

# Optimization of phytostabilization/phytoremediation of fly ash dumps through natural materials

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Through the combustion of fossil coal in power plants between 0.15 to 0.6tonne of solid waste products /ton of coal burned can result. The solid waste consists mainly of fly ash, bottom ash, boiler slag, etc. (name total coal combustion products - CCPs). The fly ash fraction of them gets to represent over 85%. Fly ash is the mineral residue of combustion composed of small particles that are electrostatically separated from the combustion gases and sent to fly ash dumps.. Physical, chemical, mineralogical characteristics of the fly ash depend on the nature of the coal, type of combustion, gas purification and on methods of storing the fly ash. In the composition of the fly ash on the studied dump, a rate of more than 99% of the particles have diameters  $\leq 0.8$  microns. CCPs is deposited on dumps located near power plants respectively the cities that are served by these plants. The presence of these dumps into the environment presents a major risk through the spreading of fine particles by deflation or precipitation. Thus the fine particles of fly ash pollute soil, water and the air from the surroundings. Pollution dramatically affects flora and fauna by destroying ecosystems. And of course it affects human health also. In this study we describe strategies to stabilize the upper layers of fly ash dumps in order to limit the scattering of the fine particles.

The strategies used for this purpose are based on versions of phytostabilization/phytoremediation. Fly ash is biologically inert. The fly ash is made of a mineral silica-alumina matrix showing inclusions of toxic metals oxides Required quantities of nutrients plant based on C, N are insufficient to install and maintain vegetation on freshly closed deposits, *i.e.* N=0.248% and carbon is found in forms that are inaccessible to the plants from the beginning.. In the old closed sectors of fly ash dump of the warehouse weeds installed themselves. Plants of the species *Tripartitus bidens*, *Spica venti*, *Pragmites communis* initially form clumps, then they take over bigger and bigger areas. Weeds easily invade neighboring farm fields and represents a major threat to agriculture.

To ensure the fast and efficient formation of a protective layer of plants against the spreading of the fly ash into the environment and provide benefits in the agrozootechnical sector, the controlled grassing of the warehouse is necessary. The initiation and

maintenance of the vegetation is needed for the fertilization of the inert layers of fly ash. Fertilizing materials were used: sewage sludge from municipal wastewater treatment, slaughterhouse sludge, manure and different kinds of composted materials. The amount of fertilizer used was 50-150 t·ha<sup>-1</sup>. In order to ensure water retention in the destroyed soil, a material with a porous structure was used, indigenous volcanic tuff (Marsid quarry) in amounts of 1-5 t·ha<sup>-1</sup>. Stored water will be released from the volcanic tuff's pores in periods of prolonged drought, according to the plants' needs. Besides the role of water tank, the tuff's pores are designed to ensure the initiation and maintenance of cultures of beneficial microorganisms that will metabolize nutrients in symbiosis with the plants' roots. This ensures continuous food for the crops.

The presented studies, conducted over a decade showed that plant species of pasture grasses and / or legumes: *Festuca arundinacea*, *Lolium perenne*, *Onobrychis vicifolia*, *Lotus corniculatus*, *Trifolium pratense* or cereals: *Avena sativa*, *Hordeum vulgare*, etc. have the ability to form stable and healthy vegetable layers on the upper levels of fly ash dumps. The table 1 shows the degrees of coverage of plants used for phytostabilization/phytoremediation of the fly ash dumps.

**Table 1** The degrees of coverage of the surface sowed with plants

Parameter	Plants specie						
	<i>Lolium spp.</i>	<i>Festuca spp.</i>	<i>Onobrychis spp.</i>	<i>Lotus spp.</i>	<i>Trifolium spp.</i>	<i>Avena spp.</i>	<i>Hordeum spp.</i>
Vegetation coverage [%]	75.5-90.0	50.0-75.0	45.2-58.1	20.0-45.0	43.8-67.3	45.3-64.2	43.3-64.3

The plants have developed roots specific to the species, pivoting or netlike which led to fixing the fine particles of the top layer of the fly ash dump. This plant cover led to the accumulation of humus.

The resulting biomass must be analyzed in time to monitor the degrees of accumulation of toxic heavy metals. Depending on the content of toxic heavy metals accumulated in the aerial part of the plant, the biomass can be directed towards agrozootechnical sectors or hazardous waste landfills.

Among the cultivated species, the one that has adapted the best and prompted a healthy cover was the *Lolium perenne*. In addition, this species has prevented the translocation of metals from the soil to the biomass. The quantity of toxic metals Pb and Cd controlled by national rules were below the permissible limits.

Variants of phytostabilization /phytoremediation also have the advantage of the ecological restoration of the environment and of the recovery of the destroyed landscape.