



## ASSESSMENT OF PHYSICO-CHEMICAL PROPERTIES OF FLY ASH AND SOIL USED FOR BIORECLAMATION OF DEGRADED AGRICULTURAL LAND FROM THE VICINITY OF CTPS CHANDRAPUR (M.S.).

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### Abstract:

In the present study the physico- chemical and some mineralogical properties of soil and coal fly ash from Thermal power plant were studied. The aim of the present work is to design the use of fly ash and its different doses for amendment and bioreclamation of degraded agricultural land. Fly ash contains some micro and macro nutrients viz. C, K, P, Fe, Ca, Mg, Cu, Zn and Mn which may change the physico- chemical and some mineralogical properties of degraded soil. Simultaneously, application of microbial isolates viz PGPR, PSB and Mycorrhizae in fly ash amended soil may enhance the fertility status of soil and crop yield.

**Keywords:** coal fly ash, physico-chemical properties, amendment, bioreclamation

### Introduction

Fly ash is produced in thermal power plants. Every year in India, more than 100 million tons of fly ash is produced. This large volume of fly ash occupies large land and became threat to environment. So there is a need for alternative and most adaptive technology for the safe management of fly ash on sustainable basis. To explore the possibilities of use of fly ash as modifier and upgrading of degraded soil for its use in agriculture to improve productivity. Coal fly ash contains micro and macro nutrients viz. Ca, Mg, K, P, S, Cu and Zn etc. and also improves its physico-chemical properties. Its amendment in soil improves fertility status of soil and texture of soil. It reduces bulk density and optimizes pH values. It also contains heavy metals which enrich the soil viz. Fe, Al, Mn, Mg, Si which converse plant nutrients.

The physico-chemical properties of fly ash are influenced by coal source and quality, combustion processes and particle size etc. Fly ash is ferro-aluminosilicate mineral. Fly ash is finer in texture (0-100 $\mu$ ). It mainly contains aluminum oxide, iron oxide, silicon oxide. It is amorphous as well as crystalline in form. Due to presence of essential nutrients and favorable physico-chemical properties fly ash may benefit plant growth and can improve soil quality.

#### Materials and Methods

In the present study physico-chemical properties of fly ash from CTPS was studied. Simultaneously, study of physico-chemical properties of soil was also organized. Soil sample was collected from the degraded agricultural land, from the vicinity of Thermal power plant i.e. from village named Choti Padoli

which is 8km away from CTPS. Soil sample is taken from the depth 15-20cm by Grid method. Fly ash was collected from waste disposal site of CTPS, Chandrapur by Grids method. The fly ash and soil samples were air dried and then sieved through 2mm mesh size. The samples were analysed for following physical and chemical properties:

Physical properties were studied as-

Bulk density is determined by taking oven dried weight of a known volume of fly ash sample and mass/unit volume was calculated.

Moisture content is determined by gravimetric method and expressed as %. Water holding capacity and particle size distribution was determined. Particle size was determined by using shaker and different sieves. Porosity is the ratio of the volume of voids to the total volume of the given fly ash mass.

Chemical properties were studied as-

pH was determined by Fly ash: Water and Soil: Water suspension of 1:2 ratio (Jackson, 1967) by using digital pH meter-111(EI). EC was determined by using conductivity meter (calibrated with 0.01M KCl) (Jackson, 1967). Organic C content was determined by rapid dichromate oxidation method (Walkey and Black, 1934). Total N<sub>2</sub> content was determined by Kjeldahl method. Available P was determined by (Olesen's, 1954) using UV-spectrophotometer-117. Available Potassium was determined by flame photometer (Systronic-130). Some elemental properties (viz. Heavy metals which are used as micro and macro nutrients for plant growth) were determined by acid digestion method by using Atomic spectrophotometer.

Some major elements determined were viz. N,P,K,Ca,Mg,Na,Fe. In fly ash important trace elements are present, which are beneficial for growth of plants. These trace elements were determined after acid digestion of solid fly ash and solution was analyzed directly by using ICP-AES (Inductively coupled plasma-Atomic emission spectrometer-Intrepid XLD) method. Viz. Cu,Zn, Mn,Mo,Pb,Ni,Cd,Cr,Co were determined in fly ash and soil samples.

## Result and Discussion

Fly ash has generally light texture due to presence of large porous and carbonaceous particles. Fly ash addition can change the physical properties of soil such as texture, bulk density; water holding and particle size distribution<sup>[1]</sup>. Fly ash contains some trace elements and also contains some natural radionuclides. Its accumulation is below permissible level but some time may toxic to plants<sup>[2]</sup>. Some researchers stated that when fly ash was added to sand and sandy loam soil, it increased its available water capabilities<sup>[3]</sup>. Present study was conducted to assess the physical, chemical and elemental properties of fly ash and soil sample. The values we get were discussed in the (Table No. 1, 2, 3) and were matched with available literature.

Acidic or basic nature of soil and fly ash is indicated by PH. PH of the soil and fly ash is affected by availability of macro and micro nutrients. In present study PH of the soil was found to be **7.6** and pH of the fly ash was found to somehow slightly alkaline i.e. **8.7**. EC is the soluble salt content of fly ash. EC indicates the availability of different ions in the fly ash sample. In present study EC was measured as 0.42mmhos/cm for soil and fly ash was 1.46 mmhos /cm. Researchers studied fly ash from TISCO and reported EC was 0.24mmhos/cm and from NCPP reported EC as 0.65mmhos/cm. Bulk density of soil was found to **1.24%** and of fly ash was **1.76%**. Study from TISCO power plant was suggested that bulk density of fly ash sample was low as 0.944gm/cc and NCPP, Dadri, Ghaziabad was found to 1.01mg/m<sup>3</sup>. It was suggested that low bulk density is more suitable for amendment of agriculture land<sup>[4]</sup>.

Water content i.e. Moisture content of soil sample was found to be 2.04% and of fly

ash sample was found to be 2.56%. From the available literature values from NCPP Dadri, it was about 56.9% and TISCO was about 0.73%. Porosity influences the water holding capacity. Many researchers suggested that higher porosity indicates the lesser density. In present study, porosity of the soil was found to 56.13% and of fly ash was 49.70%. TISCO power plant at Jamadoba, Dhanbad was found to 60.25%. Some researchers studied fly ash from RRL Bhopal and reported that application of fly ash increase the porosity of black cotton soil and decrease the porosity of sandy soils. In present study, water holding capacity of soil sample was found to 76.24% and of fly ash was found to 37.25%. Mishra et al, 2007 reported that WHC increased with increase in porosity. During present study, the values obtained for particle size distribution was given in **table no. 1**. Similar result was also reported by researchers that was sand-30.5%, silt-57.6%, clay-11.9%. In present study organic C content of soil was found to 0.56% and fly ash 0.36%. Total N<sub>2</sub> content of the soil sample was 0.04% but in fly ash sample N<sub>2</sub> was not found. Some researchers also reported the absence or negligible presence of nitrogen<sup>[4][5]</sup>.

Major elements present in fly ash plays vital role in growth of crops in degraded agricultural soil. In present study the important elements were detected viz. N,P,K,Ca,Mg,Na,Fe (**Table No. 2**) So amendment of fly ash in degraded soil helps to enhance the level of micro and macro nutrients which also modifies the physical and chemical properties of soil<sup>[6]</sup>. In the present study, some trace elements were detected viz. Cu, Zn, Mn, Mo, Pb, Ni, Cd, Cr, Co in PPM (**Table No. 3**). The concentration of these metals was significantly low. From the available literature the values (%) were reported as Cd= 0.7-130, Co=7-520, Cr=10-1000, Pb=3.1-5000, Mg= 0.04-7.6, Ni= 6.3-4300, Na=0.01-2.03, K=0.15-3.5<sup>[6]</sup>.

Of all the properties studied in the present work were aimed to designed the use of fly ash and to designed different doses of fly ash for amendment purpose in degraded agricultural soil with microbial isolates to improve fertility status of soil and crop yield. The application of fly ash and its doses will be designed on the basis of soil type and crop to be grown.

Table No. 1: Physical properties of fly ash and soil-

S. No.	Physical properties	Fly ash sample	Soil sample
1	Water holding capacity	37.25%	76.24%
2	Bulk density	1.76%	1.24%
3	Moisture content	2.25%	2.04%
4	Particle size distribution		
	a) Sand	43.94%	44.46%
	b) Silt	19.0%	32.0%
	c) Clay	19.5%	21.5%
5	Particle density	1.12%	1.02%
6	Porosity	49.70%	56.13%

Table No. 2 : Chemical properties of fly ash and soil sample-

S. No.	Chemical properties	Fly ash sample	Soil sample
1	PH	8.78	7.6
2	EC	1.46mmhos/cm	0.42mmhos/cm
3	Organic C content	----	0.56%
4	Organic matter	----	0.97%
5	Total nitrogen content	----	0.40%
6	Available P <sup>-</sup>	0.06%	0.72%
7	Potassium	0.18%	2.0%

Table No. 3 : Elemental properties of fly ash and soil sample-

S. No.	Elemental properties	Fly ash sample (PPM)	Soil sample (PPM)
1	Copper(Cu)	5.2	1.8
2	Ferrous(Fe)	2.51	4.82
3	Manganese(Mn)	186	0.48
4	Zinc (Zn)	150	0.22
5	Calcium(Ca)	5125	5750
6	Magnesium(Mg)	1500	1500
7	Phosphorus(P)	42.5	37.5
8	Potassium(K)	0.17	0.42
9	Sodium(Na)	0.73	0.44
10	Nickel(Ni)	42.5	32.5
11	Cadmium(Cd)	1.6	1.3
12	Chromium(Cr)	86.3	97.5
13	Cobalt(Co)	16.6	28.8
14	Lead(Pb)	<1	<1

## Conclusion

From the above results and discussion, it was concluded briefly that-

- Fly ash varies widely in its physical and chemical composition.
- Use in agriculture as an amendment material depends upon soil type.
- Concentration of elements like P, K, Na, Zn, Ca, Mg, Fe, in fly ash may increase the nutrient status soil.
- Trace elements detected in the present study were found to be significantly low and will be helpful in enhancement of crop.

- Application of microbial isolates viz. PGPR, PSB and Mycorrhizae will prove to be helpful

to increase and maintain the NPK level in the fly ash amended soil.

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