Electronic Supplementary Material (ESI) for Sustainable Energy & Fuels.

Supplemental Information

Effects of Solids Retention Times on Electro-Selective Fermentation Using *Scenedesmus acutus* Biomass

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This supporting information contains 5 pages, with 2 sections: Estimating the Solids Retention time and Profiling of Microbial Communities in MEC-B; . This includes Equations S1 to S3; Table S1, and Figure S1.

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S1. Estimating the Solids Retention Time (SRT)

The *SRT* of an ESF reactor is not the same as its Hydraulic Retention Time (*HRT*) due to the biofilm on the anode. Likewise, the *SRT* of the entire ESF system is a composite of the *SRT*s of the suspended biomass and the biofilm. Thus, a change to the *HRT* does not necessarily equal a change to the *SRT* system.

A biofilm's average *SRT* is the reciprocal of the biofilm's average first-order detachment rate (b_{det}) (Rittmann and McCarty, 2001), which can be estimated *a priori* by

$$b_{det} = 8.42 * 10^{-2}\left(\frac{\sigma}{1 + 433.2\left(L_f - 0.003\right)}\right)^{0.58} \quad \textit{(Eq. S1)}$$

where L_f is the biofilm thickness (cm), X_f is the biofilm density (mg / cm^3), and σ is the shear stress in dyne / cm^2 (the same as g/cm^2-s). The σ values in the MECs can be bracketed by 0.02 dyne /cm^2 to 1 dyne/cm^2, based on modest to strong mixing intensity (Rittmann and McCarty, 2001). By using values this σ range, X_f = 40 mg /cm^3, and L_f = 0.01 cm, I computed a b_{det} range of 0.004 d^{-1} to 0.4 d^{-1}. which leads to range of biofilm *SRT*s of 260 d to 27 d.

Detachment of biofilm biomass augments the suspended biomass. When the suspension receives input active biomass, its *SRT* increases according to Rittmann and McCarty (1):

$$SRT_{planktonic} = \frac{X_a V}{QX_a - QX_a^0} = \frac{X_a V}{QX_a - b_{det} X_f L_f A_b} \quad \textit{(Eq S2)}$$

where X_a is the concentration of active biomass of the planktonic biomass, V is the ESF reactor's working volume, Q is the volumetric flow rate, Q* X_a^0 is the detachment rate of the biofilm (and

the rate of biomass addition to the suspension), $X_f L_f$ is the mass of biofilm per unit surface area, and A_b is the biofilm surface area.

An overall *SRT* can be computed for all of the biomass in the ESF reactor: planktonic + biofilm. Starting from the definition of *SRT* and combining planktonic active biomass and biofilm active biomass, the $SRT_{overall}$ is:

$$SRT_{overall} = \frac{X_a V + X_f L_f A}{Q X_a} = HRT + \frac{X_f L_f A}{Q X_a} \qquad \textit{(Eq. S3)}$$

Eq. S3 shows that the total *SRT* is always larger than the *HRT* due to the accumulation of biofilm biomass.

Assuming an active-biomass concentration (X_a) of 3000 mg VSS /L in the suspended phase, a biofilm density (X_f) of 40 mg /cm^3, and a biofilm thickness (L_f) of 0.01cm, along with known biofilm area of 49 cm^2 and an anode chamber volume of 200 mL, Equations 5.S2 and 5.S3 yield the SRT values in Table 5.S1. The overall *SRTs* are only slightly greater than than the *HRTs*, regardless of long or short *HRTs* (6 d vs 2d) and different shear stress caused by different mixing intensities (b_{det} = 0.004 or 0.04 d^{-1}), because the suspended biomass ($X_a V$) dominates the biofilm biomass ($X_f L_f A$). Thus, it accurate to use the *HRT* as a surrogate of the overall *SRT* of the ESF reactors.

Table S 1 Calculated values of $SRT_{planktonic}$, $SRT_{biofilm}$, and $SRT_{overall}$ using assumptions of high and low shear stress. All SRT values are in d.

	Low shear stress (0.02 dyne/cm^2)	High shear stress (1 dyne/cm^2)
	6-d HRT	
$SRT_{biofilm}$	250	25
$SRT_{planktonic}$	6.1	6.6
$SRT_{overall}$	6.2	6.2
	2-d HRT	
$SRT_{biofilm}$	250	25
$SRT_{planktonic}$	2.0	2.1
$SRT_{overall}$	2.1	2.1

S2. Profiling of Microbial Communities in MEC-B

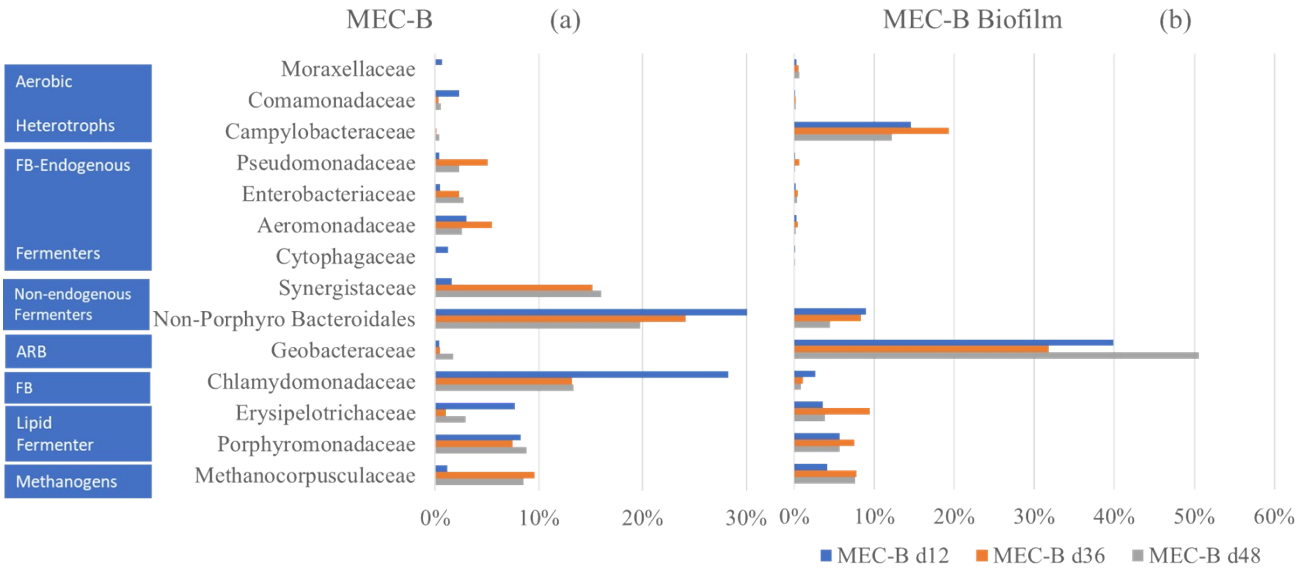

Figure S1. Phylogenetic profiling of the ESF anode effluent in MEC-B (a) and biofilm in MEC-B (b). The horizontal axis presents the percentage abundance of the families based on the total reads of the 16S rRNA gene. Functions associated with each family are shown to the left.

S3. Equations for Calculation of Extractability, Saturation and Lipid Recovery

$$\text{Ext (\%)} = [\text{Extracted LCFA COD (mg COD /L)}]_{ESF} / [\text{Total LCFA COD (mg COD/L)}]_{FB} * 100\% \quad \textit{(Eq. S1)}$$

$$\text{Sat (\%)} = [\text{Saturated LCFA COD (mg COD /L)}]_{ESF} / [\text{Total LCFA COD (mg COD/L)}]_{ESF} * 100\% \quad \textit{(Eq. S2)}$$

$$\text{Rec (\%)} = [\text{Total LCFA COD (mg COD /L)}]_{ESF} / [\text{Total LCFA COD (mg COD/L)}]_{FB} * 100\% \quad \textit{(Eq. S3)}$$