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Recovering metals from sewage sludge, waste incineration residues and similar substances with hyperaccumulative plants

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Sewage sludges as well as ashes from waste incineration plants are known accumulation sinks of many elements that are either important nutrients for biological organisms (phosphorus, potassium, magnesium, etc.) or valuable metals when considered on their own in pure form (nickel, chrome, zinc, etc.); they are also serious pollutants when they occur in wild mixtures at localized anthropogenic end- of-stream points.
Austria and many other countries have to import up to 90% of the material inputs of metals from abroad. These primary resources are becoming more expensive as they become more scarce and remaining deposits more difficult to mine, which is a serious concern for industrialized nations. Basic economic and strategic reasoning demands an increase in recycling activities and waste minimization.
Technologies to recover metals in a reasonable and economically relevant manner from very diffuse sources are practically non-existent or require large amounts of energy and chemicals, which pose environmental risks.
On the other hand agriculture uses large volumes of mineral fertilizers, which are often sourced from mines as well, and thus are also subject to the same principle of finiteness and potential shortage in supply. These converted biological nutrients are taken up by crops and through the food chain and human consumption end up in sewage systems and in wastewater treatment plants in great quantities. The metabolized nutrients mostly do not return to agriculture, but due to contamination with heavy metals are diverted to be used as construction aggregates or are thermally treated and end up rather uselessly in landfills.
The project BIO-ORE aimed to explore new pathways to concentrate metals from diluted sources such as sewage sludge and wastewater by using highly efficient biological absorption and transport mechanisms. These enzymatic systems from plants work with very little energy input. The process is called bioaccumulation and can be most effectively observed in so-called hyperaccumulating metalophytes, which are studied for its suitability to be incorporated in metal recovery processes of elements that diffusely occur in different waste streams.
In a systematic series of tests under laboratory conditions the accumulation behaviour for many different elements including rare earth metals of a selection of candidate plants growing on sewage sludge, incineration residues and industrial leftovers was assessed (quantitavely and qualitatively). Growth performance of these plants as well as the most suitable substrate properties were evaluated.
The results of this project provided the groundwork for further research and development steps that might bring to practical implementation a technological option with potentially huge benefits:
The recovery of valuable metal resources from sewage sludge, incineration ashes and metal rich wastewaters by environmentally friendly and low energy means.
Simultaneous decontamination of the input substrates from heavy metals, opening the possibility for these nutrient streams to be redirected to biological regeneration processes (for example use as fertilizers in agriculture) without fear of polluting soils with heavy metal loads.
Generation of biomass on contaminated substrates can yield usable energy surplus through incineration during or after processing.