

KRN Mephrec

Transforming sewage sludge to energy, fertiliser and iron in a single step using metallurgical phosphorus recycling

A six-month pilot project was conducted both for preparatory planning purposes and for the required pollution-control and building approval applications. The overall concept of the joint project is presented in the following.

Background

The process of sewage treatment in the city of Nuremberg produces around 40,000 tonnes of dehydrated sewage sludge per year. Together with the city partners of Erlangen, Fürth and Schwabach, this results in a total of around 70,000 tonnes per year. The sludge is mainly burnt in power stations while a small proportion is given over to agricultural and landscaping activities.

Due to the lack of alternatives, the material is transported over large distances, rendered harmless, and put into final storage, even though the sludge would also be suitable for local material and energy recycling. Sludge is a raw material that has the potential to considerably improve the energy balance of the sewage treatment plant and to cover a total of up to 40% of the domestic demand for increasingly scarce phosphorus resources.

In the course of an international ideas competition, the city of Nuremberg examined thirteen process concepts that could, in a forward-looking and sustainable manner, be used to improve regional value creation, climate protection and the efficiency with which wastewater and energy resources are treated in the metropolitan region, taking into account ecological and economic criteria.

The process ultimately selected as the one with the greatest potential involves smelting sewage sludge by way of metallurgical phosphorus recycling ('mephrec'). This technique has previously only been employed in large-scale plants and with other objectives relating to the thermal utilisation of municipal and industrial waste.

Objectives

The joint partners in the project aim to investigate the technical feasibility, cost-effectiveness and ecological sustainability of metallurgical phosphorus recycling as an integrated, thermal process of melt-gassing sewage sludge.

With the aid of a pilot system on a semi-technical scale, the process is to be tested in its core components and developed until it is suitable for constant operation.

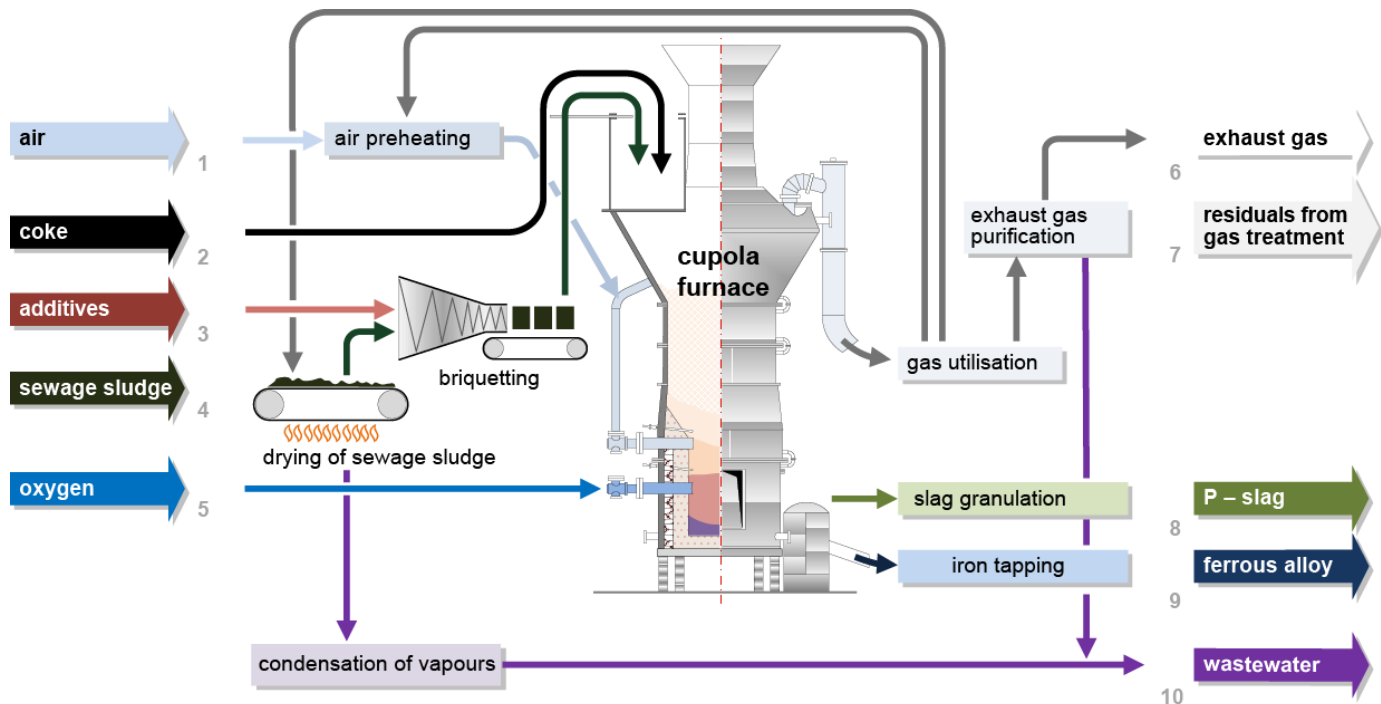


Fig. 1: Chart of the Mephrec Process

The sub-objectives of the joint project are as follows:

- a) To devise a regional management concept for the flow of energy and substances with respect to sewage sludge, including energy utilisation and recirculation/exploitation of the products in the economic cycle.
- b) To establish smelting technology as an integral component of the waste treatment process, subject to the following premises:
 - The energy requirements of the sewage treatment plant are covered by utilising the synthesis gas generated. Carbon and hydrogen contained in the sewage sludge are supplied as fuel gas with a high calorific value for supplying heat and electricity.
 - Pollutants are eliminated in the sludge by complete destruction of all organic pollutants at high temperature, and a permanent bond of the heavy metals is created in the ferrous smelt.
 - Tapping sewage sludge as a source of phosphorus by feeding the recyclable materials back into the economic cycle as low-pollutant recycles that can be absorbed as plant nutrients.
- c) Determining the scaling factors and their impact on cost-effectiveness with different site prerequisites and process combinations.
- d) Promoting operational and marketing-relevant acceptance of the technology in terms of extending the value creation chain to wastewater purification.

Project partners

Six institutions are involved in KRN Mephrec. Furthermore, the City of Nuremberg participates as an associate partner.

- Klärschlammverwertung Region Nürnberg GmbH (project coordination)
- Baumgarte Boiler Systems GmbH (investment furnace + gas purification)
- Innovatherm Company for innovative Utilisation of Combustible Material mbH
- Fraunhofer Institute for Environmental Safety and Energy Technology
- Bundeswehr University, Munich, Institute for Water Management – Settlement Water Management and Waste Engineering
- RWTH Aachen, Institute for Urban Water Management
- Institute for Energy and Environmental Research, Heidelberg GmbH

Focus of activity

The research project is structured into three thematic areas:

- Regional sewage sludge utilisation concept
- Development of a process chain
- Investigation of product quality and marketing opportunities

Under the guiding principal of a regional utilisation concept for sewage sludge, the municipal partner of Nuremberg is developing the regional management concept together with its project partners, with the aim of focusing the waste flows of wastewater treatment in the metropolitan region such that their sustainable and economically beneficial management is enabled under maximum energy efficiency and material utilisation of sewage sludge. This solution is ecologically balanced and the impact of the concept has been compared with the established sewage sludge utilisation channels in Germany.

Regarding the objective of developing a process chain, technological questions are being treated academically and their implementation elaborated on a large technical scale, taking into account established state-of-the-art processes. In the first test phase, the reactor is charged with dried, briquetted sewage sludge. In a subsequent project phase, the sewage sludge briquette will be replaced by sewage sludge ash taken from mono-combustion.

Besides demonstrating the functionality and applicability of the process, the energy-based integration of all steps in the process is the decisive factor that determines its cost-effectiveness and in turn competitiveness. Energy-intensive sub-processes are interwoven in such a way that the energy yield of all preparatory and downstream processing steps is maximised. At the same time, sewage sludge drying and exhaust air treatment processes must be adapted to the operating environment of the sewage plant such that synergies

are exhausted and the local site benefits in terms of infrastructure, exhaust air and wastewater treatment, and, in particular, energy recycling in the sewage plant, are utilised. The final thematic complex, which is to comprise investigations of product quality and marketing opportunities, will involve further-reaching work packages that will first of all look at the products and their quality and price. In addition, the overall potential of the management system will be researched, its ecological and economic aspects determined in terms of their importance to the wastewater sector of the region, and the medium-term sewage sludge utilisation and phosphorus recycling strategy of the central and state governments investigated.



Fig. 2: Cupola furnace plant for melt-gassing in pilot plant scale, © Ingitec 2009

Duration of project

- Dez. 2013 – Okt. 2014 (preliminary project)
- Nov. 2014 – Jun. 2017 (main project)

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