Fraunhofer IGB

Fraunhofer Institute for Interfacial Engineering and Biotechnology IGB

Recovery of the Nutrients Ammonium and Phosphate

We develop nutrient recovery concepts for wastewater treatment plants.

Contributing to water and climate protection

Systematic recovery of the nutrients nitrogen and phosphorus from liquid manure, digestate or wastewater can strengthen the resilience of supply chains and contribute to climate and water protection as well as to supply security. For many years, Fraunhofer IGB has been engaged in the development and implementation of sustainable, cost-effective technologies and strategies for integrated resource management: In addition to the utilization of carbon containing organic compounds from residual materials, this also encompasses the development of novel technologies for the recovery of nutrients from wastewater and organic residues.

For example, the institute has characterized wastewater, liquid manure, and digestate from biogas plants, as well as various other solid or liquid residues, investigated them with regard to the recovery of ammonium and phosphate, and successfully developed patented processes. To produce not only mineral fertilizers but also high-quality, compact organic fertilizers capable of compensating for the loss of organic soil matter, we develop technologies for recovering the organic components of agricultural residues that can be used as a peat substitute.

Advantages of nutrient recovery

- Production of fertilizers and peat substitutes
- Increased supply security for the required raw materials and resilience
- Circular economy instead of linear consumption
- Water and climate protection

More info

www.igb.fraunhofer.de/nutrient-recovery

Sources of nutrients and areas of application

Products of nutrient recycling

Wastewater (sewage treatment plants)

Wastewater streams from biogas plants used for sewage sludge digestion with high loading rates – so-called high-load digestion – are characterized by high concentrations of ammonium and phosphate, up to 1,300 mg NH_4 per liter and 200 mg phosphate per liter, respectively. In these wastewater streams, ammonium is currently converted to molecular nitrogen while phosphate is chemically precipitated using energy-intensive process steps. Reuse is therefore not possible.

Advantages of nutrient recovery

- Reduction of nitrous oxide emissions
- Energy savings in aeration
- Prevention of phosphate disposal through the production of recycled materials
- Savings on precipitants
- Compliance with limit values in the wastewater treatment plant process

Agricultural waste: manure, digestate (biogas plants)

At Fraunhofer IGB, various projects have developed processes for converting liquid manure and digestate into mineral fertilizers and organic soil improvers, which have been integrated as separate modules into a plant for on-site processing.

Advantages of nutrient recovery

- Improved storage and transportability through dewatering
- Water reuse through dewatering
- Production of specific fertilizers
- Prevention of overfertilization
- Reduction of ammonia emissions
- Phosphate usable as a nutrient
- Ammonium usable as a nutrient
- Treated water for reuse (e.g., rinse water)

Residual materials / process water from the food industry

The production of food or feed also generates organic residues and process water from which ammonium nitrogen and phosphate can be recovered. Fraunhofer IGB develops and tests appropriate processes for this purpose.

Advantages of nutrient recovery

- Internal recycling of treated process water
- Savings in raw materials
- Fresh water savings

Biogas plants can recover nutrients

Our technologies

AmmoRe: recovery of ammonium nitrogen

For the recovery of ammonium from nitrogen-rich municipal wastewater, we are investigating the process of transmembrane chemical absorption (TMCA). In this process, gaseous ammonia diffuses through a hydrophobic membrane and is bound in an absorbent solution, e.g., as ammonium sulfate.

Application: nitrogen recovery from liquids

- Wastewater from sewage treatment plants
- Liquid digestate from biogas plants
- Process water from the food industry

With our pilot plant, we investigate how ammonium can be recovered from your material stream for use as fertilizer.

ePhos®: recovery of phosphorus

With ePhos®,plant-available magnesium ammonium phosphate (MAP, struvite) is precipitated from nutrient-rich wastewater in an electrochemical process – without the addition of any extra chemicals. Struvite is a high-quality slow-release fertilizer and can be used directly as fertilizer in agriculture.

Application: phosphorus recovery from nutrient-rich liquids

- Wastewater from sewage sludge dewatering
- Process water from the food industry

We would be happy to investigate phosphorus recovery from your wastewater at our laboratory and pilot plants.

Wet-chemical phosphate precipitation

In addition, Fraunhofer IGB has also investigated processes for wet-chemical phosphate precipitation from liquid fermentation residues. This process encompasses all necessary steps, from acidification of the liquid digestate or manure through solid-liquid separation to phosphate precipitation. Fermentation substrates typically contain all the reactants required for P-salt precipitation. Precipitation occurs solely through the addition of lye.

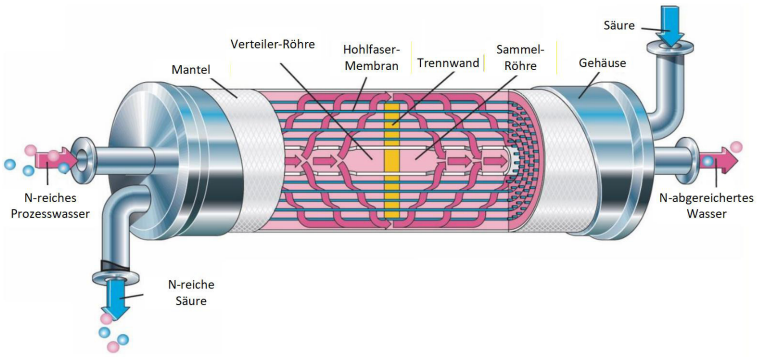
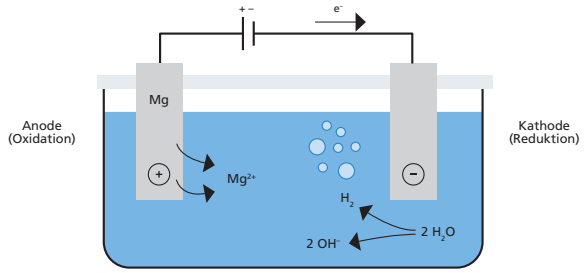


Illustration of the AmmoRe transmembrane chemical absorption process for the production of ammonium fertilizer (© Solventum 2024. Solventum and Liqui-Cel, are trademarks of Solventum. 3M is a trademark of 3M Company.)



Scheme of the ePhos electrochemical P-salt precipitation process

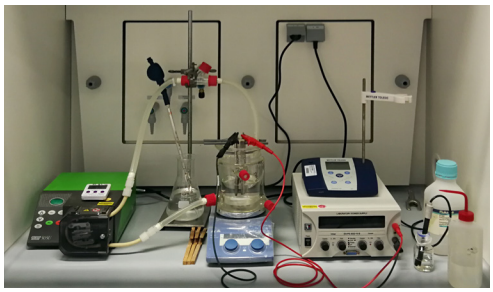
Range of services

Services at a glance

- Technology development for the recovery of ammonium nitrogen or phosphate from process water/wastewater, sewage sludge treatment, and digestate/manure
- Concept development for the treatment and utilization of manure and digestate
- Evaluation of existing data
- Laboratory analyses and evaluations to supplement the data set
- Laboratory feasibility studies using real substrates for customer-specific applications, cost estimation, and process optimization
- Construction and operation of demonstration and pilot plants
- Preliminary planning and cost estimation for large-scale implementations
- Scientific support during commissioning and operation
- Securing intellectual property rights through patenting and licensing

Equipment

- Laboratory setups for feasibility studies



Beaker setup for electrochemical P-salt precipitation "ePhos"

Pilot plant for N recovery "AmmoRe"

- Demonstration/pilot plant for in-situ operation
- Analytical laboratory, including accredited testing procedures in accordance with DIN EN ISO/IEC 17025:2018 for
  - High-performance liquid chromatography (HPLC)
  - Ion chromatography (IC)
  - Gas chromatography (GC)
  - Inductively coupled plasma atomic emission spectrometry (ICP-AES)

Pilot plant for electrochemical P recovery "ePhos"

Contact

Michael Bohn B. Sc.
Greentech Solutions
Physical and Chemical Process Engineering
Phone +49 711 970-4244
michael.bohn@
igb.fraunhofer.de

Dr. Brigitte Kempter-Regel
Greentech Solutions
Business Development
Phone +49 711 970-4186
brigitte.kempter-regel@
igb.fraunhofer.de

Fraunhofer Institute for
Interfacial and
Bioprocess Engineering IGB
Nobelstr. 12
70569 Stuttgart
Germany
www.igb.fraunhofer.de