FACULTY OF
BIOSCIENCE ENGINEERING

(ELECTRO) COAGULATION IN COMBINATION WITH ANAEROBIC DIGESTION FOR ENHANCEMENT OF RESOURCE RECOVERY FROM FAECAL SLUDGE

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BACKGROUND

– Poorly handled or even untreated **faecal sludge** causes environmental pollution worldwide.

Untreated faecal sludge pit in Fada N'Gourma

Tilley *et al.*, 2014

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BACKGROUND

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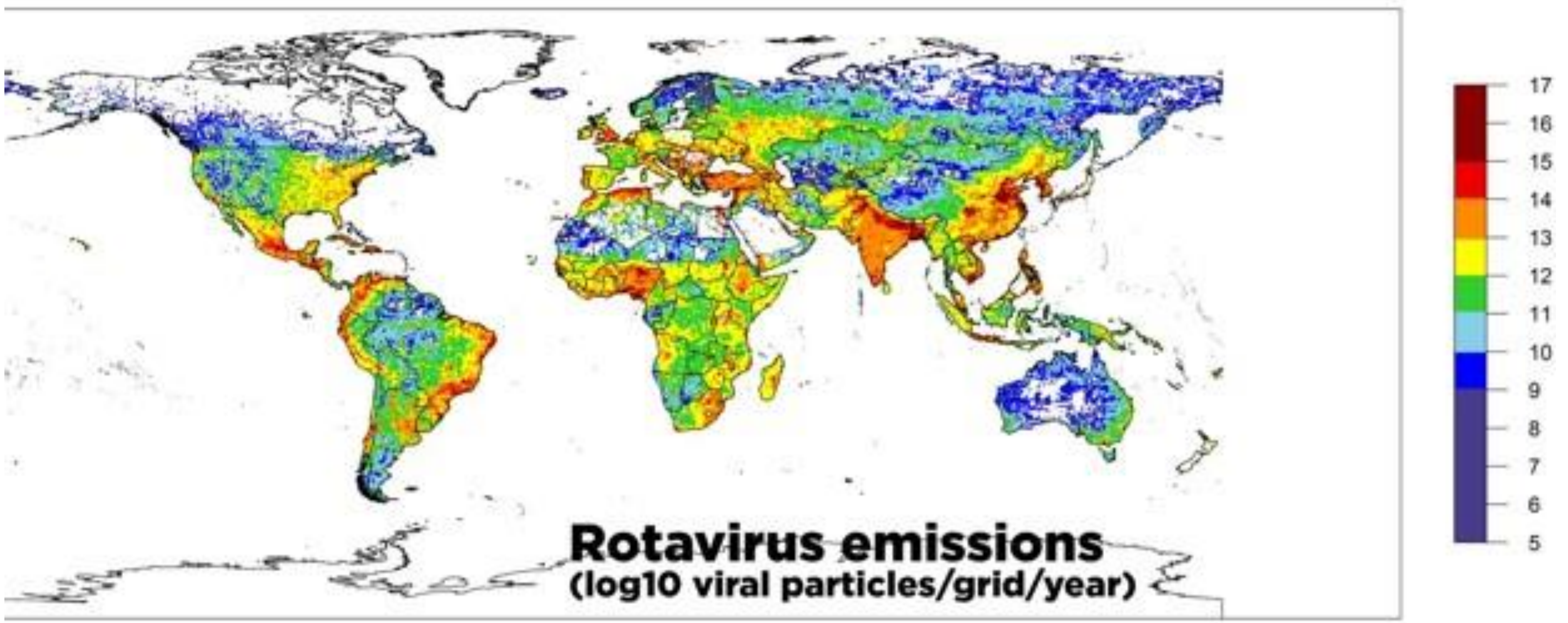

Red shades indicate severe concentrations of the deadly rotavirus, which **cause half million deaths** globally each year (Kiulia et. al.).

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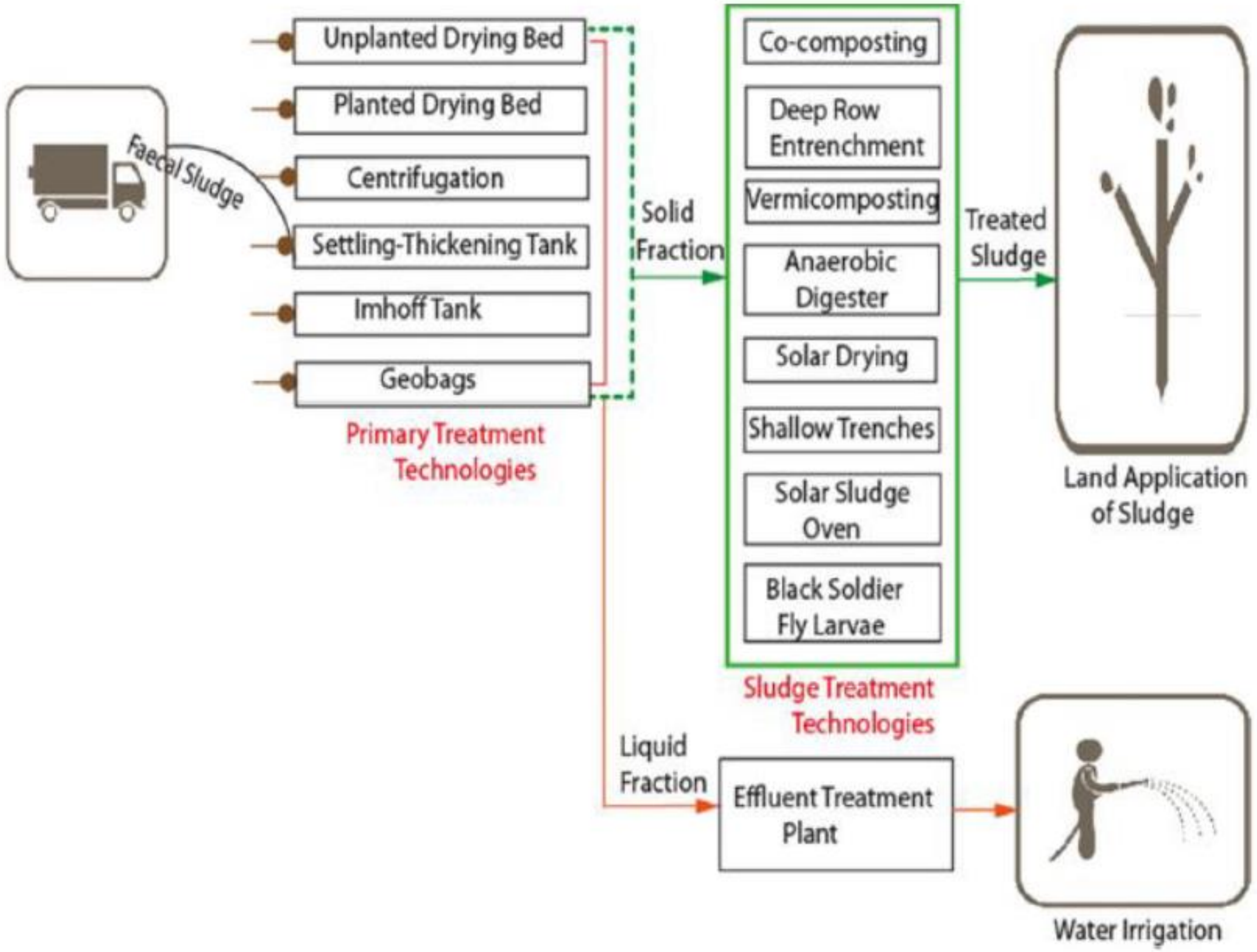
BACKGROUND

– Need for treatment
  – Faecal sludge: > 95% water -> dewatering

  – High costs -> resource recovery



-> (electro)coagulation + anaerobic digestion

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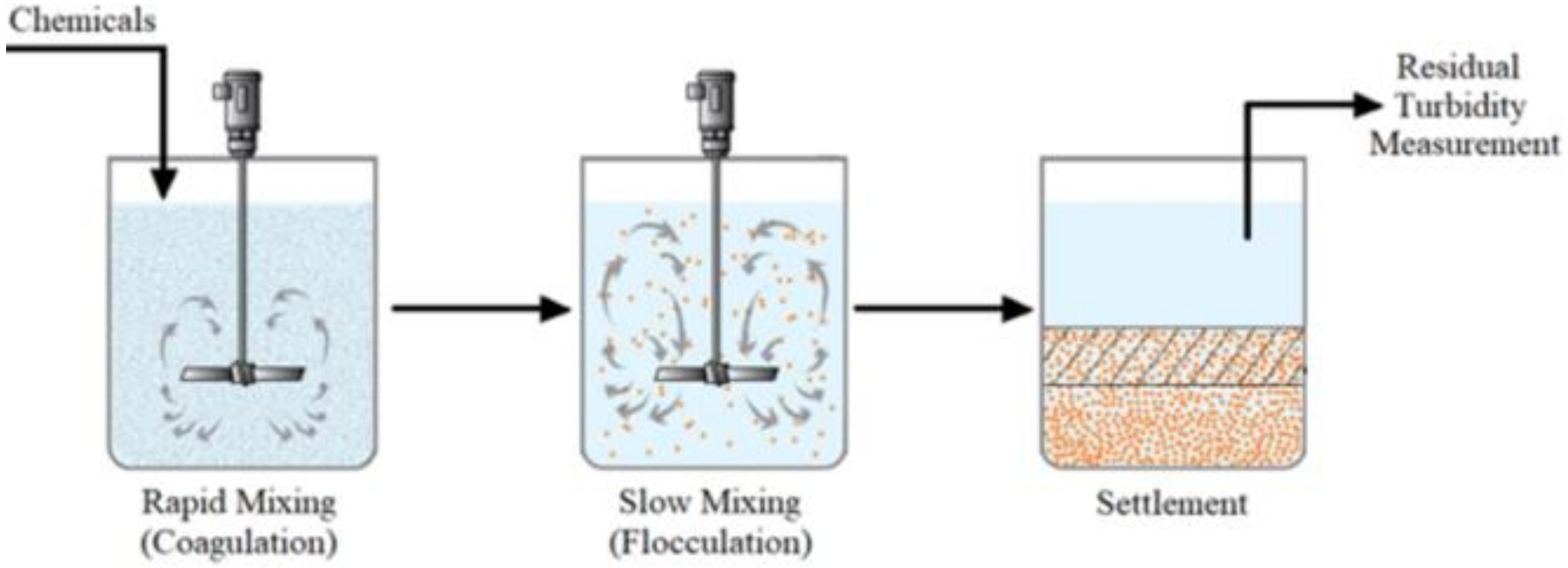
MATERIALS & METHODS

– Coagulation/flocculation
  – $FeCl_3$, $AlCl_3$, $Fe_2(SO_4)_3$, Poly ferric sulfate (PFS), Poly aluminum ferric chloride (PAFC)
  – Dosage: 20, 50, 100, 150, 200 mg/g TS



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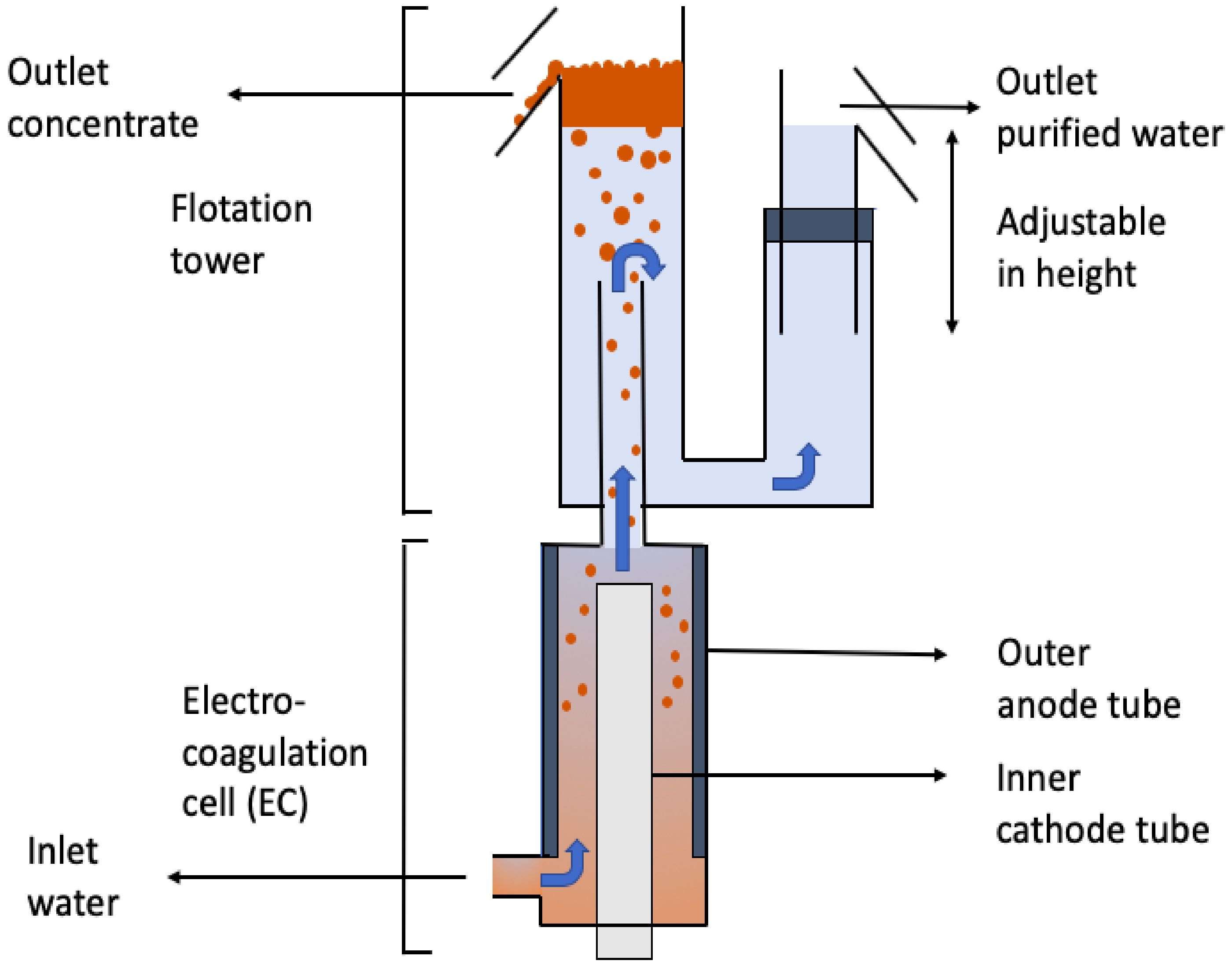
MATERIALS & METHODS

- Electrocoagulation
  - No need for chemical addition



- Current: 1 A
- EC flowrate: 10 L/h
- HRT EC: 26.4 s

MATERIALS & METHODS

- Synthetic Faeces and Faecal Sludge
  - Parameters are compatible with literature
  - More stable than real faeces
  - Repeatable experiments
  - Hygienic

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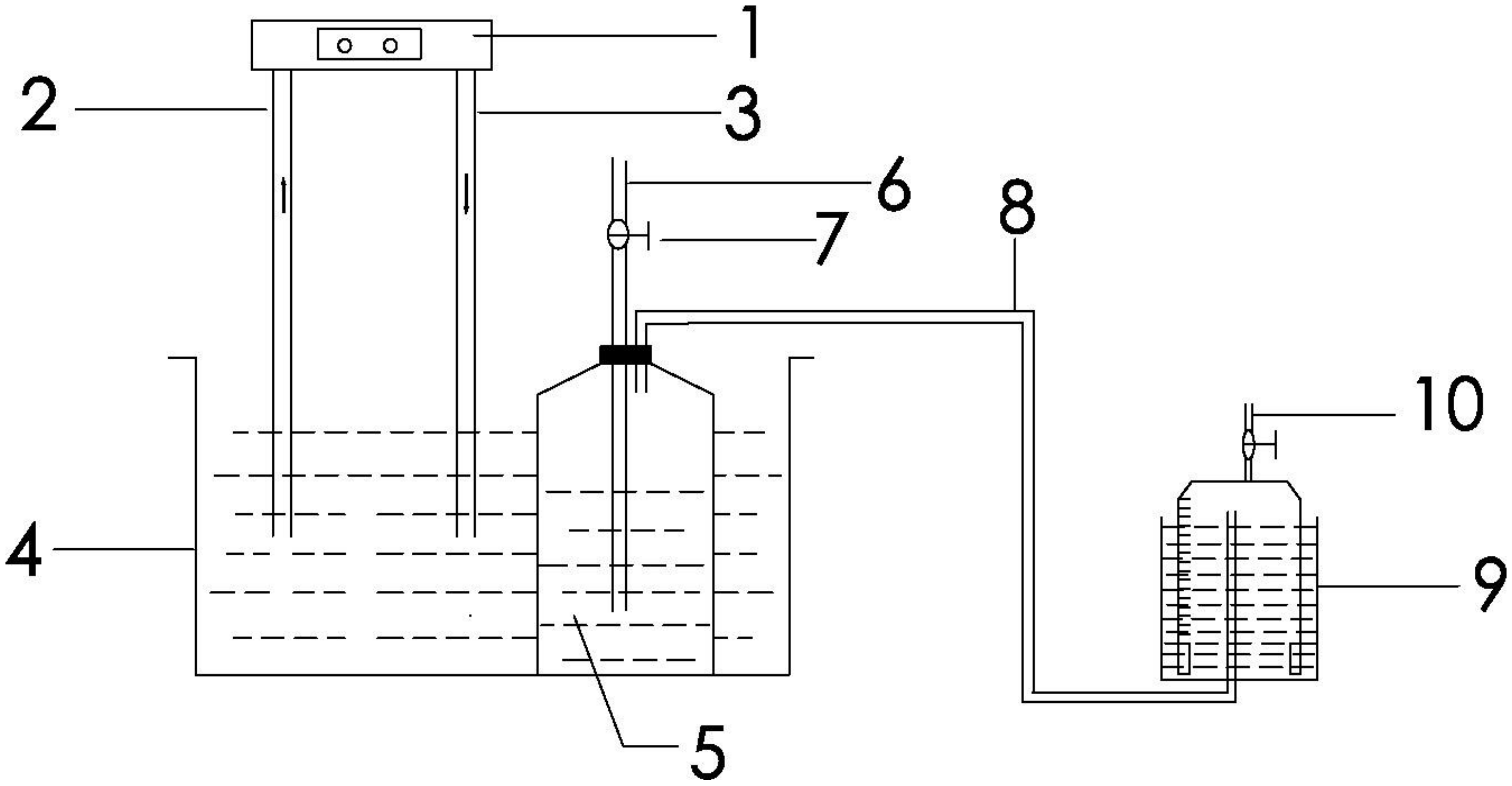
Table 1. Comparison of the synthetic faeces and faecal sludge from this study with actual faeces and faecal sludge from the literature

	This study		Literature from Penn et al.	
Parameter	Synthetic faeces	Synthetic faecal sludge	Real faeces	Real faecal sludge
COD	1318.12± 214.2 mg/g TS	8774.2 ± 125.0 mg/L	567-1450 mg/g TS	7000-106000 mg/L
NH_4^+-N	0.59 ± 0.06 mg/g TS	41.8 ± 0.6 mg/L	< 4.9 mg/g TS	< 45.3 mg/L
TN	27.08 ± 3.93 mg/g TS	845.0 ± 46.0 mg/L	20-70 mg/g TS	50-1500 mg/L
TP	5.28 ± 0.21 mg/g TS	91.4 ± 5.6 mg/L	3.9-49.3 mg/g TS	
TOC	156.93 ± 1.37 mg/g TS	1650.0 ± 256.0 mg/L		
TS (%)	19.86 ± 0.43	1.11 ± 0.01	14-37	0.5-40
VS (%)	16.7997 ± 0.38	0.86 ± 0.00	11.2-34	0.7-5.2
VS/TS (%)	84.59	77.48	80-92	
C/N	5.80	1.95	5-16	2.2-14.6
EC (μs/cm)		14.4		
pH		5.56 ± 0.2	4.6-8.4	6.7-8.5
Turbidity		904		
DO (mg/L)		7.93		

MATERIALS AND METHODS

– Anaerobic digestion of dewatered sludge
  – Ratio of feedstock to inoculum (VS): 1: 2



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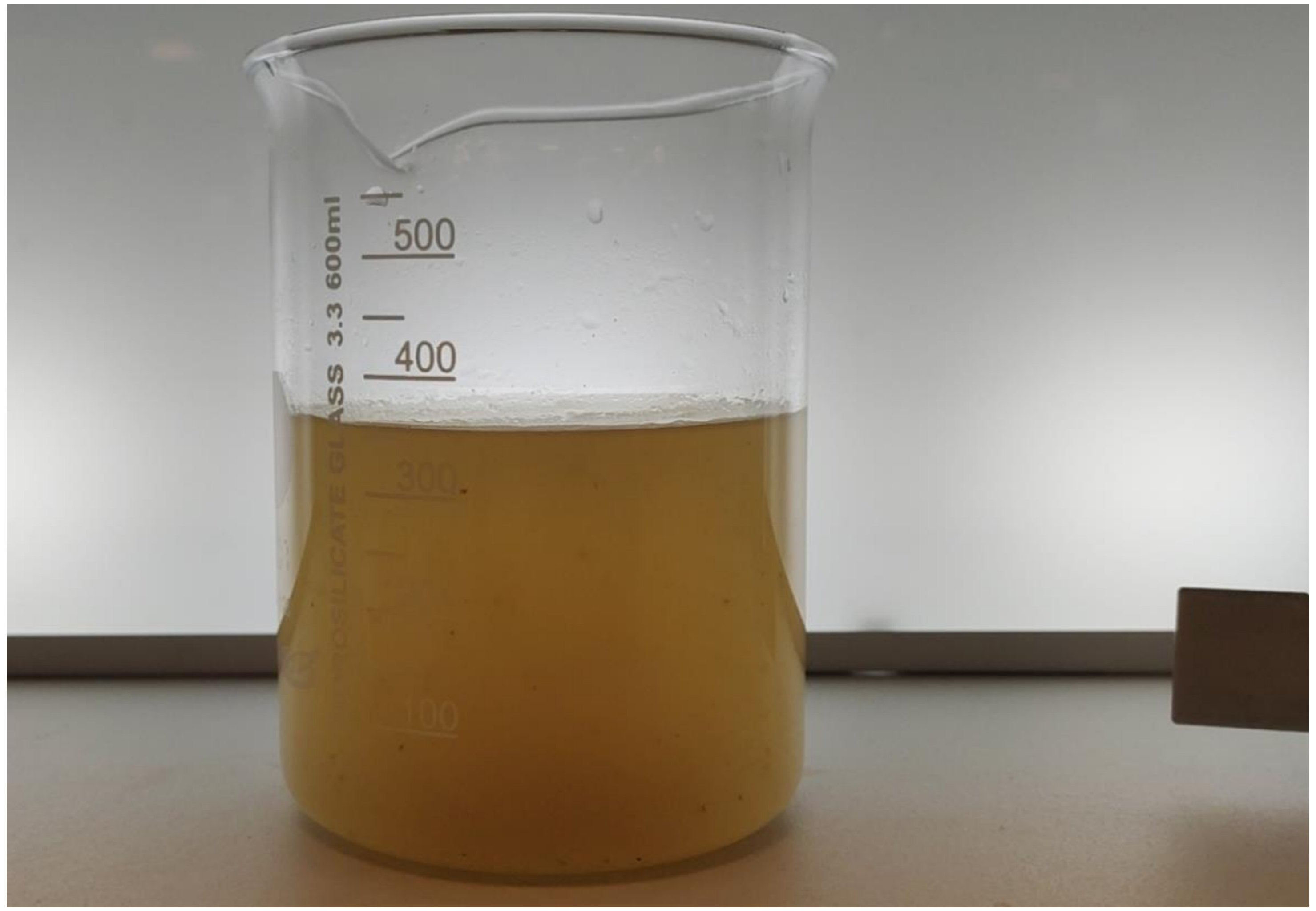
COAGULATION/FLOCCULATION

– Visual observation



Raw synthetic faecal sludge

Faecal sludge coagulated with $AlCl_3$ (dosage: 150mg/g TS)

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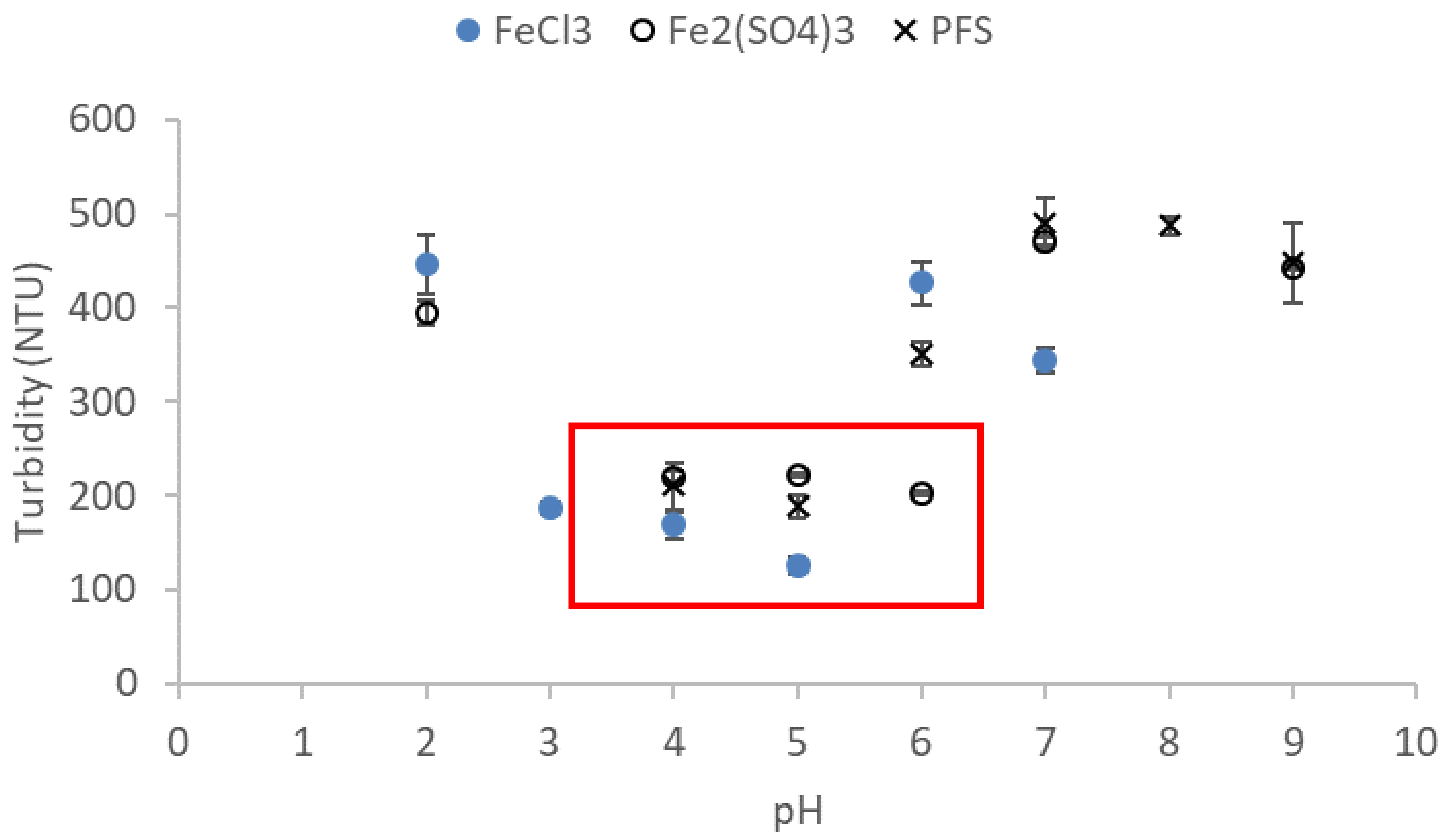
COAGULATION/FLOCCULATION

- pH optimisation
  - Initial turbidity: 904 NTU
  - Dose: 100 mg/gTS
- Fe-based: pH =+/- 5 (=initial pH)
- Al-based: pH= +/- 7



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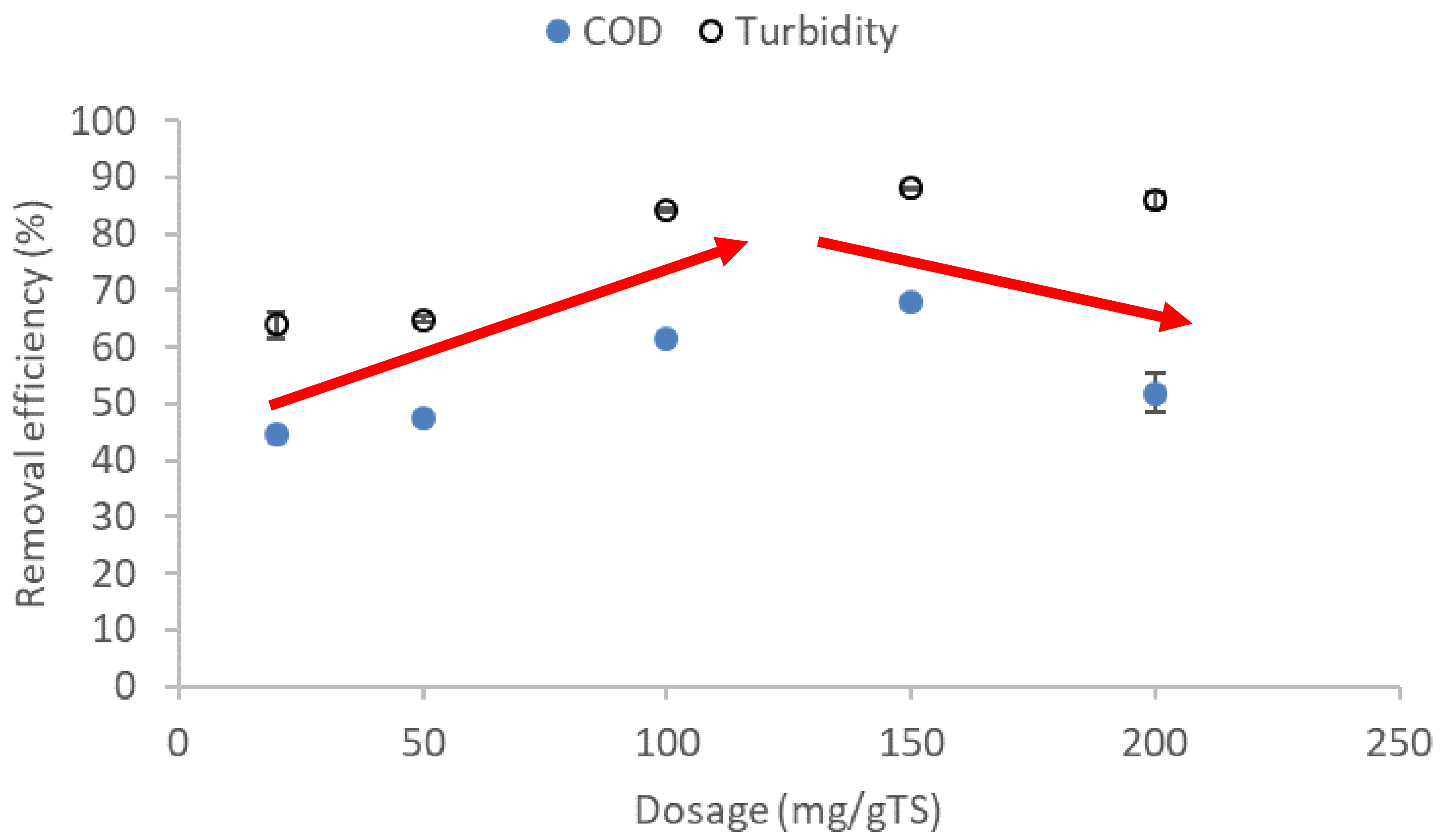
COAGULATION/FLOCCULATION

- Dose optimisation
  - Dosage from 20 to 100 mg/g TS -> removal ↑
  - Dosage 100 - 150 mg/g TS -> removal =/↓



e.g. $FeCl_3$

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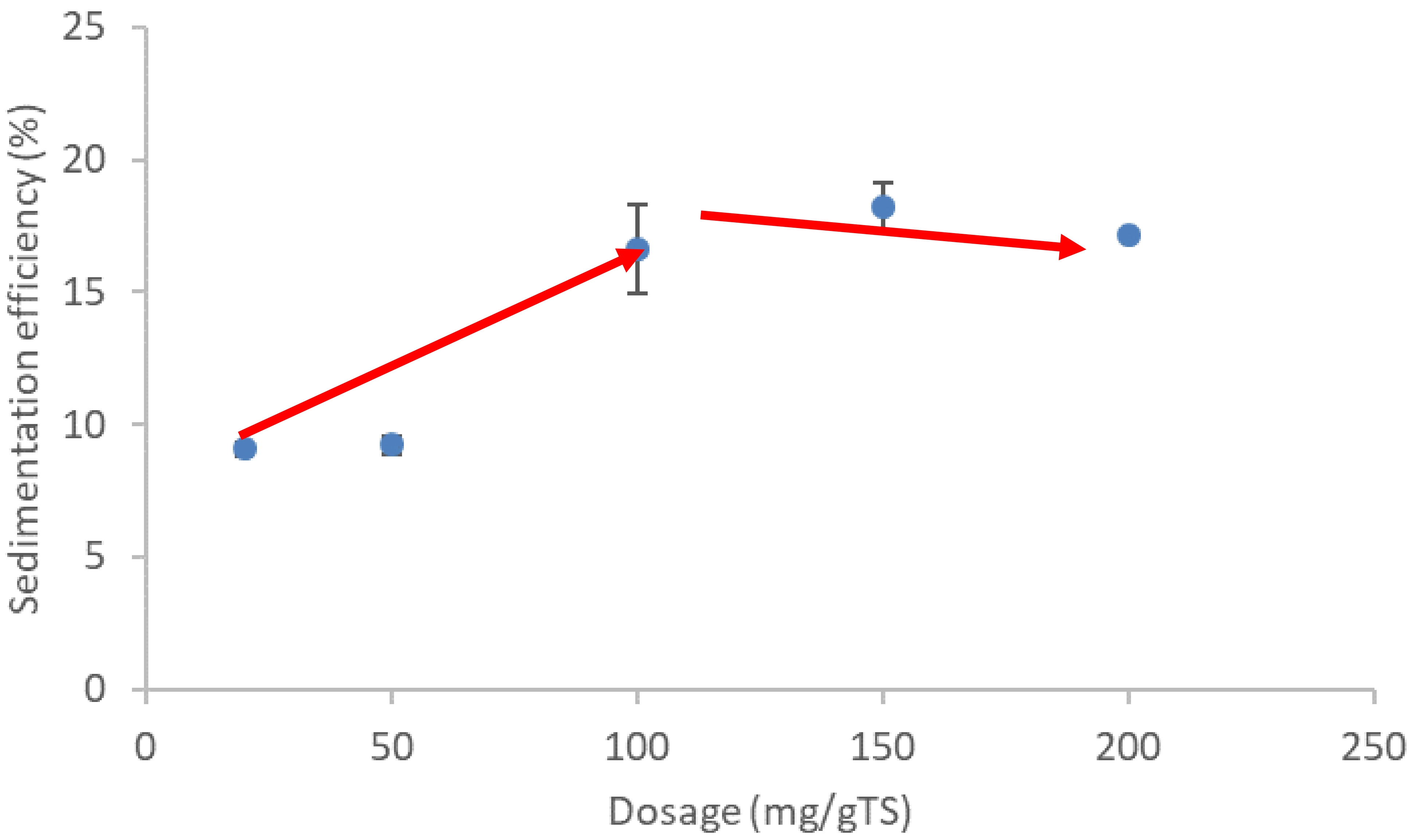
COAGULATION/FLOCCULATION

– Dose optimisation
  – Sedimentation efficiency



e.g. $FeCl_3$

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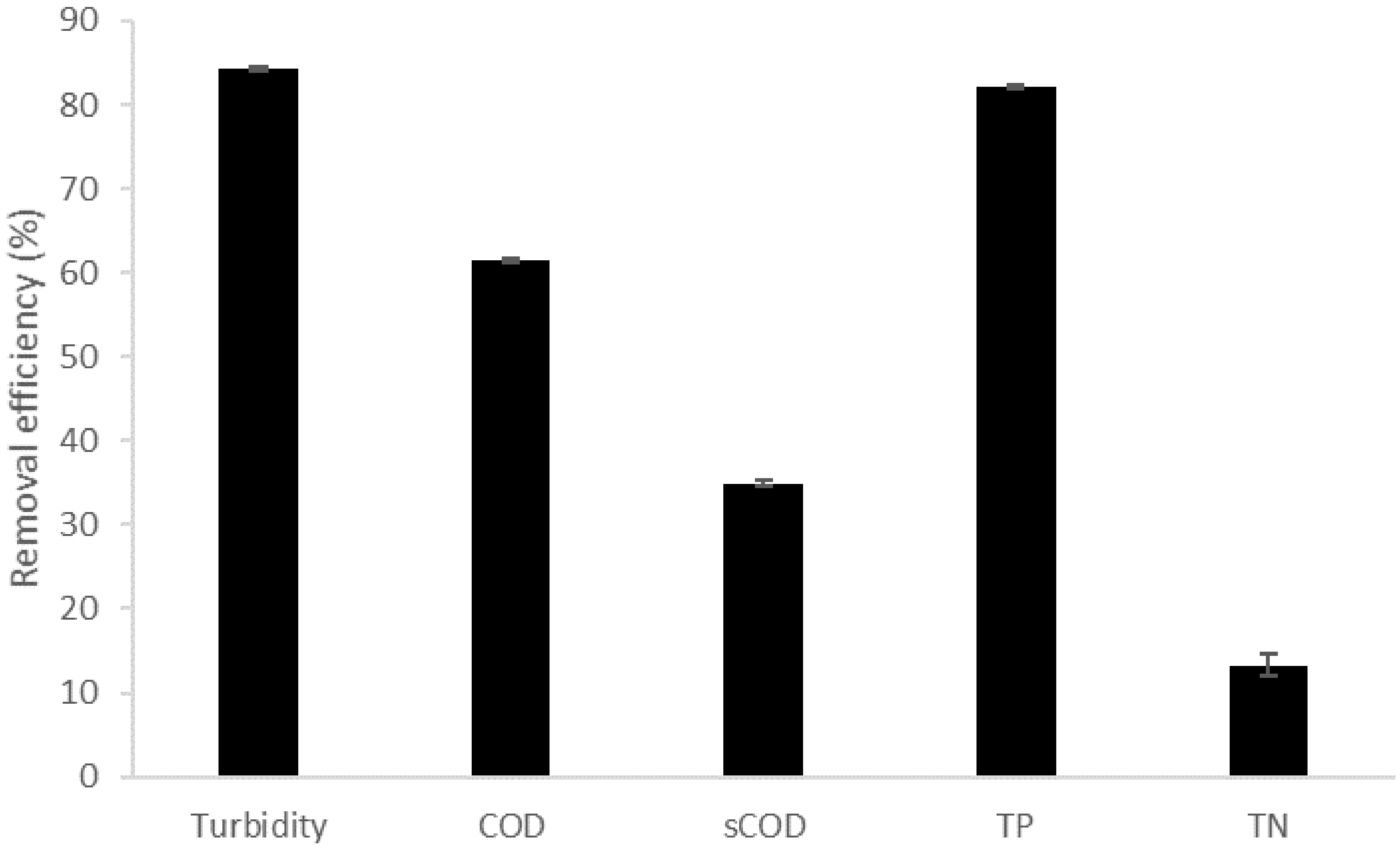
COAGULATION/FLOCCULATION

- Removal @ 100 mg/gTS
  - Turbidity and TP: excellent
  - COD: good
  - sCOD: low(er)
  - TN: bad



e.g. $FeCl_3$

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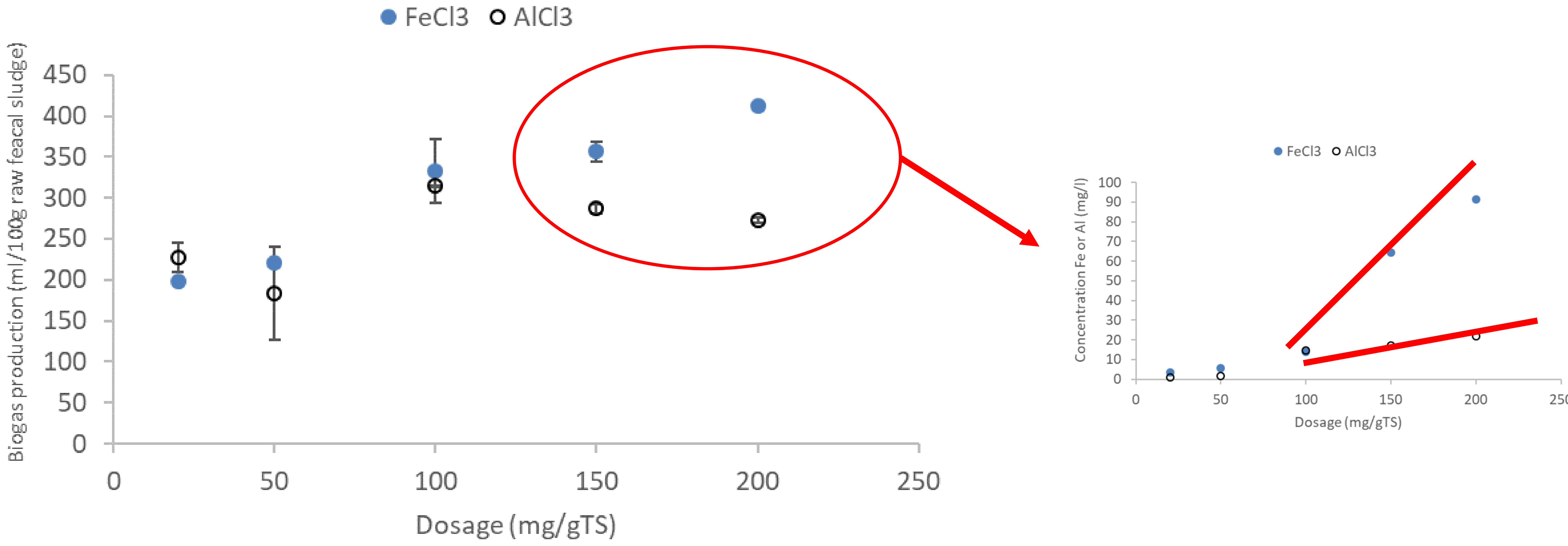
COAGULATION/FLOCCULATION

- Biogas production
  - Optimal dose: 100 mg/gTS
  - High dose: remaining Al -> inhibition

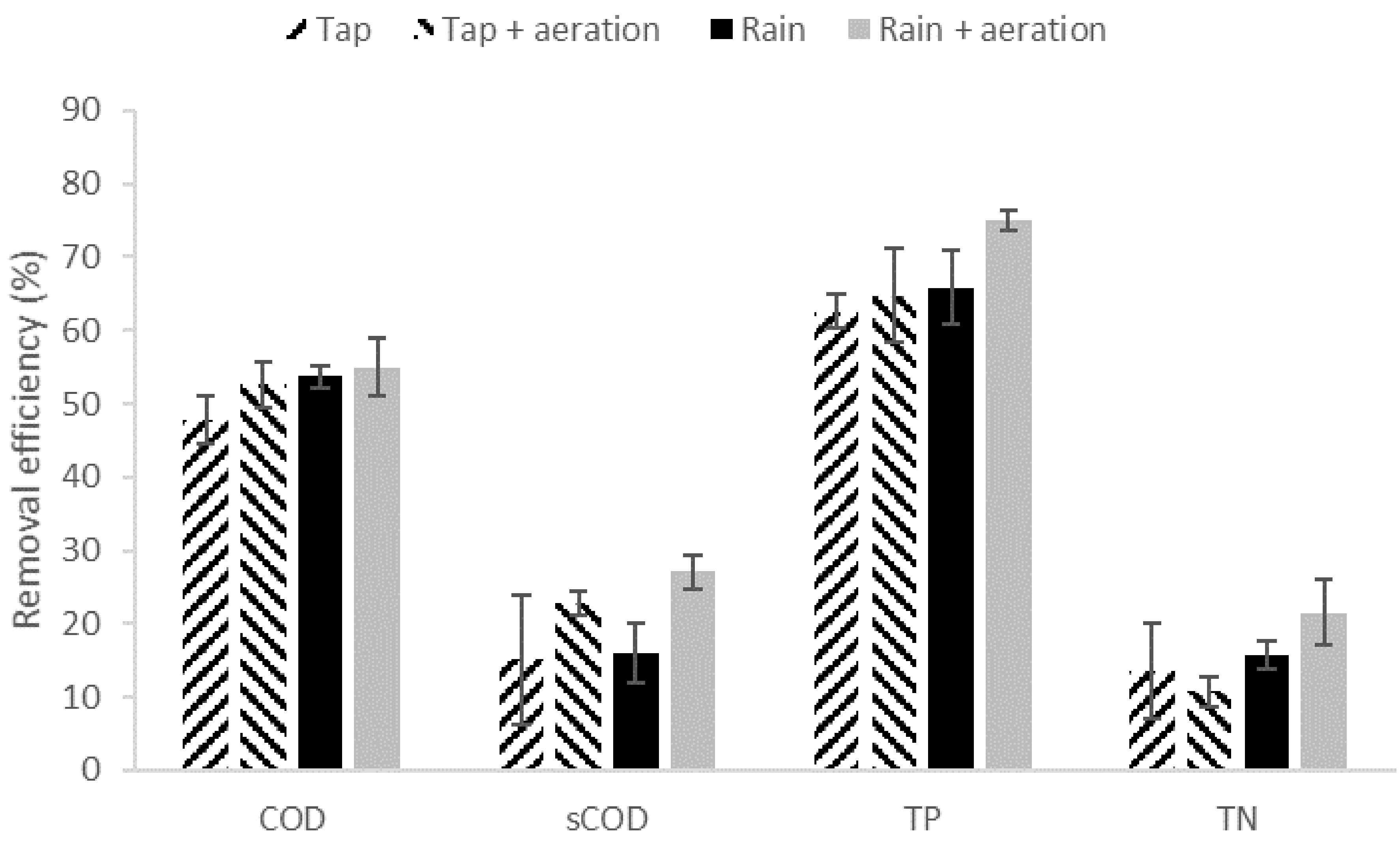


ELECTROCOAGULATION WITH IRON

- No need for chemical addition

- Similar results
  - High COD and TP removal
  - Low(er) sCOD removal

- Effect of
  - Flushing: tap or rain water
  - Influent aeration



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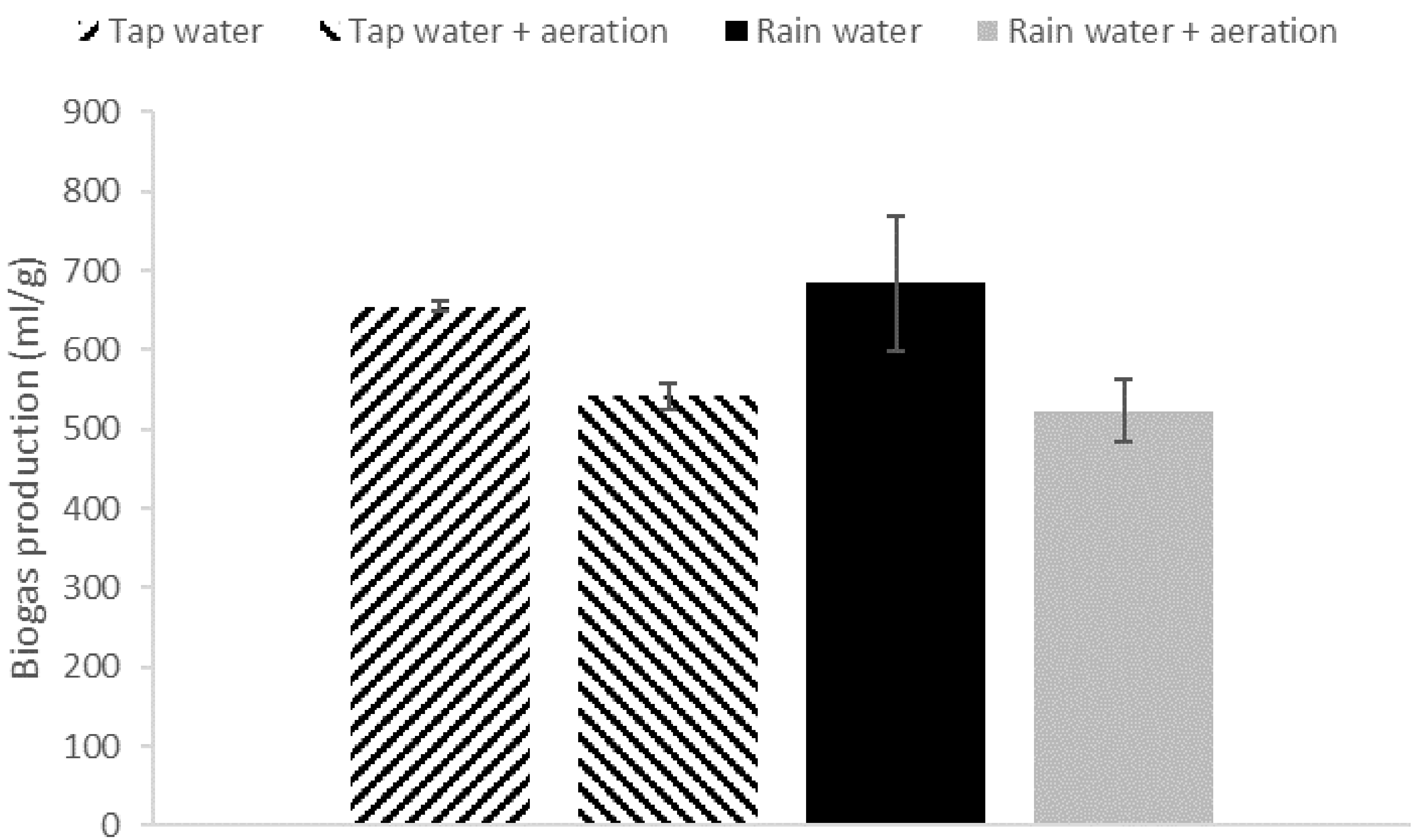
ELECTROCOAGULATION WITH IRON

- Biogas production
  - +/- 75% CH_4
  - Better results when flushing with rain water
  - Aeration: better removal but less biogas production



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TAKE HOME MESSAGES

- Chemical coagulation
  - Coagulation is beneficial as faecal sludge pretreatment
  - Fe-based coagulants perform better than Al-based
  - Dosage of 100 - 200 mg/g TS of Fe-based coagulants can be considered optimal

- Electrocoagulation
  - No need for chemical addition
  - Similar removal as chemical coagulation
  - Rain water is preferred as flushing water

QUESTIONS?

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