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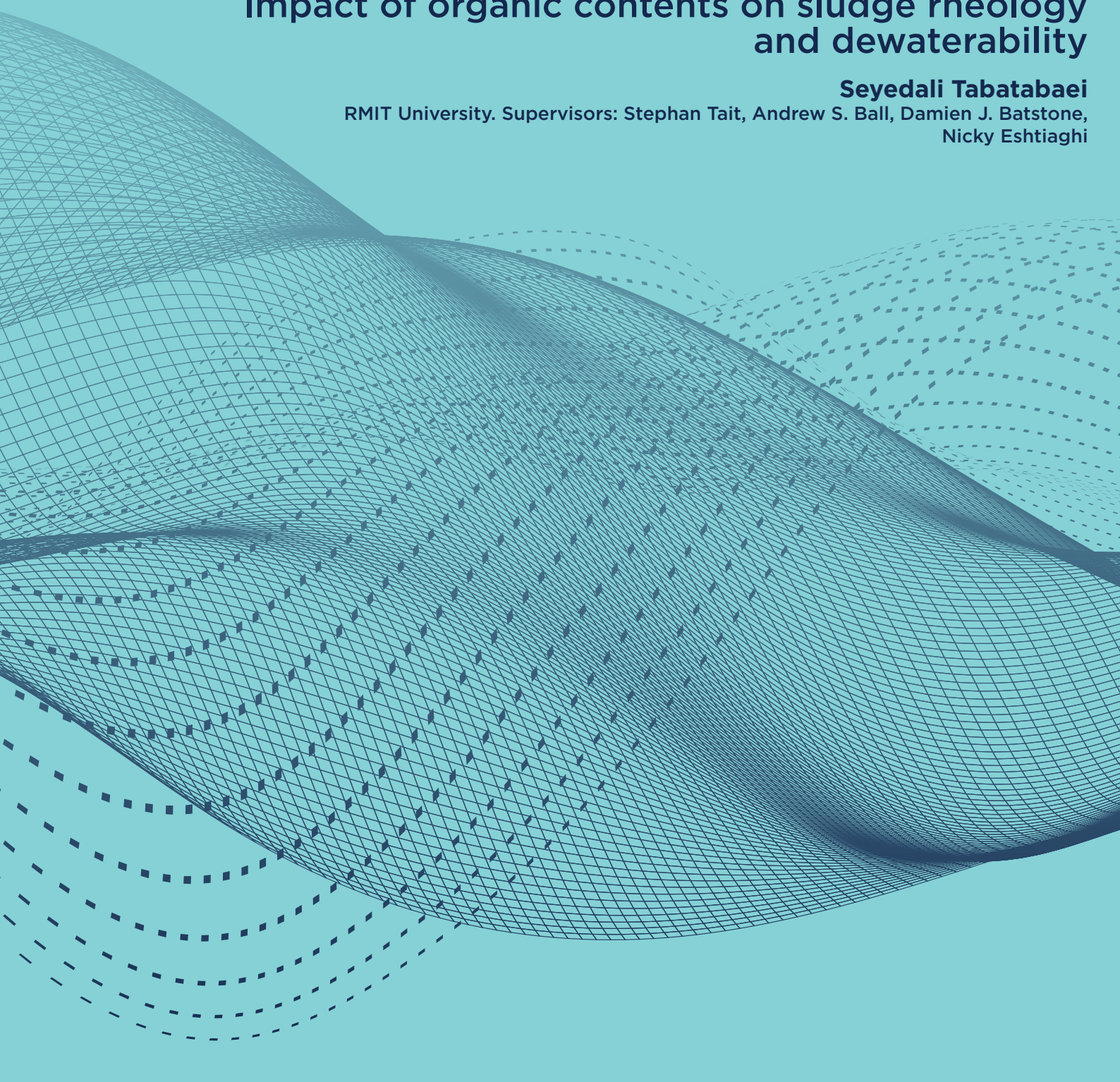

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ABSTRACT

Understanding the relationship between the rheological behaviour of digested sludge and its dewaterability is crucial for reducing the overall operating costs of the dewatering process. Municipal sewage sludge exhibits complex and unpredictable rheological properties due to its nature as a suspension containing various degradable and non-degradable organic matter, including extracellular polymeric substances (EPS). This study analyses the effect of different conditioning technologies on the non-degradable organic matter in sludge and their impact on dewatering performance and rheological behaviour. Since the change in characteristics of EPS (protein and polysaccharide) on different sludges rheology has not been investigated in previous works, this current investigation examines the effect of EPS characteristics on sludge rheology and subsequently on sludge dewaterability by characterising EPS compounds using Fourier Transform Infrared (FTIR). By examining sludge samples from various treatment plants, we aim to provide a comprehensive understanding of these effects.

Additionally, polymers are used as flocculating agents in wastewater treatment plants (WWTPs) to assist in the thickening of waste activated sludge (WAS), thereby increasing the complexity of digestate rheology during and after digestion. While existing literature often focuses on the influence of flocculant polymers as conditioners in sludge flocculation and dewatering, this study addresses gaps in understanding the impacts of these pretreatment polymers, as existing organic contents in sludge, on the digestion process as well as rheology and dewaterability of digested sludge.

KEY WORDS

Viscosity, Dewatering, Organic contents, Flocculant polymers, Extracellular polymeric substances (EPS)

RESEARCH OBJECTIVES

- Identify the impact of organic contents, EPS and its contents on rheology and dewaterability in various samples.
- Assessing the impact of polymer flocculant dosing during WAS pre-thickening on rheology and dewaterability of digested sludge.
- Effect of non-Newtonian behaviour of liquid carrier on dewaterability; understanding role of μviscosity and viscosity on sludge dewatering, and impact of shear-thinning, and yield stress of liquid carrier on cake formation and water removal regardless of organic fraction.

RESEARCH QUESTIONS

1. How do organic contents affect the sludge rheology and dewaterability?

2. How does the dosing of polymer flocculants during WAS pre-thickening affect the rheology and dewaterability of digested sludge?

3. How does viscosity, independent of organic content and solid concentration, have a fundamental effect on sludge thickening and dewaterability?

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FINDINGS TO DATE

Our research has provided key insights into sludge treatment processes, focusing on the role of organic compounds and EPS in sludge rheology and dewaterability. We discovered that EPS concentration has no direct correlation with sludge rheology or dewaterability while FTIR analysis revealed distinct spectral properties of EPS that significantly influence both viscosity and dewaterability. Additionally, we identified a strong correlation between organic fractions and sludge behaviour, where higher organic content increases viscosity and reduces dewaterability. These findings emphasise the importance of EPS composition and organic fractions in shaping sludge properties. Furthermore, we developed a novel FTIR-based method capable of accurately predicting sludge dewaterability, offering an innovative tool for process optimisation.

We further investigated polymer use in WWTPs for WAS thickening, emphasising precise dosing strategies to optimise the digestion process and improve digestate rheology. These findings highlight the potential for tailored polymer applications to enhance sludge management, reduce costs, and promote environmentally sustainable wastewater treatment practices.

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