Supporting information

The importance of OH− transport through anion exchange membrane in microbial electrolysis cells

Y. Ye and B. E. Logan*
Department of Civil and Environmental Engineering, The Pennsylvania State University,
University Park, PA, 16802, USA
*Corresponding author: Phone: 814-863-7908, Fax: 814-863-7304, Email: blogan@psu.edu
Fig. S1 (A) the structure for MEC (4 cm wide) with 2 cm electrode spacing, resulting in anode and cathode volume of 13 mL; (B) electrochemical half cells with anode chamber of 13 mL and cathode chamber of 26 mL. The cathode was incised to ventilate produced hydrogen gas from reference electrode chamber to the chamber with anaerobic tube for gas sample collection. A Pt plate was used as counter electrode, and SS mesh as working electrode, leading to an electrode spacing of 4 cm. The anolyte was a 10 mM sodium bicarbonate solution with 2 g/L sodium acetate (pH = 7 and conductivity of 7 mS/cm). The cathode potential was fixed at −1.2 V.
Fig. S2 Titrations curves showing the buffer capacities of the PBS and PoB solutions.

Fig. S3 The chloride ion concentration in the anolyte in EHCs with PoB
Details for MW distribution test of the polymer buffer

The MW distribution test was carried out using the protocol below (Bruce E. Logan, Environmental Transport Process, John Wiley & Sons, 2012, p.71):

1. The concentration of the original polymer buffer solution was tested as $C_0$. The total volume was $V_0$.

2. Permeate was collected from the ultrafiltration cell with different ultrafiltration membranes with cut-off of 2 K, 10 K, 30 K and 100 K. The volume and its TOC concentration was monitored. A set of volume and TOC can be obtained as $V_2, V_2, V_3, \ldots$ (L) and the corresponding TOC concentration of $C_2, C_2, C_3, \ldots$ (mg L$^{-1}$)

3. The cumulative mass of TOC can be calculated using the volumes and the TOC concentration as:

$$M_i = \sum_i V_i C_i$$  \hspace{1cm} (1)

4. The cumulative volume of permeate can be calculated as:

$$V_{o,i} = \sum_i V_i$$  \hspace{1cm} (2)

5. The TOC concentration could pass through the ultrafiltration $C_{r,0}$ can be obtained by non-linear fitting using cumulative masses and volumes:

$$M_i = \frac{C_{r,0}}{V_0 P_c} [V_0^{P_c} - (V_0 - V_f)^{P_c} ]$$  \hspace{1cm} (3)

where $C_{r,0}$ is the original concentration that can pass through the membrane, $P_c$ is filtration coefficient, and $V_f$ is the filtrate volume.

6. The percentage of the chemicals has MW smaller than the membrane pore size is:

$$p_{smaller} = \frac{C_{r,0}}{C_0} \times 100\%$$  \hspace{1cm} (4)

7. The percentage of the chemicals has MW larger than the membrane pore size is:

$$p_{larger} = \left(1 - \frac{C_{r,0}}{C_0}\right) \times 100\%$$  \hspace{1cm} (5)
8. With a set of membranes with different cut off, the distribution can be obtained.

An example of 100 K membrane:

$V_0=151$ mL, $C_0=260$ mg/L, $V_0=151$ mL

<table>
<thead>
<tr>
<th>Filtrate volume, $V_f$ (mL)</th>
<th>TOC (mg/L)</th>
<th>Cumulative mass (mg)</th>
</tr>
</thead>
<tbody>
<tr>
<td>15</td>
<td>186</td>
<td>2.8</td>
</tr>
<tr>
<td>30</td>
<td>217</td>
<td>7.1</td>
</tr>
<tr>
<td>49.5</td>
<td>253</td>
<td>12.1</td>
</tr>
<tr>
<td>64.5</td>
<td>229</td>
<td>15.5</td>
</tr>
<tr>
<td>78.5</td>
<td>252</td>
<td>19.0</td>
</tr>
</tbody>
</table>

The data were plotted using Cumulative mass vs. $(V_0-V_f)$, and then fitted using non-linear fitting method, Allometric2, in the Origin 8.5 pro.

The $P_c$ and $C_{r0}$ obtained from fitting:

$C_{r0}=268$ mg/L

$P_c=0.83$

The percentage ($<100$ KDa) is:

$P_{smaller} = \frac{C_{ra}}{C_0} \times 100\% = 100\%$