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Review Article

EFFECTS OF POLLUTANTS PRODUCED BY THERMAL POWER PLANT ON ENVIRONMENT: A REVIEW

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In this review, effects of pollutants have been shown on environment those are produced by thermal power plants. These pollutants specially fly ash has several uses to reduce environment pollution and economic with social factor such as manufacturing bricks, cement, ceramics, road, pavements, embankments, etc., fly ash can be used as fertilizer, polymer products to make the system economic and minimize environmental, soil and water pollution. Here problems caused by thermal power plant pollution especially by coal based pollution because it is found in abundance and used widely in thermal power plants, have been discussed and studied, after that solutions also have been provided.

Keywords: Pollution, Thermal power plant, Environment, Fly ash, Coal

INTRODUCTION

Coal is the only natural resource and fossil fuel available in abundance in India. Consequently, it is used widely as a thermal energy source and also as fuel for thermal power plants producing electricity. Power generation requirement has been increased in recent decades to meet the demand of increasing population in India. Most of the electricity, about 70% of total is generated by coal-based thermal power plants. High grade quality coal is used by the metallurgical industry. So coal supplied to thermal power plant is of poor quality. Coal is the main source used as fuel energy is converted into useful heat energy in thermal power plant which produces greatest environment and health concerns.

Combustion of coal at thermal power plants emits mainly carbon dioxide (CO_2), sulphur oxides (SOx), nitrogen oxides (NOx), CFCs particulates, such as fly ash and Suspended Particulate Matter (SPM). High ash content in Indian coal and inefficient combustion technologies contribute to India's emission including gases that are responsible for the greenhouse effect.

The present coal consumption in thermal power station in India results in adding ash estimated 12.21 million tons fly ash in to the environment a year of which nearly a third goes

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in to air and the rest is dumped on land or water. Use of coal is going to be increased as time goes on and produces environmental, soil and water pollution.

PROBLEMS ASSOCIATED WITH INCREASING FLY ASH

Environmental pollution by the coal based thermal power plants all over the world is cited to be one of the major sources of pollution affecting the environment in terms of land use, health hazards and air, soil and water. Fly ash water also affects the scale structure because it is a directly in contact with water.

Coal Combustion Residues (CCRs) are a collective term referring to the residues produced during the combustion of coal. It includes fly ash, bottom ash, boiler slag, and fluidized bed combustion ash and other solid fine particles. In India, presently coal based thermal power plants are releasing 105 MT of CCRs which possess major environmental problems. Presently from all thermal power plants, dry fly ash has been collected through Electrostatic Precipitator (ESP) in dry condition as well as pond ash from ash ponds in semi-wet condition. In India most of the thermal power plants do not have the facility for automatic dry ash collection system. Commonly both fly ash and bottom ash together are discharged as slurry to the ash pond/lagoon. These affect on environment, economy and social factor.

PROBLEMS ASSOCIATED WITH RADIONUCLIDE INCREASE IN ATMOSPHERE BY COAL COMBUSTION

Coal contains radionuclides. The levels of natural radionuclides in a geological formation depend on its composition and geological history. In the combustion process, volatile radionuclide's such as Pb210 and Po210 are partly released in the flue gases and escape to the atmosphere. A significant fraction of the radioactivity is also retained in the bottom ash or slag. The greatest part of the radioactivity in coal remains with the ash but some of the fly ash from coal-fired power plants escapes into the atmosphere. Air pollution in the vicinity of a coal fired thermal power station affects soil, water, vegetation, the whole ecosystem and human health.

Radon (found in fly ash), a radioactive material emitted in atmosphere, poses grate health hazards not only to uranium miners but also people living in normal houses and buildings and at work place like coal mines, cement industry, thermal power plants, etc. Fly ash which is a byproduct of burnt coal is a potential radioactive air pollutant and it modifies radiation exposure.

FLY ASH MITIGATION MEASURE

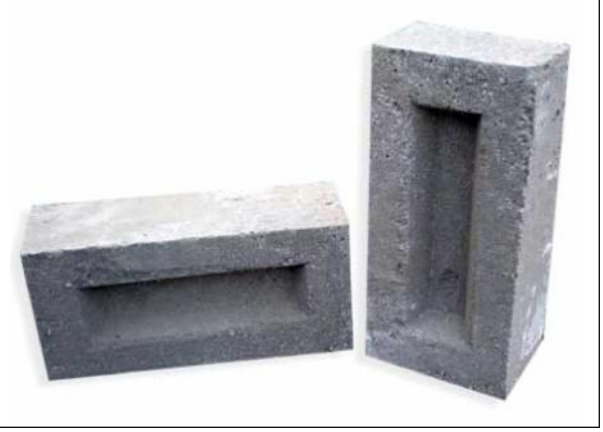
Fly ash is fine glass powder, the particles of which are generally spherical in shape and range from 0.5 to 100 micron in size. The fine particles of fly ash reach the lungs and remain there for long periods of time; they behave like cumulative poisons. The submicron particles enter deeper into the lungs and are deposited on the alveolar walls where the metals could be transferred to the blood plasma across the cell membrane. Fly ash can be disposed-off in a dry or wet state. Wet disposal of this waste does not protect the environment from migration of metal into the soil. Heavy metals cannot be degraded biologically into harmless

products like other organic waste. Coal ash satisfies the criteria for landfill disposal, according to the Environmental Agency of Japan. According to the hazardous waste management and handling rule of 1989, fly ash is considered as non-hazardous.

MANUFACTUR OF BRICKS, CEMENT AND CERAMICS BY FLY ASH

The Central Fuel Research Institute, Dhanbad has developed a technology for the utilization of fly ash for the manufacture of building bricks. Fly ash bricks have a number of advantages over the conventional bricks. Unglazed tiles for use on footpaths can also be made from it (Figure 1). Awareness among the public is required and the Government has to provide special incentives for this purpose. Total eight mechanized fly ash brick manufacturing units at Korba are producing about 90000 bricks per day. Apart from this about 23 entrepreneurs have registered for establishing ash brick units. Orissa Government in India has banned the use of soil for the manufacture of bricks up to 20 km. of a thermal power station. In the case of fly ash-clay fired bricks, a mixture of clay and fly ash is fired. The unburnt carbon of the fly ash serves as fuel for burning. Approximately 20-30% energy can be reduced by adding 25-40% fly ash.

Figure 1: Fly Ash Using for Making Bricks



A cement technologist observed that the reactive elements present in fly ash convert the problematic free lime into durable concrete. Fly ash can substitute up to 66% of cement in the construction of dams. Fly ash in R.C.C. is used not only for saving cement cost but also for enhancing strength and durability. Fly ash can also be used in Portland cement concrete to enhance the performance of the concrete. Portland cement is manufactured with Calcium oxide, some of which is released in a free state during hydration. Studies show that one ton of Portland cement production discharges 0.87 tonnes of carbon dioxide in the environment. Another Japanese study indicates that every year barren land approximately 1.5 times of the Indian Territory need to be afforested to compensate for the total global accumulation of carbon dioxide discharged into the atmosphere because of total global cement production. Utilization of fly ash in cement concrete minimizes the carbon dioxide emission problem to the extent of its proportion in cement.

Ceramic products with up to 50 wt% of mullite and 16 wt% of feldspars were obtained from binary mixtures of fly ash from the Teruel power station (NE Spain) and plastic clays from the Teruel coal mining district. The firing behavior of fly ash and the ceramic mixtures was investigated by determining their changes in mineralogy and basic ceramic properties such as color, bulk density, water absorption and firing shrinkage. To determine the changes on heating suffered by both the fly ash and the

ceramic bodies, firing tests were carried out at temperatures between 900 °C and 1200 °C in short firing cycles. The resulting ceramic bodies exhibit features that suggest possibilities for use in paving stoneware manufacture, for tiling and for conventional brick making. The National Metallurgical Laboratory, Jamshedpur has developed a process to produce ceramics from fly ash having superior resistance to abrasion.

FLY ASH AS FERTILIZER

Fly ash provides the uptake of vital nutrients/ minerals (Ca, Mg, Fe, Zn, Mo, S and Se) by crops and vegetation, and can be considered as a potential growth improver because it can be a soil modifier and enhance its moisture retaining capacity and fertility. On an average 20-30% yield increase has been observed. Out of 150 million hectare of land under cultivation, 10 million hectares of land can safely be taken up for application of fly ash per year. The fly ash treated fields would give additional yield of 5 million tone food grains per year valued at about Rs. 3000 crores. Use of fly-ash as fertilizer has been shown in Figure 2.

Figure 2a: Cabbage at Dodhar, Fly Ash Amended Soils

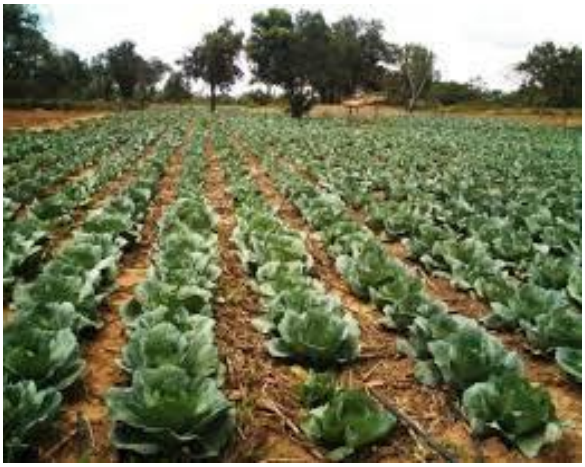


Figure 2b: Reclamation of Saline Soils Using Fly Ash (75 % Savings in Gypsum)

FLY ASH BASED POLYMER PRODUCTS

Fly ashes are also being used as wood substitutes. They have been developed by using fly ash as the matrix and jute cloth as the reinforcement. The Jute cloth is laminated by passing through a polymer fly ash matrix and then cured. The number of Laminates is increased to get the desired thickness. The product can be used in many applications like door shutters, partition panels, flooring tiles, wall paneling and ceiling. The developed material is stronger, more durable, resistant to corrosion and cost effective as compared to wood.

This technology has been developed by the Regional Research Laboratory, Bhopal in collaboration with Building Materials and Technology Promotion Council (B.M.T.P.C) and TIFAC19. One commercial plant has been set up based on this technology near Chennai, India. The Government of India has withdrawn

a 8% excise duty imposed earlier on fly ash products.

FLY ASH IN ROAD/ EMBANKMENTS/ROAD BASE/PAVEMENTS CONSTRUCTION

Fly ash has been used in large quantities in India to construct pavements/roads/flyover embankments.

In the recent past CRRI offered consultancy services in the following road/embankment projects in which fly ash was utilized:

- Construction of plant roads at Budge-Budge thermal power plant using fly ash based pavement (Collaboration with CESC Ltd., Kolkata),
- Construction of one km long rural road near Raichur in Karnataka with fly ash based flexible/semi-rigid pavement (Collaboration with Karnataka PWD and Raichur thermal power station – executed as Fly Ash Mission demonstration project),
- Construction of 1.9 km long, 6 to 9 m high road embankment for Nizamuddin Bridge in Delhi using fly ash (Collaboration with Delhi PWD and Indraprastha thermal power station, Delhi), shown in Figure 3,
- Construction of plant road and two rural roads using fly ash (collaboration with NTPC, Dadri, and UP),
- Fly ash embankment construction for Okhla flyover at Delhi adopting 'Reinforced Embankment Technique' (Collaboration with Delhi PWD – executed as Fly Ash Mission demonstration project),
- Fly ash embankment construction for Hanuman Setu flyover at Delhi adopting 'Reinforced Embankment Technique' (Collaboration with Delhi PWD and Badarpur Thermal Power Station, Delhi),
- Construction of reinforced approach embankment using fly ash at SaritaVihar flyover in Delhi (Collaboration with Delhi Development Authority and Badarpur Thermal Power Station, Delhi),
- Construction of embankment for Noida-Greater Noida Expressway project (Collaboration with IRCON International and Badarpur Thermal Power Station, Delhi).

Figure 3: Nizamuddin Bridge Approach Road Embankment at New Delhi

ENERGY SAVINGS AND ENVIRONMENTAL BENEFITS

Most of the developing countries face energy scarcity. In these countries materials for habitat and other construction activities should be energy efficient (having low energy demand).

CONCLUSION

Coals used widely as a thermal energy source in thermal power plant for production of electricity in India but available coal in India is of poor quality, with very high ash content and

low calorific value. Utilization of huge amount of coal in thermal power plant has created several adverse effects on environment leading to global climate change and fly ash management problem. Coal based thermal power plants all over the world is cited to be one of the major sources of pollution affecting environment in terms of land use, health hazards and air, soil and water. So, the disposable management of fly ash from thermal power plant is necessary to protect our environment. It is advisable to explore all possible application for fly ash utilization. Utilization of fly ash in making bricks, cement, ceramics, roads, etc., gives good result in aspect of good strength, economically feasible and environmental friendly.

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