An innovative technology for metal polluted soils – combined chemical and phytostabilisation

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Abstract

The innovative technology of combined chemical and phytostabilisation was applied to the site of Gyöngyösoroszi (Hungary), which is heavily polluted with toxic metals, such as Zn, Pb, Cd, Cu and As, due to former mining in the area. To select the most suitable chemical stabilizer and plant for the soil and mining waste materials in Gyöngyösoroszi several experiments with promising immobilising agents were performed in microcosms and field experiments.

The metal immobilising effect of alkaline and non-alkaline fly ashes, lime and other additives, such as raw-phosphate, alginite, lignite, Fe-Mn-hydroxide precipitate, red mud and the mixture of some additives were tested in microcosms including toxic metal contaminated mine wastes and soils. In the field experiments chemical stabilisers, such as fly ashes and of their mixture with lime were tested on intensively weathered acidic waste-rock and contaminated agricultural soil. The chemical stabilisation was combined with phytostabilisation, therefore four plant species were sown: grass mixture, sweet corn and two *Sorghum* species.

The stabilisation of metals was monitored by an integrated methodology, where the results of chemical analysis and toxicity testing are evaluated together. The chemical analyses of the soil included the measurement of water and acid soluble, as well as the total metal content measured after aqua regia extraction by atomic emission spectrometry (ICP/AES). The treated soil was also tested by bacterial and plant toxicity tests and the bioavailability of metals was studied by a rapid plant accumulation test. In addition to soil sampling, the field plots allowed leachate sampling, detailed plant assessment (growth rate and density) and plant sampling for chemical analyses.

According to the microcosm experiments the alkaline fly ashes and the combination of non-alkaline fly ash and lime showed the best results in the long term immobilisation of toxic metals (Zn, Cd, Pb and Cu) in the soil. The addition of 5 w/w% fly ash to the soil decreased the water soluble metal content by 99% and the acetate soluble (pH=4,5) fraction by 50%. In addition to extractability of metals the bioavailability and as a consequence the toxicity of the metals also decreased. The non-alkaline fly ashes alone also decreased metal mobility and toxicity, but a bit slower. The field experiments confirmed the results of the microcosm experiments according to the chemical stabilisation. The efficiency of the vegetation in controlling leaching and erosion was also proven. The amount of toxic metals in the collected leachate decreased with 85–99% and the metal uptake of the plants grown on the treated soils was 70–90% lower, the As emission of the eroded soil decreased by 65%.

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