Impact of flocculant polymers on anaerobic digestion performance, digestate rheology and dewaterability

Transforming Biosolids

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Abstract

This study evaluated the effects of pre-digestion dosing with synthetic, in powder and liquid form, and biopolymer flocculants on digestion process, digestate rheology, and dewaterability. Optimal dosing reduced yield stress by 20–40%, increased methane yield by 15–25%, and improved dewaterability. However, only 8–25% of the dewatering benefit remained post-digestion, suggesting partial polymer degradation.

Introduction

Residual synthetic flocculant polymers, which are largely non-degradable during typical treatment, can remain in digested sludge (DS) due to their use in sludge thickening and recuperative processes. These residues may affect in-digester rheology, digestion performance, and final dewaterability [1, 2].

Aim/Objectives

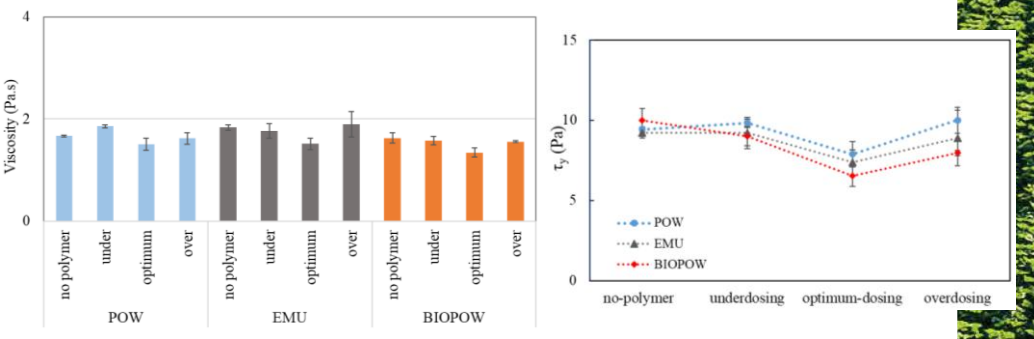
- Investigates how varying polymer flocculant dosages affect anaerobic digestion efficiency.
- Investigates how varying polymer flocculant dosages changes digestate rheology and dewatering characteristics.

Methodology

Three polymer flocculants were dosed at varying levels before batch digestion to assess their effects on sludge rheology, digestion performance, and post-digestion dewaterability. Key parameters including VS removal, biogas yield, and rheology, were monitored over 15 days. After a 15-day batch digestion, the rheological properties and dewaterability of the digestate were further analyzed to elucidate the residual effects of the polymers.

Results/Findings

- Polymer dosing increased methane production linearly up to the optimal dose; effects diminished with overdosing.
- Optimal dosing reduced yield stress (τy), indicating improved and stable sludge structure during digestion. Polymers enhanced initial floc structure and maintained lower rheological resistance, aiding process efficiency.

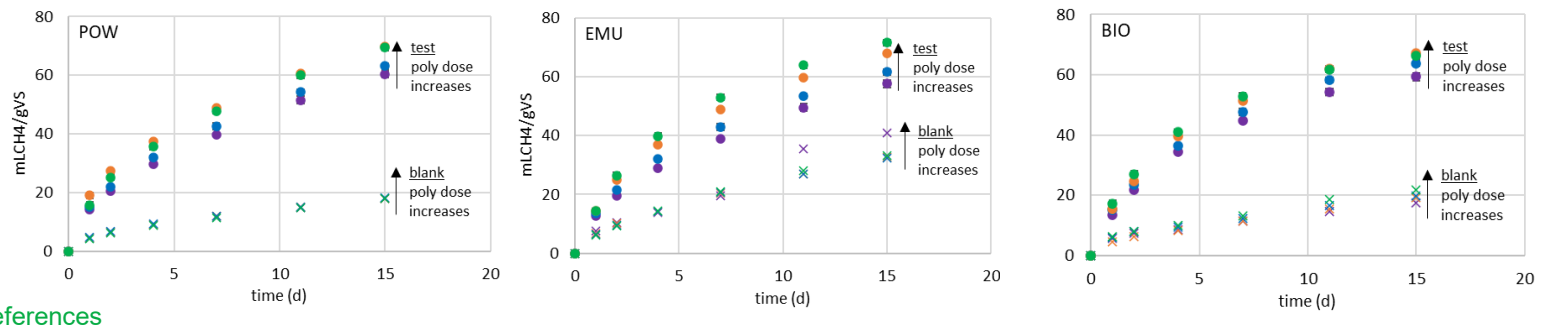


- Slightly better dewaterability was observed at optimal doses, besides retained polymer efficacy and reduced need for post-digestion dosing.

Polymer	Sample	polymer dose (type as indicated) (kgAM/tTS) added prior to digestion	EMU dose (kgAM/tTS) added to digestate for dewatering	TS after dewatering	Net polymer dose (kgAM/tTS)
POW	No-polymer	0	18.3	10.90±0.10%	18.3
	Under-dosing polymer	3.6	17.1	10.75±0.25%	20.7
	Optimum-dosing polymer	7.1	13.3	11.60±0.20%	20.4
	Overdosing polymer	14.2	13.4	10.95±0.40%	27.6
EMU	No-polymer	0	20.2	10.80±0.10%	20.2
	Under-dosing polymer	7.9	16.5	10.85±0.25%	24.4
	Optimum-dosing polymer	15.9	14.8	11.70±0.30%	30.7
	Overdosing polymer	31.8	11.8	11.35±0.20%	43.6
BIOPOW	No-polymer	0	18.2	11.00±0.20%	18.2
	Under-dosing polymer	15.6	16.6	11.25±0.20%	32.2
	Optimum-dosing polymer	31.2	13.4	12.10±0.20%	44.6
	Overdosing polymer	62.5	12.4	11.60±0.25%	74.9

Conclusion

These findings underscore the need for precise polymer dosing strategies to optimize digestion performance and sludge dewatering, leading to more efficient and cost-effective sludge management. The study highlights the vital role of polymer applications in improving sludge treatment processes, providing insights for future advancements in wastewater treatment optimization.



References

[1] Cobbledick, J. et al., Lab-scale demonstration of recuperative thickening technology for enhanced biogas production and dewaterability in anaerobic digestion processes, Water Research, 2016
[2] Kandaiah, R. et al., A comprehensive analysis and risk evaluation of microplastics contamination in Australian commercial plant growth substrates: Unveiling the invisible threat, J. Hazard. Mater., 2024

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