in plinth filling and low lying areas etc. Ash is to be evacuated on a day to day basis. There was no alternative system available except that of dry ash disposal into mines. Hence the dry ash transportation agency is to be engaged during entire monsoon period. And there is also the risk of reduced uncertain offtake by brick manufacturers.Hence there is necessity of disposal of some qty into mines even in periods other than monsoon. This in turn reduces the issue to brick units even if there is high demand during off monsoon months.

It is observed during our visits to brick manufacturing units, the quality control measures are not being followed for maintaining consistent quality. This may lead to collapse of demand for fly ash bricks in the long run. This aspect is to be looked into seriously by brick manufacturing units. Regulatory mechanisms can be developed by the involvement of government agencies by making testing mandatory and extending help to the brick units for maintaining quality. At SLPP , at present 5% cement is being replaced by fly ash in Cement Concrete works. GIPCL's fly ash is suitable for making FAL_G bricks.

Lack of demand from cement manufacturers for use of fly ash though a few of them have been approached.

Experimentation for utilising Fly ash for road construction :

Generally bituminous /concrete roads constructed over Water Bound Maccadum(WBM) surface is common. The sub grade used in construction of roads is Cohesive Non swelling soil (CNS soil).

In Mines area continuous spillage of over burden materials (clay/soil), coal/lignite is there during the movement of loaded dumpers. To avoid dust problems due to spillage of lignite water sprinkling is done. Due to continuous water sprinkling and accumulation of spilled material the life of bitumen roads reduces. If WBM is used as surface directly, there are problems of separation of stones from the surface and damage to the dumpers. Further the roads in mine are laid for short-term use and they are abandoned with the progress of Mines. So, permanent, durable roads like concrete road or bitumen roads are not economically viable.

GIPCL decided to do experimental roads with the available fly ash and limestone rejects. Over a period of time the following roads were constructed.

1. Road made with subgrade of Fly ash from Mines site office to view point (For movement of ash trucks in monsoon) (Length : 800mtrs.Width : 9 mtr.)
2. Road made with subgrade made up of Fly ash and sub base and base courses with WBM from mines site office to pit end.(Length 1200 Mtr.Width :13 mtr.)

3. Road from Power Plant to lime stone mines .(Length:2150 Mtr.Width :9 mtrs.) made with blended mix in ratio of Fly ash :65% , Limestone rejects :15% and Black cotton Soil :20% by weight, with designed OMC 26.05% and MDD of 1.594 gm/cc and Design CBR of 26%.
4. Presently one more experimental road is beng undertaken with subgrade mix as per design at 3 above with 400 mm thickness and base course cum surface course of 450 mm thick with design mix of quantities by weight consisting Fly ash : 70% , Limestone rejects 20% and Gypsum 10% with MDD of 1.34g/cc and OMC of 23.91% with design CBR of 20.5%(soaked)

The observations are:

1. Ash can be used as a very good subgrade material. The CBR is many folds better than the conventional CNS soil.
2. Ash can be used as a subgrade material in water logged area and it is experienced that heavy traffic carrying trucks of 30 MT could easily ply during monsoon. Fly ash may be the most economical material that can be used for construction of roads under wet/saturated conditions. The moorum is not suitable for directly allowing traffic.
3. The WBM road made up with ash as subgrade is more durable. The pot holes are less(almost negligible) compared to conventional road with subgrade made up of CNS(Cohesive Non-swelling Soil).
4. The road can be made with fly ash which is the least cost option, particularly when road is not permanent and road is required in monsoon for heavy traffic such as in mines application.
5. Since roads are being constructed with available waste material, the cost of road is less compared to conventional roads. At SLPP, the cost of Construction of subgrade of fly ash is 15% of Construction of subgrade made with CNS Soil.

The short coming of ash in surface course is that it is subjected to abrasion, requires continuous watering to keep it cohesive since binding property is negligible when it is susceptible to continuous traffic and to avoid dust.

Ash utilisation in miscellaneous areas:

Cutting of grass is a regular work at SLPP to avoid fire hazard. Now various fire prone areas are being levelled and covered with concrete made up of Fly ash, Bottom ash and gypsum blended in ratio of 70 : 25: 05 respectively to prevent grass growth and to provide safe movement area for the operational crew. Some of the areas are Propane tank and Screen House surrounding area etc. All brick masonry constructions in SLPP are being undertaken with Fly ash bricks.

Future plans :

SLPP intends to sustain 100% ash utilisation achieved and further increase the use of ash by exploring possibilities of other areas of use. Sustain the demand of ash from brick manufacturers and also to go with construction of road of 13 km to proposed valia mines after satisfying with the performance of experimental stretch. SLPP developed green belt all around the power plant, ash dyke, captive mines and colony and planted more than 4.15 Lakhs no.of trees. SLPP is planning to take up the project bio-reclamations for which TERI is appointed as a consultant, report is still awaited to maintain pollution free environment. Reclamation is started in already filled mines area with species of trees like Ratan Jyoth (Bio-diesel plant) , Sugar cane and bengali bawal etc.SLPP is operating with emission levels of SPM less than 40-50 PPM. SLPP is a 100% ash utilisation power plant.

Conclusions

At SLPP, ash utilisation of 100% is achieved during third year operation of the plant. Many obstacles were overcome to achieve 100% ash utilisation at an early stage of the plant operation. It has been a challenging task and it is more challenging to maintain the same. After achieving 100% ash utilisation, SLPP is experimenting on various alternate uses. SLPP ash being rich in gypsum is very good construction material particularly for sub-grade material in construction of roads. This is also good material for FAL-G bricks.