«Phosphorus Recovery» Project

Raw Materials from Waste Water?

Limited resources and increasing world market prices for phosphorus fertilisers make the recovery of phosphorus from sewage sludge an increasingly interesting prospect. Back in 2011 a feasibility study conducted jointly by PFI and the City of Pirmasens showed that some 50 % of the phosphorus present in waste water can be recovered by a novel process. After systematic further development considering aspects of sustainability and energy saving, the new process for phosphorus recovery is to be implemented by the City of Pirmasens in a pilot plant at its Felsalbe sewage works.

Background – Phosphorus

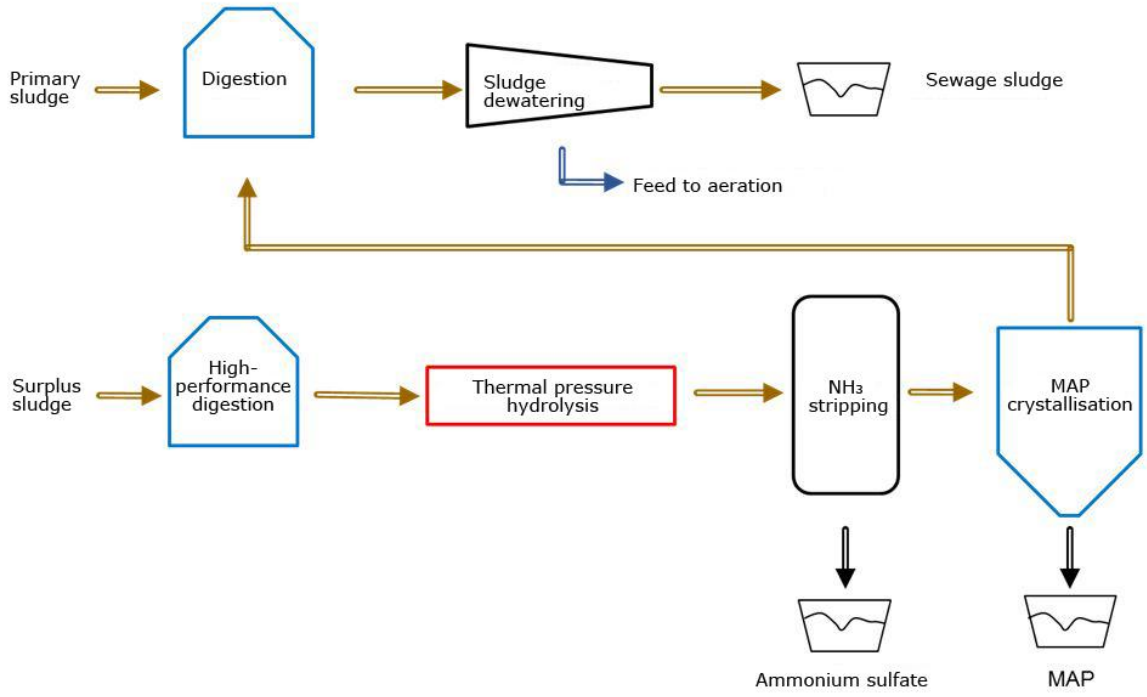
The element phosphorus is essential for life and irreplaceable because plant and animal growth are impossible without it. That is why modern agriculture uses large amounts of mineral phosphates as fertilisers.

Raw phosphate is mined at the sites of various natural deposits. These deposits are limited to just a few countries in North Africa, Asia, and North America. Germany and other European countries are therefore highly dependent upon imports. The quality of phosphorus is deteriorating because of increasing contents of contaminants such as cadmium and uranium. Unlike fossil fuels such as petroleum and natural gas, phosphorus cannot be replaced by modern developments. In 2014 phosphorus was therefore included in the European list of critical raw materials.

As a chemical element phosphorus cannot, of course, simply disappear, but will ultimately end up in the oceans and become so dilute that any further use can be discounted. A large proportion of the phosphorus used as fertiliser passes via the food chain into waste water and is precipitated in sewage sludge by biological and chemical treatment at sewage treatment facilities. This sludge may itself again serve as fertiliser – an approach which is still practiced in Rhineland-Palatinate. However, increasing amounts of microorganisms and hazardous substances such as heavy metals and organic substances may be spread on the fields in this way. Use of sewage sludge as fertiliser has been increasingly restricted through the limit values prescribed by the German Sewage Sludge Ordinance The latest version, valid since October of this year, includes a firm commitment to recycling of phosphorus.

Development

In a first research project initiated and financed by the Rhineland-Patatinate Ministry of the Environment, PFI and the Pirmasens Waste Water Disposal Operation together established in a feasibility study from 2009 to 2011 that about 50 percent of the phosphorus in sewage sludge can be recovered by alkaline digestion. The process has been refined in subsequent years with the result that today not only phosphorus but also nitrogen, another important fertiliser component, can now be recovered.



Schematic of new process

Moreover, sustainability and energy optimisation in wastewater treatment plants constitute key points of the new holistic concept. Nevertheless, waste water purification still has top priority in implementation of the new process.

The Process

The technical innovation of the new process lies in the separate digestion of phosphorus-rich surplus sludge and low-phosphorus primary sludge. The phosphorus-rich surplus sludge is fully digested in a high-performance digester and then subjected to thermal pressure hydrolysis. This leads to extensive re-dissolution of the phosphate present, which is subsequently precipitated as magnesium ammonium phosphate (MAP). Of high purity and very low heavy-metal content by virtue of its production process, MAP can be used directly as a fertiliser. MAP-based fertilisers are already being produced at a Berlin sewage plant among other places and show good plant availability in comparison to other recyclates obtained from sewage sludge and conventional commercially available fertilisers.

There are also plans to recycle part of the nitrogen content of the sludge as liquid fertiliser in the form of ammonium sulfate to counteract the accumulation of ammonium in the plant. This approach would lead to a reduction in the energy required for aeration by 20 percent with a concomitant increase in energy production as a result of increased gas production thanks to improved sludge degradation.

Improved dewatering of the sewage sludge also reduces the amount of sludge produced and hence also the associated disposal costs. Further optimisation of biological phosphorus elimination will reduce expenditure on dewatering polymers and flocculating agent by up to 60 percent.

Felsalbe sewage works near Pirmasens where the phosphorus recovery pilot project is being implemented (Photo: City of Pirmasens)

Implementation

The process is currently being implemented by the City of Pirmasens in a pilot plant at the Felsalbe sewage works, where it can be optimally integrated into the centralised sludge treatment setup. It is planned to treat 9000 m^3 of surplus sludge per year with the aim of recovering 250 tonnes of magnesium ammonium phosphate from the digested sludge. About 30 tonnes of ammonium sulfate will also be obtained. Owing to energy savings, the energy consumption can be reduced from 18 to 16 kilowatt hours per population equivalent (a reference value for the pollution load), which is equivalent to a drop in CO_2 emissions of about 75 tonnes per year.

Total investment in the project amounts to €1.6m. The Rhineland-Palatinate Ministry of the Environment, Energy, Food, and Forestry is funding it to the extent of €500,000; the Federal German government is contributing €430,000 via its Environmental Innovation Programme.

Central planning for implementation of the process lies with PFI-Bioraffinerietechnik GmbH. Groundbreaking for the earthworks already took place this autumn. Structural alteration work and connection of the new plant components will follow. Commissioning of the new plant will be completed by 2019. The two-year project will be followed by an evaluation phase predicted to take one year.

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