

Adsorptive phosphate recovery in decentralized wastewater treatment

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Motivation

Background:

- effluent class „+P“ ($c(P) < 2 \text{ mg/L}$) for small wastewater treatment plants (SWTP)
- contribution to P-recovery

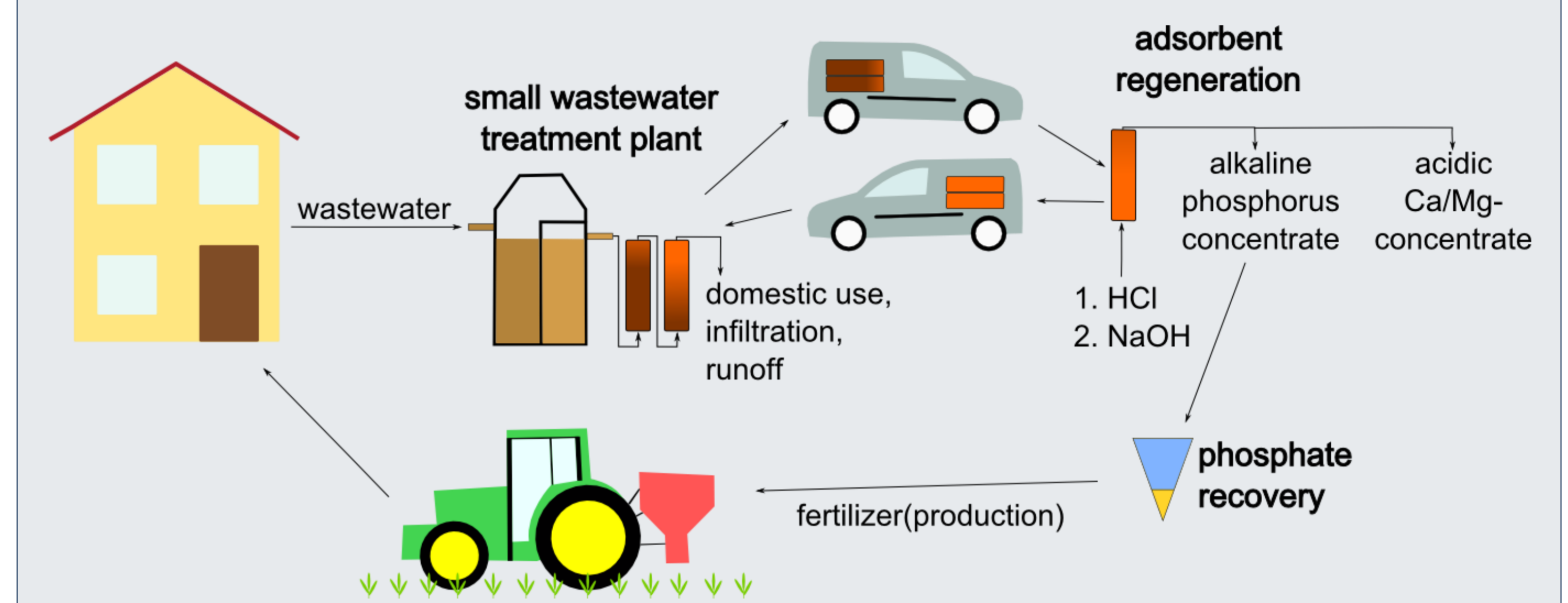
Requirements:

- hydrodynamically independent
- phosphate-selective
- low-maintenance
- space-saving

Problem:

- biological P-removal not sufficient and precipitation with FeCl_3 not suitable for SWTP

Approach



Adsorbent Screening

Water Composition

- pH: 7
- temperature: 15 °C
- c(Phosphate): 62 mg/L

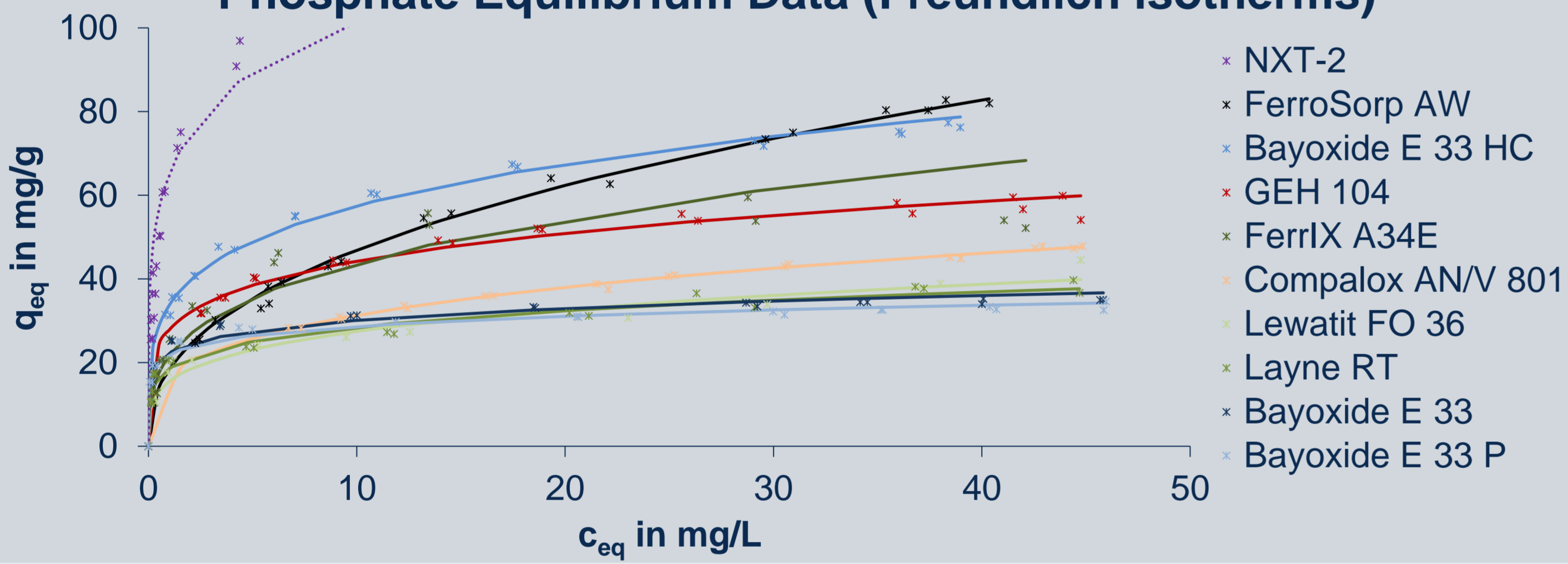
Plant Dimension

- adsorber volume: 30 L
- volumetric flow rate: 150 L/d
- maintenance interval: 6 months

Adsorbent Properties

- particle size
- porosity
- bed density

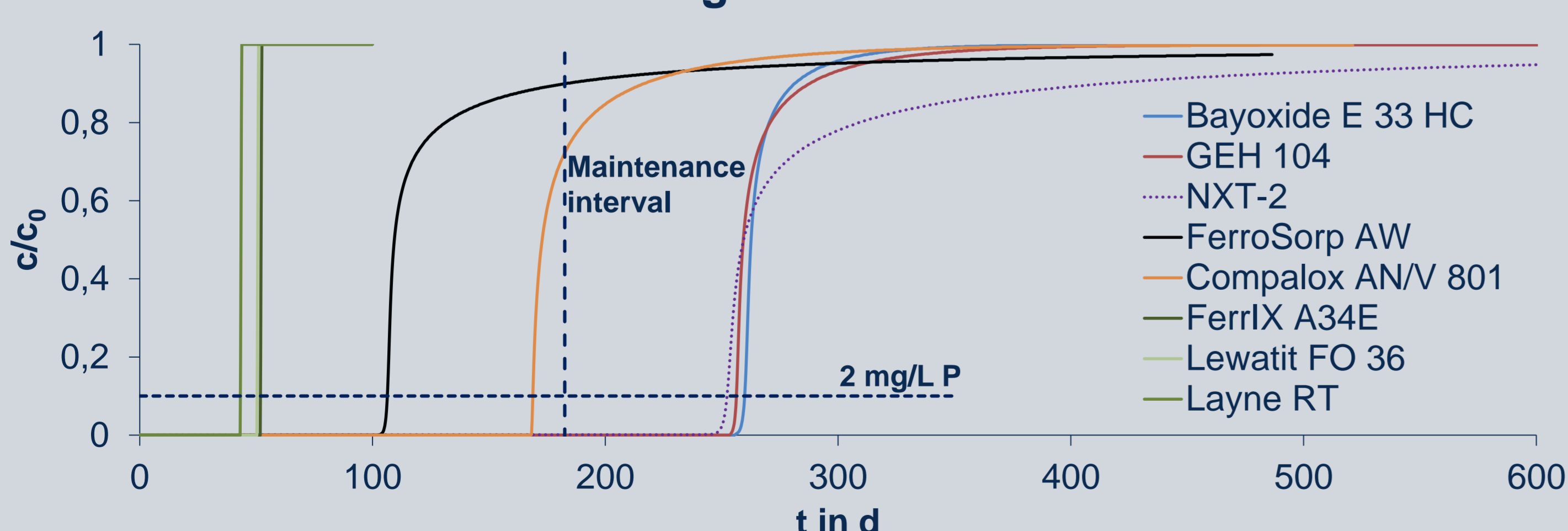
Phosphate Equilibrium Data (Freundlich isotherms)



Kinetic Studies

Material	Active component	q_{\max} [mg/g]	ρ_B [g/dm ³]	$k_f a_v$ [1/s] (Gnielinski)	$k_s a_v$ [1/s] (LDF)	ω [g/mg] (LDF)
Bayoxide® E 33 HC	$\alpha\text{-FeO(OH)}$	80	907	0,015	$2,5 \times 10^{-5}$	-0,04
GEH® 104	$\beta\text{-FeO(OH)}$	61	1241	0,021	$1,5 \times 10^{-5}$	-0,06
NXT®-2	$\text{Fe}_2\text{O}_3, \text{La}_2\text{O}_3$	121	674	0,013	$4,9 \times 10^{-5}$	-0,05
FerroSorp® AW	$\text{Fe(OH)}_3, \text{CaCO}_3$	98	542	0,010	$5,0 \times 10^{-5}$	-0,12
Compalox® AN/V 801	Al_2O_3	55	1103	0,016	$9,0 \times 10^{-6}$	-0,09
FerrIX™ A34E	HAIX (Fe)	56	308	0,005	$6,6 \times 10^{-4}$	-0,02
Lewatit® FO 36	HAIX (Fe)	43	393	0,041	$4,9 \times 10^{-3}$	-0,20
Layne® RT	HAIX (Fe)	38	374	0,010	$5,3 \times 10^{-3}$	-0,16

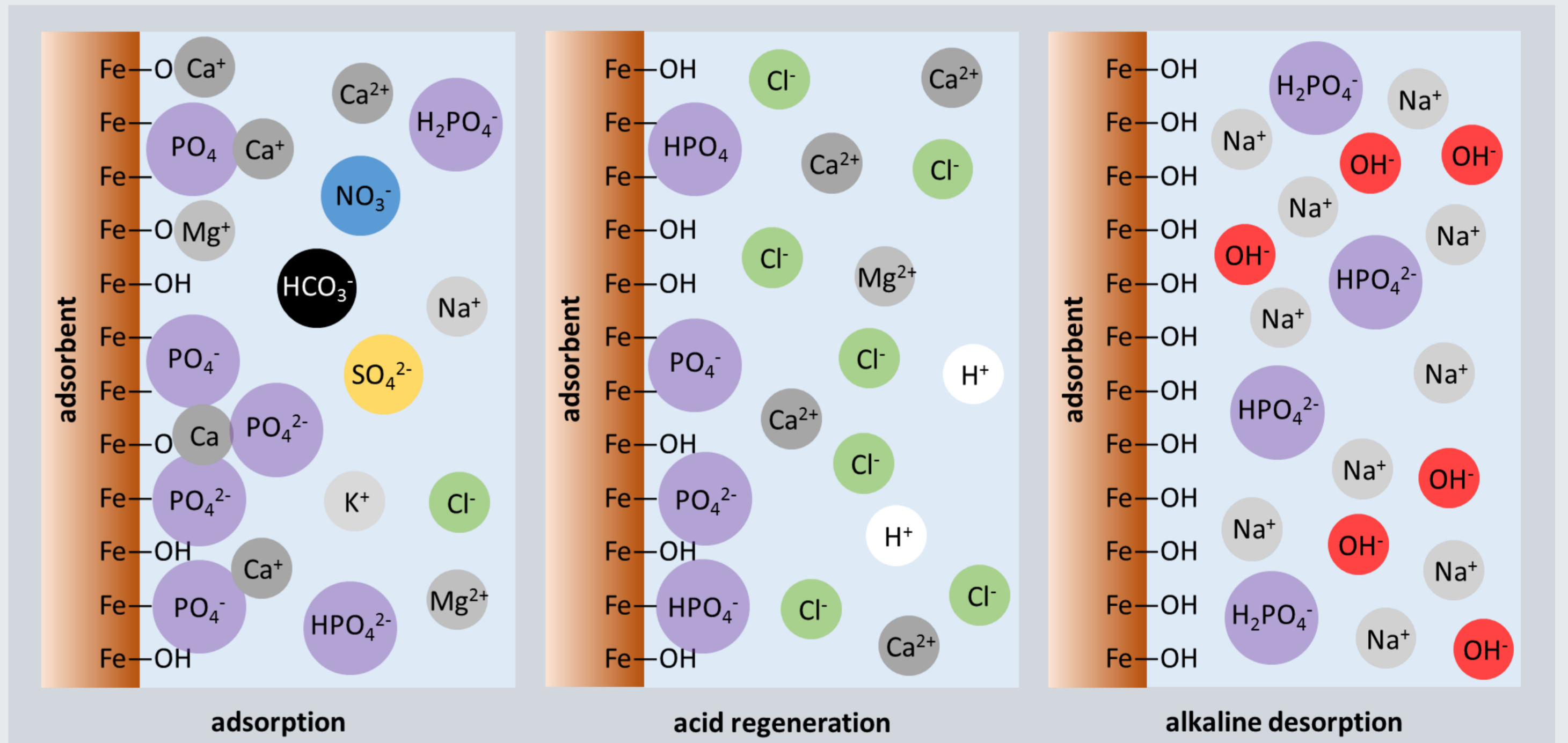
Breakthrough Model for SWTP



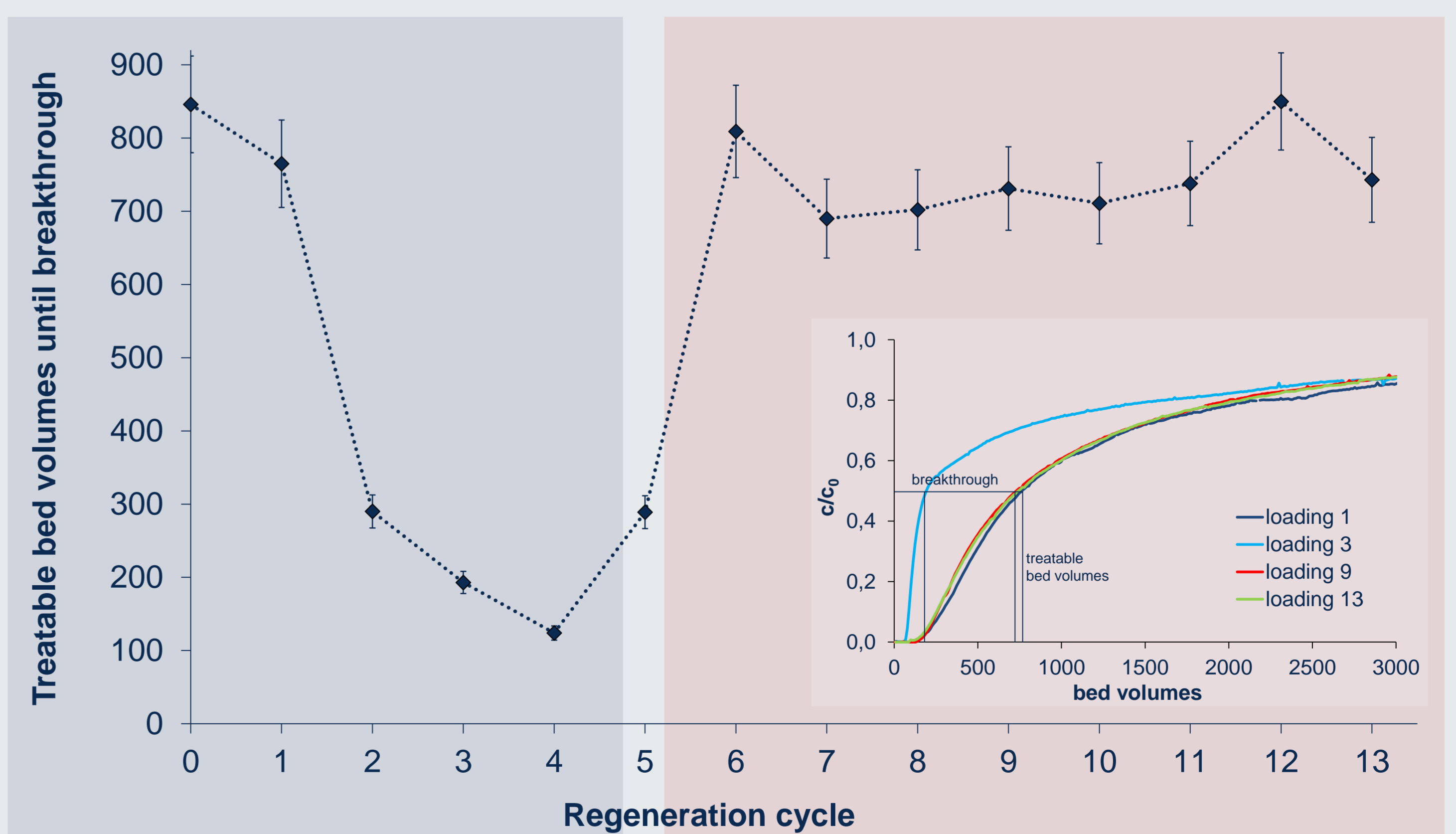
Results

- Best performance: Granular Ferric Hydroxides (GFH)
- Multiple use of GFH through novel regeneration method
- Concentrated alkaline phosphorus solution for recovery through precipitation

Improved Regeneration



Schematic novel regeneration cycle



Comparison of the conventional (blue) and the novel regeneration method (red) on the basis of the treatable bed volumes until breakthrough ($c/c_0 = 0,5$)