Innovations for 3R Technologies for Industrial Waste Management

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Abstract - Ongoing environmental innovation is the only way to reduce pressures on environmental qualities while maintaining income growth. A strict environmental policy can create the sense of urgency and strong incentives for environmental innovation.To meet the challenges of continuing growth without destroying the environment, smart city planning for sustainable development is crucial.This paper sketches a scheme of the various levels of technological change, ranging from incremental optimizations of single artifacts, major change of artifacts, systems change and technological transitions. The purpose of this paper is to provide an overview on utilization of fly ash and its beneficial potential in application of civil engineering construction as well as others.

Keywords: Environmental Innovation, Fly ash, Smart city, Sustainable development, Technological change, Utilization of fly ash

I. INTRODUCTION

Fly ash is a byproduct from burning pulverized coal in electric power plants. As the fused material rises, it cools and solidifies into spherical glassy particles called FLY ASH. Fly ash is collected from the exhaust gases by electrostatic precipitators or bag filters.

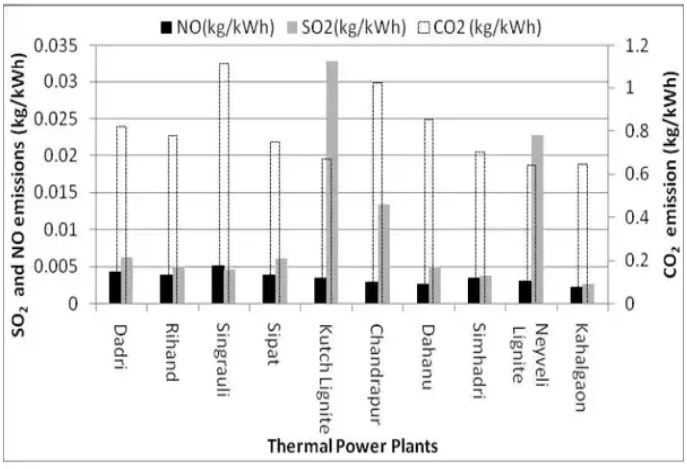
It is a residue of coal but it contains chemical components such as silicon dioxide, aluminium oxide, iron oxide in major quantity and reactive silica, magnesium oxide, sodium oxide, titanium , calcium oxide, lead oxide are also found in major quantity which makes fly ash suitable to be used in combination with cement in the production of cement. A typical chemical composition of Fly Ash

Calcium oxide	Silicon dioxide	Aluminium oxide	Iron oxide	Magnesium oxide	Sulphur Trioxide	Sodium carbonate	Potassium oxide	Titanium dioxide	Other alkaline & unidentified	Loss-on-ignition
CaO	SiO2	Al2O3	Fe2O3	MgO	SO3	Na2O	K2O	TiO2		LOI
0.37-27.68	27.88-59.40	5.23-33.99	1.21-29.63	0.42-8.79	0.04-4.71	0.20-6.90	0.64-6.68	0.24-1.73	4.0-6.0	0.21-28.37

Table 1: Content Percentage by Mass

Sub-bituminous coal, whose properties range between those of lignite and bituminous coal(it is used as primary fuel for steam electric power generation and is also an important source of light aromatic hydrocarbons for chemical synthesis industry). The value of coal depends upon the concentration of carbon in its composition. The varieties of coal found in India are ANTHRACITE, LIGNITE & PEAT.There are various coal grades with grading systems such as grade A,B,C,D, E,F,G. These grades of coal have different calorific values in descending order.

Imported coal with HIGH SULPHUR & VERY LESS ASH content is also imported from countries suchas Indonesia, South Africa, Australia. Coal of GCV in between 3000 to 3500is abduntantly available in Indian mines. In view to reduce the menace of high ash produced out of ash enriched Indian coal, Indian Thermal Plants use BLENDED COAL. Apporximately 0.7- 0.75 kg of coal is required to generate 1kwh electricity. Total 132 thermal power plants are present in India which generate 167,707.88MW of power.



Western Region	18%
Northern Region	40%
Eastern Region	7%
Southern Region	25%

Table 2:Power Generation in India by Thermal Power Stations Region wise

Southern Region	19%
Western Region	33%
Eastern Region	24%
Northern Region	24%

Table 3:Thermal Power Units Region Wise in India

II. CLASSIFICATON OF FLY ASH

CLASSC: It is produced by burning of lignite or sub bituminous coal. It posses both pozzolanic and cementitious properties. They do not require any additive substances to show the pozzolanic properties in them. CaO is an important constituent of flyassh but in some class C flyassh the quality of CaO is more than 10%.

CLASSF: It is normally produced by burning of anthracite or bituminous coal. They show the pozzolanic properties but needs additive for showing the property. They usually have less than 5% CaO content in them.

DISPOSAL OF FLY ASH

Fly ash is disposed by dry or wet methods. In dry disposal, electrostatic precipitation (ESP) is the most popular and widely used method of emission control which enables the collection of fly ash. After collecting the fly ash in ESP, it is then transported by trucks or conveyors at the sight and disposed by constructing dry embankment.

In wet method the fly ash is mixed with water into artificial lagoons and is called pond ash. Being cheaper than any other manner of fly ash removal, it is widely used method in India.

NTPC,DST, CPRI,CSMRS,BARC,CBRI are working with Ministry of Environment & Forests and Ministry of Power, Government of India to formulate a strategy to usefly ash in building components such as bricks, doors, door-frames, construction of roads, embankments, as a raw material in agricultural and wasteland development programmes. With development and application in technologies fly ash has shifted from "waste material " category to "resource material" category.

IMPACT ON THE ENVIRONMENT

The environment ministry expert panel opied that the interface between the water and fly ash at the bottom of fly ash filled void results in leaching of heavy metals into ground water system as evident by high levels of trace elements particularly heavy metals in ground water samples collected from sites located close to the ash filled voids.

Ash filled voids cannot support tree species because of poor root system development which in turn results in uprooting of roots even by low velocity winds.

Fly ash disposal remains a major problem with only about 50-60% of the total fly ash generated by the power sector being utilised. The remaining is dumped into poorly designed and maintained ash ponds. By 2021-22, the thermal power sector is estimated to produce 300 million tonnes of fly ash a year and with that utilization of all the fly ash being generated is going to become even tougher.

III. USES OF FLY ASH

Fly ash comes from one of the biggest sources of air pollution and carbon dioxide emissions on EARTH but it is considered to be a green material and especially it can save energy and power.

Fly ash was investigated as substrate for complex adsorption processes, involving tricomponent pollutant system: two heavy metals(copper and cadmium) and a dye (methyl orange).

The washed fly ash has a rough surface with a large amount of energy sites. By further alkali treatment the surface becomes smoother with a larger amount of small meso-pores. These changes result in a controlled adsorption affinity. The substrates proved to be highly efficient in dyes adsorption: methyl orange adsorbs fast and forms a homogenous substrate. The adsorption process of heavy metals in the experimental conditions is controlled by diffusion and low volume- high mobile copper cation has a faster adsorption rate comparing to cadmium.

In developed countries more than 80% fly ash is used for the manufacture of bricks, cellular concrete blocks, roads, embankments, landfill application, ceramics, agriculture, recovery of metals and dams construction. In India, about 10% ash is utilised in various segments like cement, asbestos-cement products, concrete manufacturing industries, land development, roads embankment,reclamation of coal mine, soil amender and as a source of micro and macro nutrients in agriculture.

In India"FLY ASH MISSION OF GOVERNMENT OF INDIA" is the nodal agency which undertook the responsibilty for safe disposal and gainful utilization of flyash on sustainable basis.

Fly ash has a potential in agriculture as the Indian Fly Ash is alkaline and as such improves soil quality. Fly ash consists of

all elements except organic carbon and nitrogen. In a research conducted by Maharashtra State Electricity Board considering all factors like soil quality, doses of chemical fertilizers, cyclic sowing of different food grains eertc, it is found that wih dose of 10MT fly ash per hectare and just 50% dose of chemical fertilizers (as annually required) there is increase of 20% yield in terms of grain and fodder.

Fly ash also maintains porous structure of soil and provides micronutrients and presence of macronutrients like Potassium, Boron, Calcium, Zinc etc improves the fertility of soil. CPRI Bangaluru has developed porous and hollow globules from fly ash. These globules if buried around crop, absorbs the water and retain it for longer period by resisting evaporation. This application helps to widen the gap between two watering cycles.

Fly ash improves the pH value of soil when used in low pH acidic soil. It can be used as insecticide and if used along with bio-waste, it significantly supplements the utility of chemical fertilizers.

It protects the soil from soil borne diseases and detoxifies contaminated soil. Waste lands, degraded lands, saline alkaline soils, eroded soils etc can be successfully reclaimed by fly ash.It is reported that the agricultural increase of grains is around 15%, green vegetables 35% and root vegetables 50% when ash is mixed with soil. Toxicity tests have proved that there is no toxic element due to fly ash but it has higher nutrients due to increased availability of iron and calcium.

Utilization of fly ash in mine fills has has potential to consume large quantity of fly ash. This single application of fly ash can utilise about 1/4th of total fly ash generation.It will not only save scarce river sand but also enhance coal recovery from the mines.

The absorbents are prepared by hydrothermal conversion of glass residue of fly ash with aqueous alkaline earth matter. These absorbents are suitable for purification of waste gases, drinking water purification, waste water treatment and even NH3 removal from waste water.

Organic Silicon prepared from fly ash had been tried to clean the sea water from oil pollution in UK. This technique is very cheap. Fly ash was utilized as a raw material for making various structural materials and alkaline resistant fibres useful infiltration of aggressive chemicals.

Fly ash is usually composed of inorganic minerals and unburned carbon, has been treated by physical and chemical methods to convert it to zeolite or inorganic polymer. Unburned carbon in fly ash was also used as precursor for production of activated carbon for water treatment.

It improves the adsorption fly ash can be activated by treatment with physical and chemical methods. In heat (physical) treatment, fly ash was calcined at 600c, for chemical activation, fly ash was treated in acids (Hcl and HNO3) or bases (NaOH and KOH) solutions at room temperatures.

Hydrothermal conversion of fly ash to zeolite can produce highly porous materials enhancing the surface area, pore volume and ion exchange capacity thus making higher adsorption capacity of the solid.

Fly ash utilization has great potential to lower green house gas emissions by decreased mining activities and reducing carbon dioxide production during manufacture of materials that can be substituted by fly assh.

The use of fly ash in the Nizamuddin bridge road embankment at Delhi, India for about 2kms and a height of 8 meters in a flood zone has demonstrated the use of fly ash in adverse conditions. This has not only saved the top soil and used fly ash which was otherwise a waste but also saved Rs 1.4 crores in a total project of Rs 10 crores.

IV. ADVANTAGES OF FLY ASH UTILIZATION

- Saving of space for disposal
- Saving of scare of natural resources
- Energy saving, firstly because it is a by product and secondly it can replace the material which otherwise would need to be produced by producing energy.
- Protection of environment.

SUGGESTIONS

- State governments should provide land to fly ash based building material plant.
- Fiscal concessions to fly ash utilization industries.
- Regular supply of adequate quantity of proper quality fly ash.
- All roads constructed in the vicinity of the thermal power plants should use fly ash.
- Use in landfill with top soil in the cities around power plants must be encouraged.
- All new power plants should have facility for dry collection of fly ash and its disposal to consuming industry and old must build these.

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