MIXED METAL OXIDE (MMO) COATED RIBBON ANODE

MMO Anodes consist of a titanium substrate coated with a precious mixed metal oxides (IrO2/Ta2O5). The mixed metal oxide is to activate the titanium and enables it to function as an anode. The life of the MMO anode coating is dependent on the surrounding electrolyte, such as fresh water, brackish water, seawater, coke, or sand. Based on accelerated life testing conducted, our MMO coating has proven to be superior to other MMO coatings.

- MMO Ribbon anodes are designed to suit for both newly constructed aboveground storage tanks with secondary containment liners, and existing tanks utilizing double bottom construction.
- Working Environment: Evolution of O2, Cl2 or a combination of two.
- Current output 42 mA/m in fine sand when operating at an anode current density of 3 Amp/m²
- Design Life: Min. 50 years when operating at the current density of 3 Amp/m²
- Surface area: 0.014 m²/m for RB-N and 0.028 m²/m for RB-W

<table>
<thead>
<tr>
<th>Type</th>
<th>Dimensions (mm)</th>
<th>Max Current Output</th>
<th>Life in Sand</th>
<th>Packing Length</th>
</tr>
</thead>
<tbody>
<tr>
<td>MI-RB-N</td>
<td>6.35 x 0.635</td>
<td>17.5 mA/m</td>
<td>50 Years Min.</td>
<td>155 or 76 meters</td>
</tr>
<tr>
<td>MI-RB-W</td>
<td>12.7 x 0.635</td>
<td>35 mA/m</td>
<td>50 Years Min.</td>
<td>155 or 76 meters</td>
</tr>
</tbody>
</table>

Anode Performance:

- Expected life .................................................. 50 years
- Catalyst ......................................................... Iridium Based MMO
- Minimum thickness of MMO ................................. 7 microns
- Uniformity of MMO coating ............................... Min. 85 percent
- Anode linear resistance ................................. 0.147 ohm/m

Substrate:

- Composition ..................................................... Titanium, ASTM B-265 Grade 1
- Coefficient of thermal expansion ....................... 8.7 x 10^-5/K
- Thermal conductivity at 20°C ......................... 15.6 W/m²·K
- Electrical resistivity .................................. 0.000056 ohm-cm
- Modulus of elasticity ................................. 105 GPa minimum
- Tensile strength ........................................ 245 MPa minimum
- Yield strength ........................................ 175 MPa minimum
- Elongation ................................................ 24% minimum
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Anode Length Calculation

\[ L = 2D \tan 60^\circ \]

**Expected Current Throw from Anode**

**Number of ribbon anodes: \( N \)**

\[ N = \frac{D}{S} \]

- \( D \): Tank diameter (m)
- \( S \): Ribbon anode spacing (m)

\[ A(X) = \sqrt{R^2 - X^2} \]

- \( A(X) \): Anode Length at \( X \) m from the tank center line
- \( R \): Radius of tank
- \( X \): Distance from the centerline of tank

**Total length of ribbon anode in one quadrant**

\[ A(1/4 T) = [A(1) + A(2) + \ldots + A(X)] \]

**Total anode length for tank**

\[ = [4 \times A(1/4 T) - R] + (2 \times R) \]