

Mixing Matters? Hydrodynamic Stirring and Pilot-Scale MEC performance

Maira Anam and Elizabeth Heidrich

Overview 🔍

- Microbial electrolysis cell (MEC) is a bioelectrochemical system that uses **biofilm** to oxidise organic matter into valuable by-products [1].
- Hydrogen production rate:
Lab scale (20 mL): $50 \text{ m}^3 \text{m}^{-3} \text{d}^{-1}$ [2]
Pilot scale (175 L): $0.003 \text{ m}^3 \text{m}^{-3} \text{d}^{-1}$ [3]

Research gap ✖

- A substantial **performance decline** when scaled up from lab to pilot scale.
- Hydrodynamic mixing improves **mass transfer** and **substrate availability**.
- Insufficiently explored for pilot-scale MEC.

Study approach 🧪

- Three 1 m^3 tanks (4x MEC each) operated at 1 V and 7 d HRT under different **hydrodynamic regimes**.
- MEC performance and microbial community dynamics were evaluated across different stirring regimes.

Aim: To evaluate the effect of hydrodynamic stirring on the performance of pilot-scale MEC and microbial community dynamics

Experimental setup

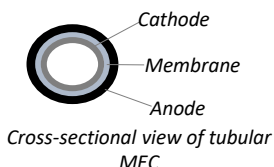


Fig: 1 m^3 tank with 4x tubular MEC

Tested hydrodynamic regimes

Condition	Stirring Intensity
Control	0 rpm
Medium stirring	200 rpm
High stirring	600 rpm

Tubular MEC



MEC performance

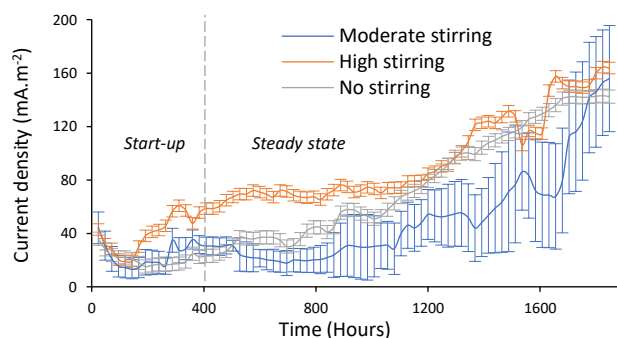


Fig: Average current density from pilot-scale MEC over the operation period of 11 weeks ($n=4$; $p>0.05$)

Biofilm diversity

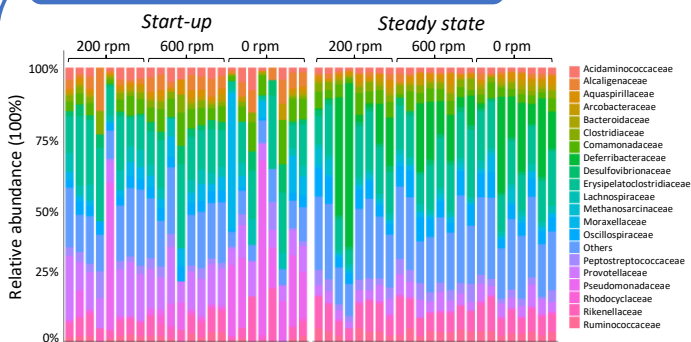


Fig: Relative abundance of top 20 bacterial families on MEC anodes

OCT imaging

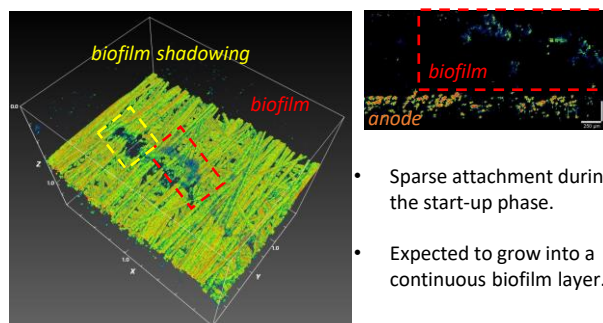


Fig: 3D and 2D OCT image showing anode biofilm formation during start-up

Conclusion

Tested stirring conditions produced **no significant** improvement in pilot-scale MEC performance

Prominent hydrodynamic effect require **large-scale propeller** and **high-intensity stirring** that's not feasible economically

Microbial community remained **similar between start-up and steady-state** operation despite different stirring regimes

OCT imaging enabled **real-time monitoring** of biofilm at pilot-scale, revealing initial growth pattern