

TetraPhos® process applied to NL and DE sewage sludge ashes

Comparative analysis

REMONDIS®

IM AUFTRAG DER ZUKUNFT



Interreg 
North-West Europe
Phos4You
European Regional Development Fund

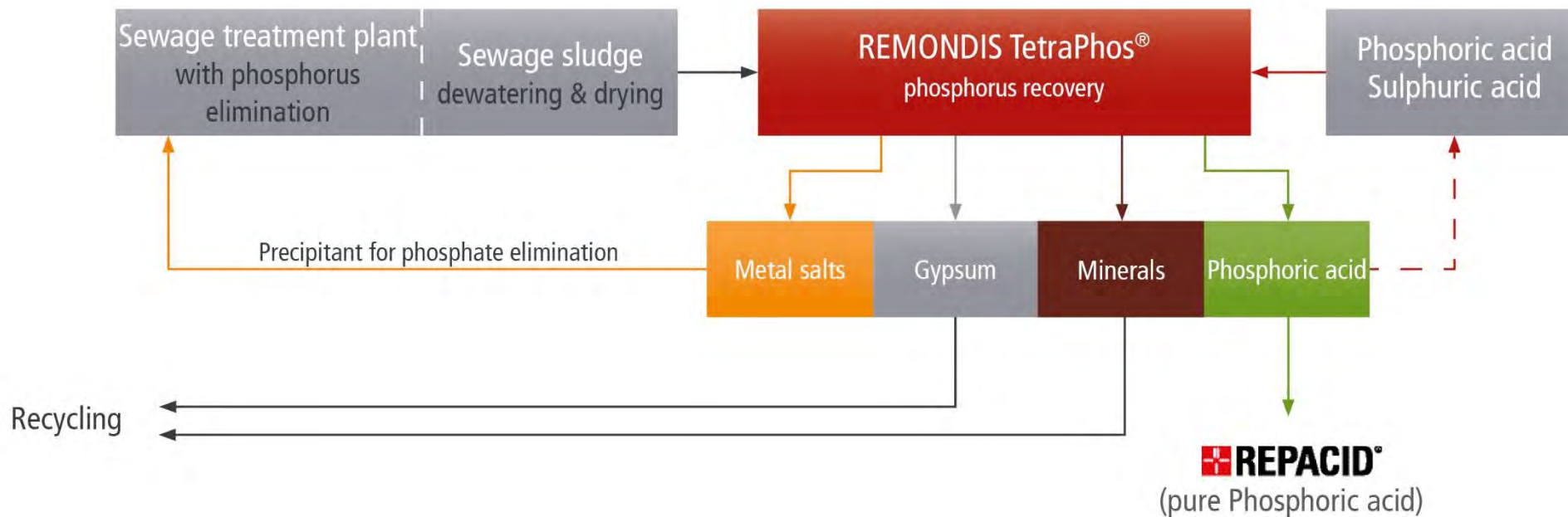
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TetraPhos® - Process

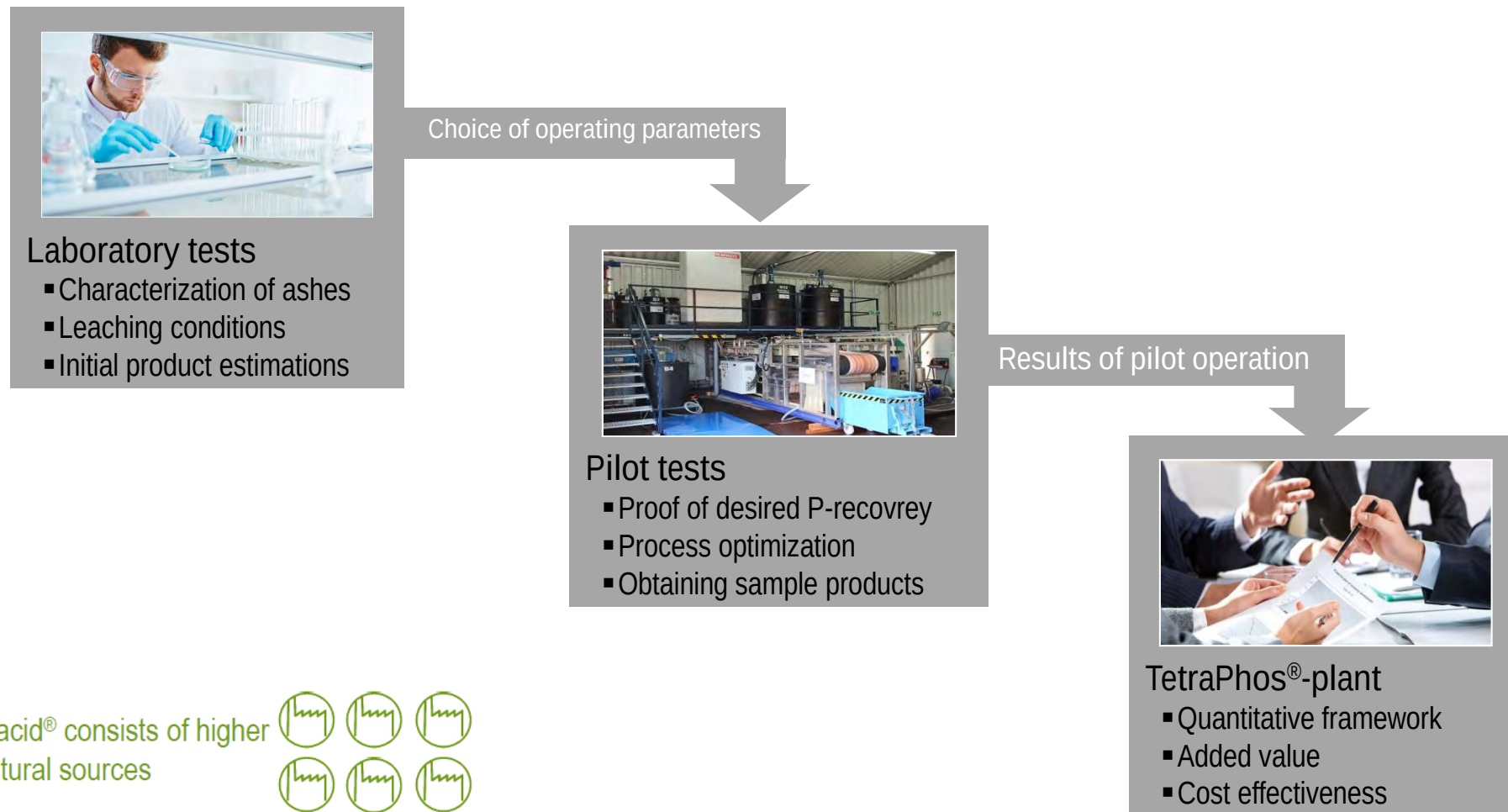
TetraPhos® - integration into process chain waste water treatment



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



Project flowchart



The recovered phosphoric acid RePacid® consists of higher quality than the raw material from natural sources



TetraPhos® - pilot plant

TetraPhos® - pilot plant



Location: Werdohl, Germany

Operation: ready to run

Input: sewage sludge ash

Capacity: 50 kg/h

Products: p-acid (H_3PO_4)

gypsum

metal-salts

minerals



<https://www.nweurope.eu/projects/project-search/phos4you-phosphorus-recovery-from-waste-water-for-your-life/>

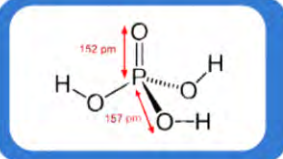



Phosphoric acid (H_3PO_4)

Origin: Phosphorus recovery plants out of sewage sludge ashes

Recycling pathways:

- Technical grade acid
- Merchant grade acid



DESCRIPTION

ORIGIN & AVAILABILITY

Phosphoric acid can be produced at a phosphorus recovery plant from sewage sludge ashes (ssa) with wet chemical processes such as e.g. TetraPhos®, PARFORCE, Phos4Life™.

Resources of phosphoric acid (75%) depending on P-content of ssa can be up to 10 000 tons/year/plant, based on ca. 30 000 tons ssa/y.

P-recovery plants are expected to be distributed in areas where sewage sludge incineration plants are located. The 1st industrial plant is constructed in Hamburg (2020) based on the TetraPhos® process.

A reliable provision of phosphoric acid from ssa over the year can be expected, as ssa volumes are relatively constant and as adjustments in the P-recovery process allow to reach a stable quality of acid.

QUALITY CONSIDERATIONS

As the required quality strongly varies according to the application field (Merchant Grade Acid, Technical Grade, Electronic grade), the targeted quality is reached at process level by upconcentrating and/or removing and recovery of some elements.

RECYCLING PATHWAYS

The recovered phosphoric acid can be recycled as chemical for industrial application or as material in the fertiliser manufacturing process. For the latter use, the EU Fertilising Products Regulation (EU) 2019/1009 and the existing national legislations are applicable.

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The specification of phosphoric acid usually includes its concentration (75-85%) and the content in elements (e.g. Al, Ca, F, Fe, K, Mg, Zn, Cl, SO₄, As, Pb).

INTEREST & VALUE

Technical and merchant grade phosphoric acid are products with an existing market. This facilitates their integration in value chains.

TIPS/BE AWARE

REACH obligations apply to recovered H_3PO_4 . Fulfilling them might be eased by the fact that different phosphoric acids for different tonnage bands are already REACH registered substances (e.g. art 2 (7)d of Regulation (EC) 1907/2006 could apply).

At the recovery plant, some by-products (e.g. metal salts, gypsum, road salt), ash residue and possibly wastewater (depending on the process) are generated. The producer needs to cope with their valorisation, recycling or disposal.

The used leaching agent and the implemented impurities separation processes lead to varying qualities of phosphoric acid and different by-products.




Acid extraction of phosphorus from sewage sludge incineration ash: REMONDIS TetraPhos®

Piloted by: Lippeverband with REMONDIS Aqua

P-source: Sewage sludge ashes with low P-load

P-product: Phosphoric acid (H_3PO_4)



The process

The REMONDIS TetraPhos® process (TetraPhos® process) enables the recovery of phosphate as phosphoric acid from ashes originating from fluidized bed combustion of municipal sewage sludge. Thereby more than 80 % of the ash phosphorus is recovered.

The TetraPhos® process treats the ash with phosphoric acid, then, after separation of acid insoluble residue, purifies the resulting leachate with sulphuric acid, ion-exchange and selective nano-filtration to generate an industrial quality phosphoric acid (brandname RePacid®).

The Emscher and Lippe regions produce sewage sludge ashes with a low P-load (8% - 11% P_2O_5). Phos4You looks at the possibilities to apply such a process with this SSA-quality.



The product

The produced RePacid® is a phosphoric acid with very low contaminant level, making it suitable for industrial applications or the use as raw material for further chemical processing to industrial products.

Indeed most of the other phosphate products are made from this important, multi-functional mineral acid, in manufacturing fertilisers or animal feed, but also in industrial application. Demand for phosphoric acid lies at over a million tonnes per year in Europe alone.

Apart from production of RePacid®, the TetraPhos® process enables recovery of iron and aluminium salts as coagulants, for recycling in sewage works phosphorus removal and gypsum intended for production of building material and a residual ash waste that either is used in the cement industry or if the latter is not possible is landfilled.

The demonstrator

Location: Germany, Sewage sludge incineration plant WFA Elverlingsen GmbH, Werdohl Germany, indoor

Commissioning: May 2018

Input material: Sewage Sludge Ashes

Input mass: approx. 50 kg DM/h

Output: H_3PO_4

Output mass: approx. 18 kg/h



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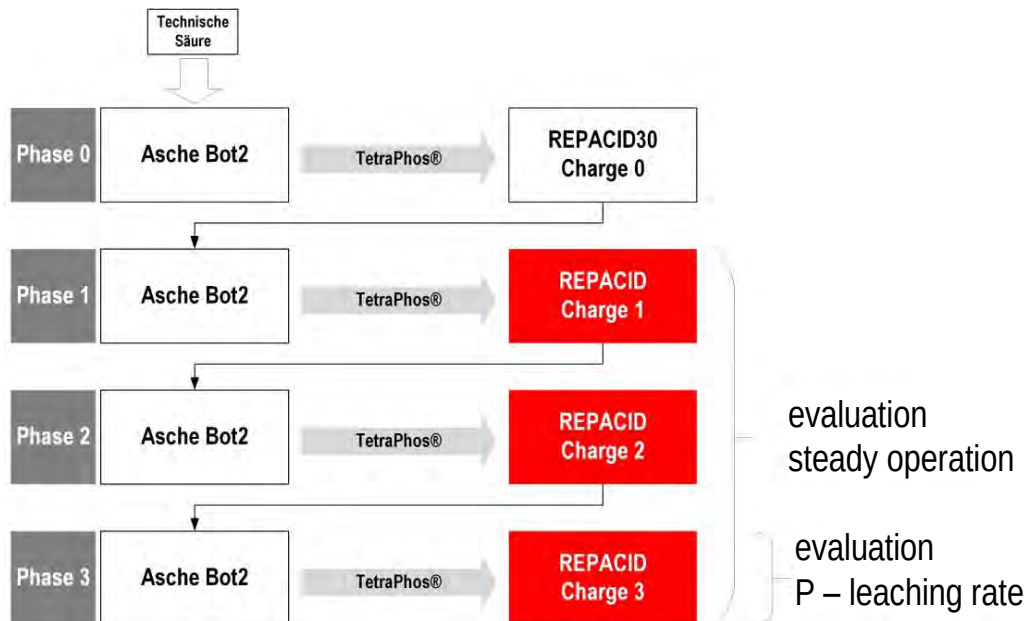
EGLV // SNB // HVC

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



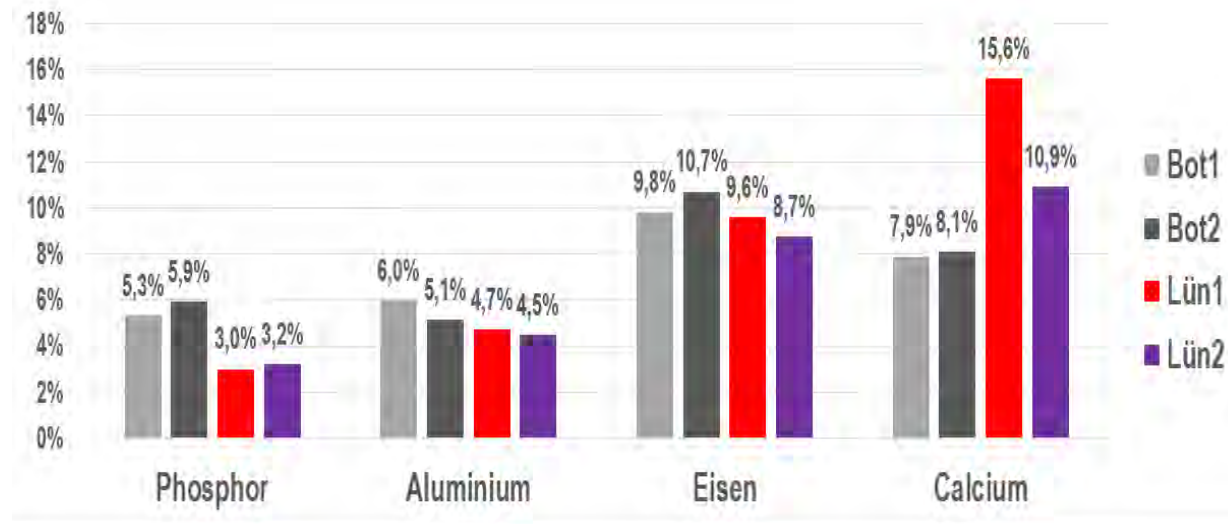


Characterization of ashes

Comparison

Characterization of ashes – key elements

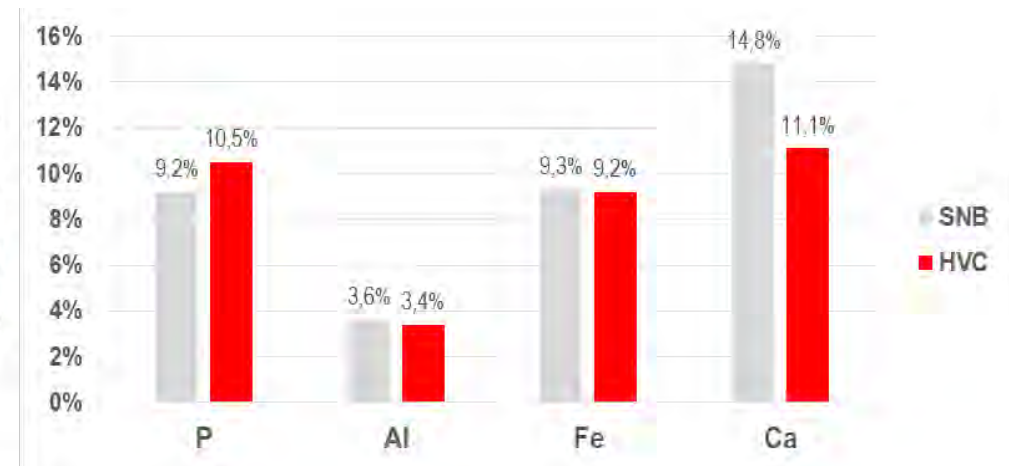
■ EGLV



- 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

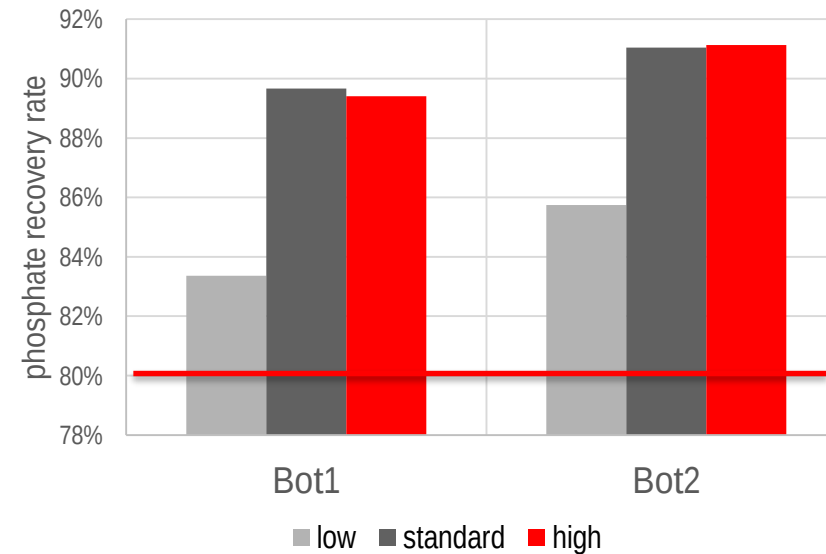


Proof of phosphate leaching

EGLV

lab scale leaching tests

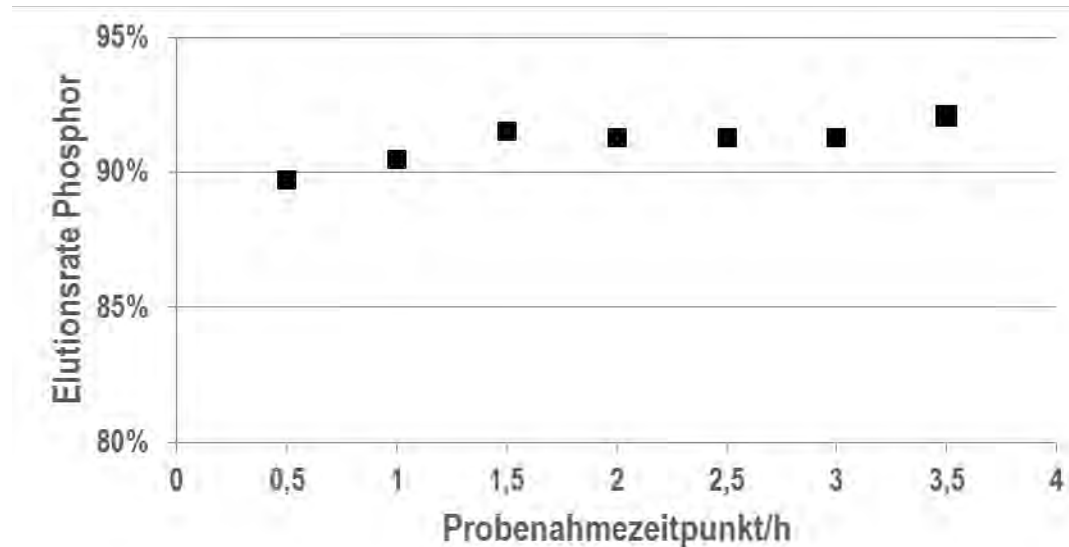
- Target phosphate leaching rate was easily achieved by varying leaching conditions



EGLV

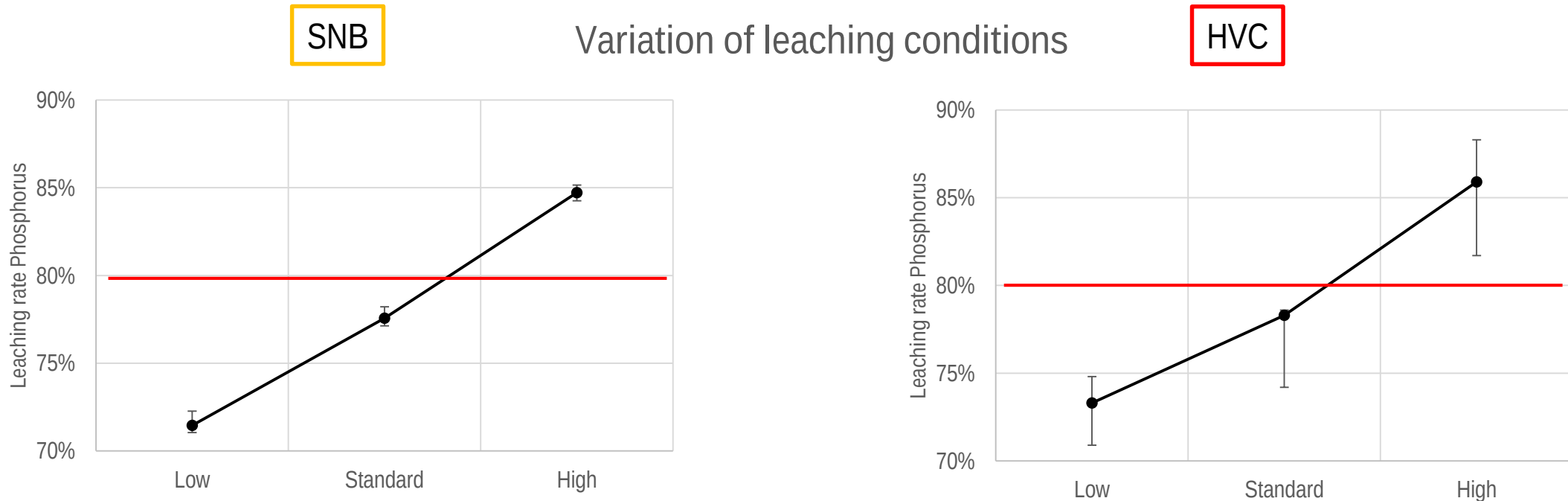
Proof of phosphat leaching

- 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

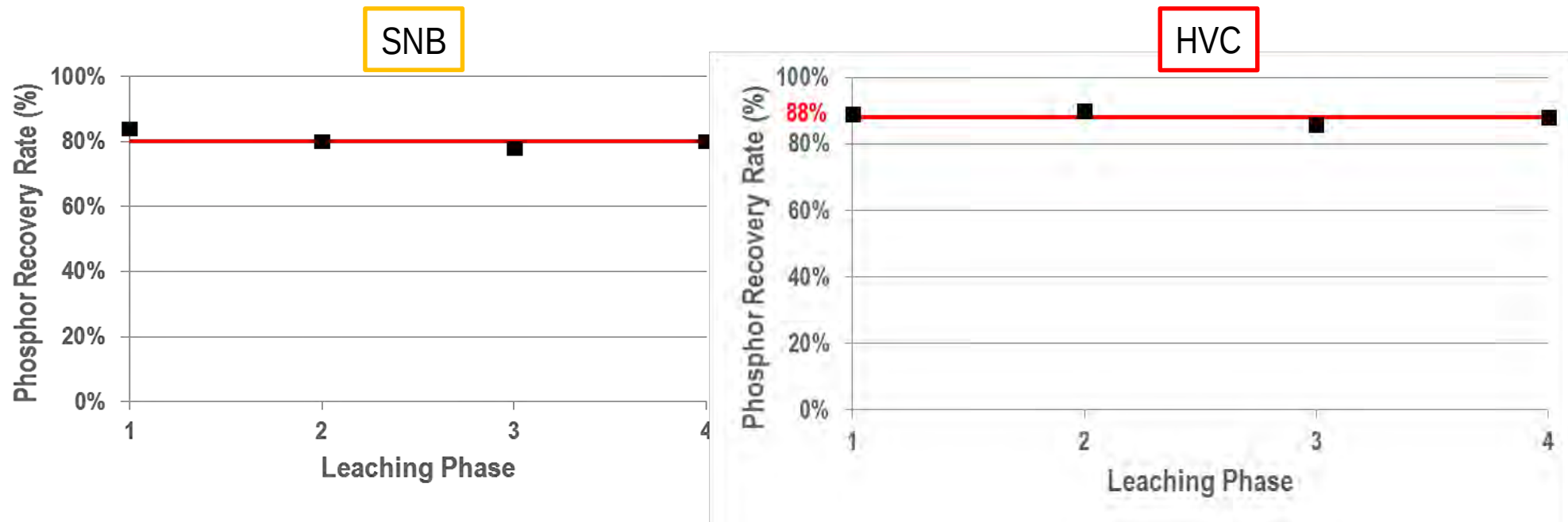


- Under identical experimental conditions, for both ashes the optimum target value of phosphorus recovery rate could be achieved at „High“ leaching conditions.

SNB & HVC

Proof of phosphat leaching

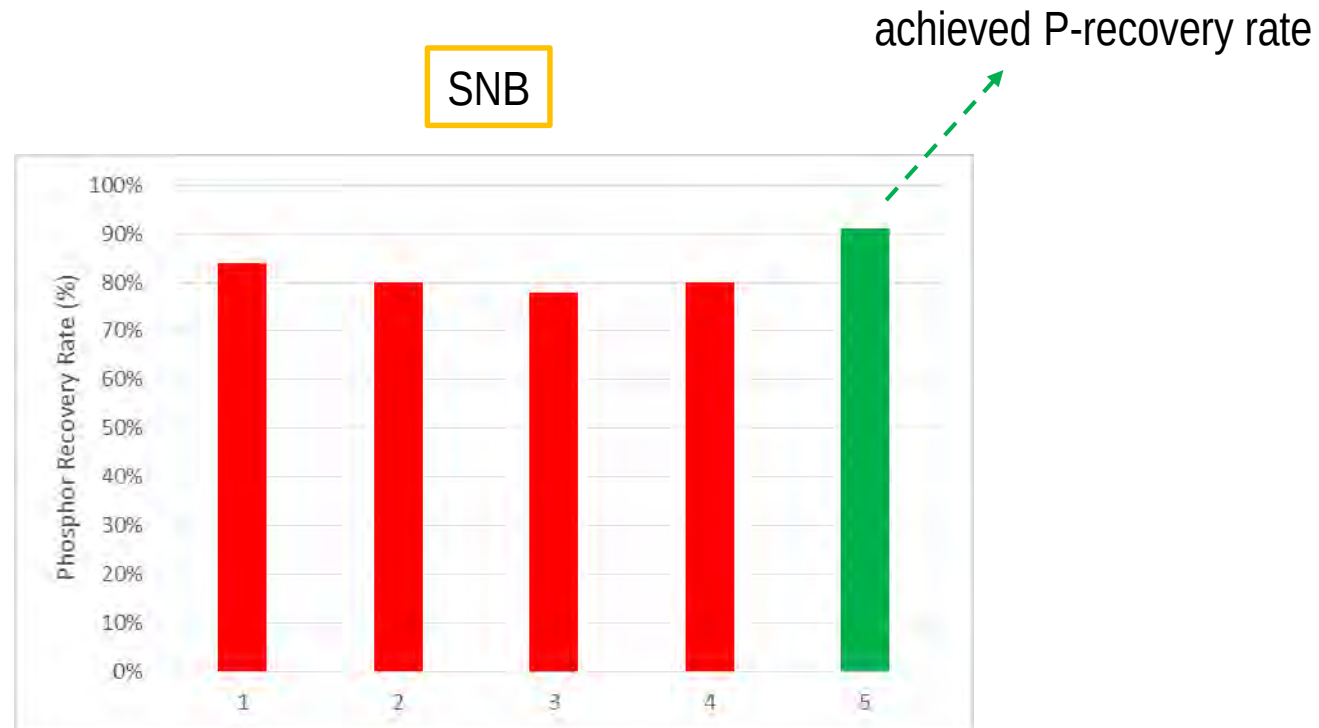
- Under identical leaching conditions:
 - SNB: Average phosphorus recovery rate of 80 % => adaptation of the leaching conditions
 - HVC: Average phosphorus recovery rate of 88 %



SNB

Proof of phosphat leaching

- 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

Parameter	Unit	REPACID® Specification	REPACID®		
			Charge 1	Charge 2	Charge 3
H ₃ PO ₄	%	75	75	75	71,5
S _{total}		0,5 -1	0,80	0,89	0,91
Al		0,1 – 1	<0,02	<0,02	<0,01
Fe		0,1 – 1	0,17	0,25	0,39
Ca		< 0,05	<0,02	<0,02	<0,01
Mg		< 0,05	<0,002	<0,002	<0,01
Cd	ppm	< 1	<0,22	<0,21	<0,1
Cu		< 3,5	<2,2	<2,2	<1
Ni		< 3	<2,2	<2,2	<1
Pb		< 3	<2,2	<2,2	<1

■ SNB & HVC

- RePacid® samples according to specification

Parameter	Unit	REPACID®- Specification	REPACID® SNB	REPACID® HVC
H ₃ PO ₄	%	75	74.5	71.5
S _{total}		0.5 -1	0.73	0.87
Al		0.1 – 1	< 0.01	< 0.01
Fe		0.1 – 1	0.52	0.34
Ca		< 0.05	< 0.01	< 0.01
Mg		< 0.05	< 0.001	< 0.001
Cd	ppm	< 1	< 0.1	< 0.1
Cu		< 3.5	< 1	< 1
Ni		< 3	2.7	2.2
Pb		< 3	< 1	< 1

Proof of product quality

Synthetic gypsum

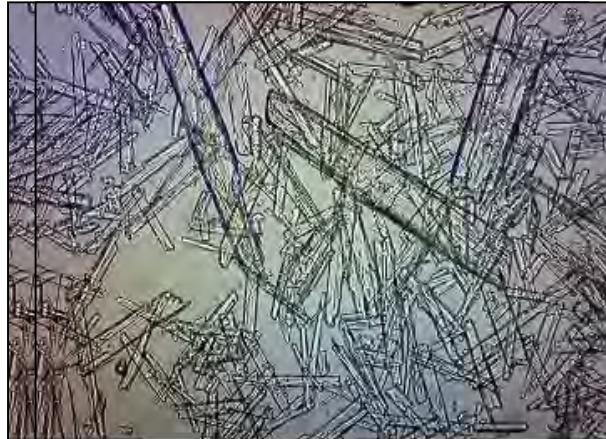
- Exceptional white color
- High purity: ~ 100%
- Average dry content: 70 – 80%
- According to expected quality

■

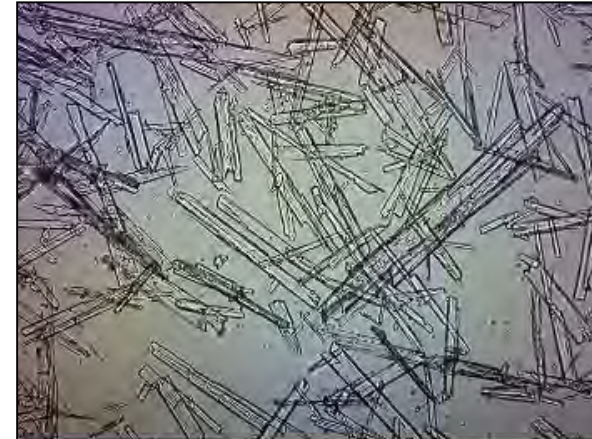
EGLV



SNB

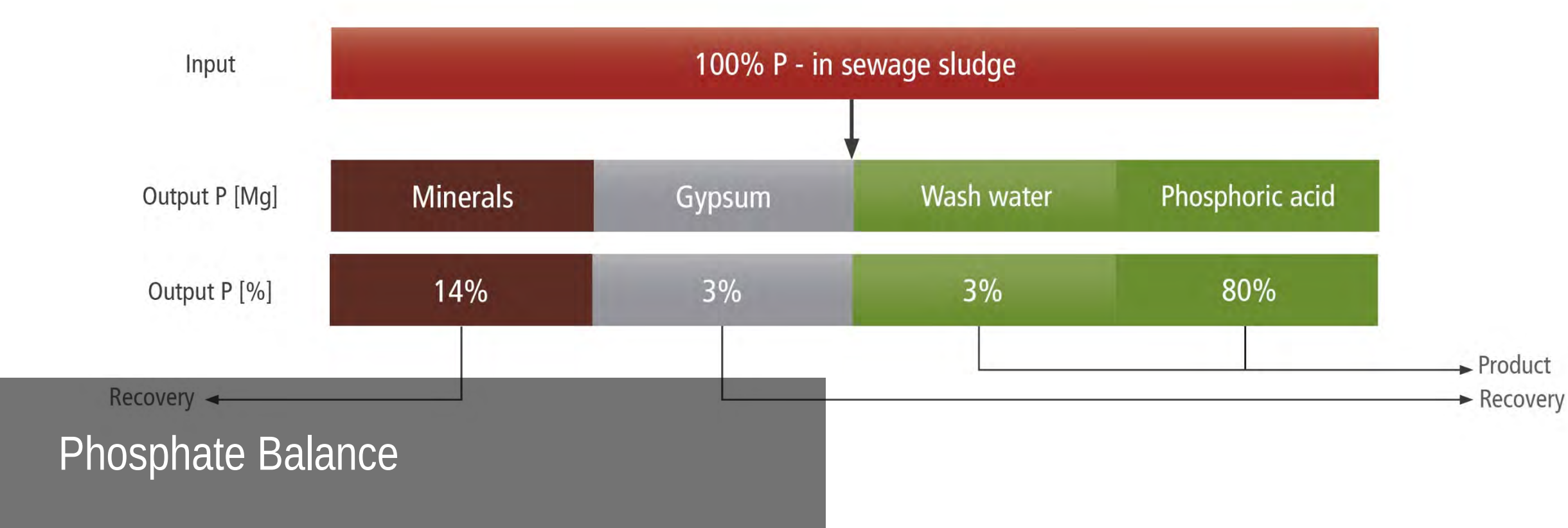


HVC

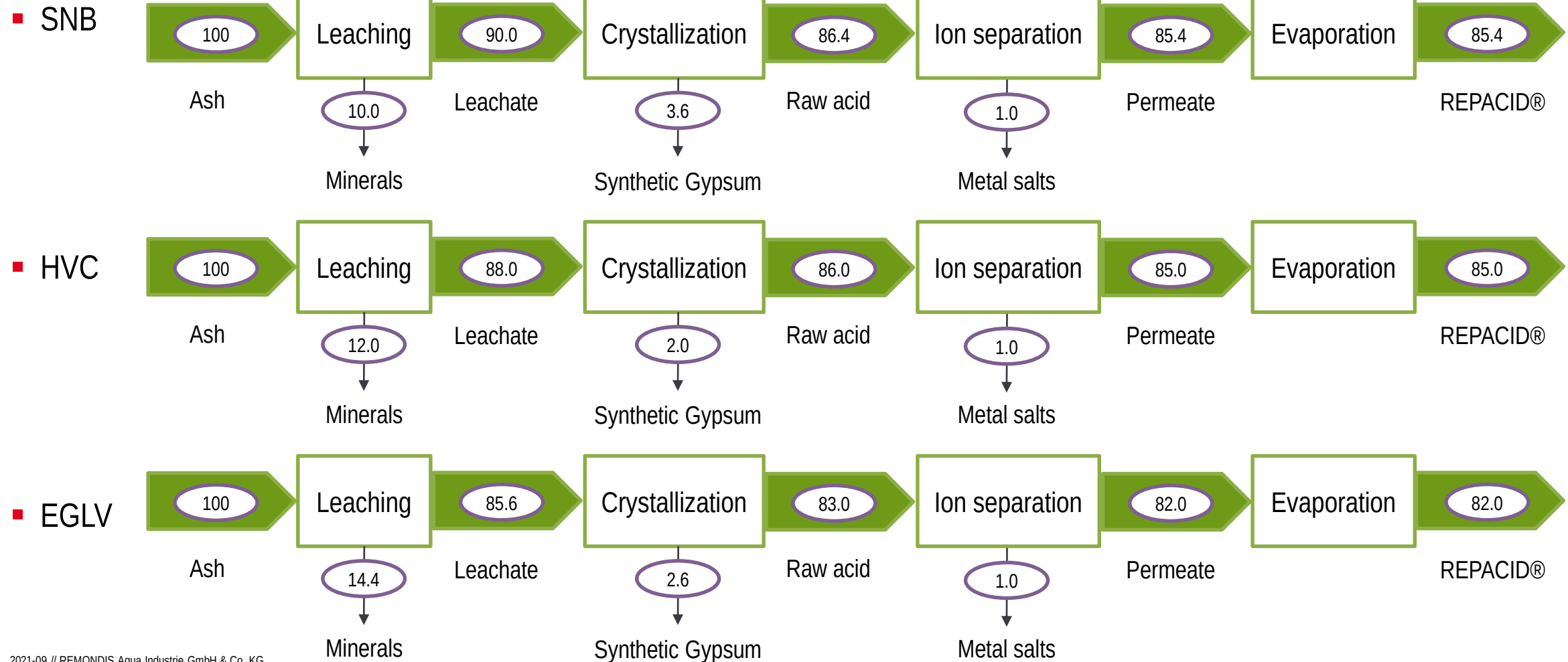




Product samples



Comparison of phosphate balance





 **GreenTec
Awards**
REMONDIS SE & Co. KG
Gewinner in der Kategorie
**Recycling &
Ressourcen**
2016

Summary

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!





Unternehmensdaten
REMONDIS Aqua gesamt