

25 November 2024

Project Summary

‘Addressing technical barriers at merchant food waste anaerobic digestion facilities (ADMax)’ Project

KEY POINTS

- Project developed novel operational support tools for timely diagnostics and feedstock selection at commercial food waste anaerobic digestion facilities
- Strong collaboration and integrated research with full-scale operations of project partners Richgro Garden Products (Richgro) and Martin Energy Group (MEG)
- Combination of full-scale waste sampling and characterisation, and bench-scale anaerobic digestion and inhibition response testing
- Research explores and integrates:
 - practically feasible waste characterisation
 - standardised and rapid inhibition diagnostics
 - inhibition by ammonia and long chain fatty acids (LCFA), including with microbial acclimation
 - Excel-based Operational decision support tool with inhibition and biogas predictions

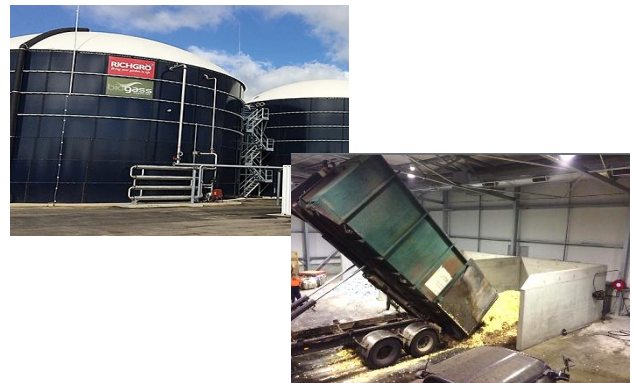


Figure 1. Operational Richgro's food waste digestion facility. Figure courtesy of Richgro.

THE CHALLENGE

Anaerobic digestion is a mature waste transformation technology to divert bulk amounts of unavoidable food waste from landfill.

Current digestion capacity is limited by waste feedstock variability and complexity, and microbial inhibition risk. These translate into process upsets by inhibitory compounds such as ammonia and long chain fatty acids which are by-products from the microbial reactions in food waste digestion.

Commercial food waste anaerobic digestion facilities do not currently have tools to proactively deal with such operational challenges in a timely manner. Consequently, they typically operate undercapacity, decreasing food waste diverted.

THE OPPORTUNITY

The current project addresses the challenge by identifying waste characterisation approaches, inhibition testing methods and diagnostics, and incorporating these into a simplified diagnostics calculation tool for use in regular operations of commercial food waste digestion facilities.

No previous tool published focussed on operational decision-making at commercial anaerobic digestion facilities, so the project represents a significant advancement on incorporating fundamental research into routine operations.

OUR RESEARCH

Full-scale sampling and food waste characterisation

Representative sampling of food waste feedstocks at full-scale operational Richgro and MEG digestion facilities. Representative Richgro feedstock mix compiled for bench-scale experiments. Samples analysed by external lab for carbohydrate, fat (including speciation) and protein. Biochemical methane potential and digestion rate measured by bench-scale anaerobic incubation tests.

Bench-scale continuous digestion of mixed food waste

Continuous bench-scale digestion emulating full-scale two-stage digestion facility of partner Richgro.

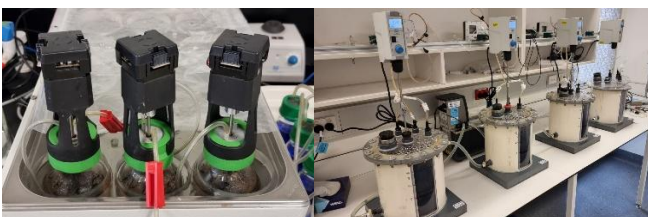


Figure 2. Bench-scale two-stage digestion set-up: (left) fermenters; (right) mesophilic continuous digesters

Tests explored:

- organic loading rate/hydraulic retention time
- effect of fermentation time on LCFA accumulation
- performance of proposed MEG co-digestion

Acute inhibition tests on ammonia and LCFA

- Specific methanogenic activity on acetate at (1) different ammonia concentration/pH combinations, and at (2) different oleic acid (a model LCFA) concentrations with parallel inhibited blank tests
- Determined threshold inhibitor concentrations for substantial loss in microbial activity
- Statistical fit testing of different empirical inhibition profiles for suitability

THE OUTCOMES

Outcomes of the research:

- Identified practical waste characterisation approach for new food waste prospects to estimate biogas energy recovery, and process inhibition risk;
- Validated short-cut inhibition test approach for LCFA which can be applied by digestion facility operations to assess inhibition risk;
- Bench-scale digestion experiments determined operational limits for a healthy digester operating with real food waste mix with high nitrogen (ammonia) and high fat components.
- Identified digester heating important for carbohydrate-rich food waste to maintain pH
- Determined threshold empirical inhibition function most suitable for LCFA inhibition behaviour
- Built simplified Excel calculation-based Operational Decision Support Tool including biogas and inhibition risk predictions. Confirmed functionality via comparison with bench-scale testing data.

THE IMPACT

Increased digestion capacity by timely diagnostics. Could divert 200,000+ tonnes per annum from landfill from 3-5 years. Potential industry profitability increase by \$9,997,077 (estimate \$21 M revenue per year and implementation cost of \$56 M for forecasted > 5 future merchant digestion facilities in Australia; > 3 meat processing co-digestion facilities; and >\$15M/year gate fees value + >\$6M/year energy value. EFW CRC impact tool estimates 895,050 T CO₂-eq saved via displacement of fossil fuels, prevention of fugitive methane emissions from landfill, and fertilisers from digestate, and potential for 142 circular economy jobs.

NEXT STEPS

Suggested next steps include applying and testing the Operational Decision Support Tool for full-scale implementation scenarios and new prospective feedstocks.

PROJECT TEAM

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PROJECT WEBPAGE

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