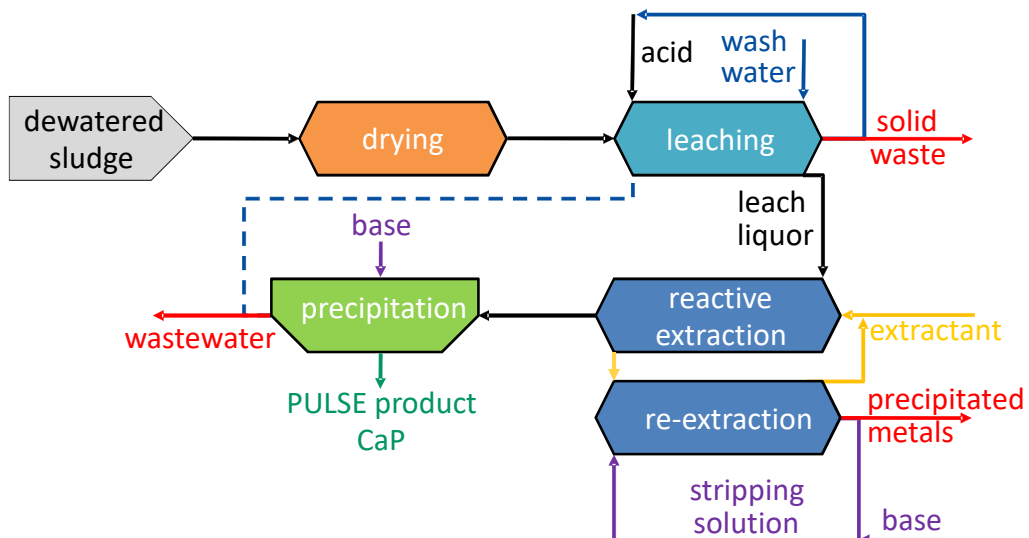


# Phosphorous Recovery From Sewage Sludge Utilizing Reactive Extraction

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## PULSE (Phosphorus University of Liege Sludge Extraction)



## PULSE demonstrator



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## PULSE demonstrator

- mobile unit
- capacity to treat up to 80 kg of dewatered sludge per batch
- 5 horizontal mixer-settlers
- locations:  
ULiège with German sludge  
Oupeye WWTP  
Bo'ness, Scotland



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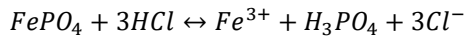


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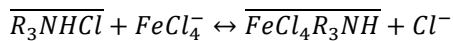
## reactions in PULSE process (examples)

- leaching of P and metals from sludge



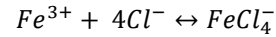
$$K_l = \frac{c_{Fe^{3+}} c_{H_3PO_4} c_{Cl^-}^3}{c_{FePO_4} c_{HCl}^3}$$

- reactive extraction of metals with organic extractant



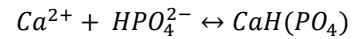
$$K_e = \frac{c_{\overline{FeCl_4R_3NH}} c_{Cl^-}}{c_{\overline{R_3NHCl}} c_{FeCl_4^-}}$$

- speciation in aqueous solution



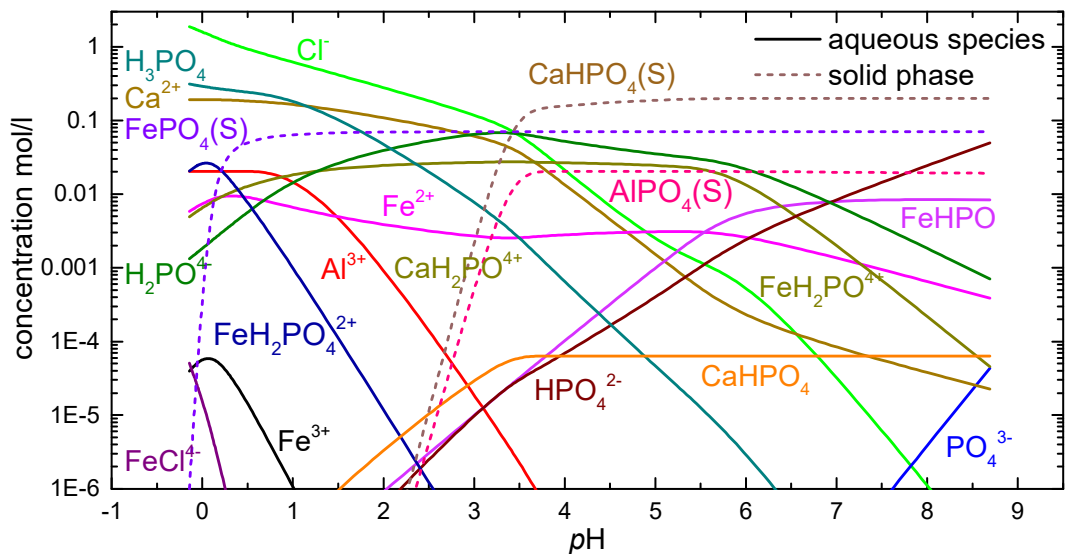
$$K_a = \frac{c_{FeCl_4^-}}{c_{Fe^{3+}} c_{Cl^-}^4}$$

- precipitation of CaP

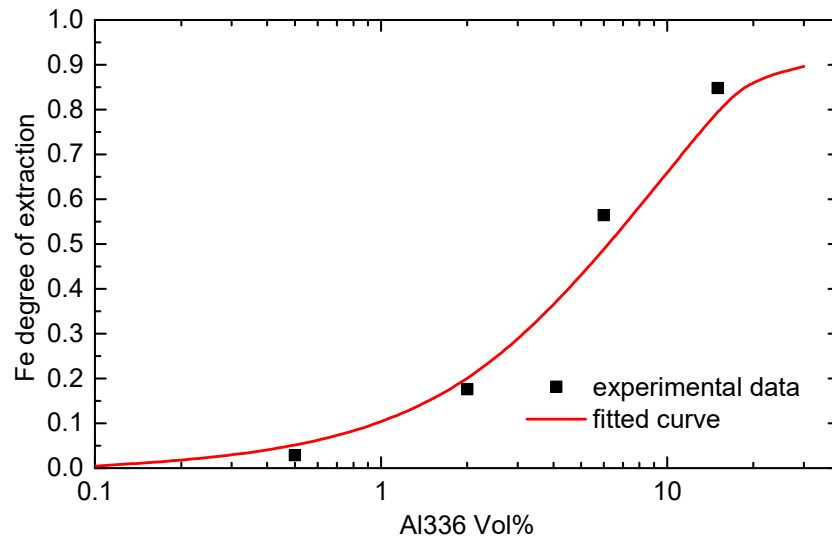


$$K_p = \frac{1}{c_{Ca^{2+}} c_{HPO_4^{2-}}}$$

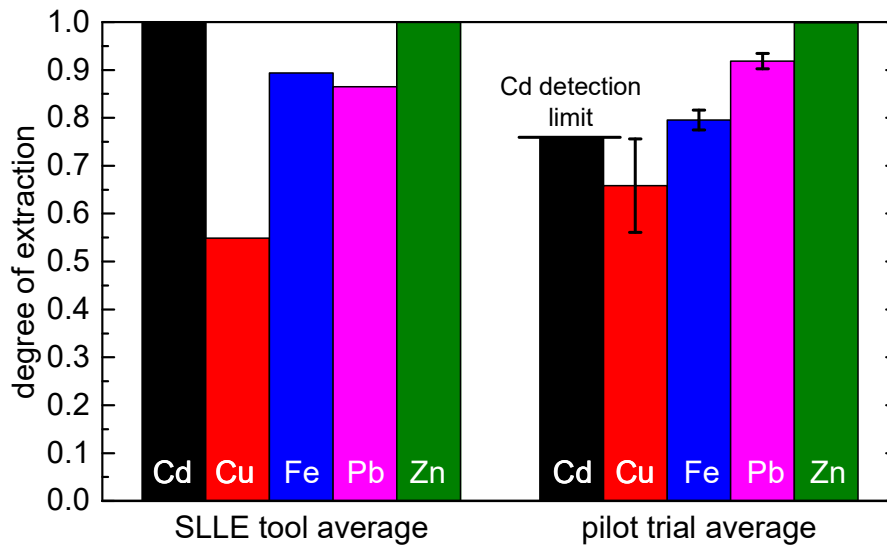
## SLLE tool simulation



## parameter fitting with SLLE tool

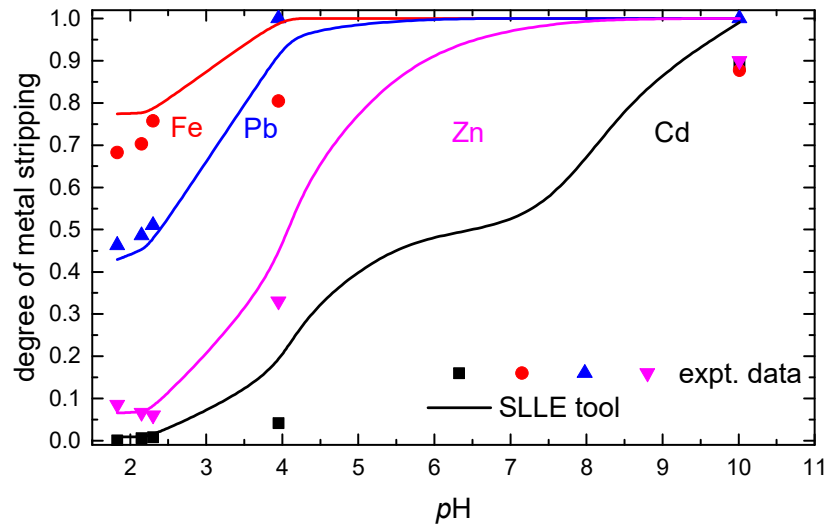


## reactive extraction of metals

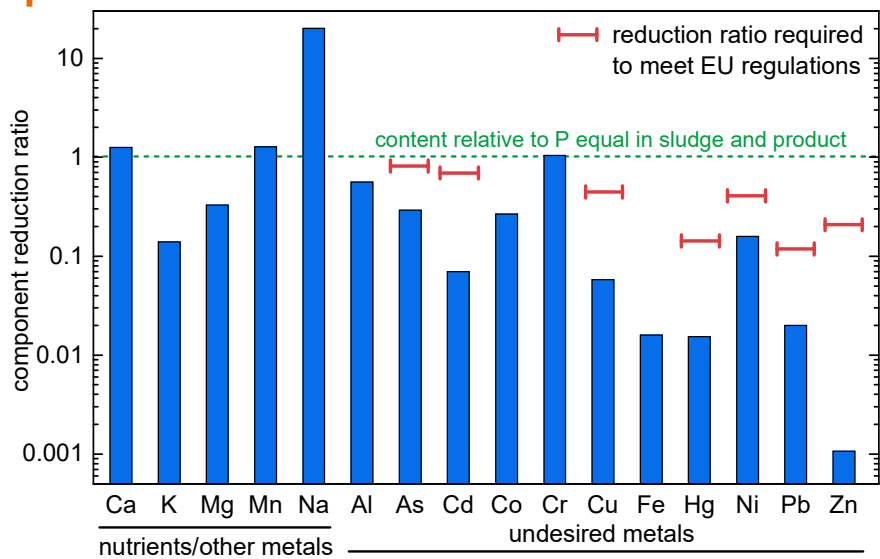


German sludge  
solvent: Alamine 336,  
TBP & Exxal 10,  
Ketrul D80  
o/a phase ratio: 1.5 to 3

## solvent stripping with Ammonia solution



## metal depollution



## summary

- pilot trials conducted with different sludges at different sites
- use of SLE simulation tool for optimization at each site
  - reduction in experimental work
  - optimization of process parameters
- solvent extraction → Fe, Cd, Cu, Hg, Pb and Zn extracted
- product analysis and granulation by Prayon → sufficient P<sub>2</sub>O<sub>5</sub> content and good granulation, low metal content
- good plant availability of P confirmed by pot trials from UGhent

## acknowledgements

- Interreg North-West Europe and Région Wallonne SPW
- BTC Europe GmbH – BASF for providing samples of Alamine336
- TOTAL Belgium for providing samples of Ketrul D80
- Exxon Belgium for providing samples of Exxal 10
- UGhent and Prayon Belgium for ICP analyses

The International Symposium for Green Solutions, ISGS 2022  
Industrial University of Ho Chi Minh City, Vietnam, Nov. 25, 2022

Interreg  
North-West Europe  
Phos4You  
European Regional Development Fund



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