TetraPhos® process applied to NL and DE sewage sludge ashes
Comparative analysis
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TetraPhos® - Process
TetraPhos® - integration into process chain waste water treatment

Wastewater is a valuable source of raw materials, not only for phosphorus! With Aquatic Mining® we are just at the beginning.
Project flowchart

Laboratory tests
- Characterization of ashes
- Leaching conditions
- Initial product estimations

Choice of operating parameters

Pilot tests
- Proof of desired P-recovery
- Process optimization
- Obtaining sample products

Results of pilot operation

TetraPhos®-plant
- Quantitative framework
- Added value
- Cost effectiveness

The recovered phosphoric acid RePacid® consists of higher quality than the raw material from natural sources.
die umlaufende graue Fläche ist zu allen Seiten gleich // % Satz der Transparenz
Wechsel der Textebene im Menü über:

TetraPhos® - pilot plant
TetraPhos® - pilot plant

Location: Werdohl, Germany
Operation: ready to run
Input: sewage sludge ash
Capacity: 50 kg/h
Products: p-acid (H₃PO₄)
gypsum
metal-salts
minerals
EGLV // SNB // HVC

Interreg VB Northwest Europe “Phos4You”

Comparison of TetraPhos® pilot tests
Goals of pilot operation

- **EGLV**
  - Proof of steady operation
  - Proof of phosphate leaching rate

- **SNB & HVC**
  - Reaching the desired leaching rate
    - samples of minerals
  - Conducting crystallization process, ion exchange, acid evaporation step
    - samples of gypsum
    - samples of metal salts
    - samples of phosphoric acid (RePacid®)
  - Determine design & upscaling factors
Characterization of ashes
Comparison
Characterization of ashes – key elements

- EGLV
  - BOT1 with coal-conditioning
  - BOT2 without coal-conditioning
  - Treated ash BOT2 is (will be) a representative sample for Bottrop

- SNB & HVC
  - Rich in phosphorus
  - Low in aluminum and average in ferric
  - SNB high in calcium
  - Treated ashes are representative samples for Moerdijk & Dordrecht
Proof of phosphate leaching
EGLV
lab scale leaching tests

- Target phosphate leaching rate was easily achieved by varying leaching conditions
EGLV

Proof of phosphat leaching

- EGLV
- Steady phosphate leaching during complete operation
- Constantly above 90 %
- Minerals in landfill class II (DK II), whereas basic ash is DK III
- Potential for cost saving
SNB & HVC
Lab scale leaching tests: comparison of HVC and SNB Ash Samples

- Under identical experimental conditions, for both ashes the optimum target value of phosphorus recovery rate could be achieved at "High" leaching conditions.
SNB & HVC

Proof of phosphat leaching

- Under identical leaching conditions:
  - SNB: Average phosphorus recovery rate of 80 % => adaptation of the leaching conditions
  - HVC: Average phosphorus recovery rate of 88 %
By varying the leaching conditions, a P-recovery rate of over 90% was simply achieved.
Proof of product quality
# Proof of product quality

## Phosphoric acid

- **EGLV**
  - All RePacid® batches are within specification

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Unit</th>
<th>REPACID® Specification</th>
<th>REPACID®</th>
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- **SNB & HVC**
  - RePacid® samples according to specification

<table>
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<tr>
<th>Parameter</th>
<th>Unit</th>
<th>REPACID® Specification</th>
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<th>REPACID® HVC</th>
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Proof of product quality
Synthetic gypsum

- Exceptional white color
- High purity: ~ 100%
- Average dry content: 70 – 80%
- According to expected quality
Product samples
Phosphate Balance

Input: 100% P - in sewage sludge

Output P [Mg]
- Minerals: 14%
- Gypsum: 3%
- Wash water: 3%
- Phosphoric acid: 80%

Output P [%]
- 14%
- 3%
- 3%
- 80%

Recovery
Comparison of phosphate balance

- **SNB**
  - Leaching: 90.0
  - Crystallization: 86.4
  - Ion separation: 85.4
  - Evaporation: 85.4
  - Ash: 10.0
  - Leachate: 3.6
  - Synthetic Gypsum: 1.0
  - Permeate: REPACID®

- **HVC**
  - Leaching: 88.0
  - Crystallization: 86.0
  - Ion separation: 85.0
  - Evaporation: 85.0
  - Ash: 12.0
  - Leachate: 2.0
  - Synthetic Gypsum: 1.0
  - Permeate: REPACID®

- **EGLV**
  - Leaching: 85.6
  - Crystallization: 83.0
  - Ion separation: 82.0
  - Evaporation: 82.0
  - Ash: 14.4
  - Leachate: 2.6
  - Synthetic Gypsum: 1.0
  - Permeate: REPACID®
Summary
Comparison of TetraPhos® pilot tests

- Incineration process has an effect on phosphate recycling process steps
- Recovery rate
  - Legal required recovery rate is reliably reached
  - Optimal recovery rate for business case is reliably reached
- Steady process and constantly high product quality is proved.
- Minerals show same landfill classification, with chance for lower class
- Synthetic gypsum has the expected high quality
- Evaporation step runs perfectly normal and is easy to be adjusted
- Business case for all three ashes are calculated
In case of questions, please feel free to ask!