Recovering phosphorus from chemical phosphorus removal sludge

A techno-economic comparison

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Contents

The challenge of chemP recovery

P in chemical sludge is bound on with metal or on sludge

- Not available as soluble PO_4^{3-}

A wide range of P-sludges bring diversity to required P recovery solution

- Precipitation chemical in water process
- Sludge processing (availability of incinerator)
- Different practices and legislation from country to country
- Desired form of the recovered P

Finding one solution that would fit all possible scen
does not seem feasible.

The goal

ChemP is the most common P removal method in Nordics

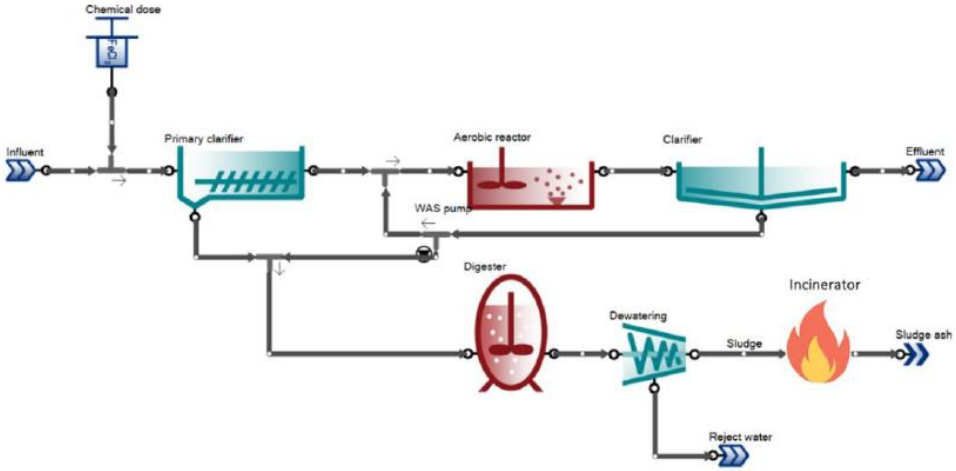
This study aims to compare five different P recovery methods

- Source material: chemical sludge (SS) or sludge ash (SSA) (from mono-incineration)
- The entire process chain is included in the analysis
  - Water process and sludge treatment
- Operational cost, end product quality, recovery efficiency and technological maturity were assessed.
- A decision-making tree is proposed

Bio-P followed by struvite precipitation was excluded from the study.

Method of comparison

- **Processes applied in representative 50 000 m³/d plant**
- **Process data was up or downscaled (linearly)**
- **A SUMO model**
  - 95% P reduction in water process
  - Water process chemical consumption
  - Sludge characteristics



Technology selection

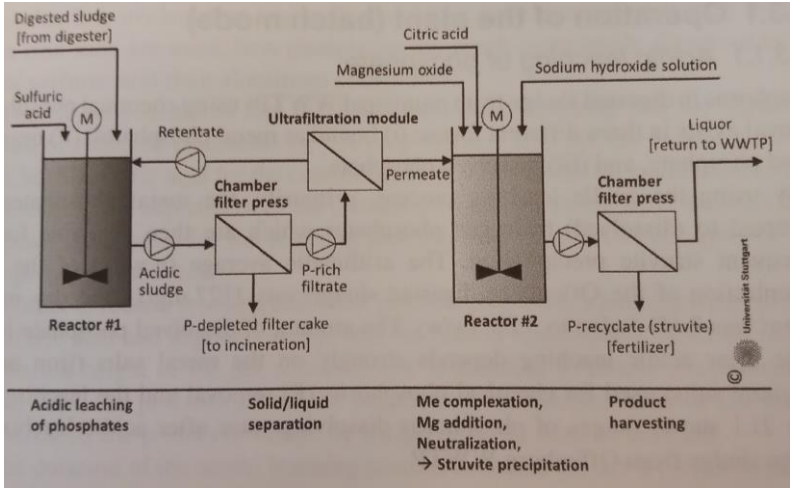
1. **Wet leaching with acid + struvite precipitation**
2. **Magnetic vivianite separation**
3. **Sludge melting gasification**
4. **Thermochemical sodium process**
5. **White phosphorus recovery**

- **Most common methods on pilot scale or higher**
- **Sufficient data available**
  - Process performance
  - Characteristics of the P source material
  - Quality of the product

Technologies: chemical processes

Wet leaching + struvite precipitation (SS+SSA)

- Stuttgart process
- Sulfuric acid leaching
- Product: **struvite**
- Large pilot scale



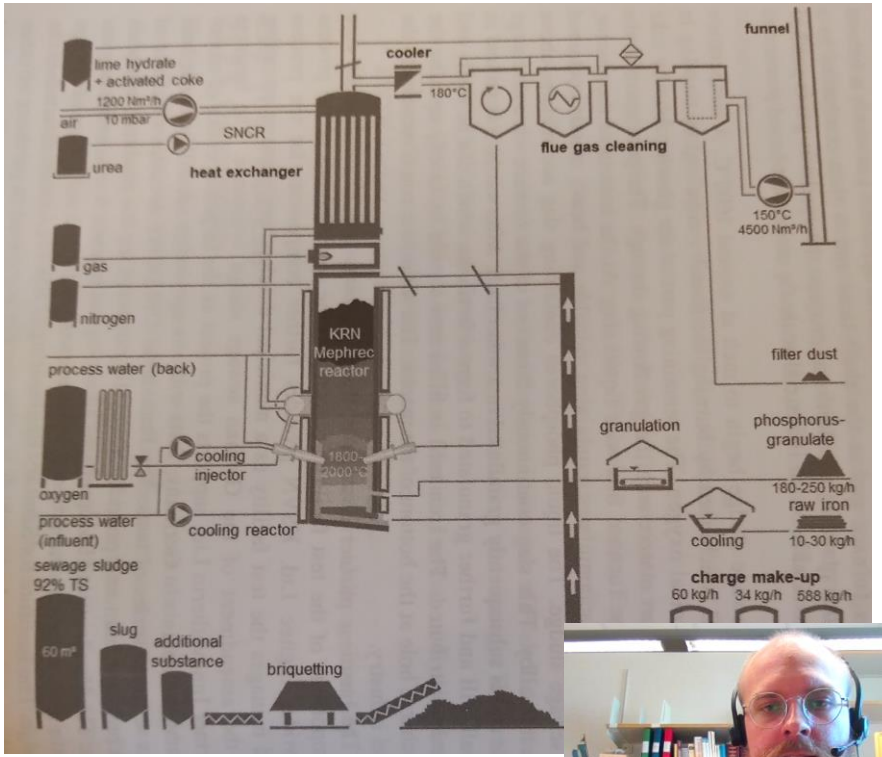
Magnetic vivianite separation (SS)

- Iron dosing in water process leads to vivianite formation in digested sludge
- Vivianite can be separate magnetically
- Product: mostly **vivianite** but some organics
- Experimental pilot scale

Technologies: Thermal processes

Sludge melt gasification (SS)

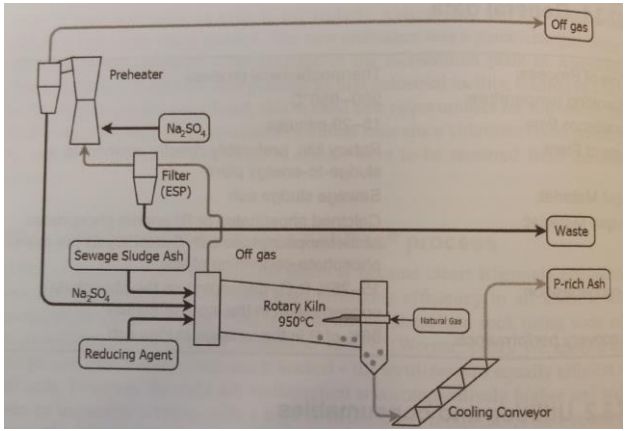
- KRN-Mephrec
- Sludge is dried and briquetted
- Thermal process at 1800-2000 °C separates metals and **P-rich slag**
- Full scale



Technologies: Thermal processes

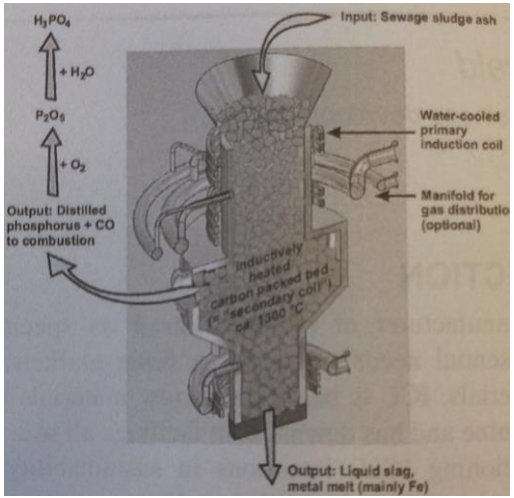
Thermochemical sodium process (SSA)

- AshDec
- Na_2SO_4 and SSA in rotary kiln form **Rhenania phosphates $CaNaPO_4$**
- Full scale



White P process (SSA)

- RecoPhos/Inducarb
- Electric arc process separates P in gas phase
- Product: **P_4 (white phosphorus)** / P_2O_5 / H_3PO_4



Full scale

Results: overview

	Wet leaching + Struvite	Vivianite	Sludge melt gasification	Thermochemical sodium sulfate process	White phosphorus
Precipitation chemical	Fe*, Ca	Fe	Ca*, Fe, Al	Ca*, Fe, Al	Al*, Ca
Recovery efficiency (%)	67	16–32	80	98	89
End-product quality (P-compound content%)	26.5****	50***	2.5**	15-25****	99.9**
Technical maturity	6–7	4–5	8–9	9	7–8
Cost of recovery €/kgP (energy+chemicals)	30.2	12.7	26.2	5.8	12.5
Requirement(s)		Fe feed to water process		Incinerator exists already	Incinerator exists already

* Metal was used in the calculation.
** P fraction of the product
*** Vivianite fraction of the product
**** P_2O_5 content in the product

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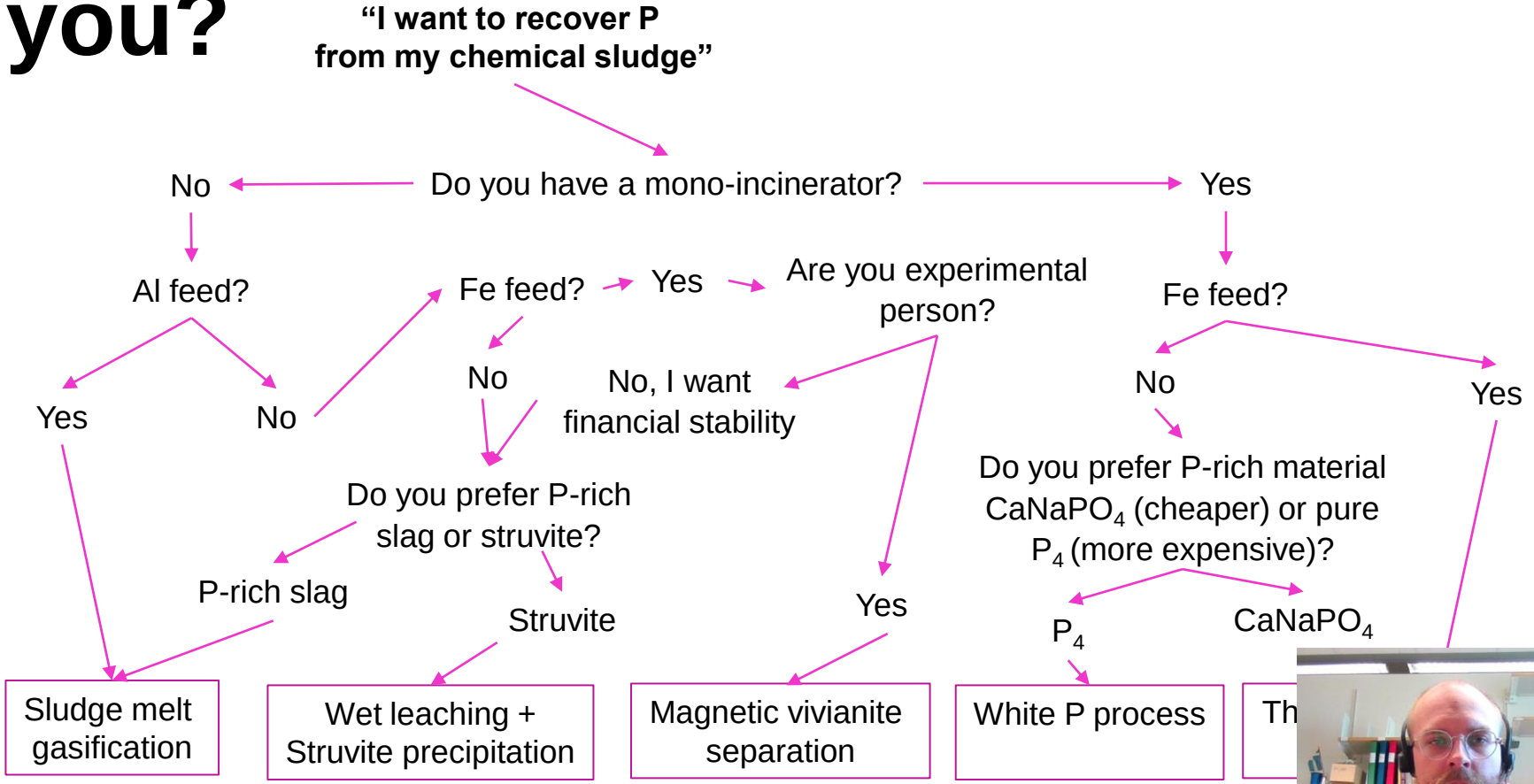
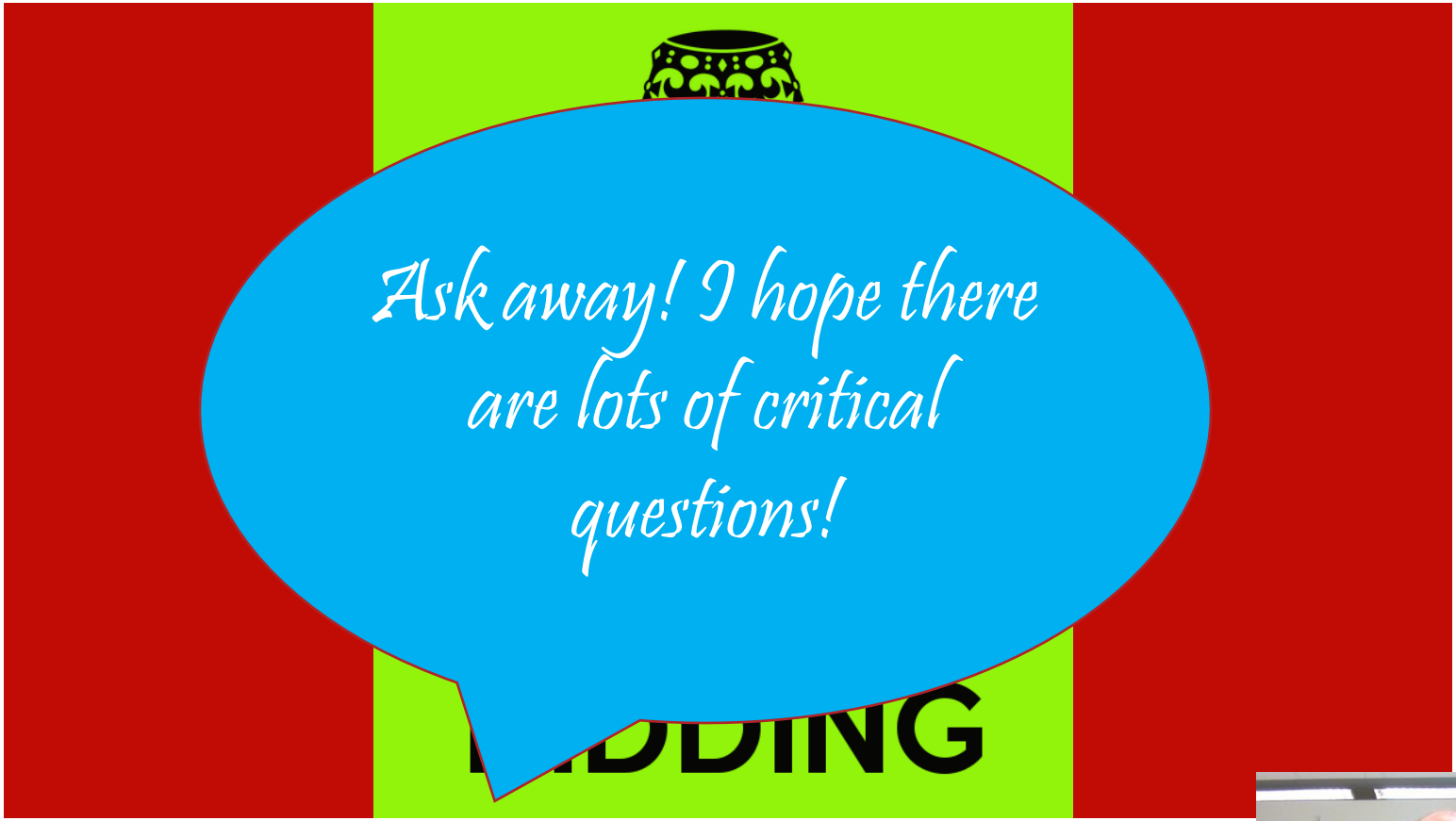
Results: What is most suitable for you?



Conclusions

- **P recovery from chemical sludge does not have a single solution that is attractive to every situation**
- **The price of recovery ranges from 5.8 to 30.2 €/kgP with selected recovery paths**
  - Existing incinerator enables more affordable processes
- **A design for a decision making tree is presented as a tool**
  - The authors hope that such a tool could help navigating the complex field of P recovery


Ask away! I hope there are lots of critical questions!