

## Betelguard MMO Coated Ribbon Anode



Betelguard MMO Anodes consist of a titanium substrate coated with a precious mixed metal oxides ( $\text{IrO}_2/\text{Ta}_2\text{O}_5$ ). 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.

### Anode Performance:

Expected Life :	Min. 50 years
MMO Coating:	Iridium Oxide Base
MMO Minimum Thickness:	7 microns
Uniformity of MMO Coating:	Min. 85 percent
Anode Linear Resistance:	0.288 ohm/m

### Substrate:

Composition:	Titanium, ASTM B265 Grade 1
Coefficient of Thermal expansion:	$8.7 \times 10^{-5}/^\circ\text{K}$
Thermal conductivity at $20^\circ\text{C}$ :	$15.6 \text{ W/m}^2\text{-}^\circ\text{K}$
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

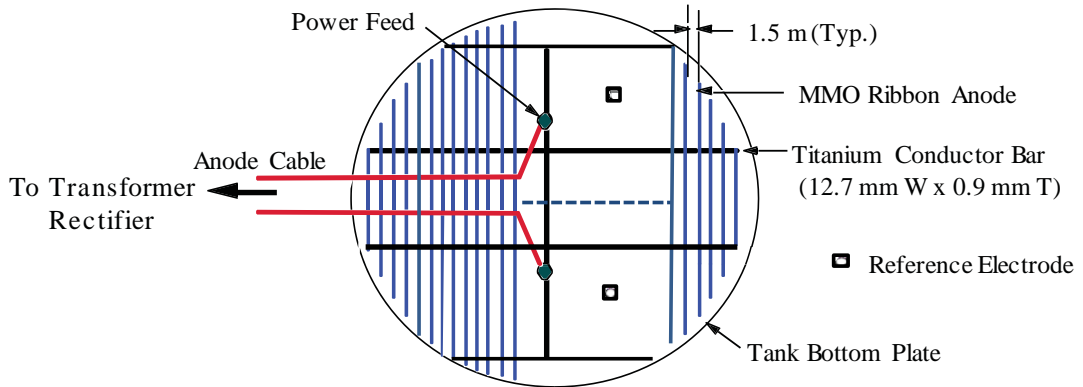
Type	Width	Thickness	Current Rating In Sand	Linear Resistance	Expected Life In Sand
MUI 100	6.35 (1/4")	0.635 (0.025")	17.5 mA/m (5.2 mA/ft)	0.28 ohm/m 0.085 ohm/ft	Min. 50 years
MUI 100 XL	6.35 (1/4")	0.635 (0.025")	43 mA/m (13.1 mA/ft)	0.28 ohm/m 0.085 ohm/ft	Min. 50 years
MUI 200	12.7 (1/2")	0.635 (0.025")	86 mA/m (26.2 mA/ft)	0.144 ohm/m 0.043 ohm/ft	Min. 50 years

Note: Other dimensions, current rating and design life are available upon request.

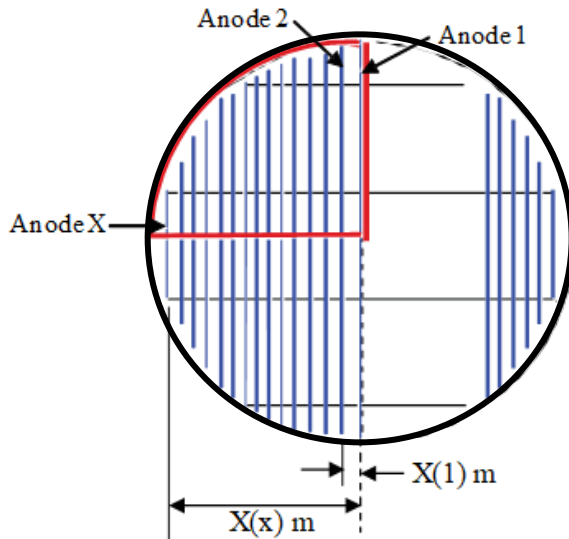
# Betelgard MMO Coated Ribbon Anode



## Grid ICCP Anode System For Tank Bottom Plate



Typical Anode Layout For Tank Bottom Plate



Number of ribbon anodes:  $N$

$$N = D / S$$

$D$ : 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 centerline

$R$ : Radius of tank

$X$ : Distance from the centerline of tank

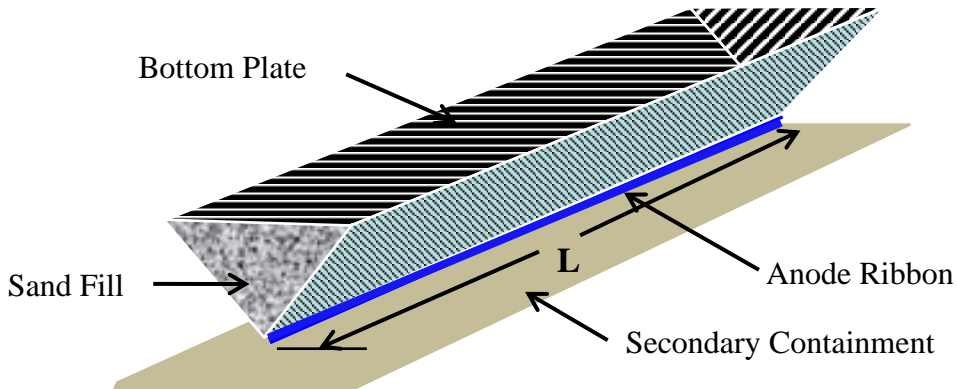
Total length of ribbon anode in one quadrant  $A(1/4 T) = [A(1) + A(2) + \dots + A(x)]$   
 Total anode length for tank =  $[4 \times A(1/4 T) - R] + (2 \times R)$

## Anode Length Calculations

## Power Feeder For Anode Connection



Power Feeder is designed for making the connection to titanium ribbon anode system. For order, specify the cable length and type.



### Estimation of Anode-Sand Resistance, R (ohm):

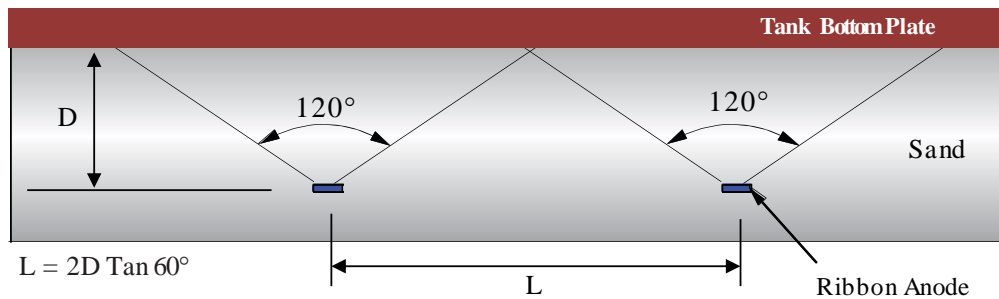
$$R = r/2 L \tan \theta$$

where:

$r$  = Sand resistivity (ohm-cm)

$\theta$  = 1/2 angle formed by ribbon and the bottom strip ( $38.7^\circ$ )

$L$  = average anode length (cm)



### Expected Current throw from Single Ribbon Anode to Tank Bottom