Development of a continuous flow MEC-AD system with autonomous feeding control and performance optimisation.

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HIGHLIGHTS:

- A self-feeding MEC-AD system has been designed and operated for the first time.
- The effectiveness of biosensor led autonomous control will be investigated.
- The MEC-AD will be given scenario based on real brewery effluent characteristics to challenge its ability to autonomously regulate feed rate.

BACKGROUND: Microbial Electrochemical Cells coupled with Anaerobic Digestors (MEC-AD) improve upon the performance of conventional AD systems, allowing shorter hydraulic retention times and higher organic loading rates due to enriched biofilm bound microbial consortia and bioelectrochemical catalysis of key process reactions. MECs have been used as biosensors to sense VFA concentrations [1] but have not yet been utilised as an control sensor for MEC-AD.

A small scale (2L) continuous flow MEC-AD reactor was designed and constructed to operate autonomously treating high strength simulated brewery wastewater (10-30g/L tCOD). The feed rate of the MEC-AD reactor was modulated by using the electrodes as a biosensor, utilising the current response of the system as a performance indicator and control parameter. Autonomous feed rate control was implemented using a threshold-based algorithm to interpret trends in current output and control feed pump speed - allowing the reactor to feed itself as it requires.

RESULTS & DISCUSSION: We investigate whether stable operation at loading rates between 2-8 kgCOD/m^3/d can be effectively maintained by adjusting feed rate in response to the current draw of the MEC reactor. The system performance and stability will be evaluated concurrently in a conventional manner to determine the effectiveness of such autonomous control and its effect on reactor health over time. The ability of the system to respond to changing influent characteristics will be tested to simulate real world operation.

CONCLUSION: Development of biosensor led, autonomous feed rate control will allow reduced laboratory testing and operator burden on commercial scale MEC-AD systems. This may reduce downtime while increasing waste treatment rates and methane yields, improving the commercial viability of the technology. This will enable the implementation of MEC-AD systems in remote areas or in response to humanitarian crises to provide sanitation and renewable energy without the need for skilled operators.

REFERENCES

1. Jin, X. et al. (2017). Bio-electrolytic sensor for rapid monitoring of volatile fatty acids in anaerobic digestion process. Water Research, 111 74–80.