Fraunhofer

RESEARCH NEWS

New process for eco-friendly phosphorus recovery

IFAT 2016: Fertilizer from wastewater

Fraunhofer researchers have developed a market-ready system that can be used to obtain fertilizer from wastewater for direct use in agriculture. A licensee is already marketing this patented technology in North America and the process itself is particularly eco-friendly. The scientists showcase it on IFAT, world's leading trade fair for water, sewage, waste and raw materials management from May 30 to June 3, 2016 in Munich (hall A5, booth 217/316).

Demand in agriculture for phosphate-based fertilizers is growing steadily. At the same time, the purity of reservoirs is declining, which means extracting and preparing phosphorus is getting more difficult and therefore more expensive. In addition, Europe is largely dependent on imports of phosphorus from countries such as Morocco and Russia. Researchers at the Fraunhofer Institute for Interfacial Engineering and Biotechnology IGB in Stuttgart developed the electrochemical process ePhos® that would recover phosphorus from wastewater without relying on chemicals or harming the environment. Now, their reactor is ready for the market. When installed at water treatment plants, it allows fertilizer to be obtained from wastewater, and in a form that is ready for use in food production.

Resource in demand

Since there is no substitute for phosphorus , efforts are focusing more on tapping existing reserves of it, found in process water from treatment plants and residues from biogas plants. The demand for nitrogen-based fertilizer is also on the rise; however, its cost is increasing as well, not least because producing it requires an inordinate amount of energy. The idea of recovering these nutrients is therefore becoming all the more appealing. What's been missing, however, is a suitable and cost-effective process for doing so. One example is ePhos®.

At the heart of this technology is an electrolysis cell that makes it possible to extract nitrogen and phosphorus using a magnesium electrode, resulting in either struvite (magnesium ammonium phosphate) or potassium struvite. "Struvite is free of biomass and can be used directly in agriculture as a high-quality fertilizer that releases nutrients slowly," explains Dr. Iosif Mariakakis, project manager at Fraunhofer IGB. What's really special about the process is that it is purely electrochemical: unlike traditional methods, there's no need to add salt or lye. "This is also good news for water treatment plant

Editorial Notes
Beate Koch | Fraunhofer-Gesellschaft, Munich | Communication | Phone +49 89 1205-1333 | presse@zv.fraunhofer.de
Dr. Claudia Vorbeck | Fraunhofer Institute for Interfacial Engineering and Biotechnology IGB | Phone +49 711 970-4031 | Nobelstrasse 12 | 70569 Stuttgart | www.igb.fraunhofer.de | claudia.vorbeck@igb.fraunhofer.de

operators – the process is very straightforward and doesn't require them to stock chemicals," Mariakakis continues.

A licensing agreement was recently signed with water treatment system provider Ovivo in the United States, who is marketing the technology now in the USA, Canada and Mexico. Due to the stringent limit values associated with water treatment, there is considerable demand for efficient ways of extracting phosphorous. Moreover, many of the water treatment plant providers in the U.S. that will use this process are also looking to sell the struvite, considering it as an attractive source of income.

Targeting the European market

But ePhos® could also quickly gain a foothold across Europe, where it will soon be mandatory to separate phosphorous from sewage sludge and where demand for cheap fertilizer is expected to grow. Given this situation, IGB is searching further licensees to introduce the technology on the European market as well. Over in the USA, Ovivo will build and market the plants in line with Fraunhofer specifications. "By the end of September, the first industrial-scale demo plant will be up and running in the USA," Mariakakis reports.

Meanwhile, the researchers are busy developing their reactor concept further. "We plan to expand ePhos® by adding processing modules that allow water treatment plants to recover ammonium, too," says Mariakakis.

Results from long-term trials at the first treatment plant to pilot the technology are convincing: the process was able to recover about 85% of the phosphorous on average. "Our method is also suitable for the food industry and for processing service water," Mariakakis adds. The only condition is that the water to be processed must contain plenty of phosphate.

Fraunhofer

New process for recycling phosphorous

Recovering ammonium (NH_4^+) and phosphate (PO_4^{3-}) from wastewater requires an electrolysis cell. Such cells consist of one magnesium anode and a cathode. Cathodic reduction results in water splitting: hydroxide ions (OH^-) form while hydrogen (H_2) is released. Oxidation occurs at the anode – magnesium ions react with the phosphate and ammonium present in the water to form struvite. The process has the benefits of not requiring any additional chemicals, such as magnesium chloride ($MgCl_2$) or sodium hydroxide (NaOH), and consuming very little energy (0.78 kWh/m³ wastewater).

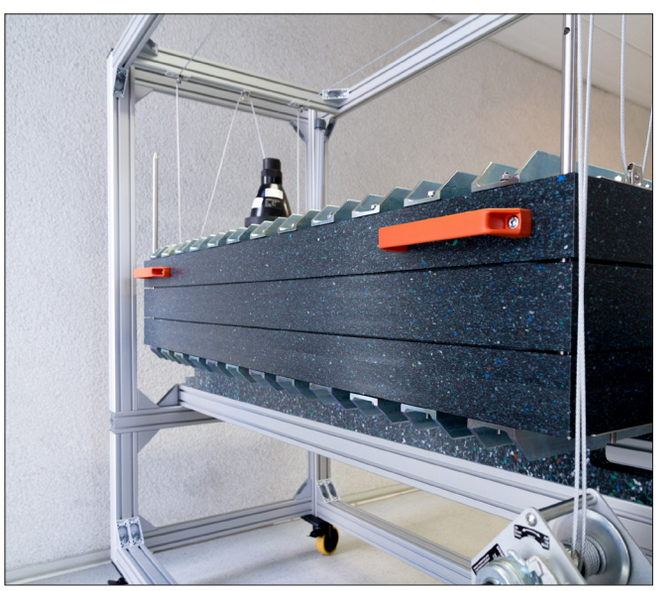
Fraunhofer IGB's research focus

The core research areas at the Fraunhofer Institute for Interfacial Engineering and Biotechnology IGB in Stuttgart are the processing of untreated water for use as drinking or process water, and identifying resource-efficient ways of disposing of or recycling wastewater. The IGB works with electricity (electrolysis), energy-rich UV radiation (photolysis) and combinations of UV radiation and excited particles (plasma process) that do not require the addition of chemicals. Recovering nutrients – including nitrogen, phosphorous, potassium, calcium and sulfur – plays a major role in the institute's research activities.

Premium struvite fertilizer

Struvite is used in agriculture as a premium fertilizer that slowly releases nutrients. Fraunhofer researchers have tested its effects on plants. Their experiments showed that the plants' yield and nutrient uptake was up to four times higher than for commercially available mineral-based fertilizers such as ammonium nitrate and triple superphosphate.

Fraunhofer



The electrolysis cell ePhos® extracts nitrogen and phosphorus purely electrochemical. The process is very straightforward and doesn't require to stock chemicals. © Fraunhofer IGB | Picture in color and printing quality: www.fraunhofer.de/en/press