Interreg Austria – Czechia
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From Waste to Resource – Recycling Sewage Sludge Ash into Phosphate-rich Plant Fertilizer

How the phosphorus contained in sewage sludge can be used to improve the closing of the phosphorus cycle.

Motivation

Phosphorus is an essential and irreplaceable resource for ensuring food production. Raw phosphate for the production of phosphorus fertilizers is limited, regionally concentrated, and mined under problematic conditions, threatening human health and the environment. Due to its importance for the fertilizer and food industry and its high import dependency, phosphorus has been on the EU's list of critical raw materials since May 2014, meanwhile raw phosphate since 2017. Approximately 90% of the phosphorus in the wastewater entering municipal treatment plants is retained in sewage sludge, which corresponds to almost 7,000 tons per year in Austria and up to 8,000 tons per year in the Czech Republic.

The current situation of sewage sludge utilization differs between Austria and the Czech Republic: In the Czech Republic, agricultural utilization is still predominant, while in Austria, only about 21 % of the sewage sludge is used for agricultural purposes, whereas the majority is co-incinerated in waste incineration plants. Solely in Vienna, all sewage sludge is incinerated in a mono-incineration plant. In Austria, sewage sludge from municipal sewage treatment plants with more than 20,000 PE_{60} (population equivalent) must be incinerated by 2033. Furthermore, at least 80 percent by mass of the phosphorus contained in the sewage sludge must be recovered from the resulting incineration ash. In the Czech Republic, a tightening of the law will soon restrict or even prohibit agricultural use, increasing pressure to find alternative uses for sewage sludge. At present, thermal utilization is the main viable option, whereby P-recovery continues to pose a further issue.

Project objectives

- Phosphorus recovery from sewage sludge ash >85 % by bioleaching and process optimization
- Production of a phosphate fertilizer according to the fertilizer regulation
- Investigation of the effect of the phosphate fertilizer on model plants
- Publication of project results
- Organization of expert workshops
- Knowledge transfer between research partners and companies
- Regular publication of a newsletter

The current state of the research

First, various dewatered sewage sludges from Austria and the Czech Republic are collected and analyzed for their general compositions and phosphorus and heavy metals concentrations. Sludges with the optimum phosphorus content are then selected for ash production. Consequentially, these selected sludges are dried in a drum dryer, and the dried sludge is then incinerated in a rotary kiln at high temperatures. Emission measurements are performed as part of the incineration tests. The addition of additives to the sludge prior to incineration can be used to transfer unwanted heavy metals to the gas phase or to convert phosphorus to a more bioavailable form, thereby increasing its solubility within the ash.

For the bioleaching of sewage sludge ash, a stirred tank system was set up to optimize biological sulfuric acid production. This biological acid is then used to leach phosphorus from the ash. Experiments are also started to isolate acidophilic microorganisms from sewage sludge.

Dissemination activities

K1-MET GmbH presented PHOS4PLANT at the "1st International Circular Hydrometallurgy Symposium" in Mechelen (Belgium) from 9 – 11 September 2024.

In addition, K1-MET had the opportunity to present the project at the "6th International Scientific Conference Biotechnology and Metals" in a talk entitled "Recycling of sewage sludge ash into phosphate-rich plant fertilizer" in Stará Lesná (Slovakia) from 10 to 11 October 2024.

Brno University of Technology (BUT) presented PHOS4PLANT at the "Adria Danube Combustion Meeting (ADCM)" in Brno (Czech Republic) from 9 to 11 September 2024. The poster contribution was entitled "Additivation in Sewage Sludge Combustion: Impacts on Phosphorus Recovery from ash: An overview".

The PHOS4PLANT project was also presented with a poster at the "Scientist's Night" by the BUT and also the Masaryk University in Brno (Czech Republic) on 27 September 2024.

BOKU also presented the project at the "European Summit of Industrial Biotechnology" in Graz (Austria) from 12 to 14 November 2024.

Involved partners

K1-MET has proven expertise in the further development of processes for the treatment of residues and recycling materials with the aim of recovering valuable materials and closing material cycles. The tasks of K1-MET are, therefore, the recovery of phosphorus from sewage sludge ashes by non-contact bioleaching or with acids and the subsequent production of the phosphate-rich plant fertilizer. This is combined with the removal of impurities, such as metals, from the sewage sludge ashes. K1-MET is the lead partner in this project.

Masaryk University (MU) is the second-largest university in the Czech Republic. The Department of Biochemistry, the Department of Chemistry, and the Department of Geological Sciences are involved in the project. The team has many years of experience in the field of acidophilic microorganisms, molecular mechanisms of plant-micro-organism interactions, structure-function analysis of microbial communities, mineral analysis, and trace element analysis.

A team from the Department of Thermal Processes and Gas Cleaning which is a part of the Institute of Process Engineering of Brno University of Technology (BUT) is involved in the project. This team has extensive experience in the field of thermal processes and emission treatment. They are responsible for the production of sewage sludge ash in the project. The institute possesses a drum dryer and a rotary kiln necessary for pilot-scale experiments. In addition, analytical infrastructure is available to measure fuel and waste properties and to analyze flue gas emissions.

The Institute of Waste Management and Circularity (ABF-BOKU) is focused on the safe disposal and recycling of waste in order to reduce the amount of waste and to save resources in primary production. Its tasks in the project are the pre-treatment of the highly alkaline ashes, which hinder the biological leaching of the material, the bioleaching of sewage sludge ashes, and the identification of acidophilic bacteria from sewage sludge. In addition, the entire process chain will be evaluated using LCA.

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