Proceedings of the 4th International Conference on Environmental Pollution and Remediation
Prague, Czech Republic, August 11-13, 2014
Paper No. 136

Use of Secondary Phosphates to Reduce Soil Pollution

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Extended Abstract

Phosphorous is essential for all living creatures and indispensable in its functions regarding bone structure, energy metabolism, and storage and expression of genetic information. It is removed from the soils through farming and husbandry and has to be replaced. Annually, more than 17 million tons of phosphorous are applied to soils in the form of mineral fertilizer worldwide (Killiches, 2013). In Germany, this accounts for 150,000 t/a. This fertilizer is produced from rock phosphate, which is often contaminated with heavy metals (Dissanayake et al., 2009), especially cadmium and uranium. Cd concentrations are around 30 mg/kg, U around 100 mg/kg, with even higher peak values. Since rock phosphate is treated with acids to make the phosphorous bioavailable, those heavy metals were also mobilized. When the fertilizer is applied to the farmland, the contaminants can pollute the soil and pose an environmental risk. Sewage sludge is another phosphorous source for farming. In Germany, 15,000 t/a phosphorous are applied to farmlands this way. However, there is a growing concern of possible environmental hazards since sewage sludge contains not only inorganic contaminants but also organic pollutants, especially pharmaceuticals and personal care products (Guardia et al., 2004).

Thus, alternative sources for phosphorous are in order to reduce the amount of pollutants applied to farmlands and diminish the respective environmental hazards. Incinerated sewage sludge is a possible alternative since it contains high amounts of phosphorous and may replace and/or complement mineral fertilizer and sewage sludge. Right now, the ash is almost exclusively landfilled or used for construction purposes. Thus all the possible resources therein are lost. We conducted a complete survey of all German sewage sludge ashes and determined its elemental composition. Thus we can calculate the recovery potentials for phosphorous and other technology metals and the possible reduction of Cd and U intake. We investigated 252 samples from 24 mono-incineration facilities and thus covered more than 97 % of the 300,000 t of sewage sludge ash that arise in Germany every year.

We dissolved the samples by means of microwave-assisted perchlorid/hydrofluoric acid digestion and determined the concentrations of 57 elements with inductively-coupled plasma optical emission spectroscopy (ICP-OES) and mass spectrometry (ICP-MS), respectively.

Phosphorous concentrations in sewage sludge ashes ranged from 1.5 to 13.1 %, with a mean value of 7.3 %. Taking into account the respective amounts of ash produced by each facility, this sums up to an annual phosphorous recovery potential of to 19,000 t. This means that more than 12 % of the so far required mineral fertilizer might be replaced by secondary phosphates. Since the concentrations of Cd and U in the tested ashes (3.3 mg/kg and 5.8 mg/kg) are some orders of magnitude lower than in rock phosphate, the use of secondary phosphates might help to reduce the heavy metal intake of farmlands. Furthermore, since the sludge is incinerated, most of the organic pollutants are expected to be degraded completely. Our survey showed only minor amounts of polycyclic aromatic hydrocarbons (sum of 16 EPA-PAH, 0.1-1.5 mg/kg). Qualitative screening for organic compounds showed several alkanes, amines, and alkyl alcohols.

References

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