Supporting information

Bio-reduction of Chromate in a Methane-Based Membrane Biofilm Reactor

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The TEM analysis method:
The 5-cm-long section of the coupon fiber was then cut into smaller pieces of ~0.5 cm length for TEM (Hitachi H-7650, Japan) analysis following eight steps (SI).

1) Incubate the fiber samples with 2.5% glutaraldehyde in phosphate-buffered saline (PBS) for 12 h at 4°C.

2) Encase the incubated samples with 1% agarose and repeat the incubation step.

3) Wash the encased fibers by PBS three times and fixe them in 1% osmium tetroxide in PBS for 1.5 h.

4) After discarding the osmium tetroxide solution and washing the samples with PBS, dehydrate them by increased concentrations of ethanol (30%, 50%, 70%, 80%, 90%, 95% ethanol, and then twice at 100% ethanol), and then transfer them to absolute acetone for 20 min soaking.

5) Place samples into 1:1 or 3:1 mixture of embedding agent and acetone for 1 h or 2 h, respectively, immerse tge samples in absolute embedding agent overnight, and then polymerize them at 70 °C for 12 h.

6) Trim and thin-section the polymerized blocks using a LEICA EM UC7 ultra-microtome to get sections 70 - 90 nm thick, and stain these sections with uranyl acetate and alkaline lead citrate for 15 min respectively.

7) Load section samples on a TEM grid (Hitachi H-7650, Japan) and captur TEM images using a Gatan instrument (Gatan Ins 832.H21WO , USA) at 80 kV.

8) Assay the elemental compositions using an EDS detector (EDAX GENESIS XM2, USA).
Table S1. The average acceptor fluxes and methane-supply fluxes for each stage of the MBfR experiments

<table>
<thead>
<tr>
<th>Stage</th>
<th>Surface loading (mg/m²-d)(^a)</th>
<th>Flux (mg/m²-d)(^b)</th>
<th>Electron donor consumed (mmol CH(_4)/m²-d)(^c)</th>
<th>Maximum CH(_4) flux (mmol CH(_4)/m²-d)(^c)</th>
<th>Actual CH(_4) flux (mmol CH(_4)/m²-d)(^c)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>128.8</td>
<td>68.0</td>
<td>0.98</td>
<td>57.9</td>
<td>0.99</td>
</tr>
<tr>
<td>2</td>
<td>365.9</td>
<td>37.6</td>
<td>0.54</td>
<td>57.9</td>
<td>0.55</td>
</tr>
<tr>
<td>3</td>
<td>119.3</td>
<td>109.2</td>
<td>1.57</td>
<td>57.9</td>
<td>1.58</td>
</tr>
<tr>
<td>4</td>
<td>233.5</td>
<td>231.3</td>
<td>3.33</td>
<td>57.9</td>
<td>3.34</td>
</tr>
<tr>
<td>5</td>
<td>377.9</td>
<td>367.9</td>
<td>5.30</td>
<td>57.9</td>
<td>5.31</td>
</tr>
</tbody>
</table>

\(^a\) Calculated from equation 1. \(^b\) Calculated from equations 2 through 3. \(^c\) Maximum CH\(_4\) flux was calculated according to Tang et al (2012), considering the Pm-if (CH\(_4\) pressure at the interface of membrane and liquid film) was 0. 1 bar = 14.5 psig
Figure S1. Measures of Cr(VI) reduction in the CH4-based MBfR when CH4 supply was stopped and recovered.
Figure S2. Photograph of the main fiber bundles in the MBfR taken at the end of MBfR operation. The sage green solids are attributable to immobilized Cr(III), particularly Cr(OH)$_3$.\textsuperscript{50}
Figure S3. SEMs of hollow fiber membrane before inoculation. SEM was observed at 200 (A) and 20000 (B) times magnification. White arrow indicates the micropores of the fiber.
Figure S4. Magnified SEM images of inoculum (A), Stages 1 (B), 2 (C), and 5 (D) corresponding to Figure 2.
**Figure S5.** Odds ratios of predictive functions assigned by KEGG category database in biofilms (stages 1-5) compared to those in the inoculated culture. The functions of human diseases and organismal systems (all <1% in abundance) are not included.