Supplementary Material

for

Algae-assisted Microbial Desalination Cell: analysis of cathode performance and desalination efficiency assessment

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Table S1. Various electron acceptors (catholyte) are used in MDC and MFC.

Type of MDC/MFC	Anolyte	Catholyte	Performance	Energy production (kWh^{-3})	Nominal Desalination rate ($L\ m^{-2}\ h^{-1}$) / Desalination efficiency (%)	COD removal (%) COD removal rate ($g\ COD\ m^{-3}\ day$)	Ref.
Conventional 3-chambered	Rumen consortia in synthetic wastewater	Potassium Ferricyanide and Nannochloropsis salina (Marine Algae)	Microalgae supported MDC power generation at lower power generation rates but higher desalination rates compared with $K_3Fe(CN)_6$ catholyte. Though the internal resistance of algae was lower than that of $K_3Fe(CN)_6$ other factors affect the power generation potential of MDCs. However, COD removal efficiency is similar in both cases since it mainly depends on different factors.	**$K_3Fe(CN)_6$** - 51mW/m^2 **Marine Algae** - 12mW/m^2	**$K_3Fe(CN)_6$** - 54% **Marine Algae** – 61%	**$K_3Fe(CN)_6$** - 85% **Marine Algae** -83%	[1]
Conventional 3-chambered	Swine-farming wastewater	*Cyanobacteria Spirulina*	Photosynthetic oxygen sustained cathodic reactions, ensuring electrochemical performances and COD removal in P-MFCs comparable to air-cathode MFCs.	4 A/m^2	-	89 ± 1%	[2]
Air-breathing -MFC (A-MFC), Water submerged-MFC (W-MFC), Photosynthetic microorganism-MFC (P-MFC)	Swine manure	Air-breathing cathode, Water-cathode, Arthrospira maxima	Biocathodes improved oxygen reduction reaction (ORR) compared to abiotic conditions, and A-MFC was the best performing system. In addition, photosynthetic cultures in the cathodic chamber supplied a high DO level.	1.66±0.04 mA **(A-MFC)** 1.06± 0.03mA **(W-MFC),** 1.48± 0.06mA **(P-MFC)**	-	-	[3]
Conventional 3-chambered	The effluent of primary clarifier of a local municipal wastewater treatment plant	MDC#1 (10 mM PBS), MDC#2 (100 mM NaCl solution), MDC#3 (50 mM PBS +100 mM NaCl), MDC#4 (bio-catholyte)	Bio-catholyte produced the highest power density of 32.6 Wm^{-3} (and exhibited the desired buffering capacity, leading to a high salt removal rate of 78.1%). In comparison, PBS (10 mM) obtained the lowest power density of 11.1 Wm^{-3}.	**MDC#1**- 11.1 W/m^3 **MDC#2** – 16.3 W/m^3 **MDC#3**- 29.4 W/m^3 **MDC#4**- 32.6 W/m^3	**MDC#1**- 52.85% **MDC#2** -60.9% **MDC#3**- 69.7% **MDC#4**- 78.1%	**MDC#1**- 69% **MDC#2** - 65.1% **MDC#3** - 73.1% **MDC#4** - 80%	[4]
Upflow MDC	Synthetic wastewater containing	Acidified water (adjusted with sulfuric acid)	-	2.5 x 10^{-4} @ 6Ω	29.1%	92.0 ±0.4%	[5]
Conventional 3-chambered	Fresh Water Media + 1.65 $g{\cdot}L^{-1}$ Sodium Acetate	Air-cathode (0.1M PBS) Ferricyanide catholyte (0.06M $K_3Fe(CN)_6$	The air cathode approach may suit brackish water desalination, even though nominal desalination rates are near one order of magnitude lower than those obtained using a Ferro-ferricyanide redox mediator. Seawater desalination could be better addressed by a Ferro-ferricyanide redox MDC; however, catholyte regeneration routes should be explored	**Air-cathode** - 0.055 (kWh^{-3}) **Ferricyanide catholyte**- 5.4 (kWh^{-3})	**Air-cathode** – 0.14 ($L\ m^{-2}\ h^{-1}$) **Ferricyanide catholyte**- 0.7 ($L\ m^{-2}\ h^{-1}$)	**Air-cathode** -1.07 ($g\ COD\ m^{-3}\ day$) **Ferricyanide catholyte**- 19.7 ($g\ COD\ m^{-3}\ day$)	[6]

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			to reduce costs and allow low-cost and efficient desalination.				
PMDC	Synthetic wastewater	Microalgae *Chlorella Vulgaris*	Using microalgae as an in situ and sustainable source of oxygen generator.	5.35mW/m^2	40%	65.6%	[7]
Multi-chambered MDC	Synthetic wastewater with acetate	Oxygen Dichromate Permanganate Hypochlorite	Hypochlorite showed the highest TDS removal efficiency and power recovery, while Dichromate and permanganate require pH adjustment, as they possess a high oxidation state under acidic conditions. Electrochemical analysis proved hypochlorite as an electron acceptor with a low internal resistance of the system.	**Oxygen**- 25 mW/m^2 **Dichromate**- 35 mW/m^2 **Permanganate**- 84 mW/m^2 **Hypochlorite-** 347 mW/m^2	**Oxygen**- 72% **Dichromate**- 78% **Permanganate**- 82% **Hypochlorite-** 89%	**Oxygen**- 80% **Dichromate**- 83% **Permanganate**- 84% **Hypochlorite**- 90%	[8]
Algae-assisted MDC	Synthetic wastewater containing	*Chlorella Vulgaris*	The addition of sodium bicarbonate ($NaHCO_3$) increased power production, microalgae growth and desalination rate. A maximum power density of 625mW/m^3 was measured, which is 7.5 times higher than studies without the addition of sodium bicarbonate using PMDCs.	660mW/m^3	42%	-	[9]
Multiple cells	Municipal wastewater as	Air–cathode MFC *Chlorella Vulgaris* abiotic–cathode	The light intensity range was 5000, and 6500 lx was concluded at the optimum range to maximize the performance of microalgae and power generation.	126mW/m^3	-	5.47%	[10]

***Note**: (-) not reported in the research article.*

Table References:

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S1. Microalgae culture.

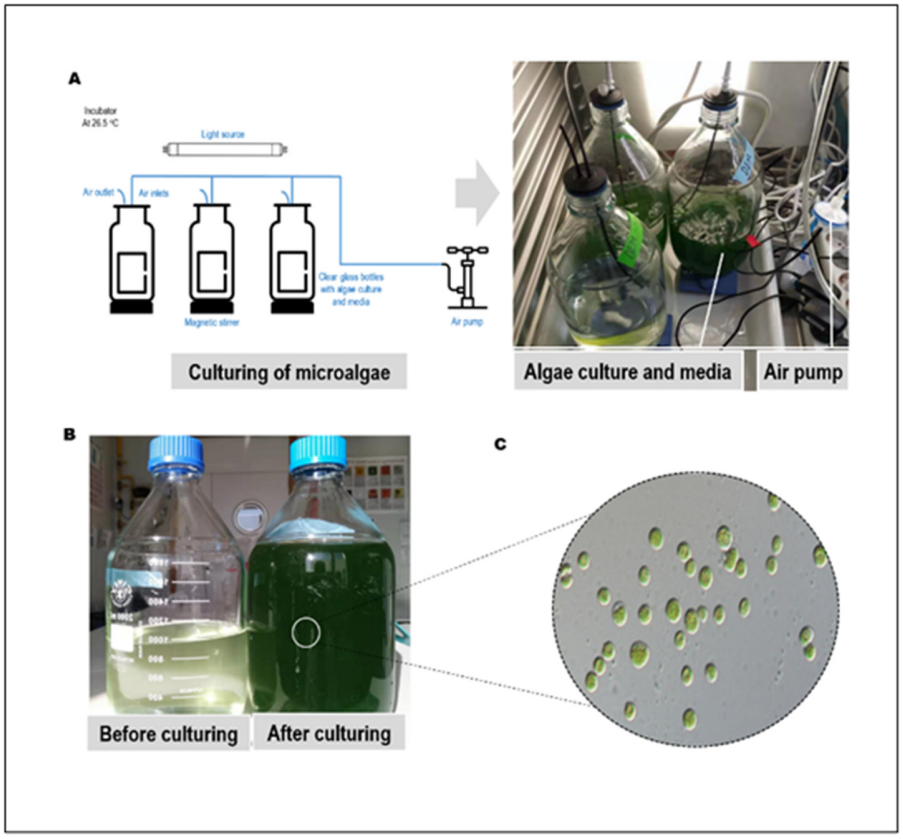


Figure S1. (A) Culture setup plan, (B) Culturing of algae culture for photobioreactor, (C) Newly inoculated BBM for culturing (right) and Photobioreactor (left) (D) Microscopic view of Chlorella Vulgaris.

S2. Experimental phases diagram.

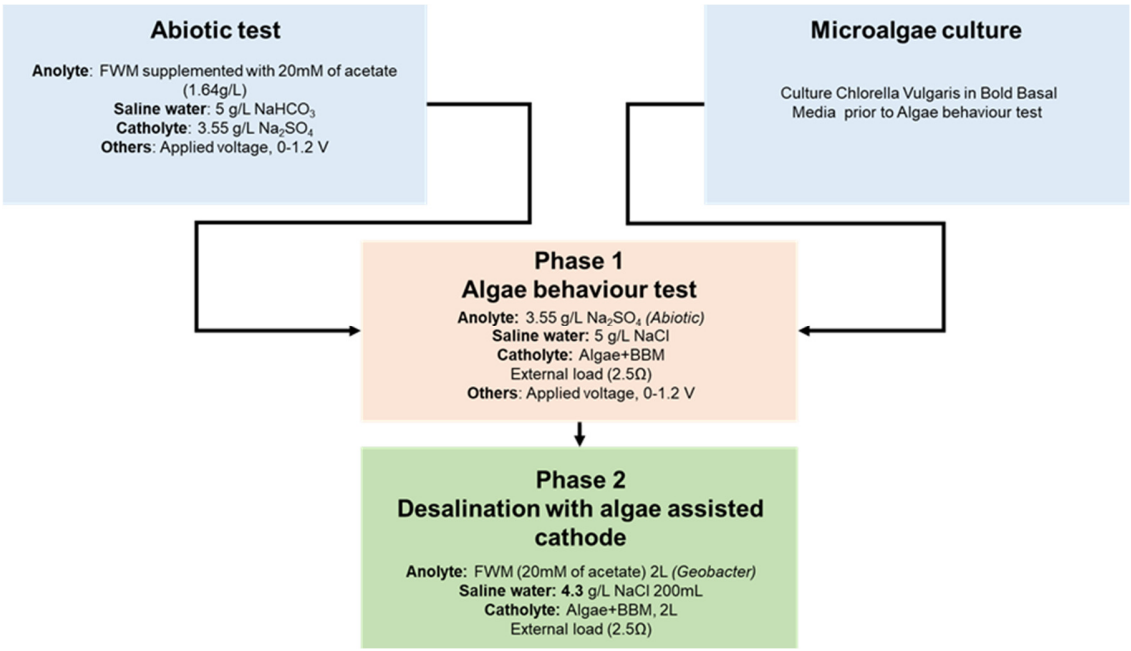


Figure S2. Experimental phases.

S3. Abiotic test: desalination experiment.

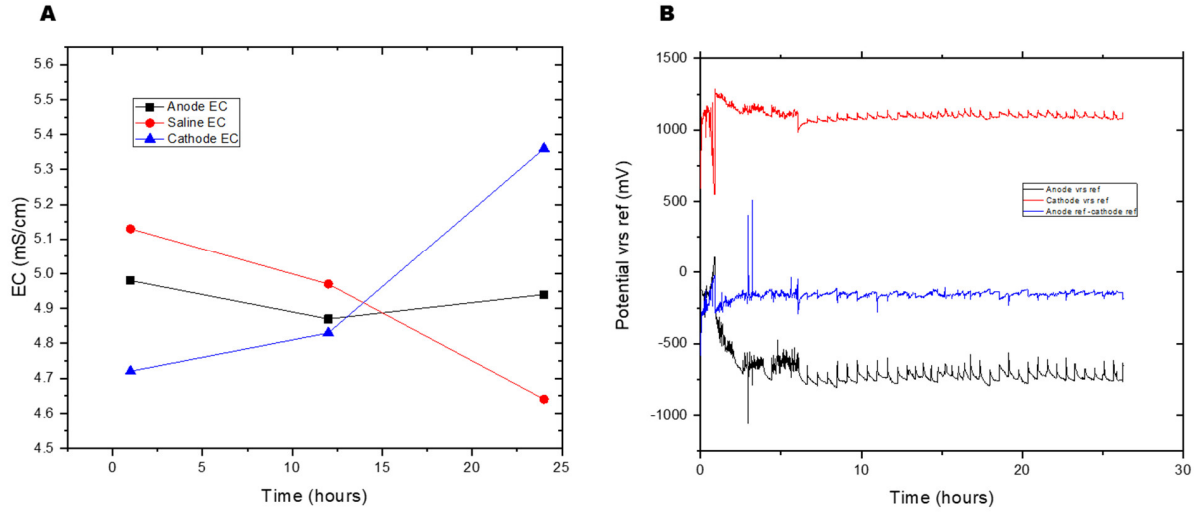


Figure S3. Abiotic test: (A)Electric conductivity in the anolyte, saline and catholyte; (B) Potential of cell, anode electrode and cathode electrode against the Ag/AgCl reference electrode.