



*We deliver Phosphorus made in
Europe*

PHOSPHORUS RECOVERY FROM DRIED SLUDGE WITH REACTIVE EXTRACTION TO REMOVE IMPURITIES

5th ECSM, 08.10.19, Liège, Belgium

Shariff Z.A., Fraikin L., Léonard A., Pfennig A.

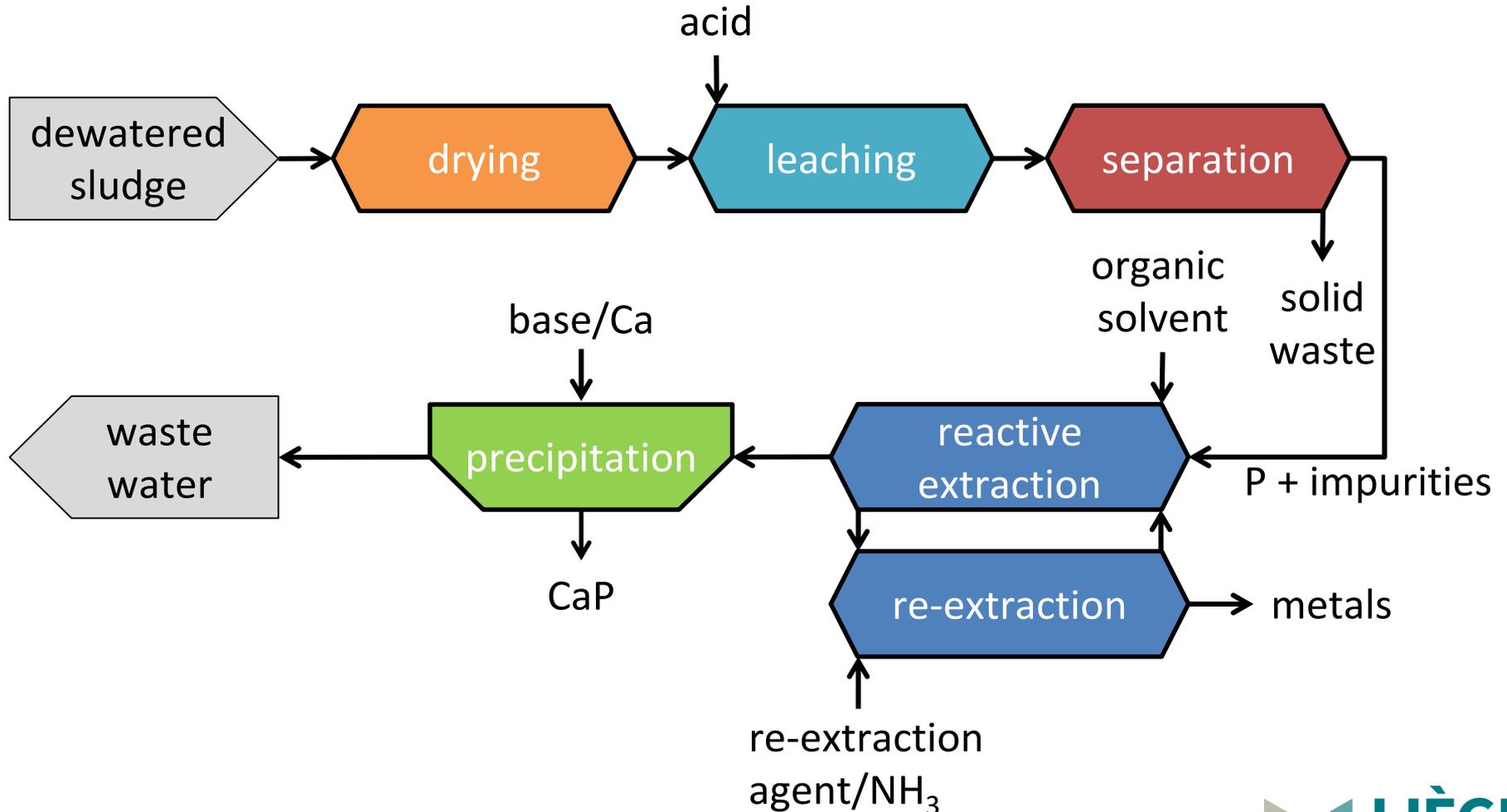
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agenda

- PULSE process concept
- process development
 - SLE modelling
 - cascaded option tree
- experimental results
- summary

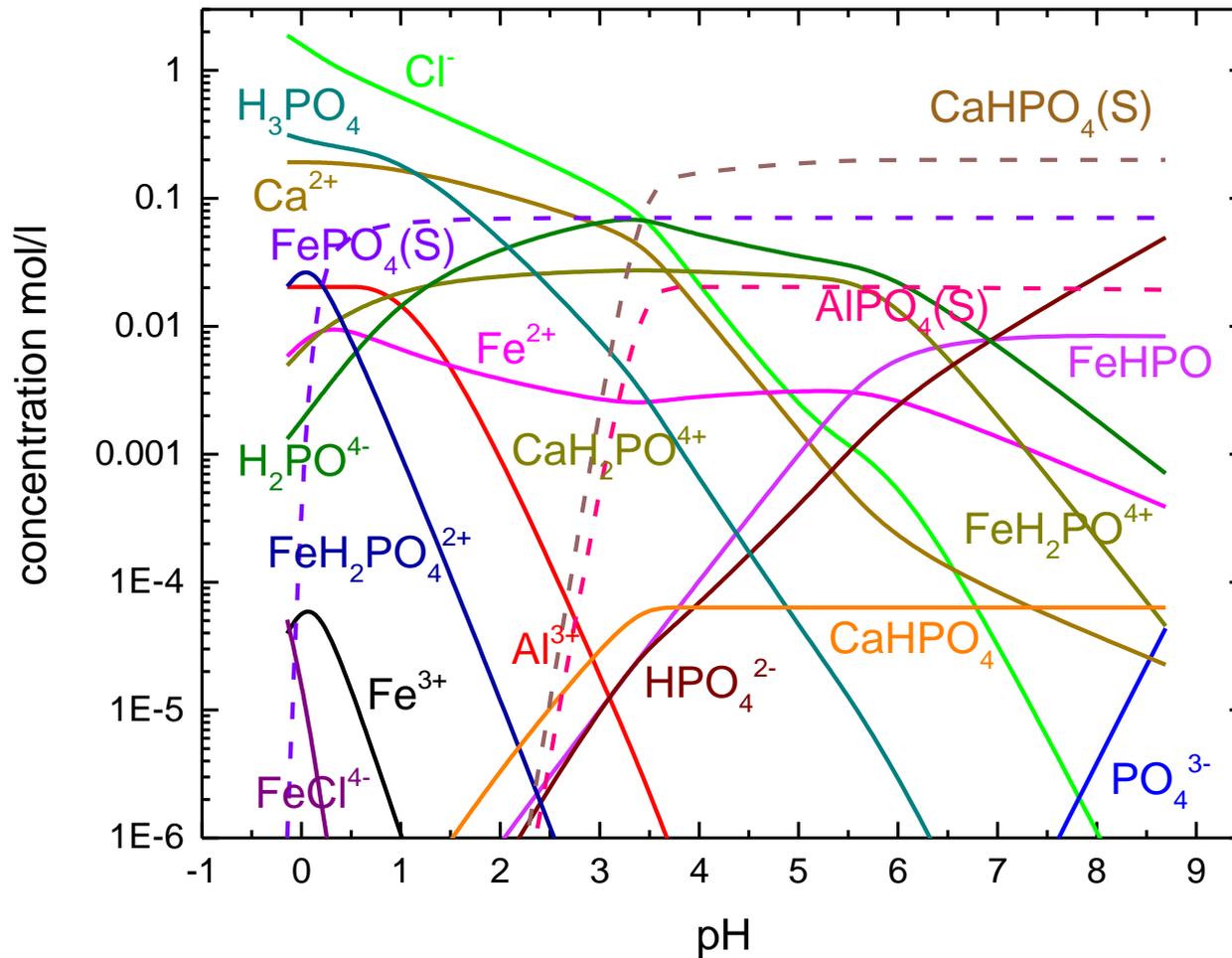
PULSE (Phosphorus University of Liege Sludge Extraction) process



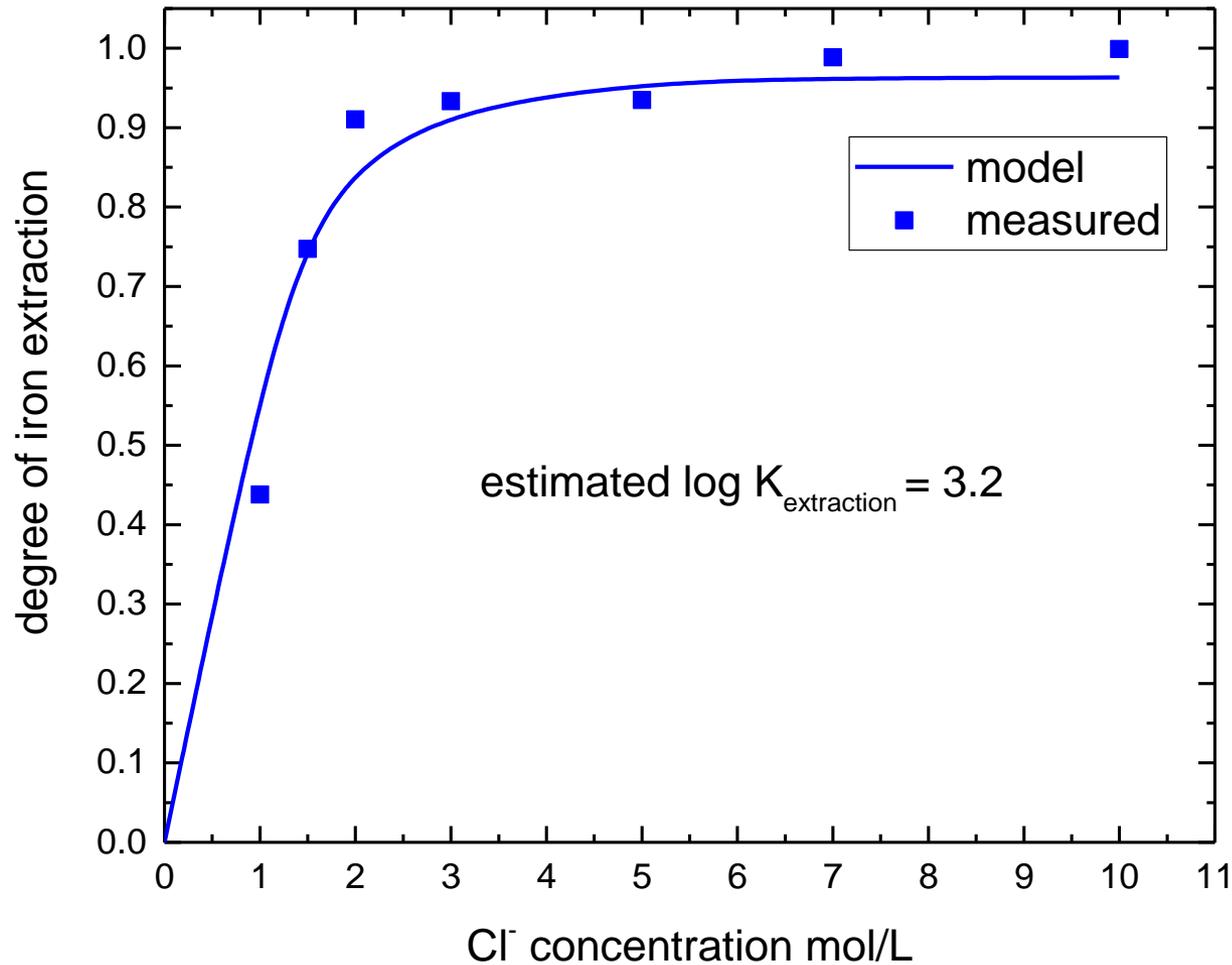
solid-liquid-liquid equilibrium

- aqueous phase speciation:
 - mass balance
 - law of mass action
 - charge balance
- solid precipitation:
 - saturation index
- activities instead of concentration to account for ionic interactions
- degree of reactive extraction with organic solvents
- evaluation of model parameters by data fitting

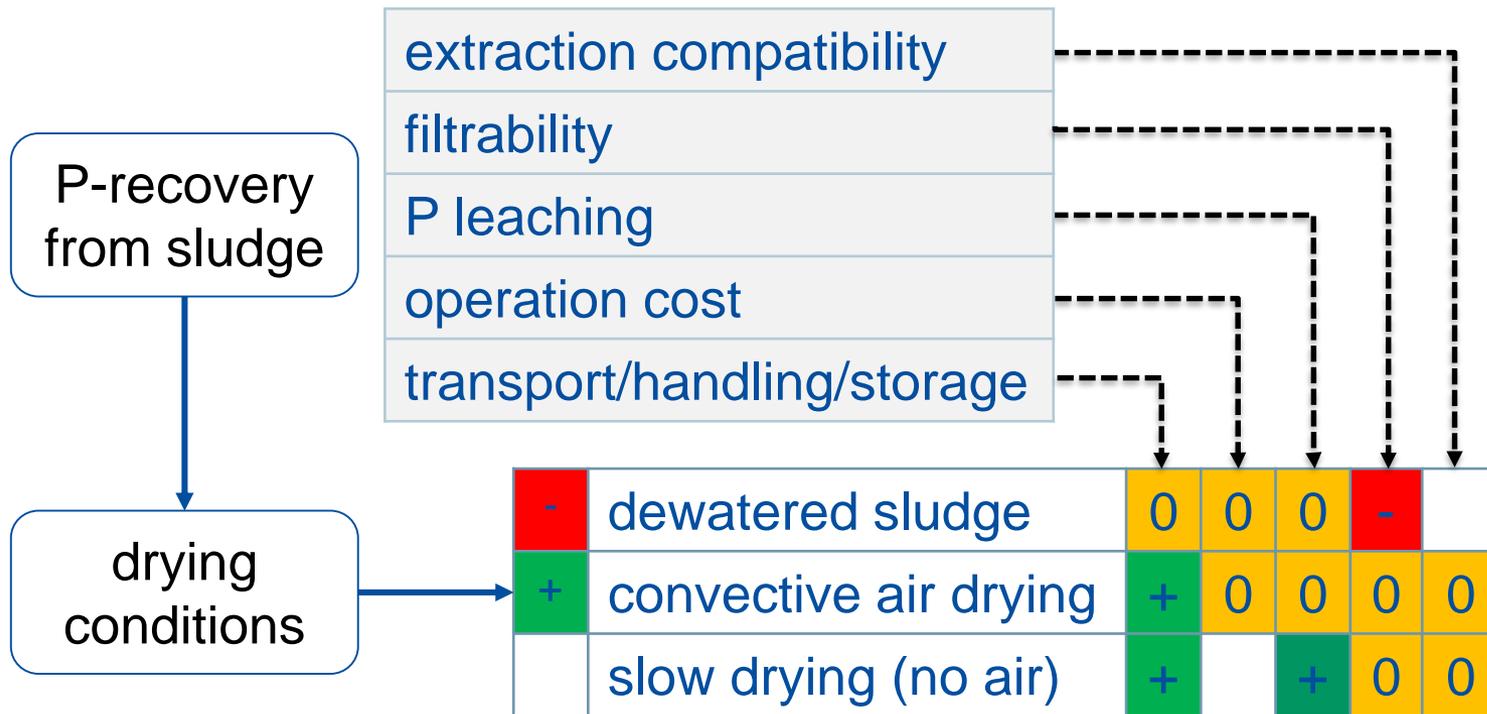
solid-liquid-liquid equilibrium



solid-liquid-liquid equilibrium



cascaded option tree: drying



dewatered
sludge



dried
sludge



- not feasible

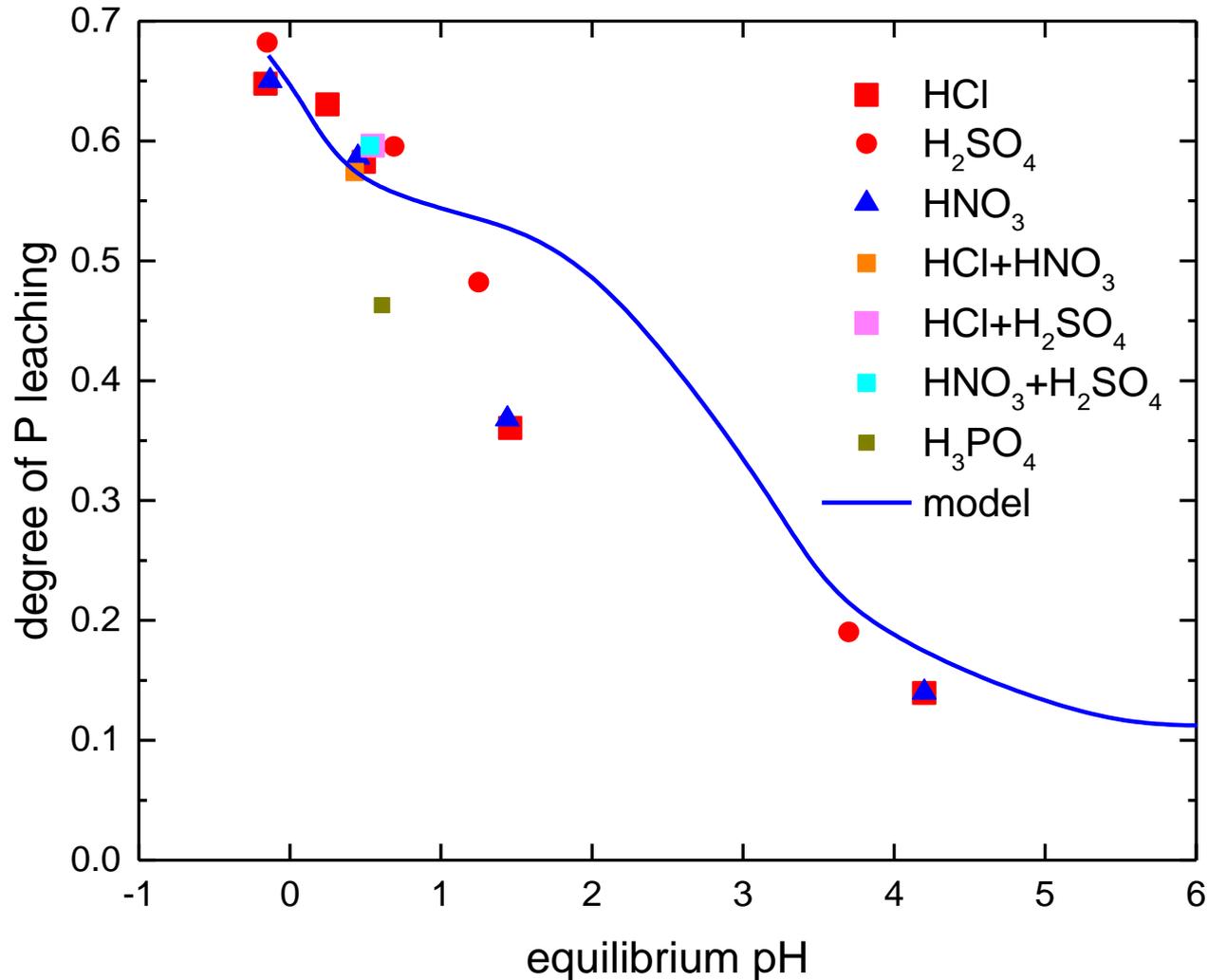
+ good

0 acceptable

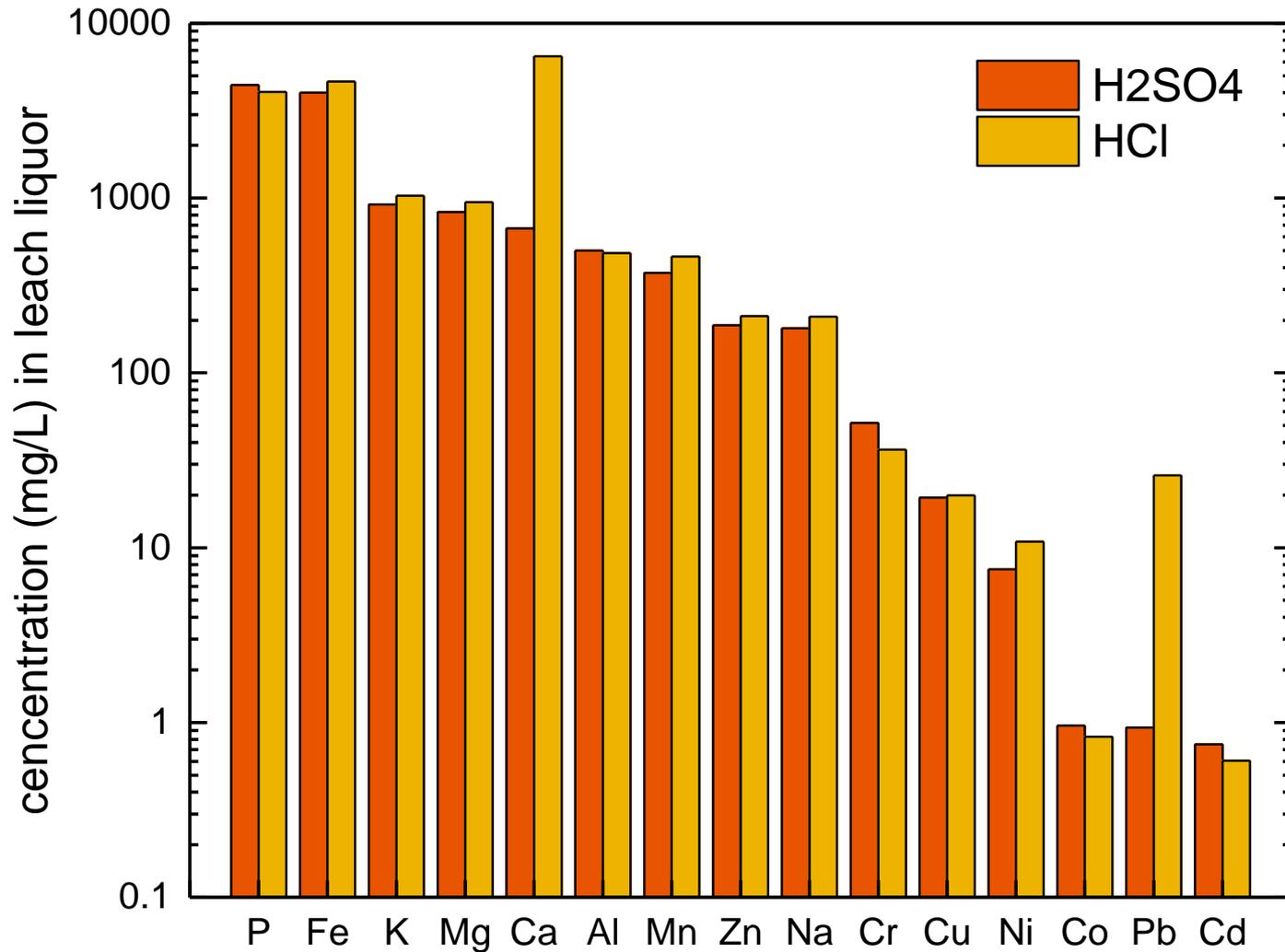
not evaluated

Bednarz, A. et al. 2014

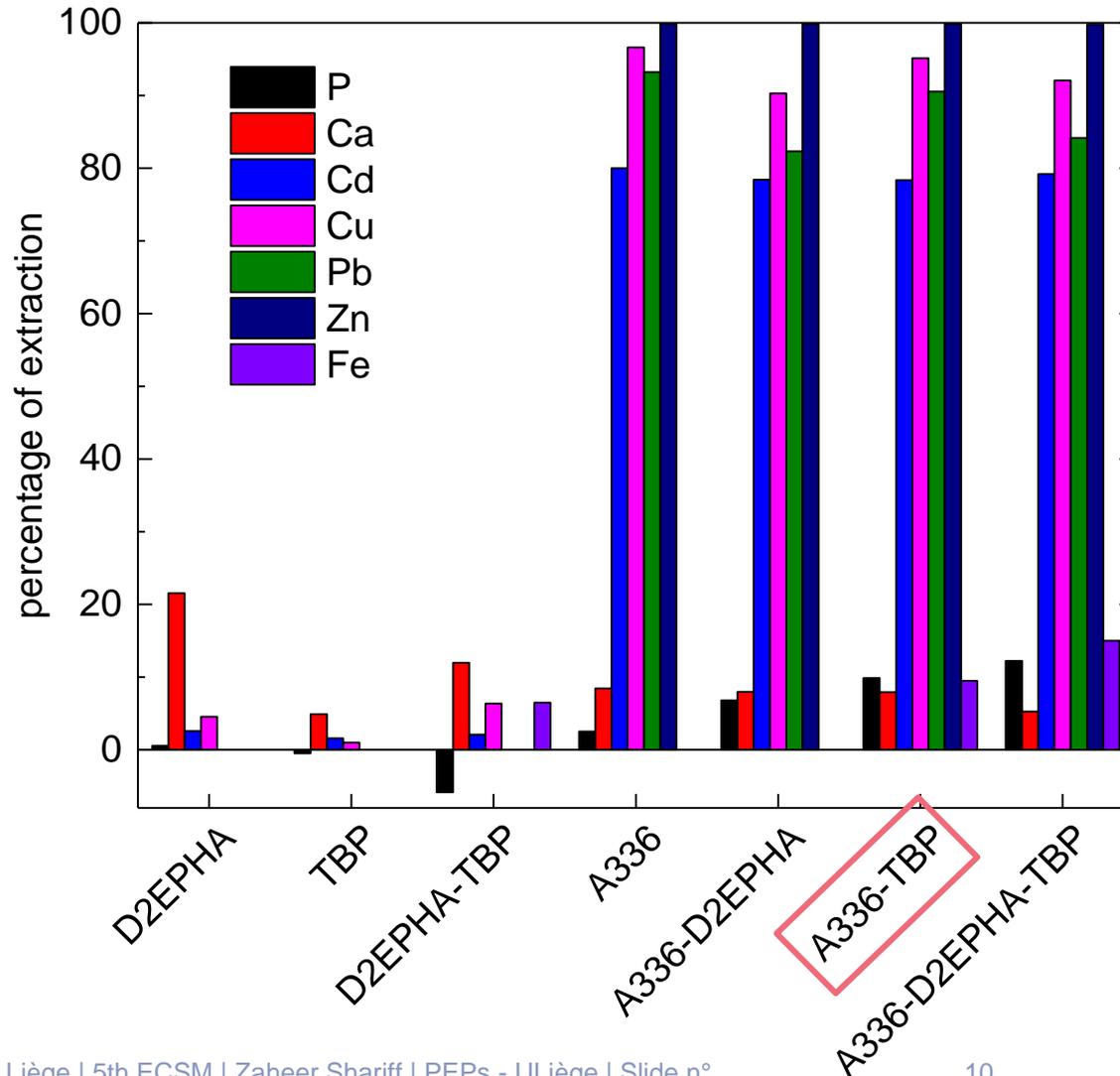
P leaching- different acids and pH



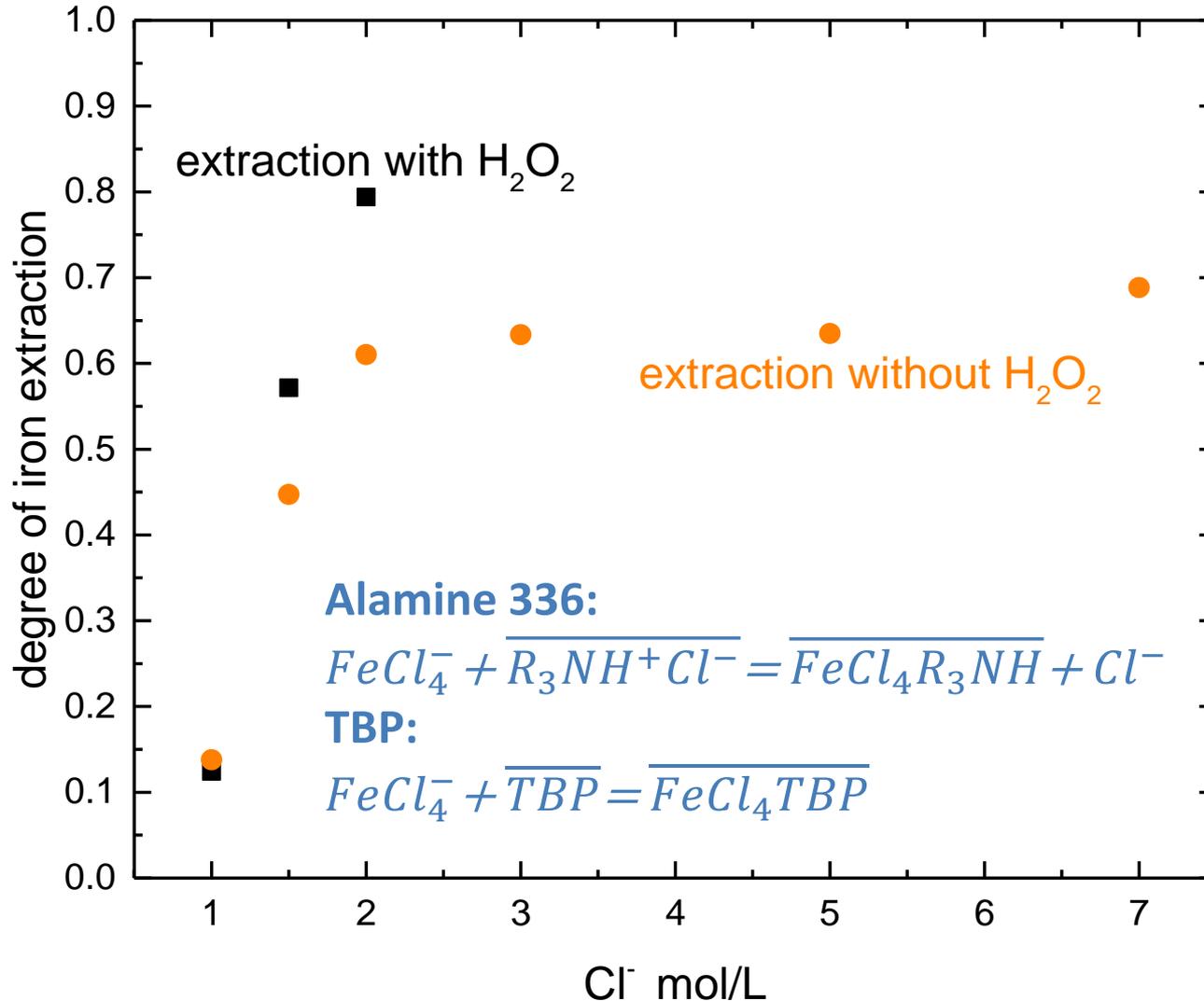
sludge leach liquor



reactive extraction with HCl conc. 1mol/L



reactive extraction of Fe with A336 + TBP



PULSE product

leaching of dried sludge

↓
filtration

↓
metal removal by reactive
extraction

↓
CaP precipitation with NaOH
(pH = 6 - 7)



| Comp. | Conc. |
|--------------------------------|-----------------|
| P ₂ O ₅ | 29.2% |
| CaO | 21.7 % |
| Total C | 6 % |
| Al ₂ O ₃ | 2.61 % |
| MgO | 1.84 % |
| Fe | 0.325 % |
| Mn | 10800ppm |
| Cr | 1530 ppm |
| Cu | 294 ppm |
| Ni | 51.6 ppm |
| Pb | 38,8 ppm |
| Zn | 8.97 ppm |
| Cd | 0.735ppm |
| Hg | 0.054 ppm |

summary

- no significant difference between P leaching from wet or dry sludge
- P leaching depends only on pH and not on the type of acid
- extraction of metals at low pH only achieved with Alamine 336
- metals concentration in product is within the limits set by the EU fertilizer regulations except in case of Cr

acknowledgements

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references

- <http://www.nweurope.eu/projects/project-search/phos4you-phosphorus-recovery-from-waste-water-for-your-life/>
- Doetsch, P., Pinnekamp, Johannes, Montag, D., Rath, W., Grömping, M., 2010. Rückgewinnung von Pflanzennährstoffen, insbesondere Phosphor aus der Asche von Klärschlamm (Abschlussbericht PASCH). Institut für Siedlungswasserwirtschaft der RWTH Aachen, Aachen.
- Bednarz, A., Rüngeler, B., Pfennig, A., 2014. Use of Cascaded Option Trees in Chemical-Engineering Process Development. Chem. Ing. Tech. 86, 611-620.