

phosphorus recovery as struvite from digested sludge experience from the full scale

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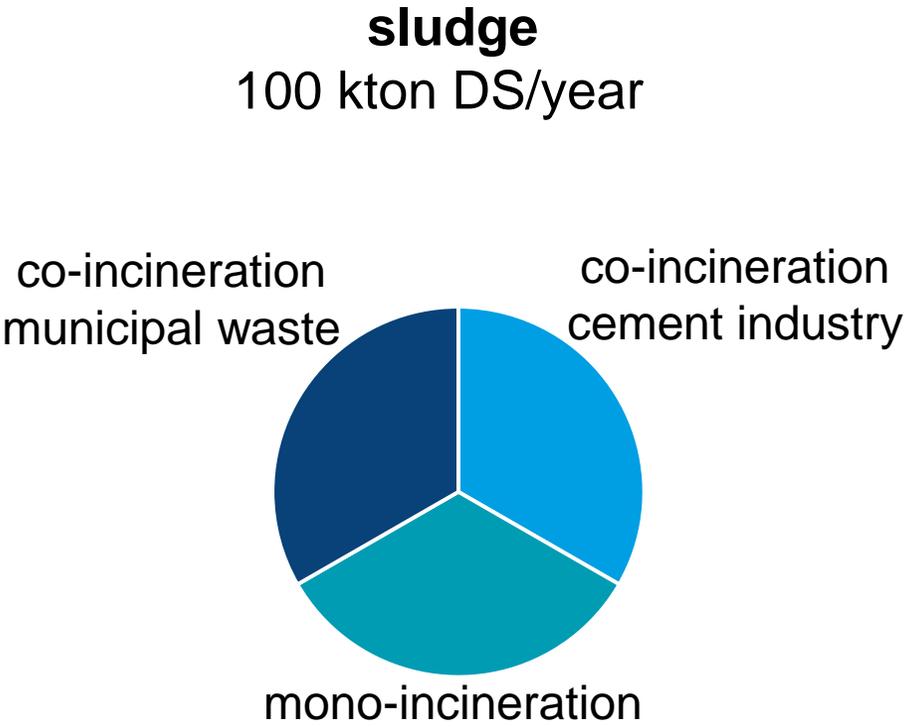
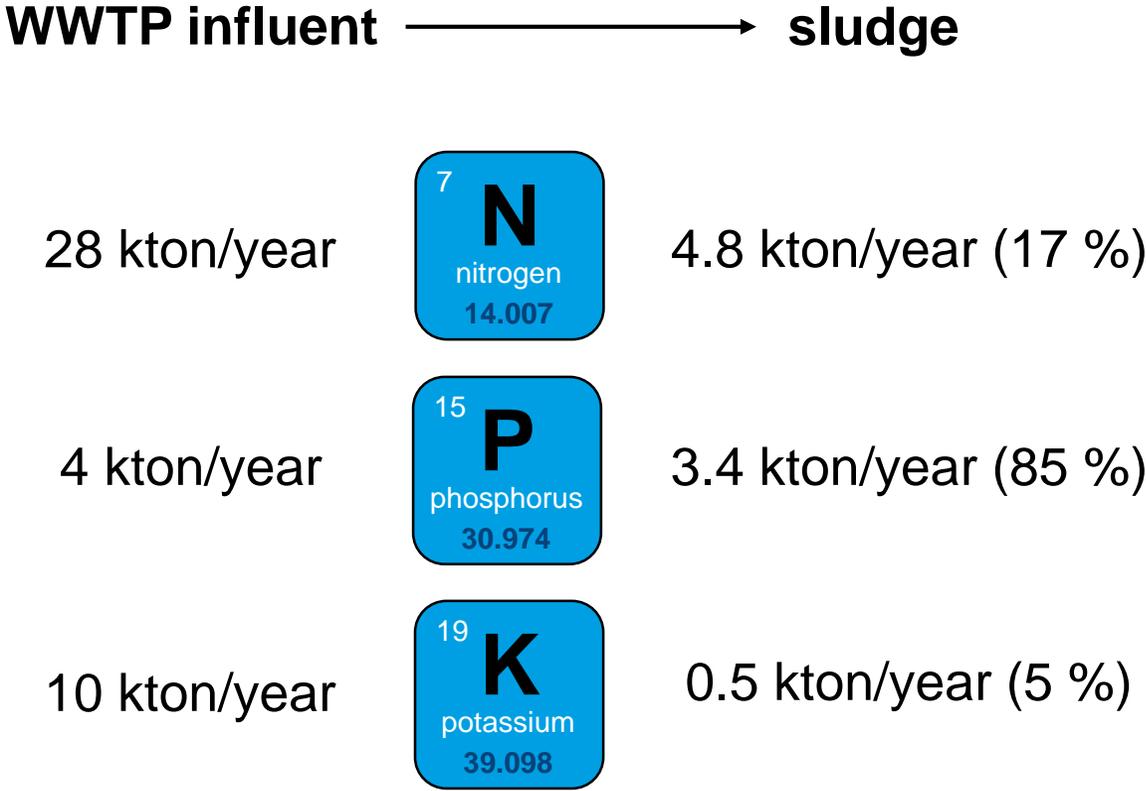


Aquafin = municipal wastewater treatment in Flanders



5.500.000	people
> 6000 km	sewerage
> 140	pumping stations
> 300	WWTP's
18	anaerobic digesters
4	sludge driers
1	sludge incinerator

Aquafin receives a significant amount of nutrients

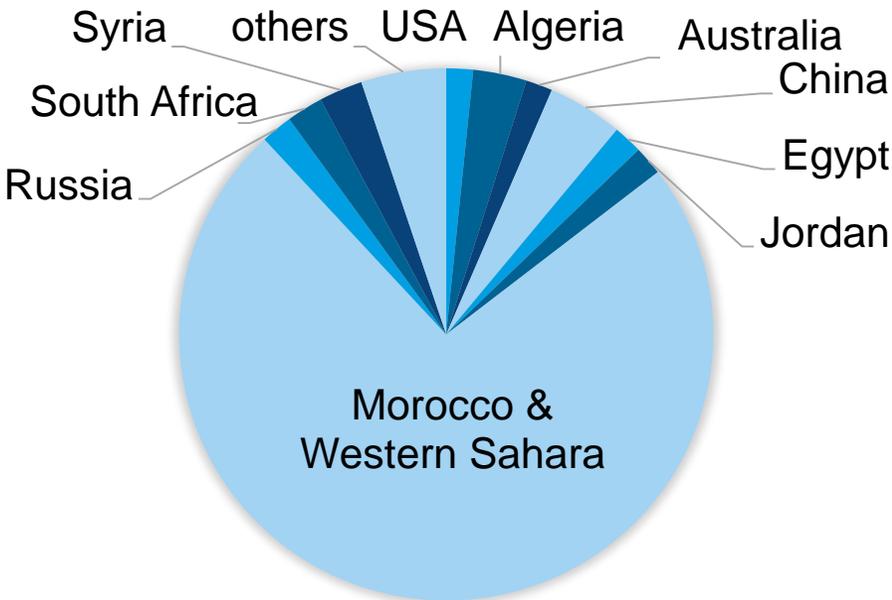


phosphorus should be recovered

reserve-to-production ratio = 300 years

critical raw material in EU

Cd, U



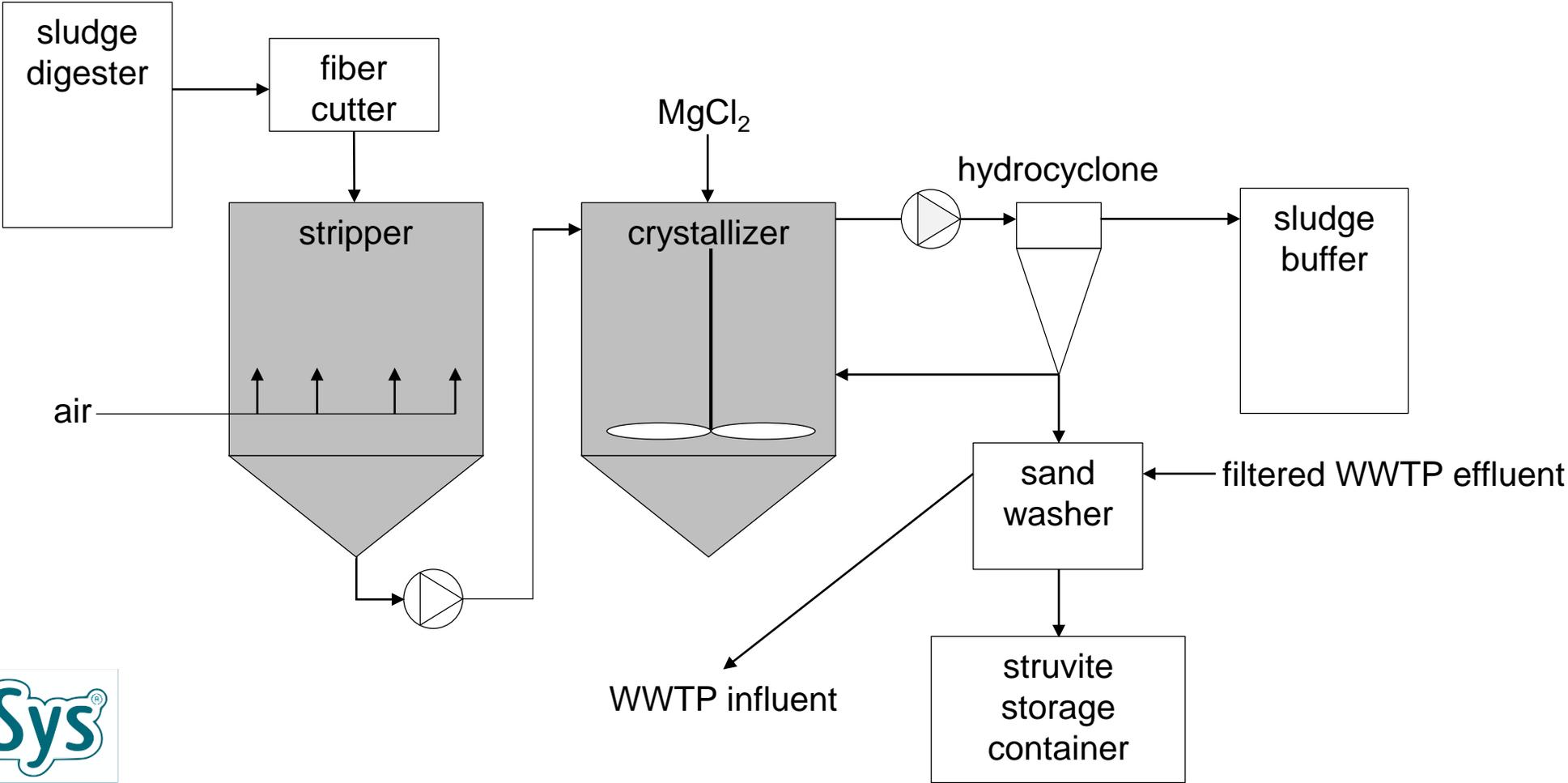
struvite precipitation from digested sludge



- + environmental impact (LCA)
- + dewaterability, maintenance
- ± cost
- ± struvite quality (vs centrate)
- P-recovery, 5–15 % (vs ISSA)
- bio-P and AD needed



struvite plant at WWTP Leuven



struvite plant at WWTP Leuven



plant performance

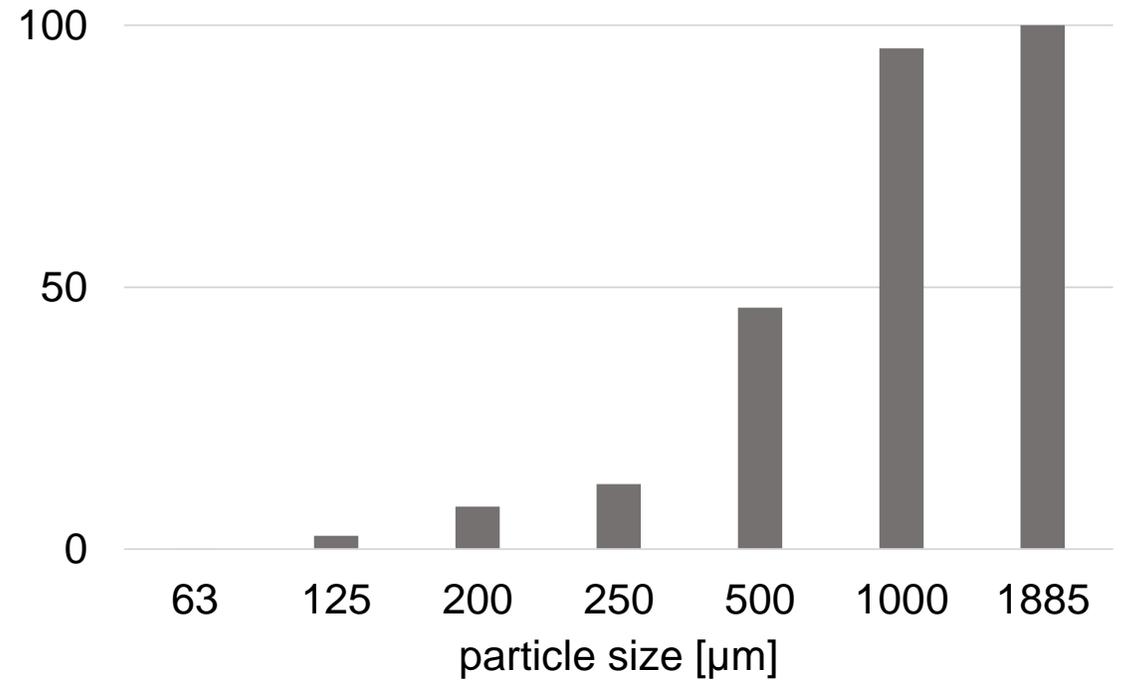
8 m³/h digestate @ 250 mgP-PO₄/L

5 % recovery

500 kg struvite weekly

improved dewaterability

cumulative mass fraction [%]



	DM [%]	ΔDM [%]	p
before struvite process	25.68	-1.89	0.008
after struvite process	27.56	/	/

pollutants

Aquafin struvite is compliant with Flemish standards for end-of-waste (VLAREMA)

	VLAREMA	struvite
As [mg/kg]	20	< 2
Cd [mg/kg]	6	< 0.2
Cr [mg/kg]	150	8.2
Cu [mg/kg]	800	6.8
Hg [mg/kg]	1	< 0.07
Pb [mg/kg]	300	< 10
Ni [mg/kg]	100	< 3
Zn [mg/kg]	1500	41
mineral oil C10–C20	560	< 100
mineral oil C20–C40	5600	< 1000
PAH-16	100	< 10
benzene	6	< 0.6
PCB	600	< 25

pollutants

Aquafin struvite is compliant with EU PFC 1(B) for microbial pathogens

	sample 1	sample 2	sample 3	sample 4	sample 5	PFC 1(B)	PFC 6(A)
storage time	> 1 year	> 1 year	0.5 year	0.5 year	0.5 year		
storage condition	dry	wet	wet	wet	wet		
dried	yes	no	no	yes	yes		
washed	no	no	no	no	yes		
Salmonella	0	0	0	0	0	0	0
Escherichia coli	< 10	< 10	< 10	< 10	< 10	1000	0
Listeria monocytogenes	0	0	0	0	0		0
Vibrio spp.	0	0	0	0	0		0
Shigella	0	0	0	0	0		0
Staphylococcus aureus	< 100	< 100	< 100	< 100	< 100		0
Enterococcus	< 10	< 10	< 10	< 10	< 10	1000	10
anaerobic spores	< 10	300	540	340	10		10 ⁵
yeasts and moulds	200	3500	20,000	> 30,000	1200		1000

struvite is an effective fertilizer

struvite was used in agriculture



external pot trial (rye grass)

Aquafin struvite works acidifying
no significant difference in yield vs TSP

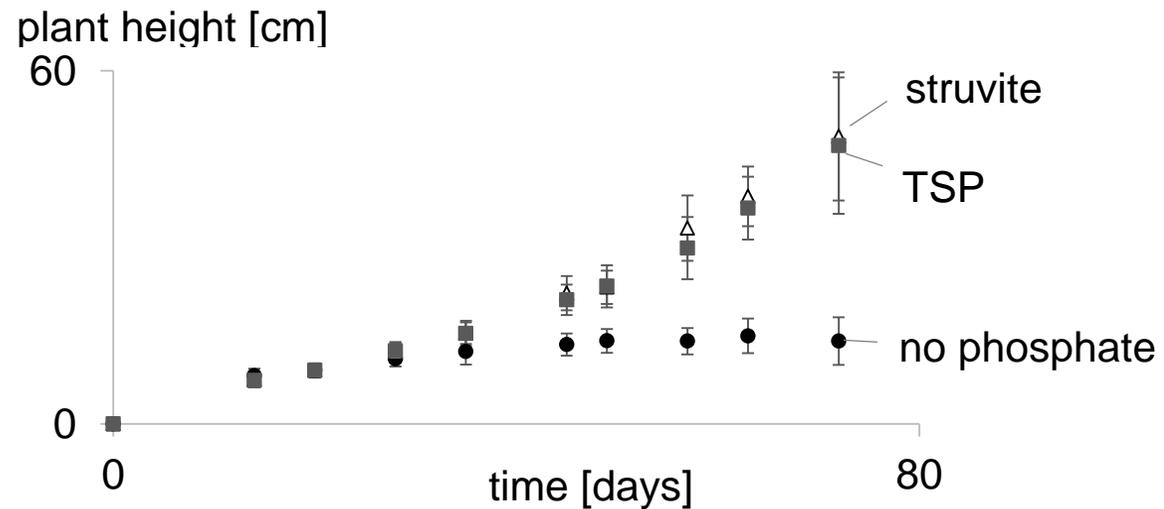


struvite is an effective fertilizer

own pot trial (coriander)

no significant difference for:

- plant height
- number of leaves
- leaf size
- seed yield



struvite production is economically viable

	optimistic	realistic	pessimistic
P-removal	80 %	70 %	60 %
maintenance	€ 2,000	€ 4,000	€ 6,000
Δ DM	+3 %	+2 %	+1 %
Δ PE	-20 %	-10 %	-0 %
gross cost [kgP ⁻¹]	€ 13.45	€ 15.89	€ 19.14
balance [ton struvite ⁻¹]	€ 1,073.40	€ 253.99	€ -866.76

gross cost = CAPEX + OPEX

balance = revenues + OBEN – gross cost

phosphate: € 1/kgP

market value of struvite: € 250/ton

lessons learned

sludge \neq centrate

hair \rightarrow fiber cutter

sand washer

hydrocyclone

maintenance

PVDF tubing

pump wear

5 % P-recovery

economically viable

struvite = interesting by-product





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