

Pilot scale electromethanogenic reactor treating brewery wastewater - progress to commercial implementation.

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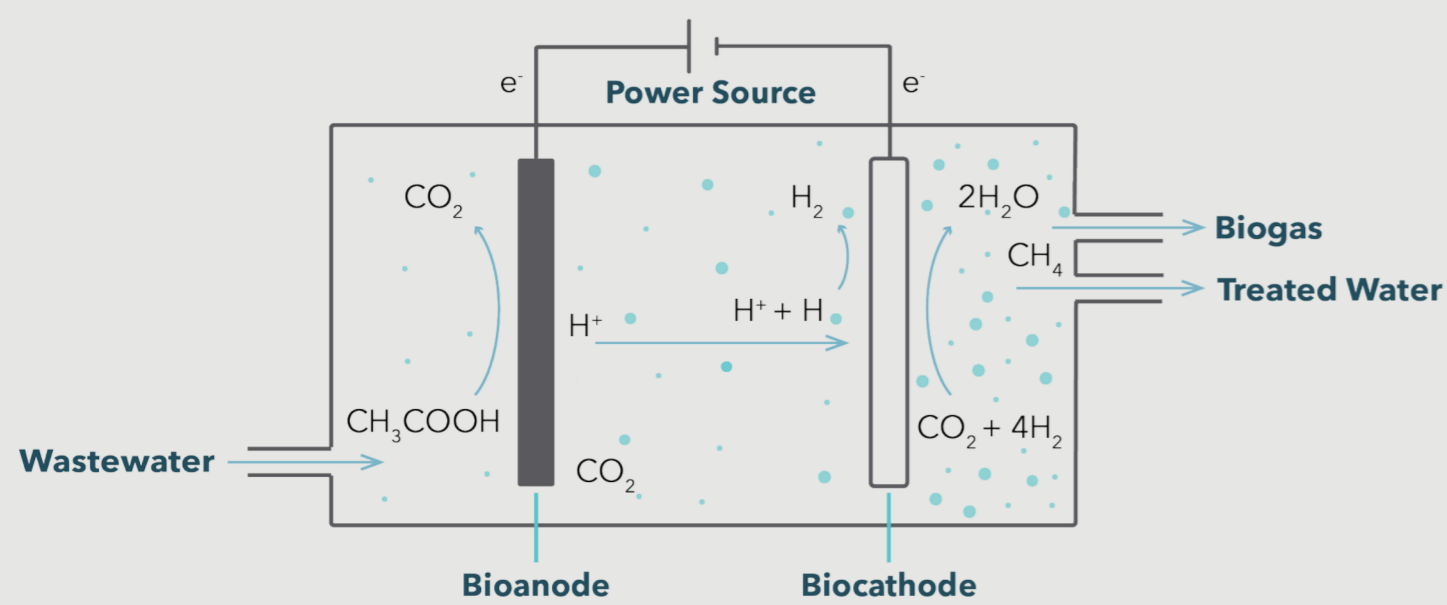


A pilot scale (4000L) electromethanogenic reactor (MEC-AD) treating brewery wastewater was designed and installed at Hepworth's Brewery, UK. This investigation presents a 4-fold increase on the next largest pilot scale MEC-AD system presented in literature (Cusick et al., 2011), and will inform the operation of 24,000L and 51,000L MEC-AD systems in the next stage of WASE's product development.

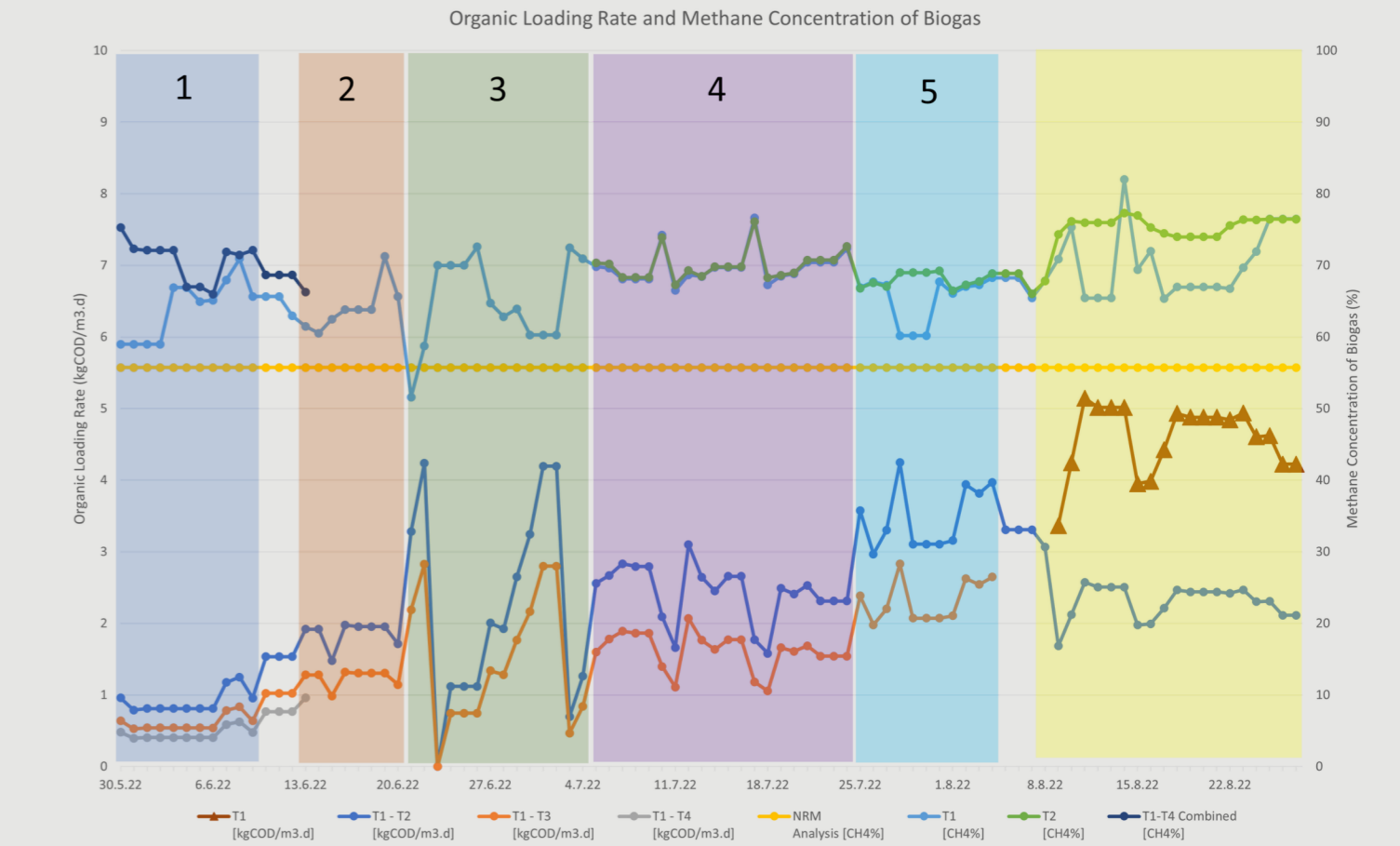
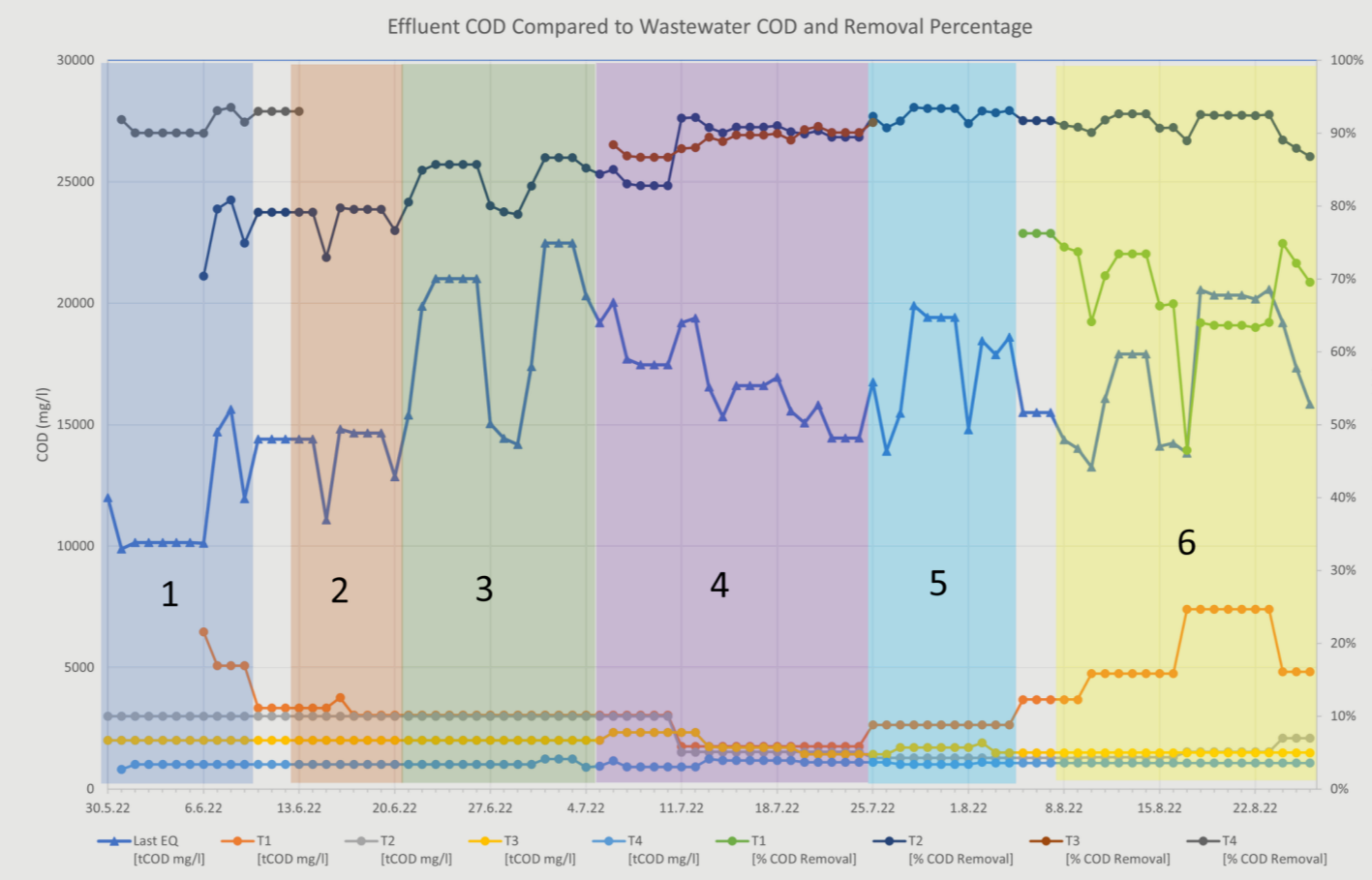
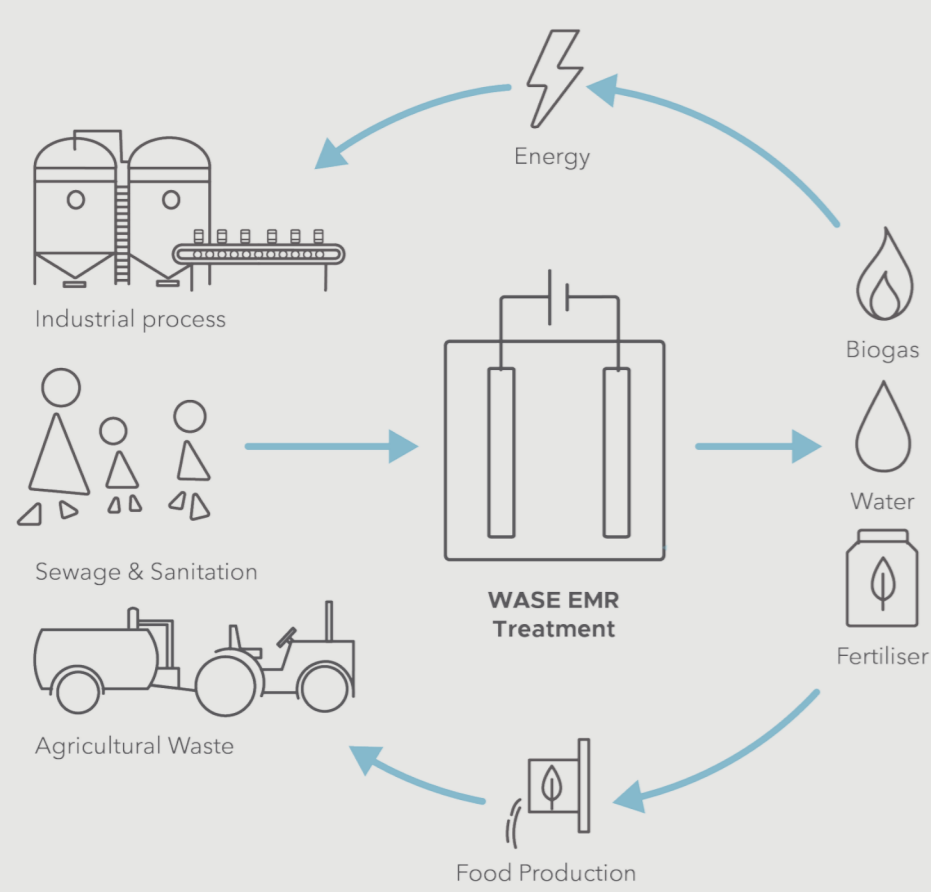
Housed in a 20ft shipping container, the pilot system features four 1000L reaction vessels arranged in series, each with a working volume of 900L. Each vessel contains 64 electrode pairs in 8 modules. Electrodes pairs were poised to 0.9V and reactors were heated to 35 C throughout.



Electromethanogenesis for circular economy



Retention times between 30 and 2.4 days were investigated to align with commercial viability targets. Organic loading rate varied between 0.4 and 6 kgCOD/m³/d. An average COD removal of 93% was observed over the 4 month investigation with on average 83% of the COD being removed in the first two stages of the reactor. A peak stable HRT of 3.1 days was achieved in the primary reactor with 85% COD removal, suggesting that the secondary stage is largely redundant with brewery wastewater of around 16000 mg/L COD. The system produced biogas of 70.3% methane on average and yielded 0.458 m³ CH₄/kg of COD removed. This equated to on average 63.1 kWh/m³ wastewater treated. Current density peaked at 3.54 A/m³ (reactor volume).



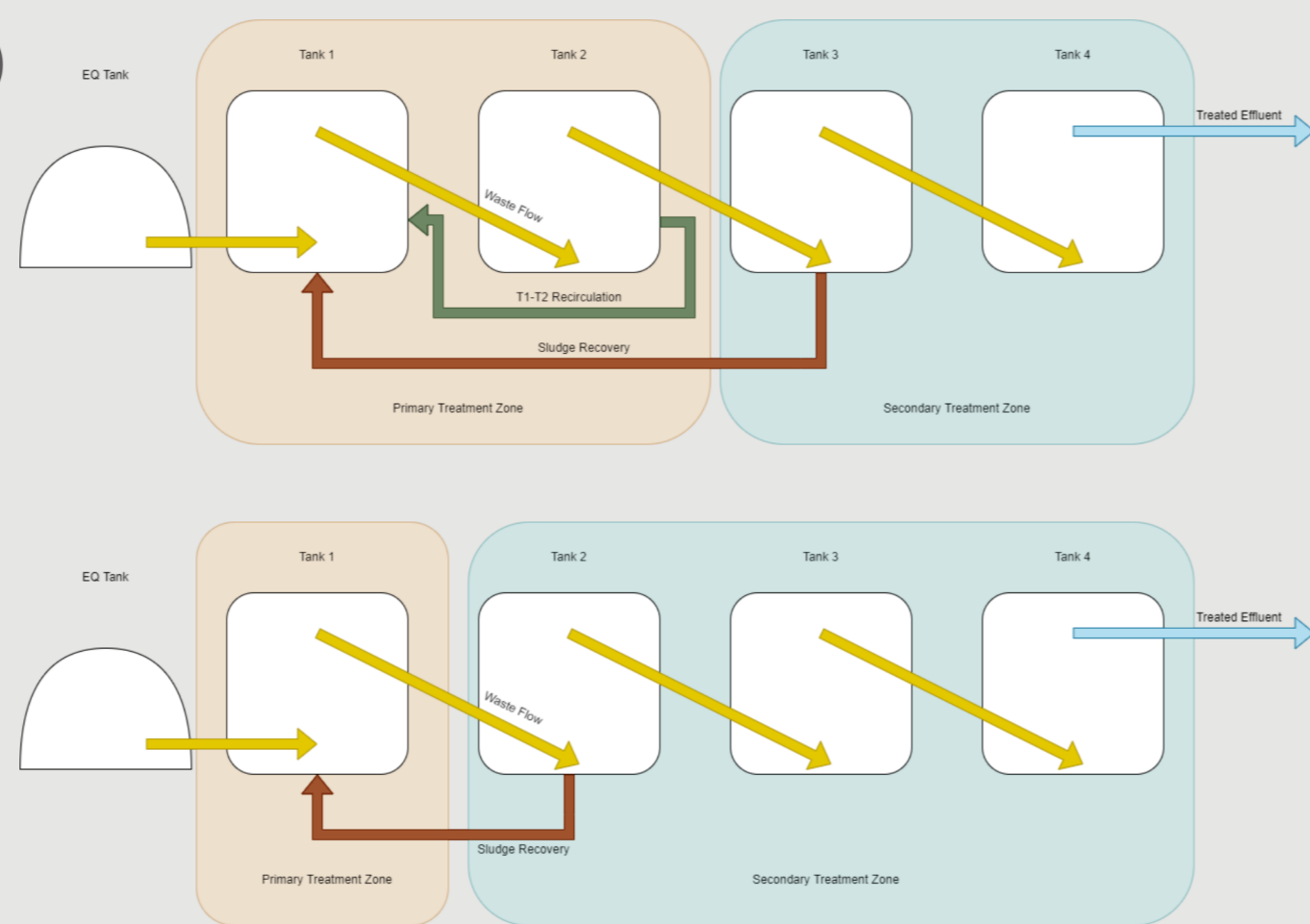
Reactor Setup - Phase 3-5

90% COD Removal (Tank 2 Effluent)
85% of total biogas production occurs in primary (T1&2)
Stability observed at 4.7d HRT (FOS/TAC)

Reactor Setup - Phase 6 - ongoing

91% COD Removal (Tank 1 Effluent)
80% of total biogas production occurs in primary (T1)
Stability observed at 3.1d HRT (FOS/TAC)

System Setup and Experimental Phases

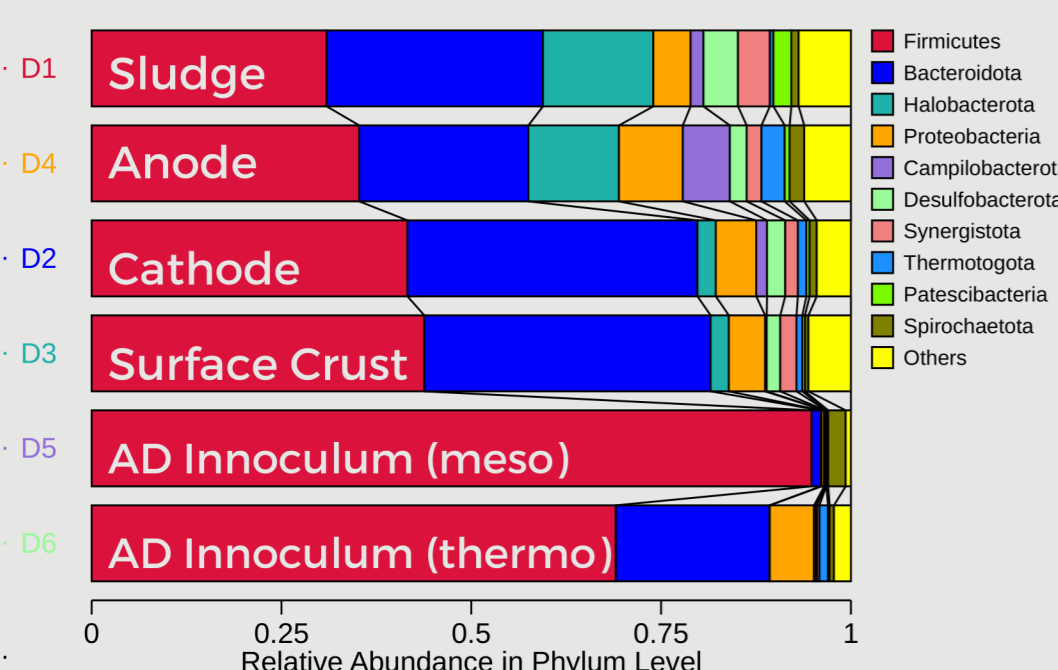


Trial Phase	Date	Wastewater treated per day (L/d)	Hydraulic Retention Time (d)	COD Removal Effluent tCOD / Influent tCOD (%)	tCOD output (mg/L)	Organic Loading Rate (kg COD/m ³ .d)	tBOD Discharge to Reed beds (mg/L) <300 mg/L BOD Required
1	30.5.22-9.6.22	144	19	91%	1011	0.9	650
2	13.6.22-20.6.22	240	14	93%	840	1.9	353
3 (reconfiguration phase T1-T3)	21.6.22-4.7.22	90-384	16	90%	2324	0.6-2.3	743*
4	5.7.22-24.7.22	288	11	89%	1627	1.6	315*
5 T1-T2 only	25.7.22-4.8.22	384	5	91%	1701	3.5	1313
6 (reconfiguration to T1 only)	8.8.22-26.8.22	248	3.8	91%	1646	4.6	527*

Yes straight from EMR Yes tertiary treatment required Extensive processing required

*estimated based on average BOD/COD Ratio

Community Analysis



Genomic DNA from biomass samples taken from inside the primary reactor were sent to NovoGene Genome Sequencing Company, China for 16s rRNA amplicon sequencing. This revealed selection and enrichment of methanogenic and exoelectrogenic species relative to the location within the system over time.

Conclusions and Outlook

The operation of this pilot scale system at Hepworth Brewery suggests that MEC-AD system can perform at greatly improved retention times over conventional AD (CSTR) and stability in COD removal at a range of organic loading rates, and at approximately 8x higher COD than in the next largest pilot investigation. In this trial, HRT was achieved in excess of the commercial viability requirement of 4.6 days, which enables the development and installation of true commercial scale systems over the next year.

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