



Indian fly-ash: production and consumption scenario

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Abstract — Electricity generation in India predominately depends upon coal based power plant for a couple of coming decades. Coal based power plant requires coal of high calorific value to generate optimum heat consequently to generate electricity, in this process a by product which is also waste fly-ash or coal ash is produced. In India coal reserve is mainly is of lignite so the power plant burns this and produces ash, Indian coal average ash content is 35-38 percent. We require electricity, we burn coal and we produce fly-ash. In this research article the production of Indian fly-ash and consumption of it discussed.

Keywords — Fly-ash; Coal; Production; Consumption; Generation

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I. INTRODUCTION

A fine, glass powder recovered from the gases of burning coal during the production of electricity is fly ash. These micron sized earth elements consist primarily of silica, alumina and iron (www.iflyash.com/whatisflyash.htm, 2011). The combustion of powdered coal in thermal power plants produces fly ash. The high temperature of burning coal turns the clay minerals present in the coal powder into fused fine particles mainly comprising of aluminium silicate. Fly ash produced thus possesses both ceramic and pozzolanic properties. When pulverized coal is burnt to generate heat, the residue contains 80 percent fly ash and 20 percent bottom ash. The ash is carried away by flue gas collected at economizer, air pre-heater and ESP hoppers. Clinker type ash collected in the water-impounded hopper below the boilers is called bottom ash (Parisaramahiti.kar.nic, 2007).

II. PHYSICO - CHEMICAL AND MINEROLOGICAL PROPERTIES OF FLYASH

Flyash being a coal combustion residue shows a wide variation in their physico-chemical and mineralogical properties depending on the nature of parent coal, conditions of combustion, type of emission control devices,

storage and handling methods (Jala and Goyal, 2006). Flyash has a low bulk density, high surface area and light texture (Asokan et al., 2005; Jala and Goyal, 2006; Sawitri, and Lasryza, 2012). Flyash consists of mainly amorphous glass and a few crystalline phases.

III. COAL DEMAND AND COAL ASH GENERATION

Indian coal has high ash content. The average ash content in Indian coal is 35-38 per cent while imported coal ash content 10-15%. In this regard, washing will help reduce the ash content by 7-8 per cent (Source, the Indian Express, 2011). A large number of Coal/Lignite based thermal power plant 90 Nos. (Central Electricity Authority 2011-12) is setup for providing electric power to rapidly growing industrial as well as agriculture sectors. In which 70 percent of the electricity generated is from coal based thermal plants (India Energy book, 2012). In order to achieve the India economic growth of 8-9 percent, the country's total coal demand, has been forecasted increase in ~ 730 Million tons in 2010-11 to ~2000 Million tons in 2031-32 of this approx. 75 percent of this coal would go thermal power plant (India Energy Book, 2012). The table below will present the projected coal demand (Million tons).

Table 1. Projected coal demand (Million Tons) (Source India Energy Book, 2012)

Sectors	2005-06	2006-07	2011-12	2016-17	2021-22	2026-27	2031-32
Electricity (A)	310	341	539	836	1040	1340	1659
Iron & Steel	43	43	69	104	112	120	150
Cement	20	25	32	50	95	125	140
Others	53	51	91	135	143	158	272
Non-Electrical (B)	116	119	192	289	350	403	562
Total of (A) + (B)	426	460	731	1125	1390	1743	2221

In the above table demand of coal in the coming decades so the generation of fly-ash will increase tremendously and the consumption rate is 54.33 percentages (Central Electricity Authority 2011-12) per annum, the consumption rate should be increased gradually to maintain a production-consumption balance. Further, the table given below shows the generation and utilization of fly-ash for the year 2010 and 2011 in India which aware us the contemporary consumption rate

Table 2. Generation and utilization of fly-ash in India 2010 and 2011
(Source: Central Electricity Authority annual Report 2010-11, 2011-12)

	2010-11	2011-12
No. of coal/Lignite based thermal power station (India)	88	90
Installed Capacity	80548 Mega Watt	83797 Mega Watt
Total Ash generated	131.09 Million Tons	66.49 Million Tons
Total Ash utilized	73.13 Million Tons	36.26 Million Tons
Percentage Utilization	55.79%	54.33%

IV. UTILIZATION OF FLY-ASH SECTORWISE IN INDIA

In the financial year 2016-17 it is expected to increase the production of fly-ash around 300-400 MT/year. The large amount of fly-ash produced if not utilized in right quantity will be hazardous to environment.

Table 3 - Fly-ash utilization during the year (2010)
(Source CEA annual report 2010-2011)

S.No.	Mode of Fly-ash Utilization	Utilization (Million Tons per annum)	Percentage Utilization
1.	Cement	35.47	48.50
2.	Reclamation of low lying area	9.31	12.73
3.	Roads and Embankments	8.52	11.65
4.	Mine Filling	6.04	8.26
5.	Bricks & Tiles	4.61	6.30
6.	Agriculture	1.27	1.74
7.	Others	7.91	10.82
	Total	73.13	100

Table 4 - Fly-ash utilization during the year (2011)
(Sources: CEA annual report 2011-2012)

S.No.	Mode of Fly-ash Utilization	Utilization in (Million Tons per annum)	Percentage Utilization
1.	Cement	17.45	48.13
2.	Reclamation of low lying area	3.16	8.72
3.	Roads and Embankments	4.72	13.02
4.	Mine Filling	2.45	6.76
5.	Bricks & Tiles	2.36	6.51
6.	Agriculture	0.37	1.02
7.	Others	5.74	15.83
	Total	36.26	100

In the cement sector the utilization is approximately same with figure of 48.50 percent and 48.13 percentage in 2010 and 2011; in roads and embankment sectors has increase in percentage utilization from 11.65 percentages to 13.02 percentages. Otherwise other sector has decrease in percentage of utilization of fly-ash which decreases the overall percentage utilization in financial year 2011-12.

Table 5 - Fly-ash generation and utilization during the period 1996-97 to 2010-11 (Source: CEA annual report on fly-ash generation-utilization 2010-2011)

S. No.	Year	Fly-ash Generation (Million tons per annum)	Fly-ash utilization (Million tons per annum)	% Utilization
1	1996-97	68.88	6.64	9.63
2	1997-98	78.06	8.43	10.80
3	1998-99	78.99	9.22	11.68
4	1999-2000	74.03	8.91	12.03
5	2000-01	86.29	13.54	15.70
6	2001-02	82.81	15.57	18.80
7	2002-03	91.65	20.79	22.68
8	2003-04	96.28	28.29	29.39
9	2004-05	98.57	37.49	38.04
10	2005-06	98.97	45.22	45.69
11	2006-07	108.15	55.01	50.86
12	2007-08	116.94	61.98	53.00
13	2008-09	116.69	66.64	57.11
14	2009-10	123.54	77.33	62.60
15	2010-11	131.09	73.13	55.79

V. TRENDS OF FLY-ASH UTILIZATION IN INDIA

Since 1996-97 to 2010-11 increase in fly-ash production is observed so the consumption (9.63 % in 1996-97 to 54.53 % in 2011-12, (Central Electricity Authority 2011-12)). India achieved utilization of 63 percentages, a highest level of fly-ash utilization in 2009-10 and 54.33 percentages in 2011-12. However, it would require lot of effort to achieve 95-100 percentage utilization. Concentrated efforts have been made by Department of Science and Technology, Government of India to increase the scale of utilization of fly-ash.

VI. UTILIZATION OF FLY-ASH IN INDIAN CEMENT INDUSTRY

Manufacturing of cement is the most important sector it take a lion share in fly-ash utilization in India. Owing to its pozzolanic properties fly-ash is used as a replacement for some of the Portland cement content of concrete. Use of fly-ash as a partial replacement for Portland cement is generally limited to CLASS F Fly-ash as this fly-ash is pozzolanic in nature, and contains less than 20% lime Cao. The current utilization of fly-ash in cement industry is 48.13% in 2011-12 (Central Electricity Authority Annual Report 2011-12). The cement industry of India is expected to add 30-40 million tons per annum (MTPA) of capacity in 2013. The industry has a current capacity of 324 MTPA and operates at 75-80 per cent utilization.

Table 4- Expected Fly-ash absorption in cement (million tons per annum)
(Source: WBCSD/CSI/LOW Carbon technology road map for Indian cement industry)

Serial No.	Year	Expected Fly-ash absorption in Indian Cement Industry (million tons per annum)
1	2015	52.65
2	2020	73.01
3	2025	94.63
4	2030	120.50
5	2035	143.72
6	2040	158.02
7	2045	167.74
8	2050	177.45

"It is anticipated that the cement industry players will continue to increase their annual cement output in coming years and the country's cement production will grow at a compound annual growth rate (CAGR) of around 12 per cent during 2011-12 - 2013-14 to reach 303 MMT," (according to a report titled 'Indian Cement Industry Forecast to 2012', by research firm RNCOS).

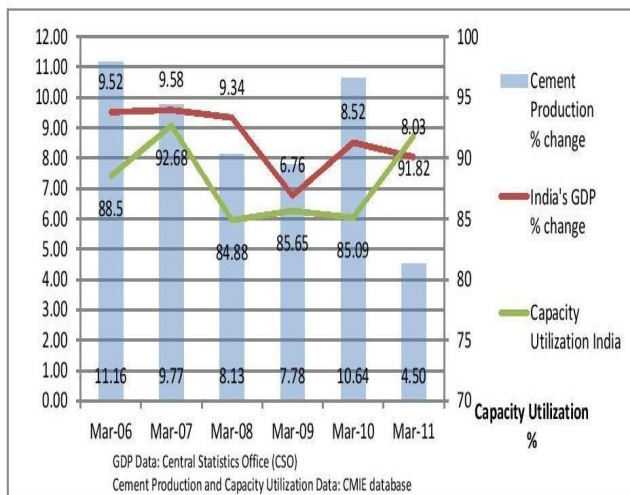


Figure 1: Cement production and capacity utilization and India GDP data (Source: Central Statistics office and CMIE India)

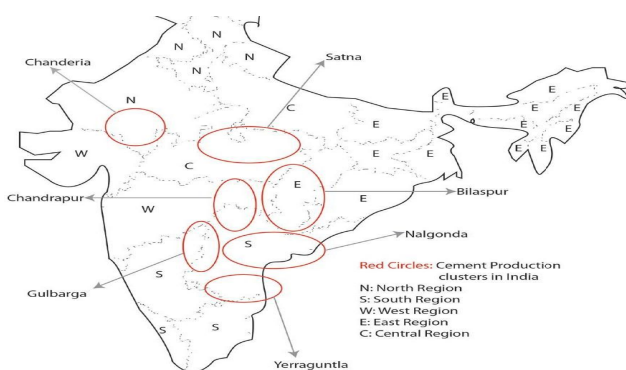


Figure 2: The division of cement production & market on the map of India (Source: cementing growth, industry report, Ernst & Young, page 18-19)

VII. RESULTS AND DISCUSSION

In India, major source of power is generated through coal based thermal power plants resulting in huge quantity of flyash generation took place in past decade and hence its safe disposal is an important concern to safeguard the cleaner environment. In coming year (2016-

17) it is expected India will produce 300-400 Million Tons per year which is approximately double the quantity it is produced now so the consumption should be increased subsequently, the major use flyash is in the building material as a cement raw material and have many advantages like it reduces Green House gases emission, solve serious waste disposal problem faced by power generation industry, reduces energy requirement.

Recently a large utilization of flyash taking place in brick, industry setup took place in 2012-13 Jindal Steel Power Limited has started its plant in Angul, Raigarh and Patratu district in India producing fly-ash bricks of 1,80,000 bricks per day consuming fly-ash of 400 tons per day (Angul Plant, JSPL 2012), 3,00,000 bricks per day consuming 550 tons per day (Raigarh Plant, JSPL 2012), 50,000 bricks per day consuming 100 tons per day (Patratu Plant, JSPL 2012).

Fly ash has a great application in the field of environment like treatment of waste water, construction activities tec. Utilization of fly ash in India has increased in various fields for example going from an open, dusty, dry transport of the flyash or by pumping of a water/flyash suspension to a special pumping system with low water content. The common flyash depot, dusty and dry, (with special care to avoid the blowing away) or a pond with an overflow of transport water now changes in a sticky, semi dry and consistent pond (for example: WEIR pumping system). Here are some areas which require further study on fly ash.

1. Considerations about the economic value of flyash.
2. Development and use of fine cement-less Ash-slag concrete from secondary mineral resources.
3. Utilization of flyash in polymer industry.

Further increase in utilization of fly-ash in other sector (cement, roads and embankment, agriculture, mine filling, reclamation in low lying area) would definitely fulfil the more and more utilization scenario of Indian fly-ash

VIII. CONCLUSION

This paper has attempted to cover exorbitant amounts of information so that the reader can better understand flyash utilization Understanding coal combustion processes provides both a background and basis for the alternative uses of the resultant flyash. Flyash even though it is an environmental pollutant, it is an important raw material for various applications. The utilization of flyash in different sectors can help a great emphasis on the development of new technology for efficient utilization of flyash. Flyash utilization programme must be extensively taken up covering various aspects at different level to minimize the environmental pollution. There is a limited amount of research information on the environmental impact of flyash as an ingredient in the preparation of materials

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