P-Recycling with the EuPhoRe-Technology

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1. Introduction

During the last 25 years, a lot of different technologies are developed to recycle P from wastewater, sewage sludge or sewage sludge ashes. One of the possible techniques is the EuPhoRe-technology, where the P-recycling is realised in parallel to the incineration process. The ash of the process is directly usable for fertilizer products. The EuPhoRe® pilot plant in Dinslaken is the first stand-alone-plant on a WWTP. Its maximum capacity is about 100 kg dewatered sludge per hour (dry matter concentration about 25 %).

2. P-recovery process / methodology

The EuPhoRe®-process is a 2-stage thermo-chemical incineration process and consists of a rotary kiln where dewatered sewage sludge is successively dried, reduced and oxidized. In the reduction step (650-750°C), a major part of the volatile matter is already transferred to the gas phase. The remainder of the pollutants is subsequently removed during the oxidation step (up to 1.000°C). Additives such as $MgCl_2$ are added to the sludge in order to improve the heavy metals removal through the gas phase.

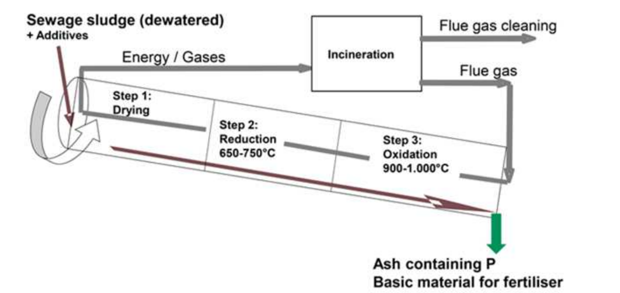

Figure 1: Basic principle of P-recovery process (© Klose and Zepke 2010, modified)

The additives also have a notable influence on the plant availability of the remaining ash. Given this process, the phosphorus contained in the sewage sludge ash of the EuPhoRe®-process is – compared to the ashes of e.g. a fluidised bed incineration – plant available and has a notably lower heavy metal content (Klose 2018). Figure 1 illustrates the process.

3. P-rich product/ LCA/QA results

The main goal of the thermochemical sludge treatment was the production of a sewage sludge ash conformable to all relevant laws which could be used as basis material for the production of P-rich fertilisers.

It could be demonstrated that the EuPhoRe-technology is capable to even transform sludges that have a notable industrial influence to a raw material for fertiliser production. All relevant heavy metals were removed below the limits as defined by the German Fertiliser Ordinance. The efficiency of the ash with regard to P-uptake and P-use of the plant (as defined by the Fertilising Ordinance) was proven by external pot trials (see figure 2).

Figure 2: Development of Ryegrass, 5th cut. Left = negative control; right = with EuPhoRe ash (© HGoTech, Bonn)

After grinding an pelletising, a marketable P-fertiliser according to type 1.2.9 (P-fertiliser originating from the incineration of sewage sludge ashes) could be produced (figure 3).

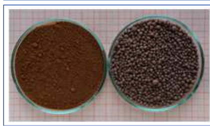

Figure 3: Left: Ash directly from the rotary kiln after incineration; Right: Ash after grinding and pelletising (© Levent Pamuk, Emschergenossenschaft)

With regard to the LCA, the impacts of the EuPhoRe system are lower compared to the reference (co-incineration of the sludge and chemical production of P fertilizer), especially in the categories of mineral and fossil resource depletion and global warming (see figure 4). This comparison indicates the advantage of the EuPhoRe system from an environmental point of view.

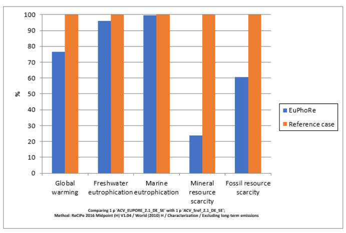

Figure 4: Comparison of the EuPhoRe system and the reference system in terms of environmental performance. (© Uni Liège)

Characterisation ReCiPe 2016 H/World H

4. Discussion and conclusion

The EuPhoRe-demonstration plant was the first stand-alone realisation of the technology, i.e. it was not combined with an existing (waste) incineration plant. Due to this, the plant had to be modified and optimised during the start-up phase. This was expected and affected mainly the periphery of the plant and its control, whereas the main technology (i.e., the rotary kiln) was basically working properly from the beginning of the project. After various technical optimisations and modifications (mainly with regard to the plant control, the sludge feeding, the gas cleaning system and the combustors), continuous operation started in spring 2021. During this period, the plant operation focussed on the fine adjustment of the additive dosing, the rotation speed of the kiln and the temperature. Chemical ash analyses and the results of external pot trials showed that the initial goal of the project – the production of an sewage sludge ash of value for fertiliser production – could be reached.

Figure 5: The EuPhoRe-Pilot Plant in Dinslaken, Germany (© Levent Pamuk, Emschergenossenschaft)

The promising results with regard to the product quality and the function of the main components of the plant are basis for a plant upscale. It is expected that the pilot plant will promote future large-scale implementations of the technology. As for the Emschergenossenschaft, theoretical upscale studies for different sites/cases will be performed.

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References: Klein, Daniel; Schmelz, Karl-Georg; Pamuk, Levent (2019): First results of the EuPhoRe pilot plant. In Université de Liège (Ed.): Proceedings. 5th European Conference on Sludge Management Liège. Liège, 6-8 October 2019

Klose, Siegfried (2018): Thermo-chemische Klärschlammbehandlung nach dem EuPhoRe®-Verfahren. In Olaf Holm, Elisabeth Thomé-Kozmiensky, Peter Quicker, Stefan Kopp-Assenmacher (Eds.): Verwertung von Klärschlamm. Neuruppin: Thomé-Kozmiensky Verlag GmbH.

Chantrain et alli, „Life Cycle Assessment – Life Cycle Costs works". In: Ploteau Marie-Edith, Althoff Anke, Nafo Issa, Teichgräber Burkhard, "Technical report of the Phos4You partnership on processes to recover phosphorus from wastewater", September 2021, edited by LIPPEVERBAND

Klose, Ingeborg; Zepke, Frank (2010): Verfahren zur Eliminierung von Schadstoffen aus Klärschlamm und Verfahren zur Herstellung von Phosphaten und phosphathaltigen Verbindungen. Patent no. DE 10 2009 014 884 A1.

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