Understanding anaerobic digestion pre-treatment methods and their impacts on the dewaterability of sludge

Ratidzaishe Tracy Mupinga*, Ewan McAdam, and Yadira Bajon Fernandez
School of Water, Energy and Environment, Cranfield University

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INTRODUCTION

- Pre-treatment technologies improve the Anaerobic digestion (AD) process, increasing biogas production.
- Products of digestion used as bio-fertilisers.
- Transport and safe disposal associated costs.

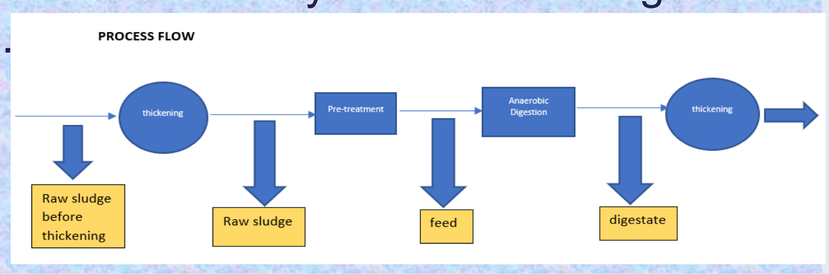
AIM

- Evaluate how anaerobic digestion pre-treatment processes impact the matrix properties that govern dewaterability and permeability for centralised sludges.

METHODOLOGY

- Samples were collected from different sites having different pre-treatments (2 biological, thermal and conventional) in England.
- TS, VS, DS, PSD, Fractal dimension, and surface charge were analysed, with dewaterability assessed through CST and batch settling.

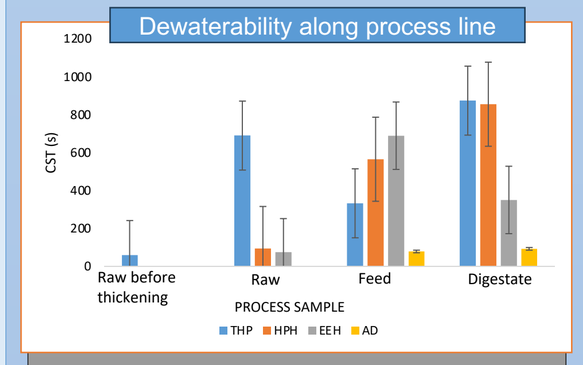
Biological-{HPH-EEH}
Thermal- THP
Conventional-AD



RESULTS

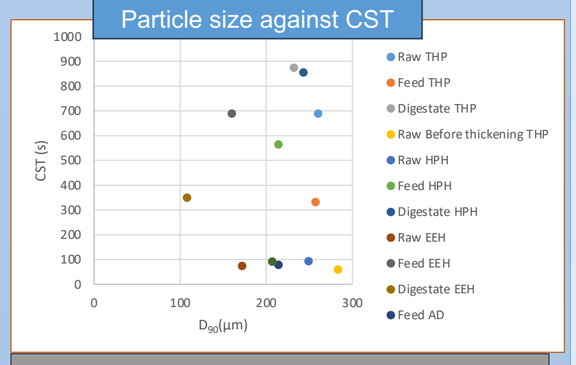
Impact of Particle size on dewaterability

Dewaterability along process line



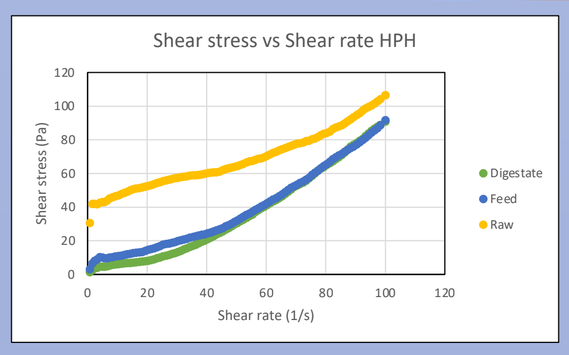
- Reduced dewaterability for digestate sludges THP and HPH.
- Unexpected increased dewaterability in EEH digestate and AD Digestate.

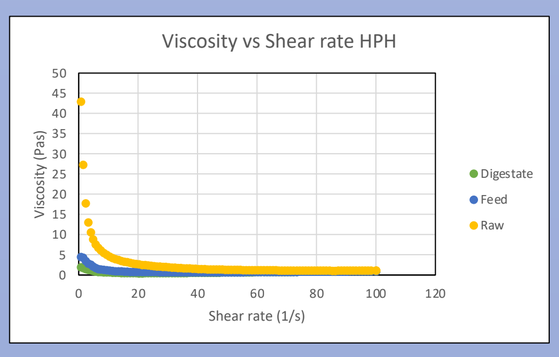
Particle size against CST



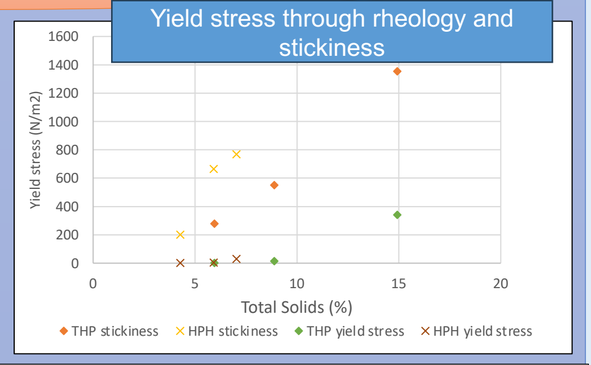
- Increased volume of smaller particles (D(4.3)) in digestate from all sites= greater CST>decreased dewaterability.

Change in rheological behaviour across process line



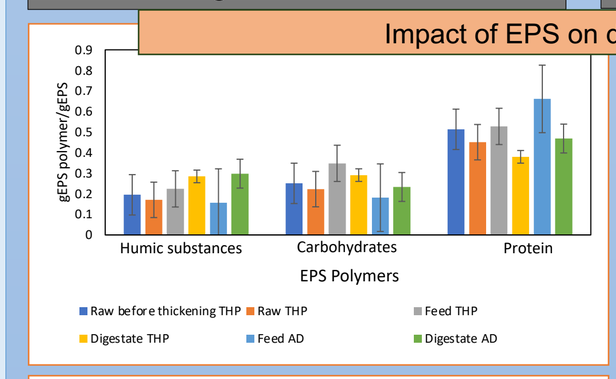


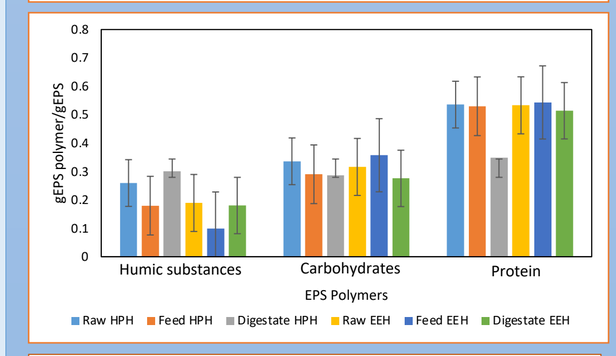
Yield stress through rheology and stickiness

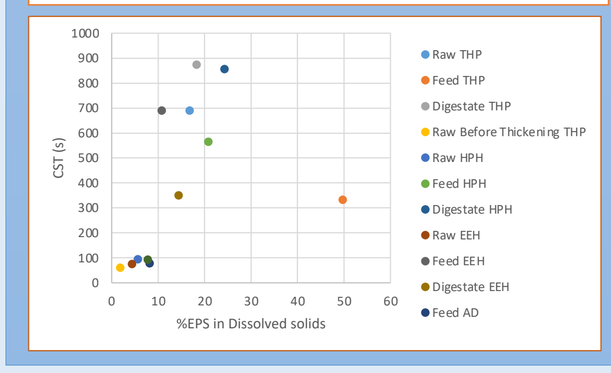


- All sludges follow the Herschel Buckley model and exhibit shear thinning.
- yield stress measures for flow are the total energy as a combination of both energy for flow as well as energy to overcome stickiness of the sludge.

Impact of EPS on dewaterability

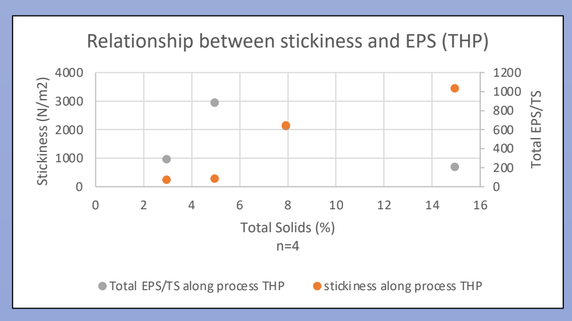


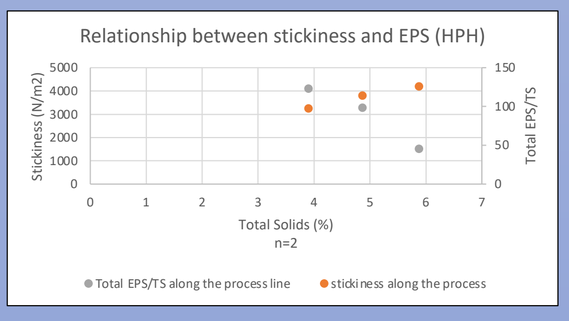


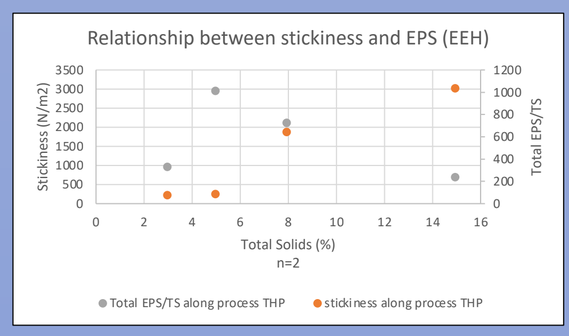


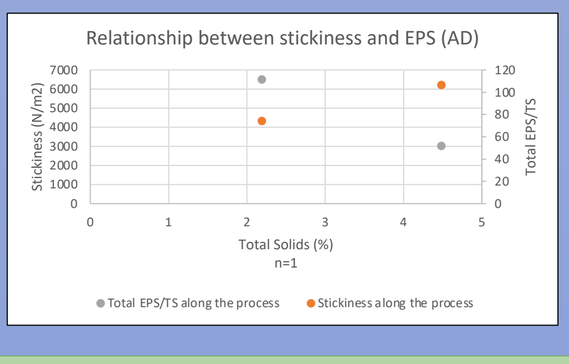
- Protein EPS for Feed sludge THP is highest which could suggest solubilisation of Protein in thermal treatment.
- General high protein production of EPS for centralised sludges.
- Despite increased EPS production, EEH sludges Feed and digestate show increased dewaterability suggesting optimum values for EPS to improve dewaterability.
- Increased humic substances in EEH digestate.

Relationship between stickiness and EPS









- Stickiness increases with an increase in TS.
- Increased EPS production is proportional to a decrease in the stickiness exhibited in HPH and AD samples clearly.

CONCLUSION

- ❖ EEH showing balanced production of EPS to optimise dewaterability with HPH production of EPS reducing overall dewaterability.
- ❖ Particle size reduction directly proportional to dewaterability. Interactions of particle size and stickiness influenced by EPS quantities.

FUTURE WORK

- ❖ Impact of matrix properties on dewaterability of decentralised sludges and fresh faeces.
- ❖ Impact of lining, aging and compaction on decentralised sludges and how these influence sludge matrix properties.

contact tracy.mupinga@cranfield.ac.uk

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