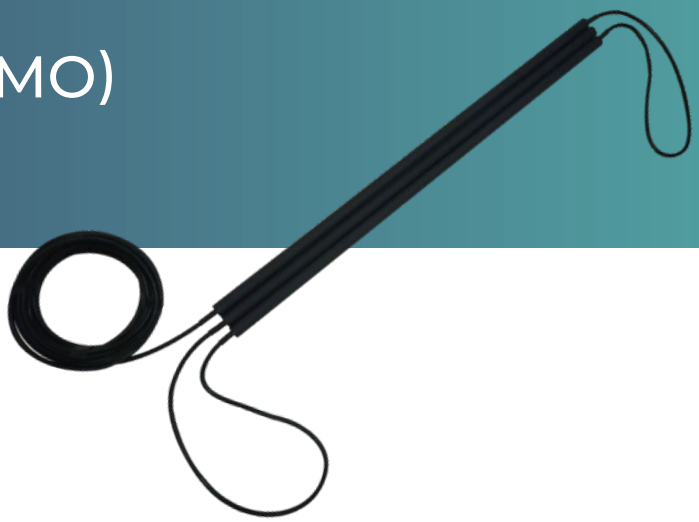
MIXED METAL OXIDE (MMO) TUBULAR ANODES



50 YEARS EXPERIENCE IN CATHODIC PROTECTION

JENNINGS ANODES

MMO TUBULAR ANODES

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MMO tubular anode is manufactured using a mixed metal oxide coating applied over hollow titanium tube. The mixed metal oxide film is a crystalline, electrically conductive coating that activates and enables the titanium substrate to function as an anode. Typically, multiple tubular anodes can be connected together in strings with threaded electrical cable.

Quality Substrate Material

Our MMO tubular anode is manufactured from high-tensile seamless titanium tube, which meets ASTM B338 Grade I standard.

Chemical Element	CAS Number	Content
Iron (Fe)	7439-89-6	0.20% max.
Carbon (C)	7440-44-0	0.08% max.
Nitrogen (N)	7727-37-9	0.03% max.
Hydrogen (H)	1333-74-0	0.015% max.
Oxygen (O)	7782-44-7	0.18% max.
Titanium (Ti)	7740-32-6	99.5% max.

Noble Metal Oxide Coating

Whether operating in soil, fresh water, seawater or mud, our mixed metal oxide coatings demonstrate high chemical stability, even in environments with a low pH value. It has an increased life expectancy when compared with other similar products on the market.

The coating composed of iridium oxide and tantalum oxide is routinely suitable for both chlorinating and oxygenating environments. And ruthenium oxide based coating shall be used in chlorinated environments such as seawater, brackish water, mud, concrete, etc.

Technical Measurement	Performance
Coating Composition	Iridium Oxides (IrO_2), Tantalum Oxides (Ta_2O_5), Ruthenium Oxides (RuO_2)
Coating Thickness	5~10 μm
Crystalline Structure Density	6~12 g/cm³
Electrical Resistivity	9~11 μΩ·cm
Working Temperature	< 60 °C

Low Electrical Resistance

This MMO anode has an extremely low consumption rate, measured in milligrams per ampere-year. The dimensions remain nearly unchanged throughout the design life of the anode, providing a consistently low resistance.

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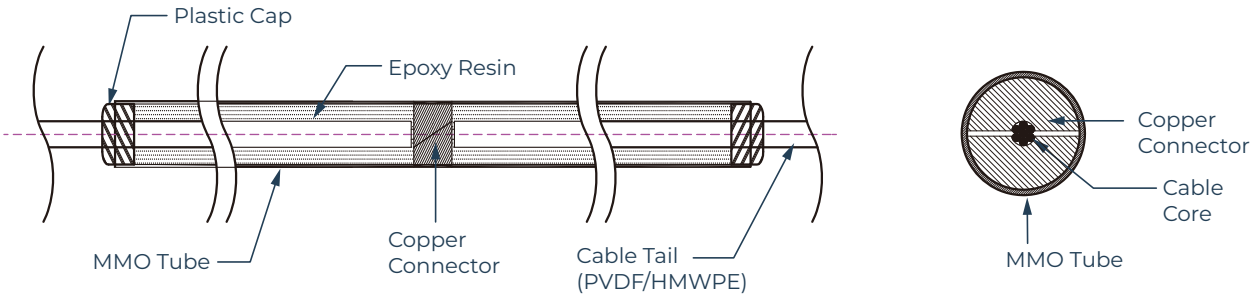
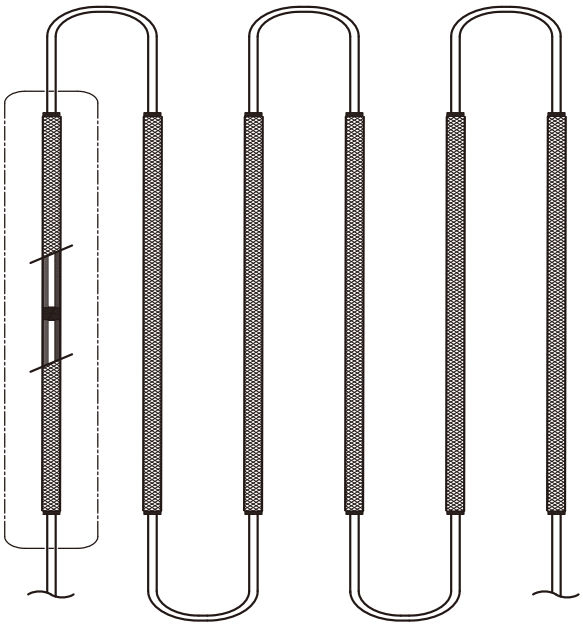


Low Maintenance Cost

Our MMO tubular anode is a high performance anode specifically designed for harsh environments and areas where conventional installations and replacements would be economically or logistically restricted. When compared to other anode types, it can save up to 15% ~ 35% of installation costs.

Wide Cable Selection

PVDF, HMWPE, HALAR, XLPE, PVC or KYNAR are all optional. We recommend dual-insulated cables (such as PVDF/HMWPE) for use in ground beds with high chloride concentration. While HMWPE is an economical choice for shallow vertical and horizontal surface beds with no chloride presence.



APPLICATIONS

Our high performance MMO tubular anode is extremely durable and can be used in severe conditions, including high acidity and in the presence of chlorine or oxygen. They are widely used for cathodic protection of metal structures in soil, mud, seawater, brackish water, fresh water, concrete, etc.

- Corrosion protection of underground pipe in deep wells
- Cathodic protection of internal storage tank walls wells
- Used as an anti-fouling electrode in sewage water treatment

Anode Connector Installation Illustration

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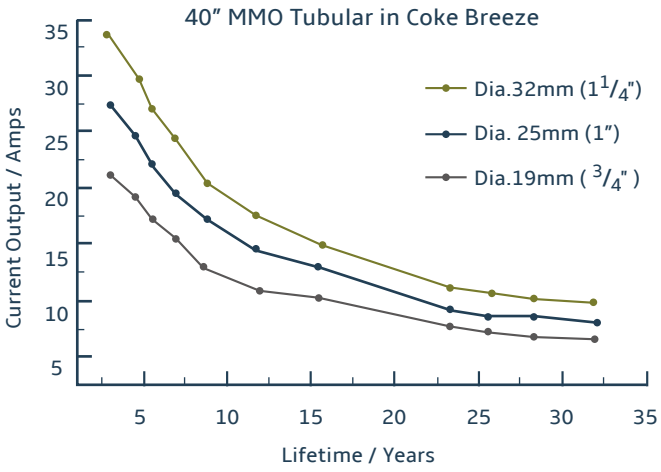
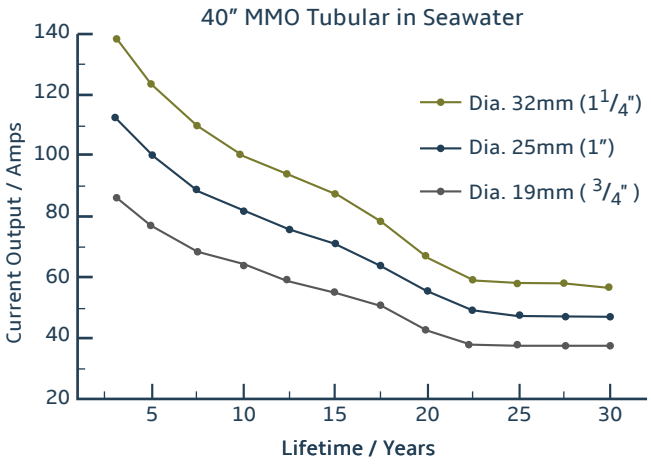
ELECTROCHEMICAL PROPERTIES





In Coke Breeze/Freshwater

Anode Dimensions		Current Density	Current Output		
ØD	L		For 15 yrs.	For 20 yrs.	For 25 yrs.
1" (25 mm)	39.4" (1000 mm)	9.3 A/ft² (100 A/m²)	11 A	9 A	8 A
1" (25 mm)	60" (1524 mm)		16 A	14 A	12 A
1 1/4" (32 mm)	48" (1220 mm)		16 A	14 A	12 A

In Brackish Water

Anode Dimensions		Current Density	Current Output		
ØD	L		For 15 yrs.	For 20 yrs.	For 25 yrs.
1" (25 mm)	39.4" (1000 mm)	55.8 A/ft² (600 A/m²)	32 A	24 A	19 A
1" (25 mm)	60" (1524 mm)		48 A	36 A	29 A
1 1/4" (32 mm)	48" (1220 mm)		48 A	36 A	29 A

In Seawater

Anode Dimensions		Current Density	Current Output		
ØD	L		For 15 yrs.	For 20 yrs.	For 25 yrs.
1" (25 mm)	39.4" (1000 mm)	55.8 A/ft² (600 A/m²)	64 A	55 A	48 A
1" (25 mm)	60" (1524 mm)		96 A	86 A	72 A
1 1/4" (32 mm)	48" (1220 mm)		96 A	86 A	72 A

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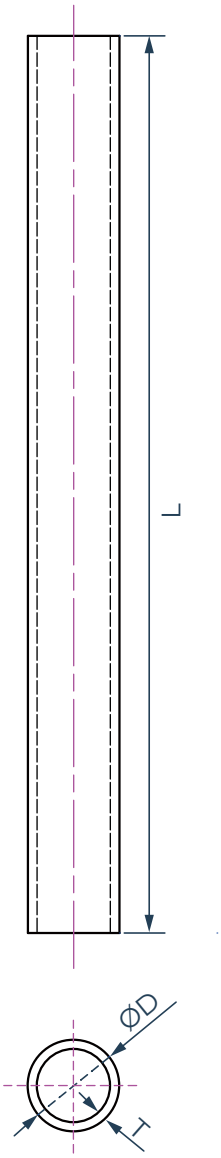
SPECIFICATIONS

In Coke Breeze

Item No.	Anode Dimensions			Current Density	Current Output	Design Life
	ØD	L	T			
JA–MMO–T160	5/8" (16 mm)	39.4" (1000 mm)	0.04" (1 mm)	9.3 A/ft² (100 A/m²)	5 A	25 yrs.
JA–MMO–T160M	5/8" (16 mm)	47.2" (1200 mm)	0.04" (1 mm)		6 A	
JA–MMO–T190	3/4" (19 mm)	39.4" (1000 mm)	0.04" (1 mm)		6 A	
JA–MMO–T190M	3/4" (19 mm)	47.2" (1200 mm)	0.04" (1 mm)		7 A	
JA–MMO–T250S	1" (25 mm)	19.7" (500 mm)	0.04" (1 mm)		4 A	
JA–MMO–T250	1" (25 mm)	39.4" (1000 mm)	0.04" (1 mm)		8 A	
JA–MMO–T250M	1" (25 mm)	47.2" (1200 mm)	0.04" (1 mm)		9 A	
JA–MMO–T250L	1" (25 mm)	60" (1524 mm)	0.04" (1 mm)		12 A	
JA–MMO–T320M	1 1/4" (32 mm)	48" (1220 mm)	0.04" (1 mm)		12 A	
JA–MMO–T500M	2" (50 mm)	47.2" (1200 mm)	0.04" (1 mm)		19 A	

In Seawater

Item No.	Anode Dimensions			Current Density	Current Output	Design Life
	ØD	L	T			
JA–MMO–T160	5/8" (16 mm)	39.4" (1000 mm)	0.04" (1 mm)	55.8 A/ft² (600 A/m²)	30 A	25 yrs.
JA–MMO–T160M	5/8" (16 mm)	47.2" (1200 mm)	0.04" (1 mm)		36 A	
JA–MMO–T190	3/4" (19 mm)	39.4" (1000 mm)	0.04" (1 mm)		36 A	
JA–MMO–T190M	3/4" (19 mm)	47.2" (1200 mm)	0.04" (1 mm)		43 A	
JA–MMO–T250S	1" (25 mm)	19.7" (500 mm)	0.04" (1 mm)		24 A	
JA–MMO–T250	1" (25 mm)	39.4" (1000 mm)	0.04" (1 mm)		48 A	
JA–MMO–T250M	1" (25 mm)	47.2" (1200 mm)	0.04" (1 mm)		57 A	
JA–MMO–T250L	1" (25 mm)	60" (1524 mm)	0.04" (1 mm)		72 A	
JA–MMO–T320M	1 1/4" (32 mm)	48" (1220 mm)	0.04" (1 mm)		72 A	
JA–MMO–T500M	2" (50 mm)	47.2" (1200 mm)	0.04" (1 mm)		114 A	



Notes: All dimensions and weights are nominal. The parameter provided is subject to variation in material compositions and Jennings Anodes foundry tolerance.

TESTING DETAILS

We employ ISO 9001:2015 quality management system and rigorous internal testing standards to ensure the optimum lifespan and performance of our anodes. Each anode is labelled with a unique serial number for quality tracking.

Technical Measurement	Chemical Composition		
Testing Standard	ASTM E120	NACE TM0108 / ASTM D3359	Foundry ITP
Testing Content	Chemical Analysis	Anode Lifetime Coating Adhesion Current Output	Dimension & Weight Coating Thickness
Equipment	Optical Emission Spectrometer OBLF QSN 750	JCM-6000 Plus Scanning Electron Microscope / DWW-K-100 Galvanostat / VCC101A Multimeter	Calibrated Digital Measuring Devices

* Third party testing is conducted by customer's special request at extra charge.

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