

University of  
South Wales  
Prifysgol  
De Cymru

# Nutrient Recovery and Water Quality Based Novel Analytical Tools



Platform yr  
Amgylchedd Cymru

Environment  
Platform Wales

**Better Water Quality for Wales  
Conference**

 **27 - 29 June 2023**

 **USW Exchange, Newport and Online**



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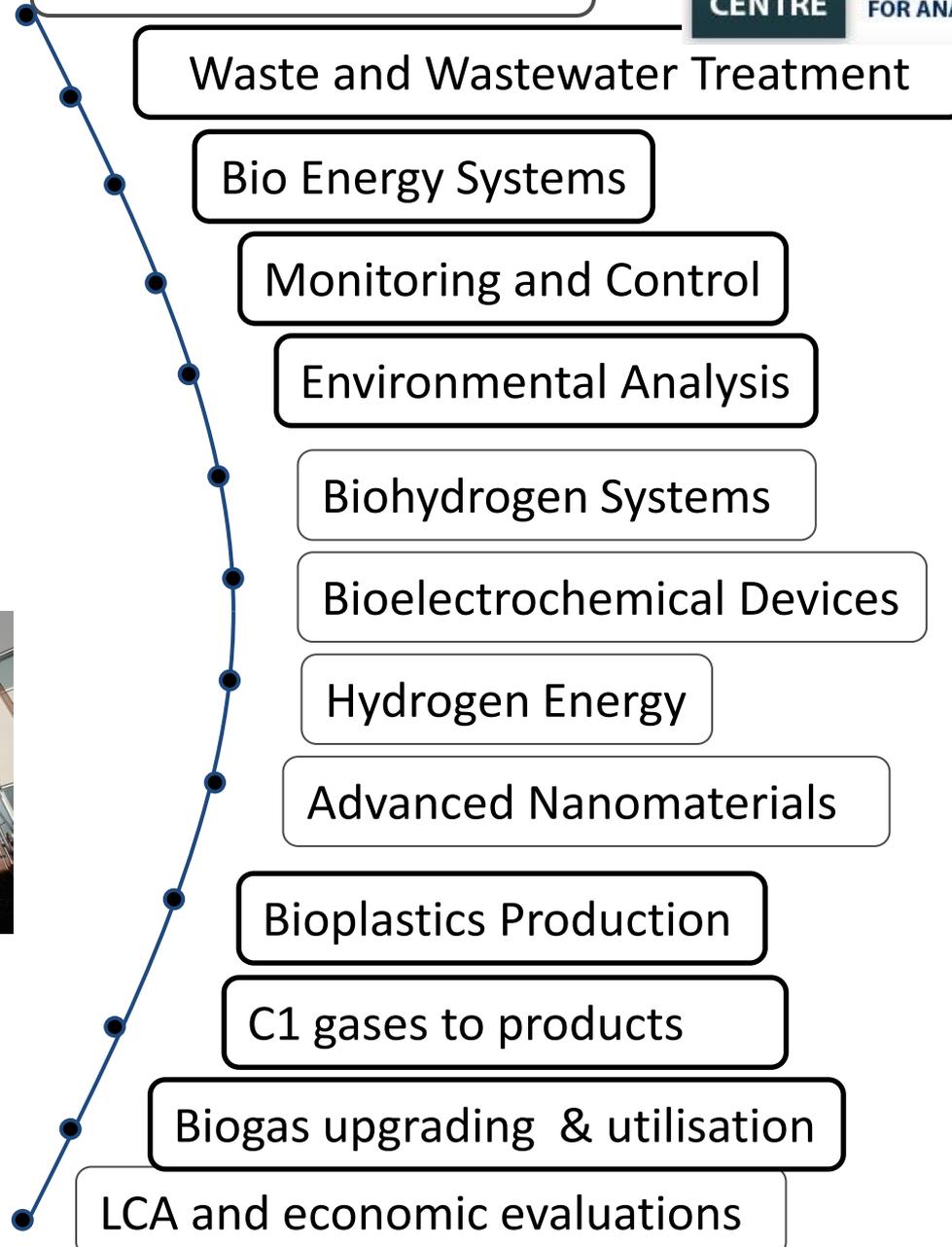
# Anaerobic Digestion

THE AD  
CENTRE

THE WALES  
CENTRE OF EXCELLENCE  
FOR ANAEROBIC DIGESTION

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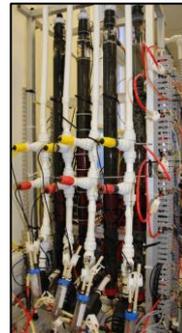
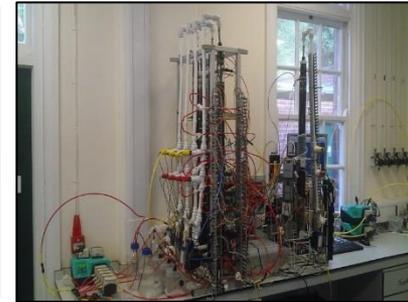
**SERC**  
SUSTAINABLE  
ENVIRONMENT  
RESEARCH CENTRE



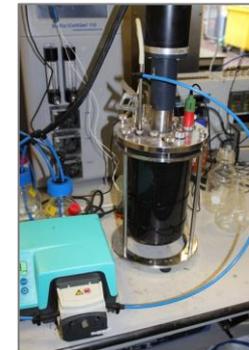
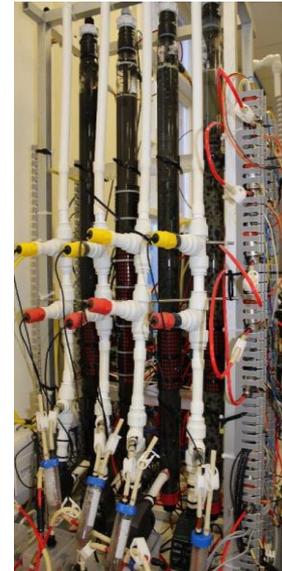
**H<sub>2</sub>** The  
Hydrogen  
Centre

# USW Team's Expertise & Facilities

- Team experience in bioreactors design, integration, monitoring, modelling and control
- Novel process development in the lab (1-100 l), pilot (200 l - 30 m<sup>3</sup>) and full scale experience (up to 7000 m<sup>3</sup>)
- Pure and mixed culture reactor facilities
- C1 Gases fermentation lab facilities
- 450 m<sup>2</sup> floor - 13 labs
- Extensive suite of analytical equipment – Chemical and Molecular Biology



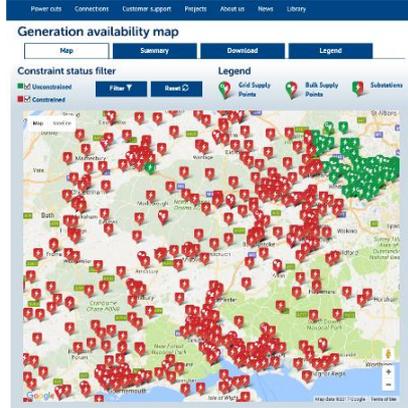
# C1 Gases Fermentation Lab Facilities



# Biotechnologies Able to Address Challenges



**CO<sub>2</sub> / Ammonia Emissions**



**Power Grid Constraint**



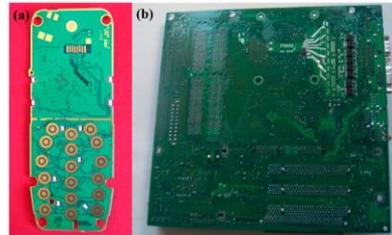
**Large Scale Energy Storage**



**Decarbonise Gas/Fuel**



**Recycling of (Bio)Plastics**



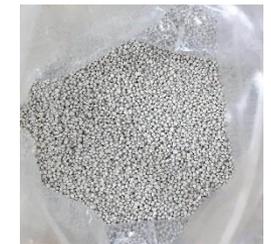
**Metal recovery via bioleaching**



**Resource Recovery**



**Alternative Protein**



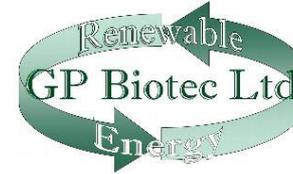
**Fertilisers**

# SMARTExpertise:

## SMART Collaboration for an Industrial Resource Circular Economy (CIRCLE) Project Partners Sept. 2017 – Oct 2022



THE WALES CENTRE OF EXCELLENCE FOR ANAEROBIC DIGESTION



 Biomethanation / CO<sub>2</sub> Utilisation

 Heat Recovery

 Nutrient / Metals recovery

 Advanced Process Monitoring

 High Value molecule recovery



# A Biorefining Centre of Excellence for Wales

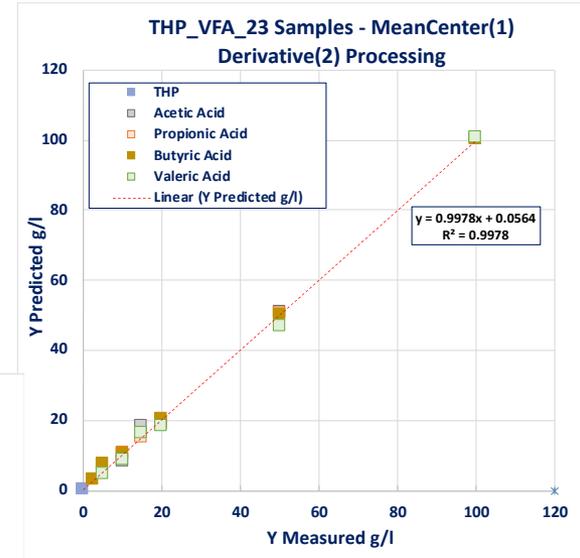
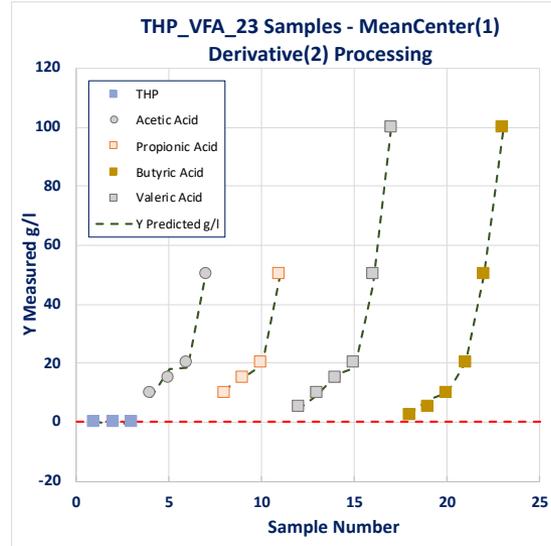
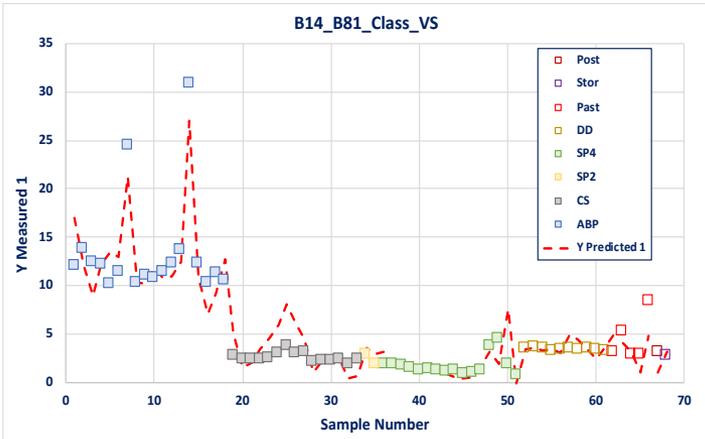
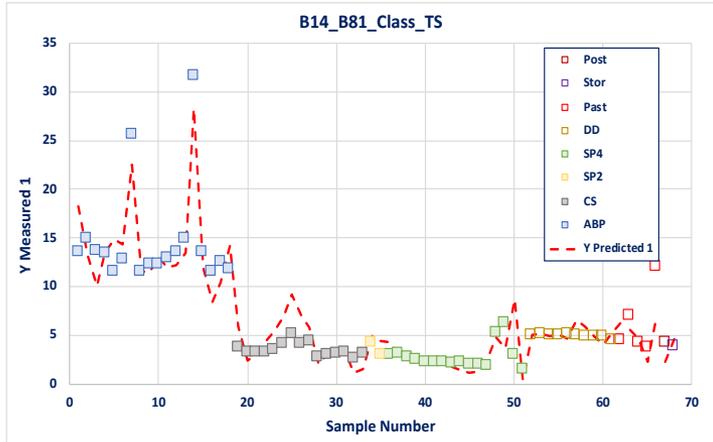
July 2019 – Dec 2022



From plants to products  
O blanhigion i gynhyrchion

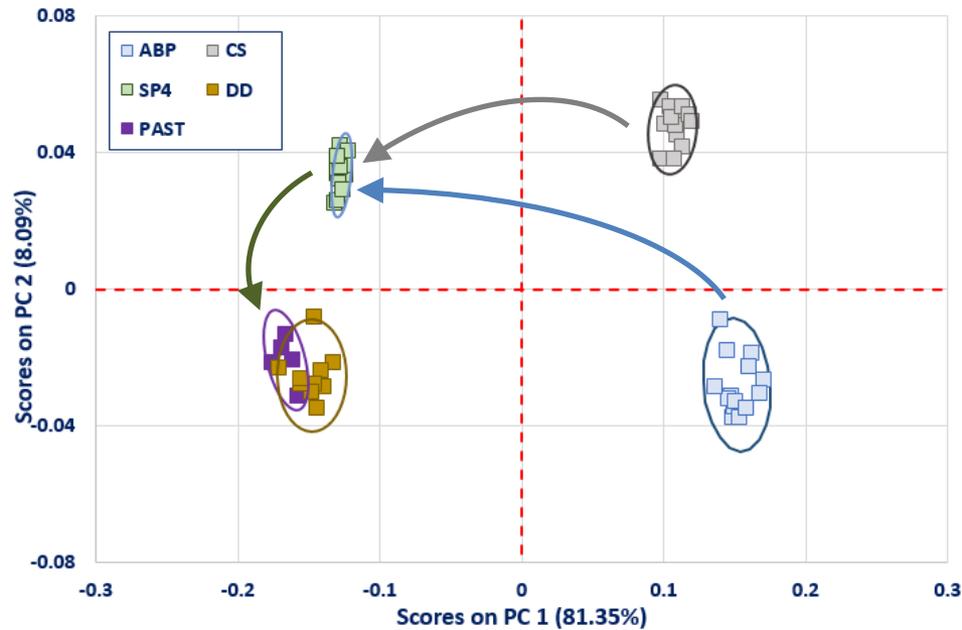


# Real-time Solids and VFA Content using FT-NIR



# Classification of Anaerobic Digestion Matrices

## Feedstocks and Products



Development of a Classification Tool, using Principal Component Analysis, for

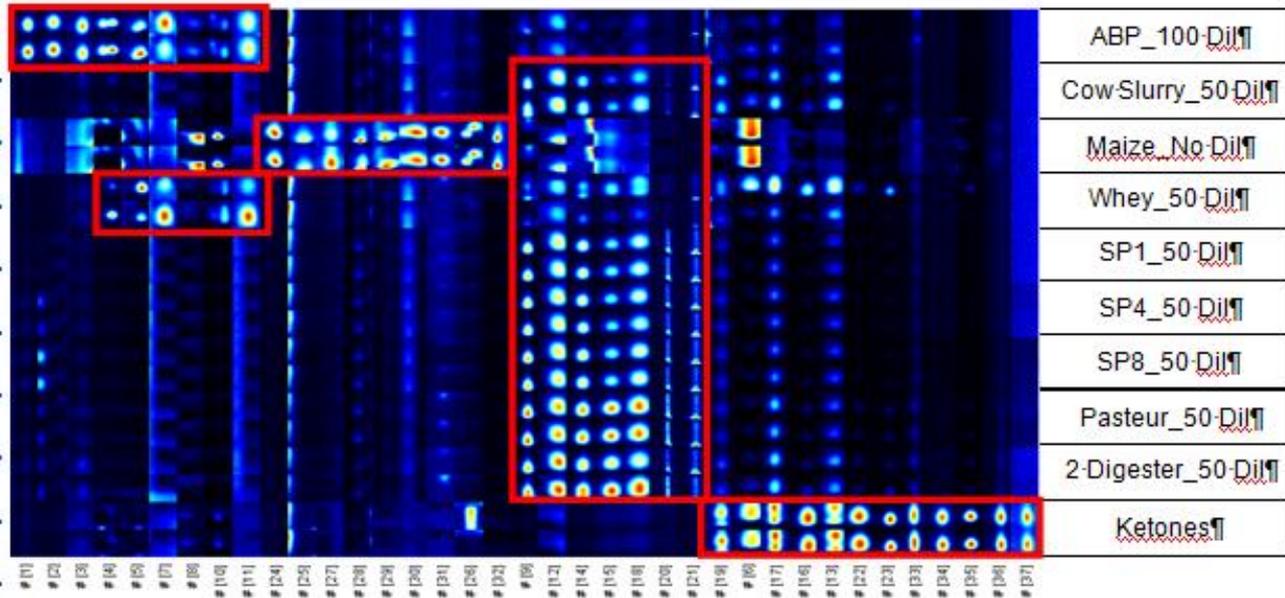
- Process Monitoring
- Optimise Process Control
- Identify Origin of Materials

### Inter-process monitoring

PCA analysis of the Bryn Power plug flow digester illustrates the potential of in-tank process monitoring.



# GC-IMS Chemical Fingerprinting Feedstocks, Intermediates and Digestates



terpenes, ketones, aromatics, alcohols, aldehydes, volatile fatty acids, esters and ammonia



## Rapid fingerprinting and differentiation of pollutants potentially entering the environment using GC-IMS and SOM

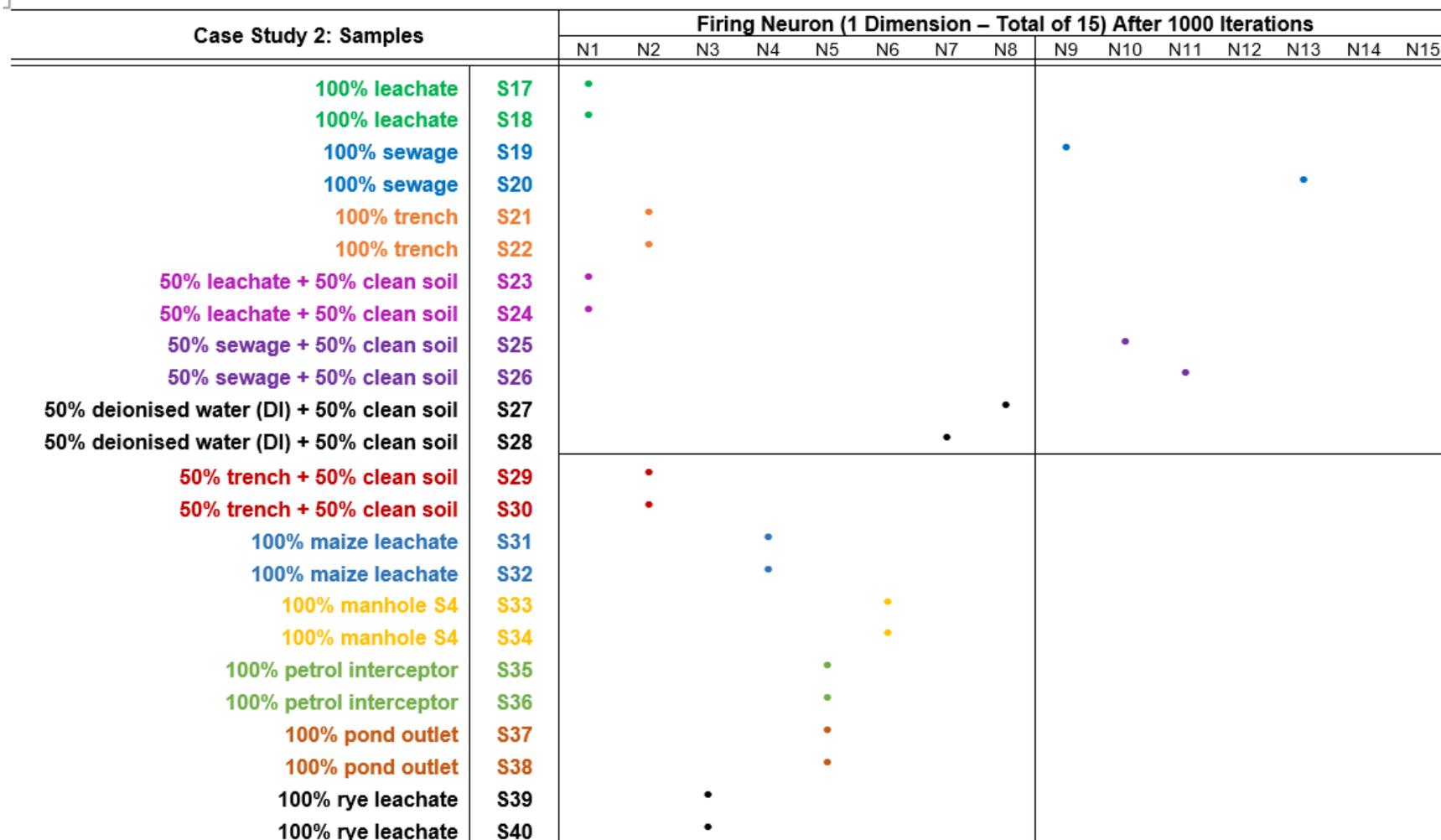
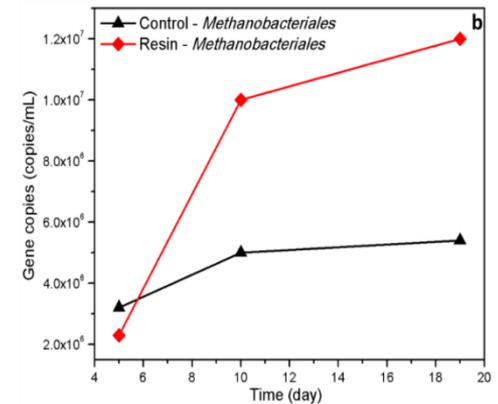
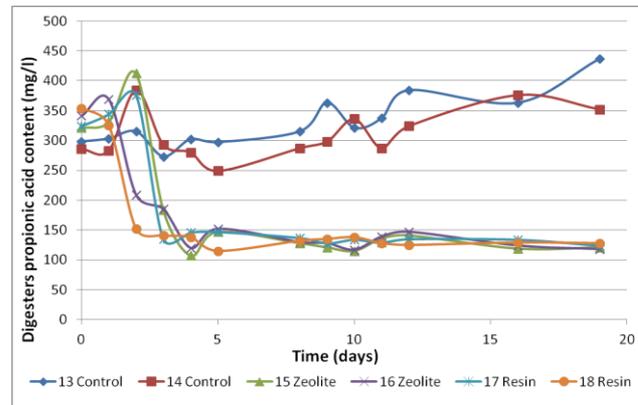
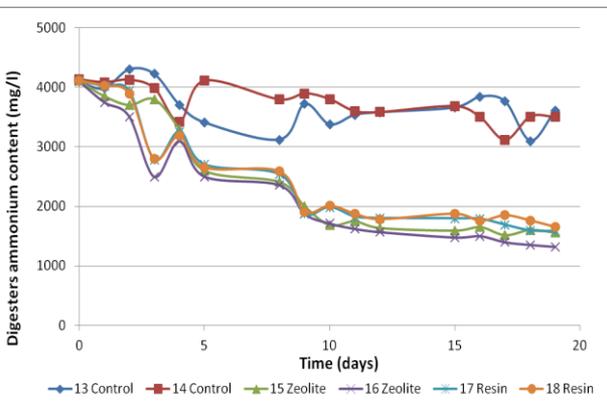
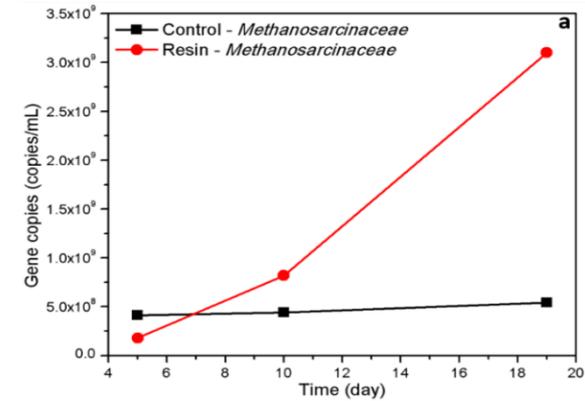
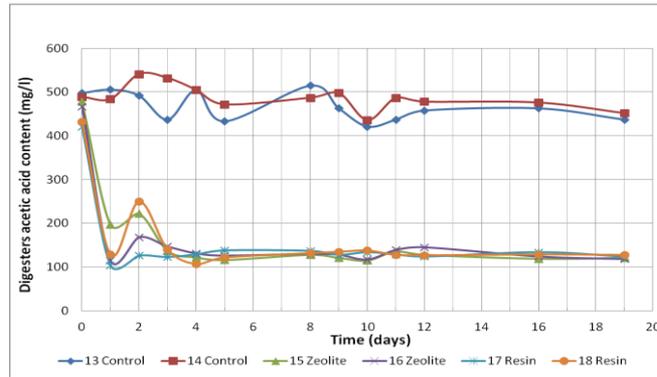
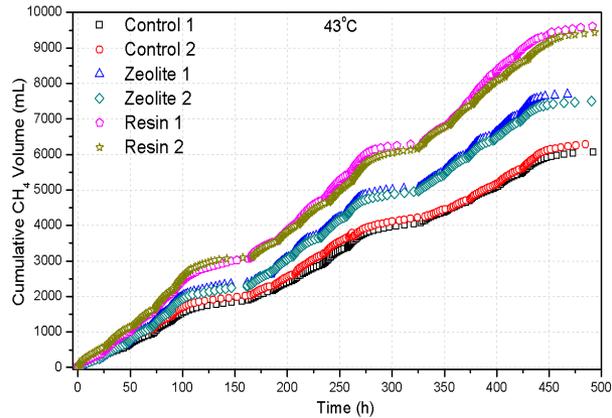


Figure 3B. SOM for case study 2

# Ammonia Recovery from High Sewage Sludge Content Digesters

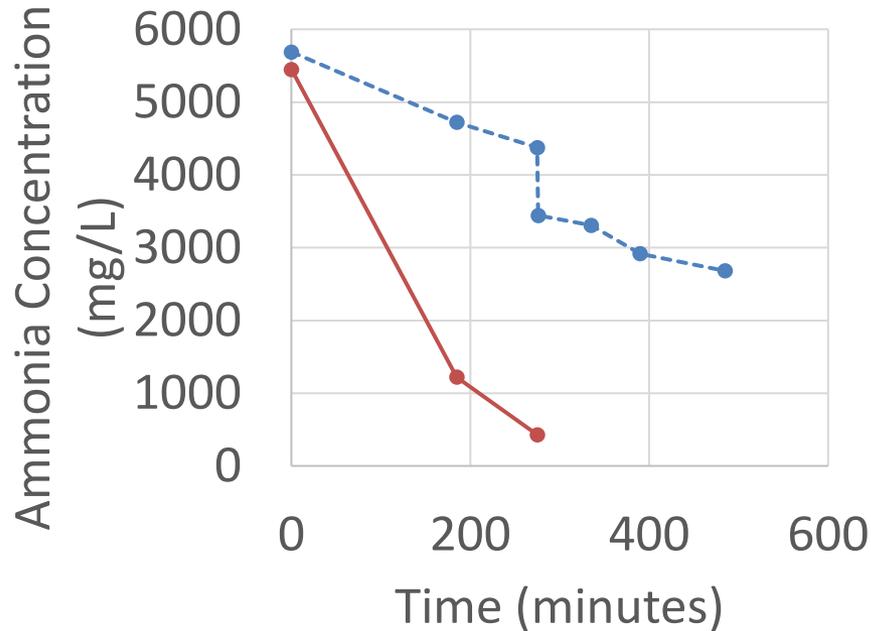


# Digestate Fractionation

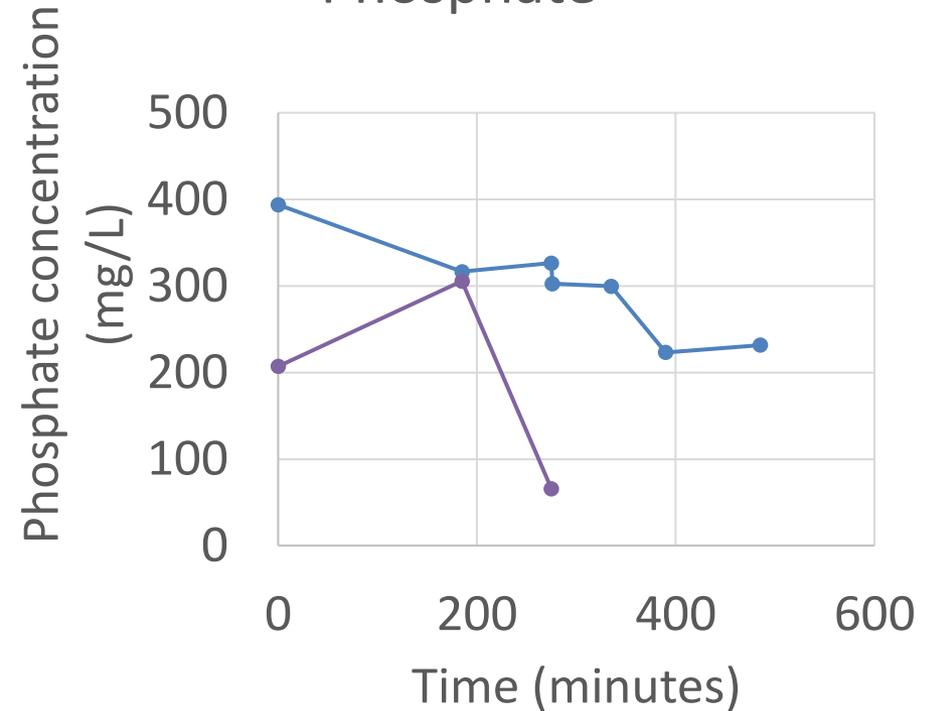
>90% Recovery of NPK



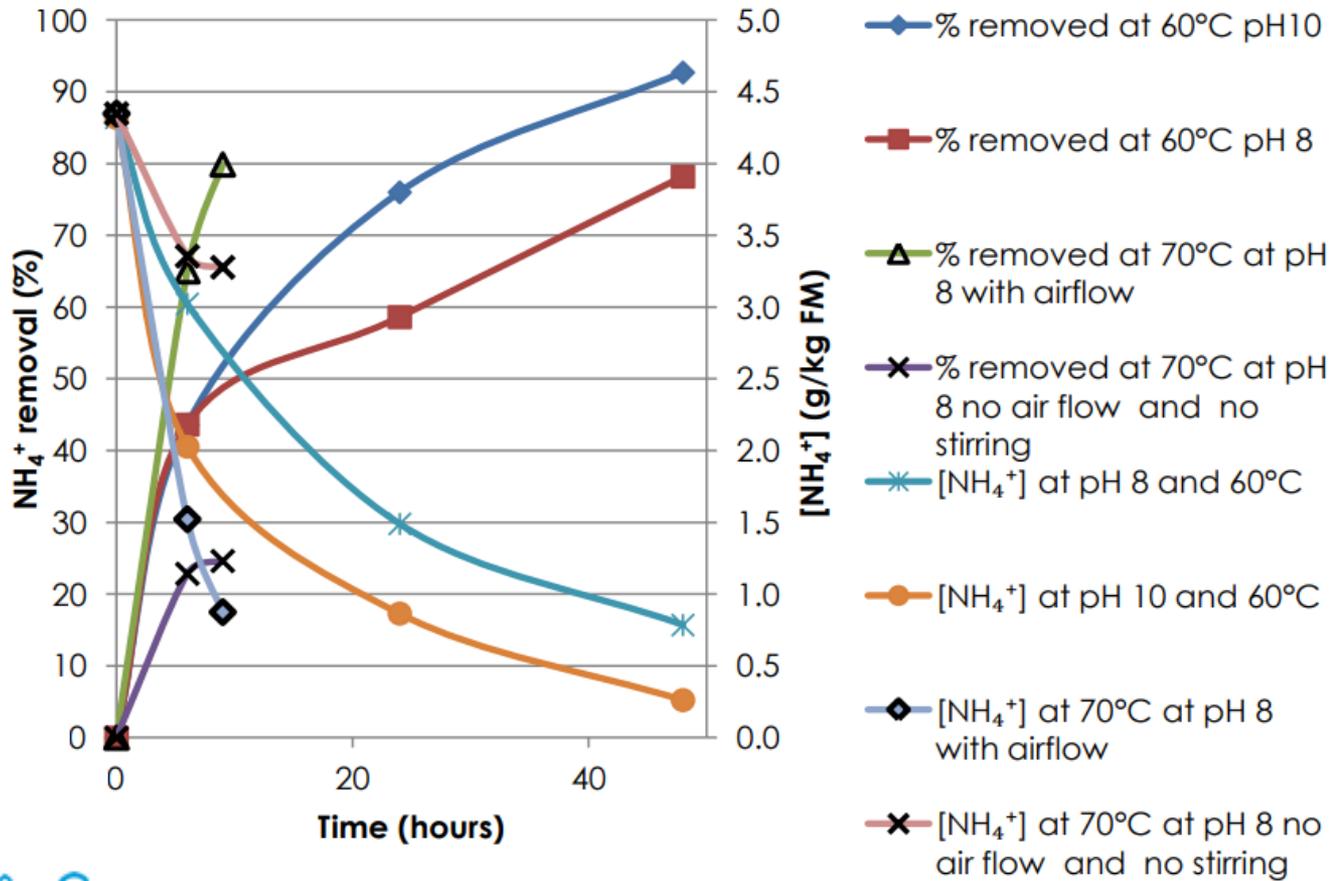
## Ammonia



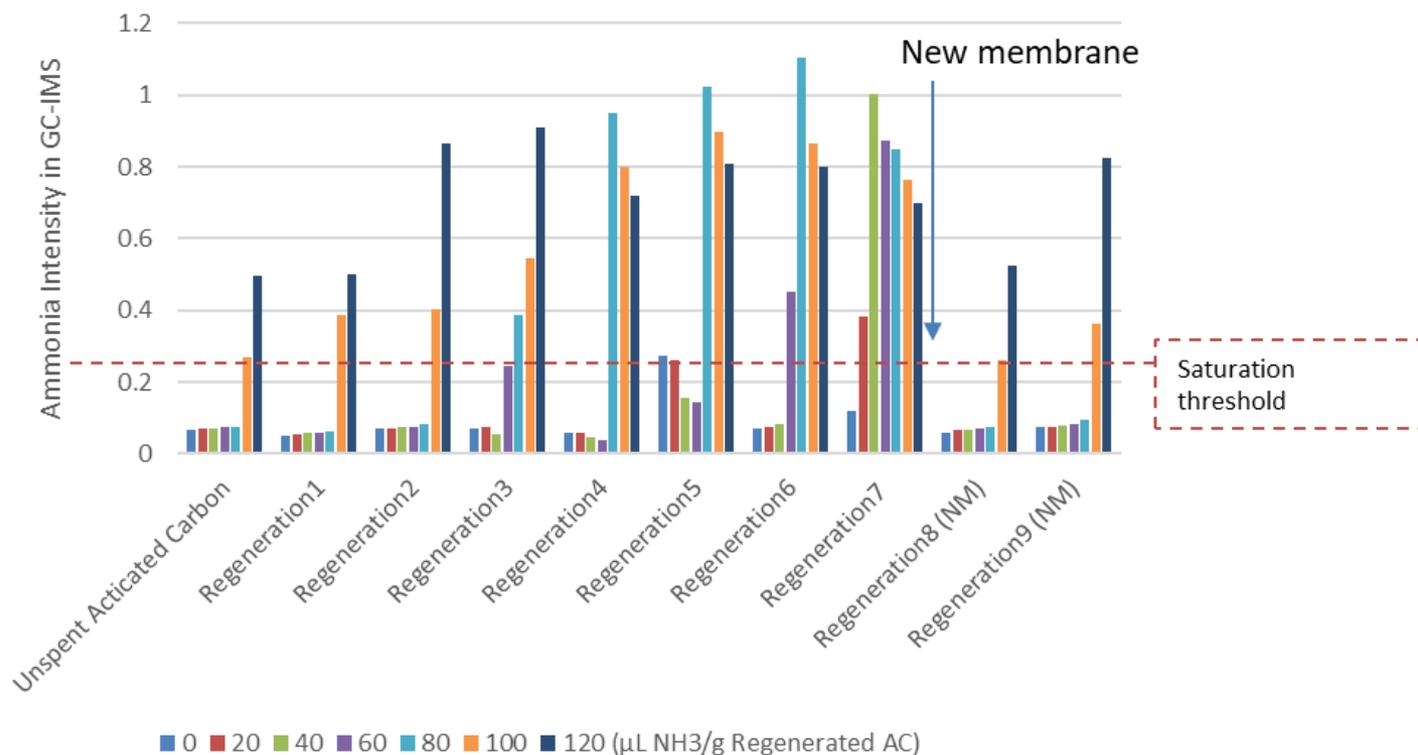
## Phosphate



## Ammonia Stripping - Effect of temperature, mixing and air flow on the rate of ammonium removal from digestate



## Spent Activated Carbon Regeneration using a Membrane System



NB: AC - Activated Carbon, NW-Membrane replacement

Regeneration of the AC was effective  
up to cycle 9  
For GP Biotec ~ 5 years usage rather  
than 6 months



# Water Breakthrough Challenge

## Transforming the energy balance of wastewater treatment

### September 2022 – August 2026

- Develop solutions to reduce the energy required for wastewater treatment
- Decarbonise wastewater treatment – reducing nitrous oxide emissions and recovering beneficial resources including N and P
- The water industry consumes between 2-3% of electricity produced in the UK (~powering over 1.2 million homes) and ~55 % is linked to the processing of wastewater



# Special Acknowledgements



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**Dr. Raj Gangappa**



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**Dr. Adam Henley**



**Dr. Angela Oliveira**



**Ciaran Burns**



**Michael Darke**



**Dr. Bing Tao**



**Dr Ivo Oliveira**

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# Acknowledgments



THE WALES  
CENTRE OF EXCELLENCE  
FOR ANAEROBIC DIGESTION



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