

A STUDY OF PHYSICO-CHEMICAL CHARACTERISTICS OF COAL MINE OVERBURDEN AND FLY ASH FOR RECLAMATION OF MINE SITE

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Abstract - In India coal is the major source of power generation. The coal obtained in India is very high in ash content and has low calorific value. Out of two methods of coal mining techniques opencast coal mining contributes to 81% of total coal generated in our country. Opencast mines having capacity of 10 million tons per annum are being in operation in India. This opencast mining activity in huge forest areas are responsible for loss of biodiversity and loss of nutrient quality of soil. Therefore, huge amount of waste is generated on the surface of the Earth while these mines are in operation phase. Generation of coal is higher that's why there is generation of more amount of fly ash. It means that India consumes more amount of coal to generate same amount of power than other countries. Therefore, one of the major issues related to coal based thermal power plants is disposal of fly ash. In earlier times it was considered as total waste and due to its environmental hazard its use nationwide was limited to some extent. The unscientific disposal of this fly ash into rivers, open dumps the fine particles of this fly ash disperse in air and causes air pollution, degrades land and pollutes groundwater table as well. In this study, the site selected for overburden dump is W.C.L. Umred (Western Coalfields Limited, Umred) and overburden samples are collected for physico-chemical chemical analysis of samples along with the testing on fly ash to check whether cultivation on this soil can be done or not. Physico-chemical properties such as bulk density, pH, grain size distribution, electrical conductivity, available nitrogen (N), phosphorus (P), and potassium (K) and organic matter is tested. The positive results are generated so far.

IndexTerms - Coal mine overburden, Fly ash, Physico-chemical properties, land reclamation.

I. INTRODUCTION

Land is one of the limited and most important source on which we humans depend. India holds third place after China and USA in producing coal. There are two mining techniques which are performed in India i.e. underground mining technique and open cast mining. Out of these two about 80% of coal produced in our country is from opencast mines. In an opencast mine for the extraction of minerals out from the site there is generation of different types of wastes which as compared to other methods like underground mining practices is huge in amount. The major types of wastes generated are Waste rock, Tailings, Coal refuse and overburden spoil. After successful extraction of minerals from mine sites these overburden dumps are backfilled to its original site. While filling back there is a mixture of sand, soil, shale and many more chemicals in it and therefore it becomes toxic in nature and cannot sustain natural vegetation on that soil. Coal contains earth's deadliest toxics like Arsenic, Lead, Mercury, Cadmium, and Chromium. These are the chemicals which are hazardous for any natural vegetation to occur on abandoned mine lands. Therefore, there is a need to study the chemical and physical properties of the overburden soil so as to see whether the soil will allow plantation or not. After coal mine overburden immediate concern comes in mind is of fly ash disposal as its disposal is major issue for coal based thermal power plants. Usage of fly ash in our country for agricultural impose is limited to 1.8%. To increase this percentage in agriculture, sector this methodology will be useful. Along with this there will be reduction in environmental pollution as there will not be illegal and unscientific dumping of fly ash. Most of the coal based thermal power plants are situated nearby coal mines as transportation of the coal for generation of electricity shall be closer therefore this will be an advantage for us to reduce the transportation cost of fly ash as this fly ash will get disposed of in an eco-friendly manner. This data can be used to for reclamation of opencast coal mine in Nagpur, India.

II. MATERIAL AND METHODOLOGY

A. Overburden Sampling (OBD soil)

Coal is sedimentary formation which consists of weathered sandstone, shale, sand and other impure materials store in piles at the opencast mining sites during the mineral extraction process. the samples from the site are collected manually by using split tube coring tool (depth 15 cm). These samples are properly stored and brought to the laboratory for checking physicochemical properties of the soil samples. The sample consisted of different types which are weathered sandstone, top most bed soil and detrital mantle. All these materials are mixed with each other in equal quantities and then passed through 2mm mesh sieves. This material is then added with 40% fly ash.

B. Overburden and Fly Ash Analysis

The different physicochemical factors were determined by different methods. The bulk density of soil was determined with the help of the gravimetric method. As well the grain size distribution of the soil samples was determined by same method of gravimetric method by taking the wt. of fraction passing the samples thorough given sieves 75 microns, 0.2 micron, 0.4 micron, 1.0 mm, 2.0 mm and lastly 4.75 mm respectively and it is divided by its total wt. of the samples. pH was determines using pH meter. Electric conductivity was determines using conductivity meter. The organic matter testing in overburden soil and fly ash was determined by using Walkley and Blake method (Sayar Yaseen et.al 2012). Alkaline potassium permanganate method was used to determine the organic carbon of the soil (Keeney and Bremer, 1966). And for determination of available Phosphorus Olsen's method is used (Bray and Kurtz, 1966). The physico-chemical analysis, the values of natural soil and overburden soil collected from coal mine site is given.

C. Statistical Analysis

The data collected is subjected to the Pearson's matrix to study the positive or negative correlation between physico-chemical properties at significant levels. The difference between natural soil properties and mixture of coal mine overburden soil and fly ash were analyzed. On the basis of all the data obtained whether plantation of bamboo saplings can be done or not is analyzed. The table shows what are different physical and chemical properties of good natural soil and coal mine overburden soil samples collected and added with the fly ash. The different physico-chemical parameters are given in tabular form below in table 1.

Table 1: Physico-Chemical Properties of Natural Soil and Coal Mine Overburden Soil.

Parameter	Natural Soil	Overburden Soil
pH	8	7.75
Electrical conductivity	0.25	1.08
Water Holding Capacity	0.26	0.3
Total Organic Carbon	1.4	1.8
Total Organic Matter	4.6	3.1
Available Nitrogen	14	0.7
Available Phosphorus	15	19
Available Potassium	17	21
Copper as Cu	0.03	2.17
Zinc as Zn	0.92	1.43
Iron as Fe	1.01	1.92
Manganese as Mn	1.24	3.85

III. SOIL SAMPLES COLLECTED



1. Top most bed soil

2. Detrital mantle

3. Weathered sandstone

IV. RESULTS AND DISCUSSIONS

A. Soil pH

Soil pH is the measure which is the terms of acidity and alkalinity of any soil. The pH shall range from 0 to 14. The material having pH 7 is called neutral. And if the pH is below 7 it is called acidic and if it is above 7 it is considered alkaline. For most of the plants optimum range of pH required for healthy growth is between 5.5 to 7.0. The soil samples collected from western coalfield limited, Umred is showing pH level at 25 degree of soil sample as 7.75. This value of pH level indicated that it is above 7 and therefore soil is alkaline in nature. Here there is a need to bring down the pH levels.

B. Electrical Conductivity

Electrical conductivity refers to the particle size and texture of the soil. It is a measure of total amount of salts dissolved in a solution which improves plants ability to absorb water. In horticulture measuring the salinity of soils helps in obtaining effects of soluble salt on growth of plants. The electrical conductivity of soil samples is determined to be 1.08. which is quite high as compared to the good healthy natural soil.

C. Water Holding Capacity

Water holding capacity of a soil is total amount of water, any soil can hold or a capacity of soil to hold water at field capacity. Sandy soils tend to hold low amount of water due to its loose texture. The water holding capacity obtained for good healthy soil is 0.28 ml/gm which is perfect and overburden soil samples has got water holding capacity as 0.30 ml/gm which in range. This is one of the positive point which can be considered for cultivation of bamboo.

D. Total Organic Carbon and Organic Matter

The total organic carbon (TOC) is total amount of carbon which is found in organic compound and is mostly used as nonspecific indicator. The natural soil is having an organic carbon of 1.4%. The overburden soil samples are obtained with the total organic carbon of 1.8%. The value of organic carbon obtained for overburden soil is in range. Result for organic carbon is positive. The total organic matter refers to large amount of carbon based compounds found in soil. It is matter consisting of organic compounds which are obtained from remains of plants and animals and their waste materials. For good growth of plants, it is necessary to have good amount of organic matter in soil. The natural soil samples have organic matter of 4.6%. The overburden soil sample is having an organic matter of 3.10%.

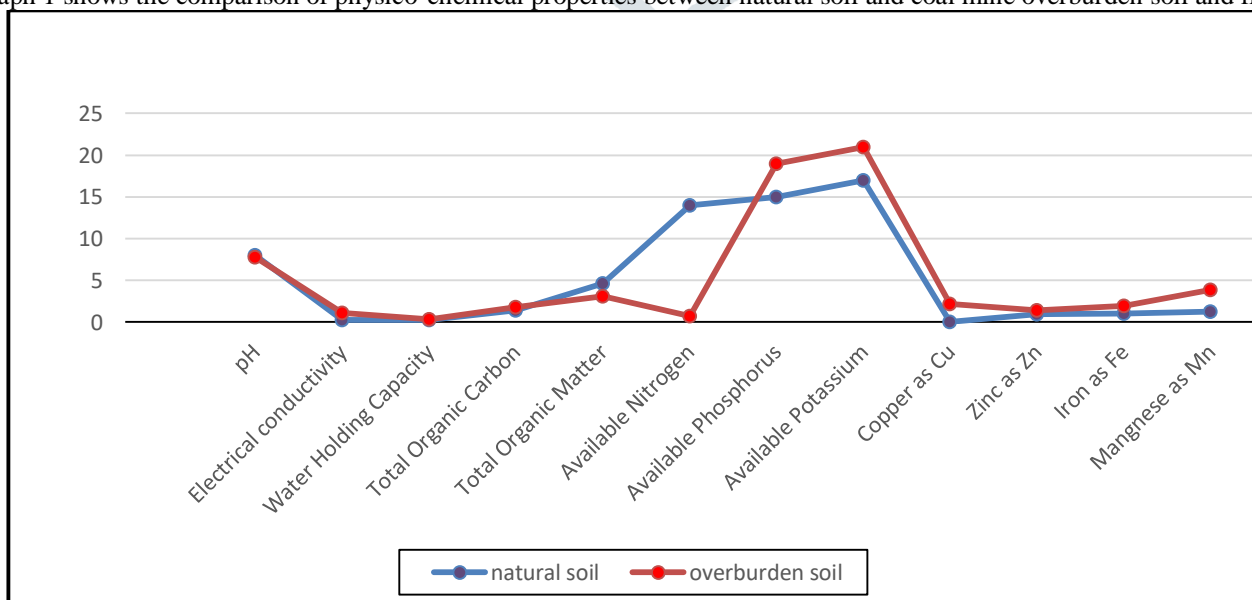
E. Available N,P,K

Nitrogen is a factor which is used by plants for their leaf growth and gain green color. Phosphorus is mainly useful in forming new roots, seeds, flowers or fruits. Potassium is used by plants to make roots and stem strong and for faster growth. It is scientifically said that the good N-P-K ratio is 16-16-16 in percentage. The natural soil has got N-P-K ratio of 14-15-17. The overburden soil sample is having N-P-K ratio of 0.7-19-21 which is quite high.

F. Total Copper (Cu), Zinc (Zn), Iron (Fe), Manganese (Mn)

As the soil samples are collected from coal mine it is necessary to check the contains of Copper, Zinc, Iron and Manganese in soil. The overburden soil shows copper as 2.17 mg/kg, Zinc as 1.43 mg/kg, Iron as 1.92 mg/kg and Manganese as 3.85 mg/kg respectively.

Graph 1 shows the comparison of physico-chemical properties between natural soil and coal mine overburden soil and fly ash.



Graph 1: Graph showing statistical analysis of natural soil and coal mine overburden soil values

V. CONCLUSION

From the above study, it is concluded that the overburden soil collected from the coal mine site from Nagpur is having a Soil pH slightly alkaline. The soil is slightly high in organic carbon and low in organic matter due to lower microbial activities and remains of plants and animals. Electrical conductivity of overburden samples is slightly high due to salinity of soil. This will be controlled by bamboo cultivation as bamboo are good in reducing salinity of soil. Water holding capacity of overburden soil samples is slightly higher than natural soil this is an advantage. The high water holding capacity may be due to higher accumulation of salts in soil. The NPK values of overburden soil is showing very less amount of nitrogen which will require addition of extra fertilizer and manure but phosphorus and potassium shows high amounts in soil. Therefore, the overburden soil samples collected from coal mine site Nagpur are suitable for bamboo cultivation.

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