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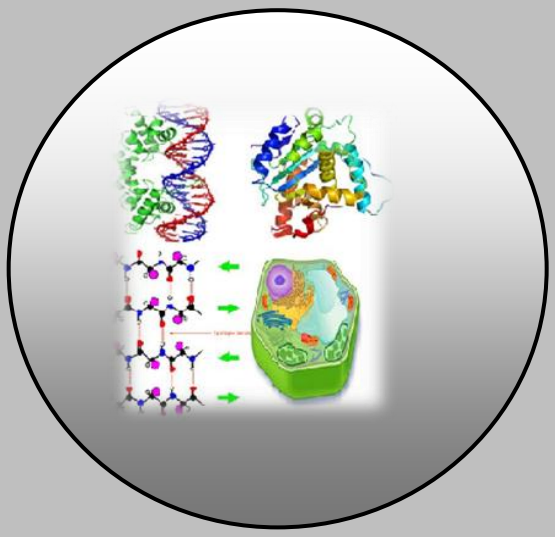

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Fly Ash as a Resource Material in Mines

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ABSTRACT

Thermal Power Stations (TPSs) using pulverized coal as fuel generate large quantities of Fly Ash as by-product. There are about 125 power plants in India, which form the major source of Fly Ash in the country. With the commissioning of Super Thermal Power Plants and with the increasing use of low grade coal of high ash content, the current production of Fly Ash is about 112 million tonnes per year and is expected to reach around 170 million tonnes by 2012. This has posed a serious disposal and ecological problem in addition to occupying large tracts of scarce cultivated land. Although the beneficial usage of Fly Ash in concrete, bricking making, soil stabilization treatment and other applications have been recognized, only a small quantity of the total Fly Ash produced in the country is currently utilized in such applications. Most of the Fly Ash generated from the power plants is disposed off in the vicinity of the plant as a waste material covering several hectares of valuable land. Evolving suitable and appropriate methodologies for sage disposal and bulk utilization of Fly Ash is the challenge before the Thermal Power Plants/ Fly Ash producers. Keeping this view and importance of the environmental problems, it is necessary to find out suitable avenues for bulk utilization of Fly Ash. In this manuscript an attempt has been made to highlight some of the possible areas in Mining Industry where Fly Ash can be utilized in large volumes to mitigate the environmental degradation of its disposal on the land endangering the air and the water quality deterioration of the area.

Keywords: Coal ash, AMD, FGD, Bricks & Blocks, Stabilization, Reclamation, Environmental issues.

INTRODUCTION

In India, Thermal Power Plants (TPPs) account for about 65% of electricity installed capacity and 70% of electricity generation. About 260 million tonnes of coal being currently used by TPSs which is also about 65% of total coal production. There are about 125 TPPs in the country which currently produce about 112 million tonnes of Fly Ash per annum. Considering the growth plans of power sector, the annual Fly Ash generation is expected to be about 170 million tonnes by 2012 AD (Naik, 2006). Since low ash, high grade coal is reserved for metallurgical and other industries, the TPPs have no choice but to use low grade having ash content up to 50%. Further, the deteriorating quality of coal will aggravate the situation, if clean coal technologies are not adopted on a large scale. Most power stations dispose off ash using wet slurry transport system. This method is now proving a luxury in terms of land and water requirements. Further, it downgrades the cementitious properties of dry Fly Ash. Generally, more than 1 acre of land is required for ash pond area per megawatt power capacity (Sahu, 1999; Panda & Viswanathan, 1999). In recent times dry ash collection has gained momentum. In addition, increasingly power stations are shifting to separate of Fly Ash and Bottom Ash with growing realization that each kind of ash has advantageous uses. Till the early 1990s only a very small percentage (3%) of the Fly Ash was used productively in India and the balance material was being dumped in slurry form in vast ash ponds close to power plants. As a result of the focussed thrust being provided by Fly Ash Utilization Programme (FAUP) of Government of India along with many other agencies and the integrated approach covering all possible areas of ash utilization, its utilization since then have increased to 38% during 2004-2005 (of 112 million tonnes ash production) which is presented in Table 1 (Gupta et. al., 1999).

Table 1. Ash Generation and Utilization in India (in million tonnes)

Year	Fly Ash generation	Fly Ash Utilization
1993-93	40	1.2
1994-95	50	2.5
1995-96	60	4.2
1996-97	70	7.0
1997-98	80	9.5
1998-99	85	15.0
1999-00	90	16.0
2000-01	95	19.0
1001-02	100	23.0
2004-05	112	43.0

In a global context Table 2 below provides a relative comparison of the Fly Ash utilization in different countries.

Table 2. Country-wise Utilization Levels of Fly Ash

S No.	Country	% Utilization
1.	Australia	40
2.	Canada	40
3.	China	35
4.	Czechoslovakia	40
5.	Denmark	85
6.	France	70
7.	Germany FR	85
8.	Greece	45
9.	India	38
10.	Israel	80
11	Japan	40
12	Netherlands	110
13	Poland	100
14	South Africa	35
15	United Kingdom	60
16	USA	35

REGULATIONS PERTAINING TO FLY ASH UTILIZATION IN INDIA

The salient features of the gazette of India-extraordinary, Part II-section 3, subsection (ii), Ministry of Environment and Forests (MoEF)Notification, New Delhi, dated 14th September, 1999 is prescribed below with respect to Fly Ash utilization in India. It states that it is necessary to protect the environment, conserve top soil and prevent the dumping and disposal of Fly Ash as discharged from coal or lignite based TPPs on land and there is a need for restricting the excavation of the top soil for manufacture of bricks and promoting the utilization of Fly Ash in the manufacture of building materials and in construction activity within a specified radius of 50km from coal or lignite based TPPs (Venkatachalam et. al., 1999; Vasudevan and Bopanna, 1999).

Use of Fly Ash or Pond in the Manufacture of Bricks and other Construction Activities

No person shall within a radius of 50km from coal or lignite based TPPs, manufacture clay bricks or tiles or blocks for use in construction activities without mixing at least 25% of ash with soil on weight basis

The authority for ensuring the use of specified quantities of ash as per para (a) above shall be the concerned Regional Officer of the State Pollution Control Board (SPCB) or the pollution control committee as the case may be. In case of non-compliance. The said authority, in addition to cancellation of consent order issued to establish the brick kiln, shall move the district administration for cancellation of mining lease. The cancellation of mining lease shall be decided after due hearing. To enable the said authority to verify the actual use of ash, the TPP shall maintain month-wise records of ash made available to each brick kiln.

Utilization of Coal Ash by Thermal Power Plants

All coal or lignite based TPPs shall utilize the ash generated in the power plant as follows:

(a) Every coal or lignite based TPPs shall make available ash, for at least 10 years from the date of publication of this notification, without any payment or any other consideration, for the purpose of manufacturing ash-based products such as cement, concrete blocks, bricks, panels or any other material or for construction of roads, embankments, dams, dykes or any other construction activity (Sinha & Agarwal, 1999; Trivedi & Sood, 1999).

(b) Every coal or lignite based TPP commissioned subject to environmental clearance conditions stipulating the submission of an action plan for full utilization of Fly Ash shall, within a period of 9 years from the publication of this notification, phase out the dumping and disposal of fly ash on land in accordance with the plan. Such an action plan shall provide for 30% of the Fly Ash utilization, within 3 years from the publication of this notification with further increase in utilization by at least 10% points every year progressively for the next 6 years to enable utilization of the entire Fly Ash generated in the power plant at least by the end of ninth year. Progress in this regard shall be reviewed after 5 years.

(c) Every coal or lignite TPP not covered by para (b) above shall, within a period of 15 years from the date of publication of this notification, phase out the utilization of Fly Ash in accordance with an action plan to be drawn up by the power plants. Such action plan shall provide for 20% of Fly Ash utilization within 3 years from the date of publication of this notification, with further increase in utilization every year progressively for the next 12 years to enable utilization of the entire Fly Ash generated in the power plant.

(d) All actions plans prepared by coal or lignite based TPPs in accordance with sub-para (b) and (c) of para 2 of this notification, shall be submitted to the CPCB/ committee and concerned, SPCB/ committee and concerned Regional Office of the MoEF within a period of 6 months from the date of publication of this notification.

(e) The Central and State Government Agencies, the Electricity Boards. The National Thermal Power Corporation (NTPC) and the management of the power plants shall facilitate in making available land, electricity and water for manufacturing activities and provide access to the ash lifting area for promoting and setting up of ash-based production units in the proximity of the area where ash is generated by the power plants.

(f) Annual implementation report providing information about the compliance of the provisions in this notification shall be submitted by the 30^{th} day of April every year to the CPCB/ Committee concerned SPCB/committee and concerned Regional Office of the MoEF by the coal or lignite based TPPs.

PRESENT STATUS OF FLY ASH UTILIZATION IN INDIA

Fly Ash proved to be versatile material with many possible applications in the construction industry. Commercially the bulk uses of the Fly Ash in construction industries are as follows:

Used as structural fill, manufactured of Portland pozzolana cement and mass concrete, manufacture of metallurgical cement, slag-Fly Ash cement and low heat cement. Manufacture of oil well cement, making sintered Fly light weight aggregates, cement silicate bonded Fly Ash/ clay binding bricks and insulating bricks, cellular concrete bricks and blocks, lime and cement Fly Ash concrete, pre cast Fly Ash concrete building units, structural fill for roads, construction on sites, land reclamation, Fly Ash embankments, Fly Ash as backfills, amendment and stabilization of soil (Kumar & Singh, 2006; Jain and Sastry, 2006).

Specific Utilization of Fly ash

Utilization of Fly Ash can be broadly divided into the following three categories:

Low value high volume utilization i.e. in applications where special qualities of fly ash are not of any importance such as stowing in the underground mines, back-filling of open cast mines, control of Acid mine drainage (AMD) in coal mine sites.

High value low volume utilization i. e. where special characteristics of fly ash are used, for example, for treatment of waste land acidic soils and their reclamation for agriculture, as soil stabilizer for embankments, pavements or road base courses and surface-mine spoils reclamation.

Medium value utilization i. e. where in pozzolanic and lime reactivity properties are used.

Fly Ash Utilization in Mines

Mine void filling is another potential area which can provide scope for environmentally safe and large volume utilization of Fly Ash. In particular, the availability of Fly Ash in the proximity of a mining site can create economically favourable conditions for its use as a fill medium. The river sand which is a traditional mine void filling medium in underground coal mines is rapidly getting depleted in India. Fly Ash/ bottom ash can be a potential alternative to either fully or partially replace the river sand. To meet this goal of mine void filling, effective transportation of the Fly Ash and creation of the fill with acceptable strength characteristics are the two main issues that require attention (Mishra and Pani, 2006; Ghosh et. al., 2006).Fly Ash is also reported to offer the benefit of neutralizing any possible AMD that could be generated in a coal mine site. Most of the applications that require the placement of Fly Ash back at the mine site are extensively researched by the Office of Surface Mining (OSM), US Department of Interior. The research indicates that the placement of Fly Ash at the mine site usually results in a beneficial impact human health and to the environment and in most cases at a minimum has no negative effect (Lahiri et. al., 2006; Singh and Goel, 2006). Considerable research findings and field applications are noted in the literature in terms of the utilization of Fly Ash and mill tailings for backfilling. Noteworthy cases of the backfilling operation related to the Fly Ash, mill tailings and mixture of these materials are presented below:

(a) Reclamation of an abandoned surface coal mine in Southern Indiana using a back fill mix of Fly Ash, bottom ash and soil. The low permeability capping material consisted of poz-o-tec and a manufactured material composed of scrubber sludge, Fly Ash and quick lime. Reclamation was initiated in late 1995 and in all, about 1, 10,900m^3 of Fly Ash/ bottom ash and 3,06,000m^3 of poz-o-tec was used in the reclamation.

(b) Stabilization of an abandoned room and pillar coal mine using grout columns consisting of crushed limestone and Fly Ash was done and a power station was constructed over the stabilized mine. Three separate stabilization programs at different parts of the mine were conducted in 1965, 1975 and 1985, prior to construction of the power house, cooling tower and coal handling facility respectively.

(c) A detailed work program for the three phase demonstration of the stowing pond ash in the SCCL mines at Manuguru, AP was conducted during the year 2002-2003. The phase-I demonstration was conducted with 280m^3 of pond ash and phase-II demonstration was conducted with 2,000m^3 of pond ash filling. The third phase demonstration was commenced with pond ash in a regular sand stowing depillaring district. The first two demonstrations pointed out that persons could walk readily over pond ash bed within half an hour after stowing.

(d) There are three reported instances of use of Fly Ash to abate AMD in mining sites. In the first instance, reclamation of 37 acre of surface coal mine at Clinton County, Pennsylvania was done. In the second instance, injection of a mixture of non-fixed flue gas desulpharization solids (FGD), AMD sludge and fine coal refuse into its underground coal mine near Redhouse, MD was performed by Mettiki Coal Corporation in 1996. In third instance AMD problem from the abandoned Omega underground coal mine complex in North Central West Virginia was tackled with the help of cement Fly Ash grout injection.

(e) Fly Ash can also be utilized for the following purposes by mining industry: Back filling of abandoned surface coal mines

Stabilization of abandoned room and pillar underground coal mines Haul road repair and maintenance in open cast coal mines

For oil and grease trap in the workshops where HEMM are monitored

For repair and maintenance of sedimentation ponds of coal handling plants For surface-mine spoil reclamation

Control of coal mine fire

SUGGESTIONS

In order to propagate the effective use of Fly Ash as a backfilling and building material, suitable strategies should be seriously evolved. Some suggestions are as follows:

Fly ash should be accorded the status of a National Resource material for building and mining industry.

Various fractions should be characterized with the help of material characterization techniques and Fly Ash should be grated in term of their intended utilization.

Extension centres should be opened to provide training to the engineers, architects and entrepreneurs in various Fly Ash technologies for building products.

Government may consider suitable measures to ensure the use of Fly Ash in appropriate materials particularly in bricks in order to conserve good quality clay for agricultural purpose.

CONCLUSION

Thus it can be stated that Fly Ash has a great potential to utilize as a mine void filling material by improving its binding properties and mean particle size. Fly Ash can also be utilized as a barrier in AMD prone area. It can also be clubbed with sand for utilization in stowing purposes. Huge amount of Fly Ash is available for mine void filling and their availability is in the vicinity of mines. Only consideration is to utilize this easily available material for filling requirements through best possible techniques without affecting the quality of mining and environment.

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