

SOIL QUALITY STANDARDS (SQS) FOR BIO-RECLAMATION OF COAL OVERBURDEN DUMPS: ISO-14000 REQUIREMENTS

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ABSTRACT

In India 18,289 hectares of land is under various type of land degradation due to coal mining in which 1100 ha is by overburden dump. With the increase demand of coal and its opencast mining degrade 1400 ha of fertile land every year. This deterioration in the fertility is due to loss of soil through water erosion, contamination through leaching of heavy metals and siltation with runoff. The essential nutrients with micro-flora and fauna from the soil disappear from the mining affected areas. In environmental management plan and under the ISO certification for environment ISO: 14000 must include soil as important input and output character in the reclamation process and their must be defined standards in the successful mine closure. In this paper a brief discussion is made to define the soil quality standard for the reclamation of affected mining land to meet the ISO: 14000 norms in the mine closure.

INTRODUCTION

Land degradation is the most serious environmental impact of opencast mining. The gravity of the problem is more complicated in case of surface mining. Surface mining leads to a variety of environmental problems, the most serious amongst them being land degradation. Virtually all surface mining methods produce dramatic changes in the landscape due to large scale excavation. It results in the formation of large overburden dumps and huge voids in the

opencast mining sites (Namdeo, 1989). The country has today 18,289 ha of land degradation due to coal mining (Agarwal and Shankar, 2004). In the process of opencast mining several changes occur in the physical, chemical and microbiological properties of soils (Kundu and Ghose, 1998). Renewal of degraded land has become a great problem to Indian mining industry.

Efforts to grow vegetation on damaged land as a part of biological reclamation are not being successful. Degradation of soil quality depends on climatic conditions and various other factors. If the biological reclamation is not done in proper time, leaching will lose the nutrients released by microbiological activity and erosion by rainwater and the nutrient cycle will be broken down and soil will be ultimately biologically unproductive.

The objective of this paper is to assess the deterioration of soil quality due to mining and to define the soil quality standards (SQS) in the rehabilitation and re-vegetation in the mine closure. This must be added in the ISO: 14000 norms and could be strictly followed.

Soil quality deterioration

In the process of opencast mining, the area is completely stripped of vegetation to remove the soil and overburden covering the coal seam. As a result the soil and overburden are dumped in a haphazard manner without any considered for their respective sequence altered the physico-chemical and biological characteristics significantly which does not support plant growth and devoid of plant essential nutrients and toxic with heavy metals due to leaching. The pH and EC increases due to leaching of heavy metals. Moisture content, field capacity and water holding capacity were found to be lower due to less organic carbon and this may be due to lower humification and lack of micro-biota in the overburden dump. High bulk density due to use of heavy machineries. The suitable plant nutrient decreases substantially due to opencast coal mining and unsystematic pilling of overburden dumps. It indicates that the productivity of the mined soil decreased and ultimately will become sterile after certain period of time.

ISO: 14000 norms

The International Organization for standardization is a non-governmental, International organization based in Geneva. The entire standards that ISO develops are voluntary, consensus and desirable standards. This establishes a new approach to environmental protection. It guides and challenges each organization to take of its environmental aspects, establishes its own objectives and targets, commits itself to effective and reliable process and continual improvement, that brings all employees and managers into system of shared and enlightened awareness with personal responsibility for the environmental performance of the organization.

This covers a wide range of subjects include environmental management, environmental auditing, life cycle assessment, environmental performance and much more. Under this most important part is the ISO: 14001 certificate, which is enlisted as Environmental management system (EMS) - specifications and guidance for use. The environmental management system is that part of the overall management system which includes organizational structure,

planning, activities, responsibilities, practices procedures, processes and resources for developing, implementing, achieving, reviewing and maintaining the environmental policy. The five major elements of an EMS are policy, planning, implementation and operation, checking and corrective action and management review. Mining projects especially have a very crucial role to play in implementing ISO: 14001 standards in the organization. Getting this certification to any organization shows clear indication of its commitment to environment protection and improvement in environment performance in future. By this industry gets benefits by receiving self imposed standards, air pollution control, water management, rehabilitation of mined out areas, disposal of spent lubricants, proper waste management and community development.

Soil Quality Standards (SQS)

Setting the soil quality standards for reclaimed and re-vegetated coal overburden dump is not easy. The relationship between soil quality standards and plant productivity proves too complex. It varies with climate, soil type, vegetation type, moisture regime, soil texture, soil structure, soil chemistry, soil ecology and reclamation methods. Though after too much complexity, in general a soil quality standard has been defined for the overburden dump which very much reaches near to the properties of the original land taken on the lease.

Under the physical properties of the overburden dump the bulk density may be in the range of 1.33 - 1.55 g/cm³, moisture percentage may varies from 10-15% and water holding capacity varies from 15-25% were found to be supportive. Chemical properties contains pH which varies from 6.5 to 7.5, EC varies from 0.155 to 0.255mmhos/cm, organic carbon 0.50 to 0.75 %, CEC 15 to 20meq/100gm are the supportive requirement for plant growth.

Essential nutrients like available nitrogen, phosphorus and potassium present at the minimum level may vary from 75 to 100; 2 to 3.5 and 75 to 100ppm respectively. The heavy metals should not crossed the upper limit for the standard soil are Ag 2ppm; As 20-50ppm; Cd 3-8ppm; Co 25-50ppm; Cr 75-100ppm; Cu 60-125ppm; Hg 0.3-5ppm; Mn 1500-3000ppm; Mo 2-10ppm; Ni 100ppm; Pb 100ppm; Sb 5-10ppm; Se 5-10ppm; Ti 1.0ppm; V 50-100ppm and Zn 70-400ppm respectively for supporting the vegetative succession on the overburden dumps.

Whereas, the microbiological characteristics concerned the bacteria (CFU/g) 5X10³; fungi (CFU/g) 60; actinomycetes (CFU/g) 10²; rhizobium (CFU/g) 9; Azotoacter (CFU/g) 10 and VAM/10g 5 respectively are minimal requirement for the re-vegetation on overburden dumps.

These values against each soil physico-chemical and biological characteristics shown are reflecting the minimum and may be defined as soil quality standard. These soil quality standards must be present at least at minimum to support the re-vegetation and its natural succession on the reclaimed or re-vegetated overburden dumps. These values for the reclaimed and re-vegetated overburden dumps must be retained and sustained after the mine closure. The reclamation is the compulsory process in the mine closure and

incorporating the soil quality standard (SQS) will add more values and weight age to the ISO: 14000 norms.

Scope

Generation of data bank followed by modeling and simulation for the physico-chemical and biological characteristics of the soil/overburden dump top material after the reclamation or re-vegetation will not only help in the defining the soil quality standards (SQS) but also help in the understanding the best approaches for the recovery of damaged land due to opencast coal mining for some useful purposes. These soil quality standards will help the mining industry to recover the damaged land with an appropriate measure in stipulated time for the successful closure. This will be a site specific approach but help to give an idea for the process and methodology for the best reclamation practices of that area.

Soils and reclamation

Typically, on reclamation sites, the soil has a naturally low fertility level and poor water-holding capacity. Much of this is due to the extremely low levels of organic matter present in newly reclaimed mine soils and from compaction caused by earth-moving equipment. Soil microbial populations and beneficial mycorrhizal fungi are low or not present. Organic matter in the form of dead leaves, stems and roots in a productive soil creates protective mulch that reduces soil erosion and water evaporation. Organic matter acts as a sponge that absorbs and holds nutrients and water in the soil for plant use. Decomposed organic matter, called humus, binds soil nutrients to its surface. Humus slowly releases soil nutrients that plants can use. Without humus, soil nutrients added by fertilizing are quickly leached out of the rooting zone before the plants have the opportunity to use them. Soil organic matter also feeds beneficial soil organisms that break down humus and release soil nutrients, especially nitrogen and phosphorus. Once organic matter and soil organisms are present in the mine soil, nutrients can be cycled from dead plants to humus, then from humus to living plants to begin the process again. This process is called nutrient cycling. The more organic matter that is produced, the more nutrients are stored by the humus and clay particles until an equilibrium is reached. The higher the level of nutrients that are present in the soil, the more productive the soil will be. Productivity on reclaimed mine soils is directly related to the amount of organic matter present and the amount of nutrients being cycled in the soil. Warm-season, native grasses produce huge amounts of organic matter throughout the rooting zone, promoting these beneficial soil processes in mine soils.

The movement of heavy equipment compacts reclamation soils, which inhibits root growth and reduces the soil's water-holding capacity and infiltration rate. Over time, roots and fungi penetrate the soil and increase the number and size of soil voids, or pore space. Native grasses are particularly successful at this. This action reduces soil compaction and increases the water holding capacity of the soil. Soil organisms like earthworms burrow through the soil, further decreasing soil compaction and converting fresh organic

matter into nutrients available to plants. Alternating cycles of freezing and thawing, wetting and drying, and physically breaking up the compacted soil over a period of many years. Shrinking and swelling of clay particles also contribute. These processes require time and protection from livestock and vehicles to prevent additional compaction and vegetation loss that lead to erosion. Native soils have undergone these processes for thousands of years, unlike mine soils that have been created in months or years.

Reclamation is a soil-building process. In natural systems, drastically disturbed lands undergo a succession of living organisms that may take decades or even centuries for successful colonization to occur. The foundation of natural succession is the development of an ecological system with the plant community being the most visible portion. However, before this plant community can be expressed, a soil biological system must be developed that creates the correct environmental conditions to allow those plants to complete their life cycles. Plants are most susceptible to harsh environmental conditions and disturbance just after germination.

Many plants produce abundant seeds because most seedlings will die. The environmental changes of the micro-site that result from a developing soil biological system enable many young seedlings to survive this early establishment. Native grasses accelerate soil-forming processes and promote natural succession on mine lands. They can grow and persist on harsh reclamation sites providing excellent wildlife habitat and forage. Their success and long-term maintenance depends upon correct establishment techniques and proper management.

CONCLUSION

The soil quality standards (SQS) for the reclaimed and re-vegetated overburden dump must be defined in order to give a guidelines to mining industry at the time of closure of opencast coal mines. This will not only help the industry to comply in better ways to recover the land by optimize the recovery which is being requested in this paper to be included in ISO: 14000 norms strictly to be followed-up in the reclamation and rehabilitation process.

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