Plant-wide modelling of P-recovery from anaerobic digestates

WWTmod2016

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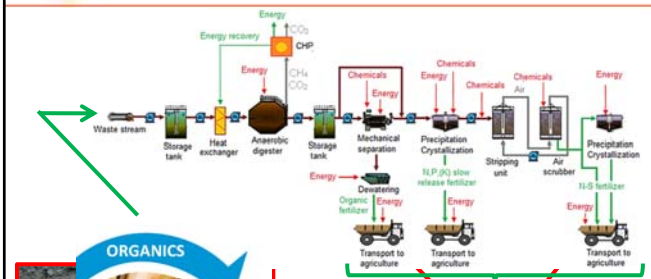
Nutrient Recovery Model (NRM) library



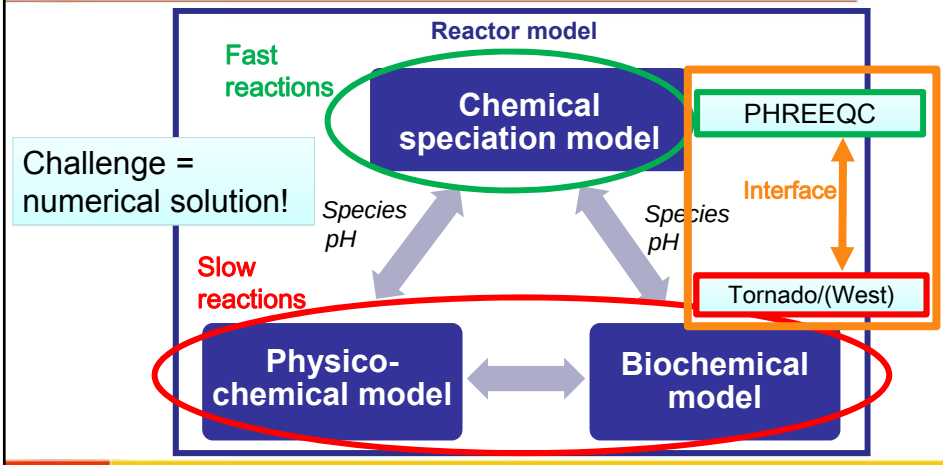
WRRF* or StaRRE

** Waste(water) resource recovery facility*

N K P

2

Combined three-phase physicochemical-biological models

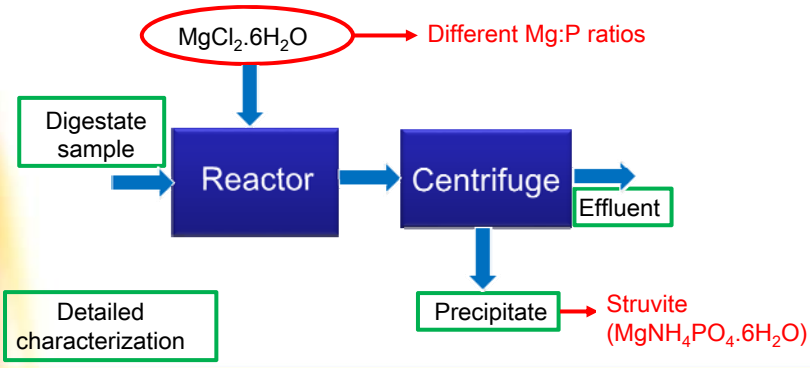


Important findings & contributions

- Speed-up of model simulations:
  - Selective database reduction (> 3000 to 77 species)
    - ⇒ Speed X 4-5
  - Tight model coupling (software engineering)
    - ⇒ Speed X 10
- Geochemical databases incomplete:
  - ➔ Extended database for nutrient recovery, e.g. $(NH_4)_2SO_4$, $AlPO_4$, …

Model validation: example NRM-Prec

- Lab-scale experiments P-precipitation



Model validation: NRM-Prec

- Experimental vs. simulation results (after 12h)

Mg:P	Digestate 1 % P-recovery			Digestate 2 % P-recovery	
	Experim.	Original PHREEQC	Extended PHREEQC	Experim.	Extended PHREEQC
1:1	41	95.60	41.32	28	27.76
2:1	44	97.91	43.62	29	29.29

NaH_2PO_4

⇒ Good agreement with experimental results at steady state

⇒ Importance of a detailed chemical solution speciation and input characterization!

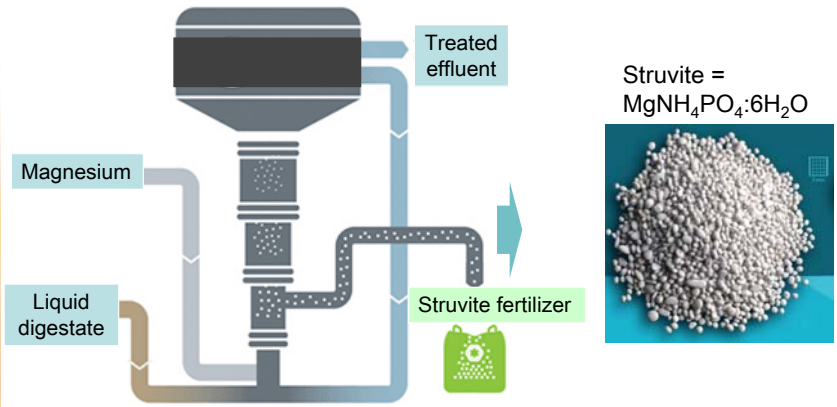
Global sensitivity analysis (GSA)

- Selection of factors with highest impact on model outputs (e.g recovered nutrients) (performed for sludge waste digestates/manure)

Acquired understanding

Optimal treatment train configuration

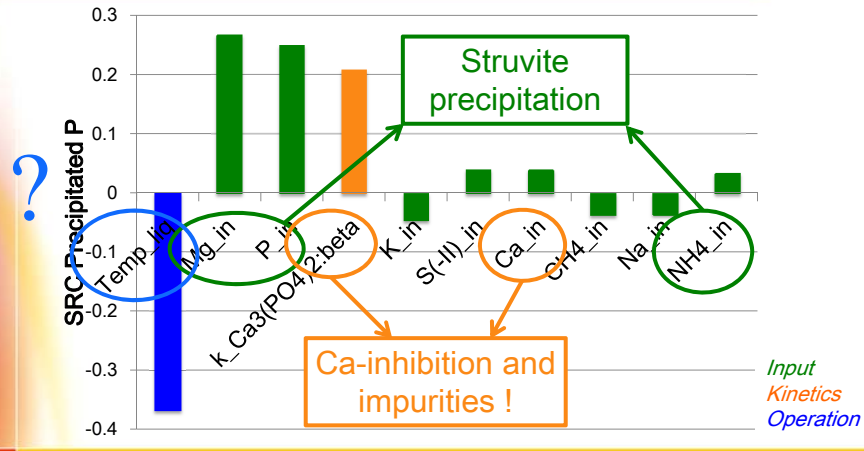
NRM-Prec: Process lay-out



Struvite = $MgNH_4PO_4{:}6H_2O$

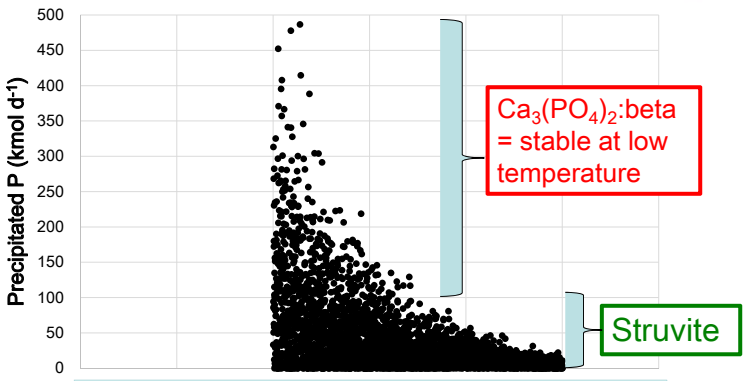
NRM-Prec: Factor ranking

SRC Precipitated P manure



NRM-Prec: Monte Carlo results

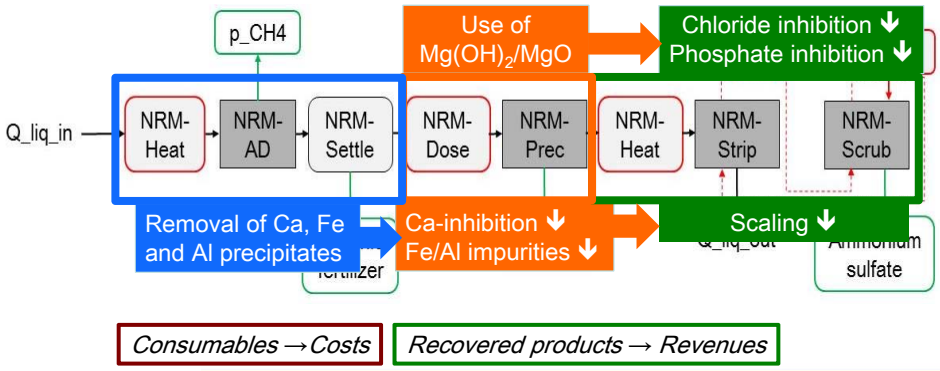
Effect of temperature on P precipitation



⇒ Struvite purity ↑ if temperature ↑

Treatment train configuration
Target = struvite + ammoniumsulfate

OPTIMAL OPERATING CONDITIONS



Consumables → Costs | *Recovered products → Revenues*