Estimation of total energy requirement for sewage treatment by a microbial fuel cell with a one-meter air-cathode assuming Michaelis-Menten COD degradation

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Supplementary Table 1. The comparison of performance in the MFC treating municipal wastewater

Supplementary Fig. 1 The polarization curve of an MFC with the same configuration operated in a water channel of effluent of the primary sedimentation tank.
Supplementary Table 1. The comparison of performance in the MFC treating municipal wastewater

<table>
<thead>
<tr>
<th>Type</th>
<th>Bio-cathode-MES</th>
<th>Biocathode-de-IEM-MFC</th>
<th>Air-NIE-MFC</th>
<th>Air-CEM-MFC</th>
<th>Air-AEM-MFC</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total wastewater volume [L]</td>
<td>1000</td>
<td>1000</td>
<td>250</td>
<td>255</td>
<td>85</td>
</tr>
<tr>
<td>Operation time [d]</td>
<td>75</td>
<td>1</td>
<td>130</td>
<td>98</td>
<td>1 month</td>
</tr>
<tr>
<td>Anode^a</td>
<td>CB</td>
<td>GAC</td>
<td>CB</td>
<td>CB</td>
<td>CB</td>
</tr>
<tr>
<td>Cathode^b</td>
<td>CB</td>
<td>GAC</td>
<td>Pt/CC</td>
<td>SSM/AC</td>
<td>SSM/AC</td>
</tr>
<tr>
<td>Separator^c</td>
<td>PS</td>
<td>CEM</td>
<td>PP</td>
<td>GFM</td>
<td>CPTMW</td>
</tr>
<tr>
<td>GDL^d</td>
<td>-</td>
<td>-</td>
<td>16^7</td>
<td>17^10</td>
<td>26^15</td>
</tr>
<tr>
<td>COD_{effluent} [mg/L]</td>
<td>260</td>
<td>250</td>
<td>333^9</td>
<td>141^12</td>
<td>212^13</td>
</tr>
<tr>
<td>COD_{effluent} [mg/L]</td>
<td>25</td>
<td>&lt;50</td>
<td>70</td>
<td>90</td>
<td>90^17</td>
</tr>
<tr>
<td>HRT (h)</td>
<td>5</td>
<td>2</td>
<td>144</td>
<td>43^12</td>
<td>12^13</td>
</tr>
<tr>
<td>COD-RE(%)</td>
<td>91</td>
<td>70-80</td>
<td>79</td>
<td>41^12</td>
<td>25^13</td>
</tr>
<tr>
<td>TN-RE(%)^b</td>
<td>64</td>
<td>-</td>
<td>71</td>
<td>18^12</td>
<td>7.0^13</td>
</tr>
<tr>
<td>Current density [A/m^2-SP]</td>
<td>0.071</td>
<td>-</td>
<td>0.22</td>
<td>0.35-0.4^12</td>
<td>0.05-0.1^13</td>
</tr>
<tr>
<td>Current density[A/m^2]</td>
<td>1.0</td>
<td>-</td>
<td>1.7</td>
<td>1.4-1.6^12,14</td>
<td>0.2-0.4^13,14</td>
</tr>
<tr>
<td>Power density [W/m^2-SP]</td>
<td>0.029</td>
<td>0.42-3.64</td>
<td>0.05</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Power density [W/m^2-CA]</td>
<td>-</td>
<td>-</td>
<td>0.1</td>
<td>0.043^12</td>
<td>0.011^13</td>
</tr>
<tr>
<td>Power density [W/m^2]</td>
<td>0.41</td>
<td>7-60</td>
<td>0.4</td>
<td>0.18^12</td>
<td>0.045^13</td>
</tr>
<tr>
<td>Energy density [kWh/m^3]</td>
<td>0.0020</td>
<td>0.033</td>
<td>0.057</td>
<td>0.0077^12</td>
<td>0.00054^13</td>
</tr>
<tr>
<td>CE(%)</td>
<td>0.64^4</td>
<td>41-75</td>
<td>5</td>
<td>30^12</td>
<td>3.8^13</td>
</tr>
<tr>
<td>EGE [kWh/kg-COD]^f</td>
<td>0.0085^5</td>
<td>-</td>
<td>0.22</td>
<td>0.18^12</td>
<td>0.015^13</td>
</tr>
</tbody>
</table>

References: He et al., 2019; Liang et al., 2018; Feng et al., 2014; Hiegemann et al., 2019; Rossi et al., 2019; Ge et al., 2015; Ge and He, 2016; This study

^a CB: carbon brush, GAC: granular activated carbon, GNF: graphite non woven fabric


^c PS: Polyurethane sponge, GFM: Glass fiber mat, CPTMW: Cellulose/Polyester textured nonwoven
wipe, CEM: Cation exchange membrane, AEM: Anion exchange membrane

d PTFE: Polytetrafluoroethylene, PVC: Polyvinyl chloride

*e ASSA: Anode specific area per wastewater volume
*f CSSA: Cathode specific area per wastewater volume
*g SSSA: Separator specific area per wastewater volume

h EGE: Energy generation efficiency

*1 The surface area of the brush as a cylinder divided by the reactor volume
\((1.52n\times2+3.0n\times110)\times48\times8/10000)/1.2\)

*2 \((1.52n\times2+3.0n\times110)\times48\times7/10000)/1.2\)

*3 \(1.0[m]\times1.0[m]\times14/1.2\)

*4 \(1.0[A/m^3]\times3600[s/h]\times5[h]/[(260-25[g/m^3])\times32[g/mol]\times4[n/mol-O_2]\times96485[C/mol]]\times100\)

*5 \(0.0020[kwh/m^3]/0.235[kg/m^3]\)

*6 \(66\times33\times5/10000/0.02\)

*7 The surface area of the brush as a cylinder divided by the reactor volume \((1.52n\times2+4\times100)\times32/10000)/0.25\)

*8 2[m^2]/0.25[m^3]

*9 70[mg/L]/(1-0.79)

*10 4.2[m^2]/0.255[m^3]

*11 1.04[m^2]/0.255[m^3]

*12 The value obtained in 14-35d

*13 The value obtained in 77-98d

*14 The values obtained by multiplication of current density [A/m^2] \times CSSA[m^2/m^3]

*15 The surface area of the brush as a cylinder divided by the reactor volume \((2.5^2n\times2+5.1n\times61)\times22/10000)/0.085\)

*16 \((5n*100/10000)/(2.5n*100/1000000)\)

*17 The value obtained in MFC-AC

*18 The value obtained in MFC-Pt

*19 The value obtained in both MFC

*20 The value in effluent of anolyte

*21 The value in effluent of catholyte tank

*22 The value was shown only in a graph and hard to read visibly.

*23 The value in 12h of anodic chamber and 6h of catholyte tank

*24 The value in 12h of anodic chamber and 6h of catholyte tank

*25 The value obtained in the effluent in catholyte collection tank.

*26 (156-33)/156×100(%), The value was obtained in the effluent in catholyte collection tank.

*27 0.3/(500n\times12)\times1e^-4, 0.15A of the maximum current was visibly read from a graph

*28 0.3/(625n\times12)\times1e^-6, 0.15A of the maximum current was visibly read from a graph

*29 0.06/(500n\times12)\times1e^-4

*30 0.06/(625n\times12)\times1e^-6

*31 1.4[W/m^3] \times 12[h]

*32 5.0[A/m^3] \times (625n\times1e^-6)/500n\times1e^-4, the value was read visibly from a graph

*33 5.0[A/m^3], the value was read visibly from a graph

*34 1.0[A/m^3]\times3600[s/h]\times5[h]/[(260-25[g/m^3])\times32[g/mol]\times4[n/mol-O_2]\times96485[C/mol]]\times100
Supplementary Figure 1 The polarization curve of an MFC with the same configuration operated in a water channel of effluent of the primary sedimentation tank. The PI curve was obtained by connecting an external resistance of 1000 ~ 2Ω.