"Residus To Resource" Environment Friendly Fly Ash Utilisation At ITC-Bhadrachalam.

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ABSTRACT

Indian Paper Industry is the fifth largest power consumer and with the increase in the cost of purchased power, the paper industry has to generate its own energy through captive or co-generation by the use of available coal in the country. Due to high ash content in the coal, the industry is bound to generate very large quantity of fly ash which will pose a disposal and environmental threat. At the same time, the MOEF has come with the legislation to utilise cent percent fly ash in a stipulated time. ITC- Bhadrachalam has successfully come out with suitable solutions in converting the residual fly ash into a resource.

INTRODUCTION

In India about 400 pulp and paper mills are in existence accounting to 3.0 million tonnes of paper and paper board. The paper industry is energy intensive and occupies fifth position in Indian Industrial scenario. The total energy consumed by the pulp and paper industry is more than 1000 crores. The average Indian paper industry consumes 11.4 to 14.0 tonnes of steam per tonne of product and 1500-1700 units electrical energy per tonne of product, which, constitutes 25% to 30% of the total cost of production. Indian paper industry meet its 30-40%, energy demand by internal fuel and rest 60% is purchased power. While in developed countries, industry cover 80% demand through internal fuel and only 20% is purchased power. Considering the element of energy cost in its production, it is clear the cost of energy is one of the major aspect in the overall economy of the mill and will continue to do so in future also (1). It is also known that paper industry in India is an environmental sensitive one and falls under Red category of Industries, which are on constant watch by the MOEF. (Ministry of Environment and Forest)

Till 90's the economy scenario of pulp and paper industry was different under the protected market conditions and cheaper grid power supply for industrial consumers. Today the case is different, State Electricity Boards have raised the cost of power by 300-400%. Hence, the paper industry has left with no other option except to generate its own power by captive/cogen power installations and to upgrade them for optimum utilization considering basic principles of combustion and thermal energy transfer (2). For this, the only option available is to utilize low grade coal available in the country which has very high ash content. Thus the boilers generate large quantities of fly ash. Table-1, shows the ash content and calorific value of coal available in India and developed countries. Table-2, shows the estimated ash generation and coal consumption for power generation in the country.

FLY ASH AND ITS PROBLEM

Fly ash is an environmental hazard. Flyash being light, gets airborne very fast and pollutes the atmosphere. Long inhalation of flyash causes silicosis,

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Table-1

ASH AND CALORIFIC VALUE OF COALS

COAL DATA		INDIA	DEVELOPED COUNTRIES
1. Ash content %	:	30-40	6-10
2. Calorific value, kcal/kg	:	3000-4000	6000-7000
3. Ash production Metric tonne/hour for 200 MW Unit	:	50-60	7-8

Table-2

ESTIMATED ASH GENERATION AND COAL CONSUMPTION IN INDIA

YEAR	1995	2000	2010	2020
1. Installed Thermal Power Generation Capacity, M.W.	54,000	70,000	98,000	137,000
2. Coal consumption Million Tonnes.	200	250	300	380
3. Ash Generation Million Tonnes	75	90	110	140

fibrosis, lung bronchitis and phenonitis, etc. Fly ash corrodes structural surfaces and its deposition affects horticulture. Slurry disposal to lagoons/ settling tanks become breeding grounds for mosquitoes and bacteria. In addition, fly ash holds the danger to contaminate the ground water resources with traces of toxic metals present in it. Flyash disposal in sea/rivers causes damage to aquatic life cycle (3).

STATUS OF FLY ASH UTILIZATION

Lack of awareness and enlightenment continue to identify fly ash as a waste in India, inspite of its technical virtues as a resource. In developed countries flyash utilization ranges from 50 to 80%; Germany 80%, Holland 70%, Denmark, France and Belgium 65%, Britain 55%, Poland 50%, Denmark imports flyash and exports finished products such as prefabs, celular concrete and precost building units, flyash blocks etc. Germany has banned use of top soil for building materials which is one of the reasons for high utilization factor (4). Most of the flyash in India is collected in wet state and only about 20% is collected in usable dry state Fly ash utilization in India is hardly reaching 5% utilization. Efforts are being put in by various Govt. and Private institutions through their R&D sections to develop successful methods of fly ash utilization. Even the CPPRI has taken up a sponsored project on fly ash utilization from pulp and paper mills. Fly ash Mission under Dept. of Science and Technology, GOI, is doing lot of works on fly ash utilization.

Some of the major problems and constraints in the way of large scale utilization of flyash in India are;

a) Bulk of flyash is available in usable and wet state.

b) Lack of facilities of transportation of both wet and dry flyash.

c) Quality variations in flyash and non-availability of certified quality of fly ash.

d) Acceptability of flyash based bricks, Cements and products

ADVANTAGES WITH INDIAN FLY ASH

Indian flyash generally consists of SiO_2 : 55-65%, Al_2O_3 : 15-25%, Fe_2O_3: 4-9%, unburnt carbon 15% and small amounts of alkalies and sulphates which makes it a versatile material, can be used in a variety of applications. Its geotechnical poperties permit it to

Table-3

UTILISATION POTENTIAL OF FLY ASH

LOW VALUE	MEDIUM VALUE	HIGH VALUE
• Mine Fills	• Light Weight aggregte	• Mineral & Metal Extraction
• Embankment	• Fly Ash Concrete	• Mineral Wool
• Back Fills	• Pozzolona Cement	• Cenosphere
• Highway Base	• Cellular Concrete	• Plastic Fillers
• Soil Stabilisation	• Bricks	• Ceramics
• Water Dam Concrete	• Slabs & Wall Panels	• Exotic High Temperature Resistance Tiles
		• Light Weight Refractory

be used in areas like construction of roads and embankments, structural fills etc. It also has excellent pozzolonic properties, which enable its use in areas such as manufacture of fly ash bricks, cement and building materials. Its physico-chemical properties being similar to soil and presence of essential plant nutrients in it enables it to be used in agriculture and soil amendment. Table-3 shows the utilization potential of fly ash.

THE EXISTING ENVIRONMENTAL REGULATIONS ON FLYASH

Economy and environment has to be friendly to achieve sustainable development for prosperity of the human beings. In order to protect environment and achieve the goal of sustainable development, discharge standards for gaseous emissions and waste water coming from power plant has been specified under Environment Protection Act. these standards are shown in Table-4 and 5. Suspended particulate matters in Stack emissions and ash pond effluents are considered for fly ash particulates. However, the other standards applicable are stack height for sulphur dioxide emissions, Boiler and cooling tower blow downs and ambient air quality.

The Hazardous Waste (Management and Handling) Rule, 1989 and its amendment 2000, does not consider fly ash as any hazardous element. The dust nature of fly ash is reflected in the classification by the United Kingdom Govt's health and safety executive as nuisance particulate, rather than a potential healthy hazard with a limiting indusrial exposure to 10 mg/m^3, (5).

The Central Pollution Control Board has recommended that the use of fly ash should be made compulsory for the existing as well as new power plants. A time bound programme should be framed by each power plant. State Pollution Control Boards may stipulate in the consent conditions about the use of ash.

The Ministry of Environment and Forests, GOI, has also published a guidelines of for use of fly ash. The areas of emphasis for potential use of flyash are;

i) Use of fly ash in building activities like Clay fly ash bricks, of Calcium silicate bricks, mixing with Cement, Cellular concrete, sintered light weight aggegate and fly ash gypsum products.

ii) Use of fly ash as manure for agriculture and tree plantation.

iii) Back filling of abandoned mines by using fly ash

iv) Lining of irrigation canals.

Finally, MOEF has issued notification on 14.9.99., it over rides the earlier notifications. The main contents of the notification is given in Table-6. From the notification, it can be seen that State Pollution Control Board has been empowered to ensure that the ash is utilized for manufacturing conventional bricks.

Table-4

EMISSION STANDARDS FOR THERMAL POWER PLANT (E.P. ACT)

Power Generation Cap (acity (MW)		Particulate matter
: Less than 210 MH	:	350 mg/Nm^3
: 210 MW or more	:	150 mg/Nm^3
Note: State PCB can modify the norm of 350 to 150 mg/Nm^3 depending upon Local conditions.		

Moreover, it has stipulated for formation of dispute settlement committee so as to ensure unhindered supply of ash. It is also seen that this notification takes into account the possible problem of non-availability of ash. These changes are welcome (6).

FLY ASH UTILIZATION AT ITC BHADRACHALAM

With the improved energy efficiency, today ITC-Bhadrachalam meets its 95% of power requirement through captive/CO-generation of power. As a result of it on an average daily 300 tonnes of fly ash is generated. To find a solution to the flyash utilization, meeting the bricks demand for housing the masses and in support of nation's policy on flyash, ITC-Bhadrachalam has taken up a project on flyash utilization in the year 1992 itself in a big way by just investing about Rs. 5 lakhs for purchase of equipments such as Pan mixer and solid brick moulding machine to manufacture fly ash bricks and for experimentation.

CONVERTING FLYASH INTO LOW COST BUILDING MATERIALS

Clay brick is the unchallenged walling material in India on account of its techno-economic logistics. The structure of clay brick industry in India has not changed even in this space age where not less than 90% of the production units are still confined to cottage and smal scale sector (7), Based on the above logistics to produce flyash bricks of better quality than clay bricks, cheaper and durable, R&D work was done to develop environment friendly flyash bricks. After an year's effort a suitable composition of utilizing the following three industrial wastes, fly ash, lime and gypsum was found out, which gives a compressive strength of about 80-100 kg/cm^2. In this, the composition of flyash goes as high as 88%, that too without fire curing as done with clay bricks. Daily on an average about 45 tonnes of flyash is converted into flyash brick blocks of size 400 x 200 x 100 mm. The flyash consumption for brick making for the past several months has been shown in the Table-7.

Table-5

DISCHARGE STANDARDS FOR ASH POND EFFLUENT (E.P. ACT)

PARAMETER		LIMITS
pH	:	6.5-8.5
Suspended Solids	:	100 mg/l
Oil and grease	:	20 mg/l

The process involved in flyash brick making is as follows

In the presence of moisture, flyash reacts with lime at ordinary temperature and forms a compound possessing cementitious properties. Gypsum is used as a chemical to accelerate the reaction. After reactions between lime and flyash Calcium silicate hydrates are produced which are responsible for the high strength of the compound. Fly ash bricks made by this way are chemically bonded bricks. These bricks are suitable for use in masonry just like common burnt clay bricks. These bricks have the advantages over the clay bricks such as;

- Process crushing strength more than that of a good quality clay bricks and can be therefore be used as a load bearing member.
- Have Cement colour in appearance, are uniform in shape and smooth in finish, and require no plastering for building work.
- Are lighter in weight than ordinary clay bricks, are less porous than the ordinary clay bricks.
- Using these flyash bricks, more than 100 houses have been built in the ITC-Bhadrachalam colony

Table-6

MINISTRY OF ENVIRONMENT AND FORESTS

ON FLY ASH

FINAL NOTIFICATION DATED SEP. 14TH 1999

PROTECT THE ENVIRONMENT, CONSERVE TOP SOIL, PREVENT THE DUMPING AND DISPOSAL OF FLY ASH DISCHARGED FROM COAL OR LIGNITE BASED THERMAL POWER PLANTS ON LAND AND IN LANDFILLS.

E.P. RULE

01) Use of Flyash, Bottom Ash or Pond Ash in the manufacture of Brick and other construction activities.

I. No person to manufacture clay bricks/ Tiles/Blocks without mixing at least 25% of ash within the radius of 50 kms from Coal/Lignite Thermal Power Plant.

II. Concerned Regional Officer of State Pollution Control Board or Pollution Control Committee is responsbile for the implementation. TPP shall maintain monthwise record of ash issued to brick kilns.

III. Each TPP shall consittute a dispute setilement committee.

02) Utilization of Ash by Thermal Power Plants.

I. All TPP shall make available ash for 10 years without any payment / consideration for manufacture of ash based products / Roads/Embankment/Dams/Dykes/for any other construction activity.

II. Preparation of action plan by TPP to utilize fly ash.

	New (E.C.)	Old
100% Flyash utilization	9 Yrs.	15 Yrs.
30% Flyash utilization	3 Yrs.	-
20% Flyash utilization	-	3 Yrs.

* Every year 10% increased utilization of fly ash.

* Progress shall be reviewed after 5 years.

III. Action plan to be submitted to SPCB/CPCB within six months.

IV. All TPP to provide Land/Power/Water with access to ash lifting area to promote fly ash utilization.

V. Every year status report to be sent to SPCB/CPCB by 30th April.

VI. Flyash products should meet standards.

VII. Govt. / Private agencies should use fly ash materials and prescribe construction rules.

Table-7

UTILISATION OF FLY ASH FOR BRICK MAKING AT ITC BHADRACHALAM

MONTH (1999)	APRIL	MAY	JUNE	JULY	AUG.	SEPT.	OCT.
FLY ASH (MT)	1792	1296	1332	1080	1422	963	1233
MONTH	**NOV.**	**DEC.**	**JAN.00**	**FEB.**	**MAR.**	**APRIL**	**MAY**
FLY ASH (MT)	1035	1575	1350	1404	1800	1323	1782

and even the factory buildings have been built with this. Encouraged by this, the neighbouring industries like M/s. The Singareni Collieries, M/s. Andhra sugars have started using these fly ash bricks for their day to day construction activities. The Andhra Pradesh Housing Corporation has started in a big way utilising these fly ash bricks for the construction of houses for the masses in the Khammam District of Andhra Pradesh. To meet the demand, the Company has encouraged the entrepreneurs to set up fly ash brick manufacturing units. With this, two units have started functioning near the mill and another three at a distance from mills using the free technical and marketing assistance from the milll. To the nearby units, fly ash supply and transportation is free. The manufacturing cost of the brick is given in Table-8. Today, it is a successful reality of utilising fly ash into a useful building material. Many far and near fly ash generating thermal plants including NTPC, NLC, INDAL & APSEB etc. have visited our Unit and sought the assistance from ITC-Bharachalam to set up such units at their Units. The milll also has made a resolution that in all its construction activities, only fly ash bricks to be used.

UTILISATION OF FLY ASH TO MAKE A GREEN MOUND

This is a totally new concept and development with an adventure. It is an environment friendly utilizing dry fly ash for converting it into large mounds. Harsh appearance of ash mound is appropriately landscaped. It is a practice in any power generating plants by use of coal, has to dispose its ash is a wet slurry to a lagoon. Lagoon area provision to be made at the rate of 0.3 hectare per megawatt of installed capacity (8). For wet disposal system, the ash storage density depends on the natural profile of low lying areas. It is now possible to enhance this with the innovative design of enhancing ash lagoon capacity of raising existing dyke with utilization of pond ash.

As an estimate, the ash storage density for dry disposal is 3 to 5 times that for wet disposal of ash. Area and cost of land for dry disposal is 20% compared to that for wet disposal. The other advantages are; i) no ground water contamination due to leaching, ii) Air borne dust emission can be total avoided with green cover, which will be a permanent affair and iii) cost of transporation is 5 to 10 times cheaper than wet slurry transport.

To construct the ash mound at ITC -BPL, an abanduned lime sludge lagoon is taken and on it ash mound is being raised. The present height is about 5.0m and expected to raise upto 15.0. For this, ash conditioners at ash soils are provided, the conditioned ash is transported by open tippers, unloaded at mound site without dust emission. The ash is compacted with dozzer. With this innovative method of ash mound making, the fly ash disposal problem for the mill has been totally solved. One can say, that fly ash utilisation is cent percent at M/s. ITC Bhadrachalam.

FLY ASH STOWING INTO MINES

Use of fly ash in backfilling of open-cast mines and stowing of underground mines, can be a major area for utilisation of ash. As far as underground mines are concerned, ITC-Bhadrachalam had got laboratory studies conducted through Central Mining Research Institute, Dhanbad and found its suitability for fly ash stowing. M/s. Singareni Coal Colleries Ltd., has utilised this fly ash for stowing into its mines by mixing with sand. Pressures are put in by the pit head industries on M/s. SCCL., to use their ash also in mine stowing.

CONCLUSION

Fly ash is a misplaced resource from power generating Units, causing disposal and environmental problems. The problem is expeeted to be of a very high magnitute in the near future. The practical solutions

Table-8

COST OF MANUFACTURE AND SALIENT FEATURES OF FLY ASH LIME GYPSUM BRICKS

1.0	RAW MATERIALS		
	Fly Ash (88%)	:	Generated from Coal Fired Boiler
	Lime (8.0%)	:	Waste Lime sludge (CaO) available from oxyacetalene Plants using calcium carbide.
	Gypsum (4.0%)	:	Waste from fertiliser Plants.
2.0	APPROXIMATE COST OF RAW MATERIALS		
	Fly Ash	:	Free of Cost
	Lime / Lime Sludge	:	Rs. 1150 per M.T.
	Gypsum	:	Rs. 800 per M.T.
3.0	SIZE OF BRICKS AND COST		
	400 X 200 X 100 mm size		Rs. 3.63 (S.P.)
	230 x 200 x 100 mm size		Rs. 1.98 (S.P.)
4.0	RATE OF PRODUCTION		
	4000 No. Equivalent normal size of bricks (200 x 100 x 100 mm) per shift of 8 hours.		
	6000 No. Equivalent normal size of bricks (200 x 100 x 100 mm) per shift of 8 hours.		
5.0	COST COMPONENT OF MANUFACTURE		

			"SHIRKE"	"BRICKMAN"
Labour	%	:	45	33
Lime + Gypsum	%	:	47	48
Misc.	%	:	8	19

available to the industry is to convert it to environment friendly bricks and the left out can be used for stowing into mines and make green mounds. This strategy will help the power captive industries in converting its residue into resource.

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