**Supplemental material**

# 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**

| Type | Bio-cathode-MES | Biocathode-IEM-MFC | Air-NIE-MFC | | | Air-CEM-MFC | | | Air-AEM-MFC |
|---|---|---|---|---|---|---|---|---|---|
| Total wastewater volume [L] | 1000 | 1000 | 250 | 255 | 85 | 4 | 200 | 190 | 9.6 |
| Operation time [d] | 75 | 1 year | 130 | 98 | 1 month | 450 | - | 1 year | 120 |
| Anode[a] | CB | GAC | CB | CB | CB | CB | CB | CB | GNWF |
| Cathode[b] | CB | GAC | Pt/CC | SSM/AC | SSM/AC | CC/AC CC/Pt | CC/NAC | CC/NAC | CC/AC |
| Separator[c] | PS | CEM | PP | GFM | CPTMW | CEM | CEM | CEM | AEM |
| GDL[d] | - | - | PTFE | PTFE | PVC | - | - | - | - |
| ASSA[e] [$m^2/m^3$] | 34[*1] | - | 16[*7] | 17[*10] | 26[*15] | - | - | 80[*16] | 14 |
| CSSA[f] [$m^2/m^3$] | 29[*2] | - | 8[*8] | 4.1[*11] | 7.3 | 80[*16] | 80[*16] | 80[*16] | 14 |
| SSSA[g] [$m^2/m^3$] | 12[*3] | 54[*6] | 8[*8] | 4.1[*11] | 7.3 | 80[*16] | 80[*16] | 80[*16] | 14 |
| $COD_{influent}$ [mg/L] | 260 | 250 | 333[*9] | 141[*12] 212[*13] | 376 | 280 | 156 | 155 | 180 |
| $COD_{effluent}$ [mg/L] | 25 | <50 | 70 | - | 90 | 90[*17] 93[*18] | 33[*24] | 97 | 99 |
| HRT (h) | 5 | 2 | 144 | 43[*12] 12[*13] | batch, 11[d] | 11 | 18[*25] | 12 | 12 |
| COD-RE(%) | 91 | 70-80 | 79 | 41[*12] 25[*13] | 80 | 65-70[*19] | 79[*26] | 38 | 47 |
| TN-RE(%)[h] | 64 | - | 71 | 18[*12] 7.0[*13] | - | 27[*20] 76[*21] | - | 68 | - |
| Current density [$A/m^2$-SP] | 0.071 | - | 0.22 | 0.35-0.4[*12] 0.05-0.1[*13] | 0.39 | - | 0.16[*27] | 0.063[*32] | 0.26 |
| Current density[$A/m^3$] | 1.0 | - | 1.7 | 1.4-1.6[*12,*14] 0.2-0.4[*13,*14] | 2.8 | [*23] | 13[*28] | 5.0[*33] | 3.6 |
| Power density [$W/m^2$-SP] | 0.029 | 0.42-3.64 | 0.05 | - | - | - | 0.032[*29] | - | 0.023 |
| Power density [$W/m^2$-CA] | - | - | 0.1 | 0.043[*12] 0.011[*13] | 0.083 | - | 0.032[*29] | - | 0.023 |
| Power density [$W/m^3$] | 0.41 | 7-60 | 0.4 | 0.18[*12] 0.045[*13] | 0.61 | - | 2.5[*30] | - | 0.32 |
| Energy density [$kWh/m^3$] | 0.0020 | 0.033 | 0.057 | 0.0077[*12] 0.00054[*13] | - | 0.026[*17] 0.024[*18] | 0.03[*31] | - | 0.0038 |
| CE(%) | 0.64[*4] | 41-75 | 5 | 30[*12] 3.8[*13] | - | 11 | - | 4.9[*34] | 19 |
| EGE [kWh/kg-COD][f] | 0.0085[*5] | - | 0.22 | 0.18[*12] 0.015[*13] | - | 0.0034[*17] 0.0192[*18] | - | - | 0.054 |
| 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:granule activated carbon, GNWF:graphite non woven fabric

[b] CB: Carbon brush, GAC: Granule activated carbon, CC: Carbon cloth, SSM: Stainless steel mesh, AC: Activated carbon, Pt: Platinum, NAC: Nitrogen-doped activated carbon

[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 (1.52π×2+3.0π×110)×48×8/10000)/1.2
*2 (1.52π×2+3.0π×110)×48×7/10000)/1.2
*3 1.0[m] ×1.0[m] ×14/1.2
*4 1.0[A/$m^3$]×3600[s/h]×5[h]/{(260-25[g/$m^3$])/32[g/mol]×4[n/mol-$O_2$]×96485[C/mol])} × 100
*5 0.0020[kwh/$m^3$]/0.235[kg/$m^3$]
*6 66×33×5/10000/0.02
*7 The surface area of the brush as a cylinder divided by the reactor volume (1.52π×2+4×π×100) ×32/10000)/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 in14-35d
*13 The value obtained in77-98d
*14 The values obtained by multiplication of current density [A/$m^2$] ×CSSA[$m^2$/$m^3$]
*15 The surface area of the brush as a cylinder divided by the reactor volume ($2.5^2$π×2+ 5.1π×61) ×22/10000)/0.085
*16 (5π*100/10000)/($2.5^2$π*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
*23 The value was shown only in a graph and hard to read visibly.
*24 The effluent from 12h of anodic chamber and 6h of catholyte tank
*25 12h of anodic chamber and 6h of catholyte tank
*26 (156-33)/156×100(%), The value was obtained in the effluent in catholyte collection tank.
*27 0.3/(500π×12)×1e-4, 0.15A of the maximum current was visibly read from a graph
*28 0.3/(625π×12)×1e-6, 0.15A of the maximum current was visibly read from a graph
*29 0.06/(500π×12)×1e-4
*30 0.06/(625π×12)×1e-6
*31 1.4[W/$m^3$] ×12[h]
*32 5.0[A/$m^3$] ×(625π×1e-6/500π×1e-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/$m^3$]×3600[s/h]×5[h]/{(260-25[g/m3])/32[g/mol]×4[n/mol-O2] ×96485[C/mol])} ×100

**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.