MMO/Ti Flexible Anode

Pre-packaged linear anode for impressed current cathodic protection in soil

Technical Data Sheet CP-DS-FA-001 | Revision B | 27 October 2026

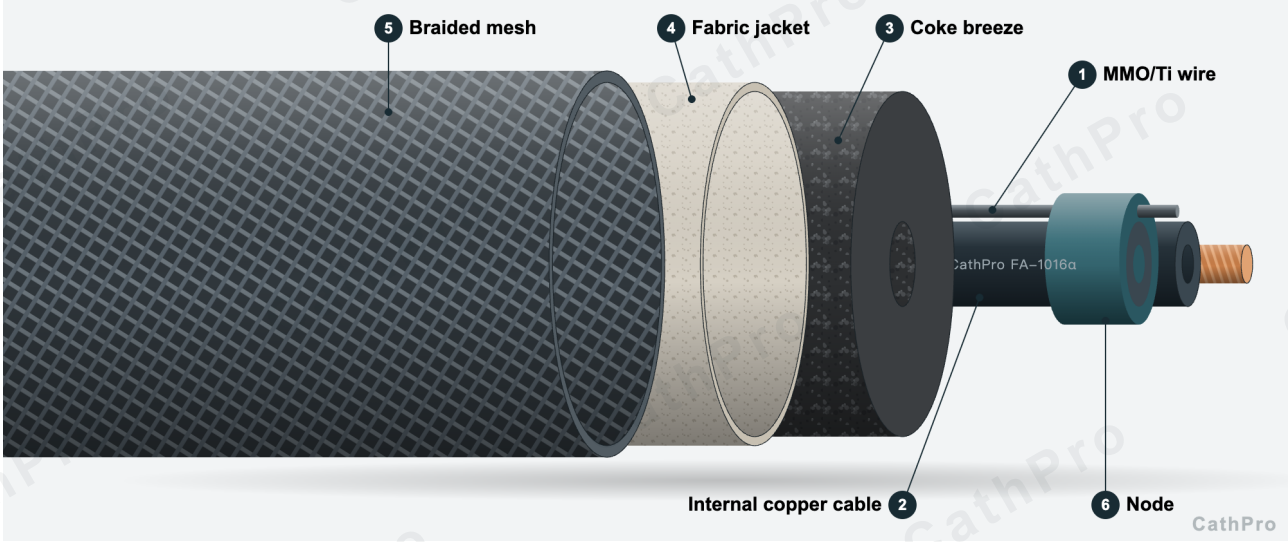


Figure 1 – Construction of the MMO/Ti flexible anode (schematic, not to scale; item numbers as in Section 3)

1 Description

The CathPro MMO/Ti flexible anode is a continuous, factory pre-packaged linear anode for impressed current cathodic protection (ICCP) of buried steel structures. A titanium wire with a mixed-metal-oxide (MMO) coating runs alongside a continuous internal copper cable and is connected to the copper at fixed intervals (nodes). Both are embedded in calcined petroleum coke and enclosed in a fabric jacket and an abrasion-resistant braided mesh.

Supplied on reels, the anode is laid continuously close to the protected structure, so that the protective current is distributed evenly along its full length. There is no ISO or IEC product standard for linear MMO anodes. This data sheet is the CathPro product specification: materials and tests refer to the international standards listed in Section 12, and the cathodic protection system is designed to ISO 15589-1 or the project specification.

2 Typical applications

- **Station and plant areas:** dense buried piping with many earthing points.
- **Buried pipelines:** laid parallel to the pipe in the same trench.
- **Storage tank bottoms:** laid in the sand pad under the tank as concentric rings or in a serpentine pattern (see API RP 651 and AMPP SP0193).
- **Airport apron piping and similar sites:** where deep-well groundbeds are unsuitable or stray-current interference with nearby structures must be kept low.

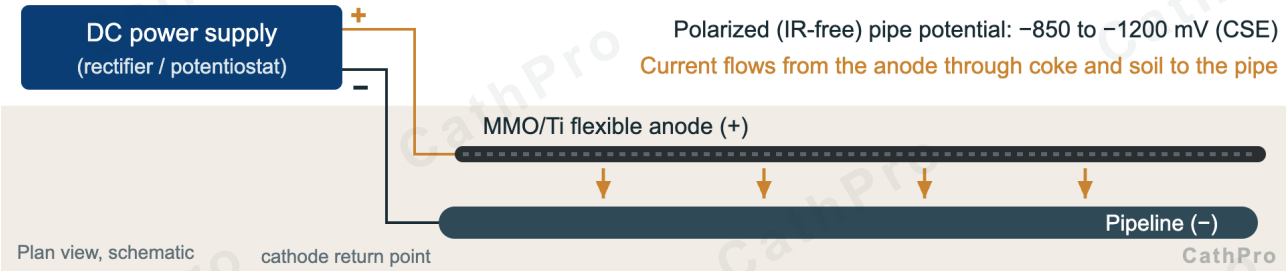


Figure 2 – Working principle: the power supply drives current from the anode through coke and soil to the pipeline

3 Construction

No.	Component	Description
1	MMO/Ti wire	Titanium wire to ASTM B863, Grade 1 (Grade 2 on request), with mixed-metal-oxide coating: α = IrO_2–Ta_2O_5 or β = RuO_2–IrO_2. Nominal diameter 0.8, 1.0, 1.5 or 2.0 mm.
2	Internal cable	Continuous single-core copper cable, 10, 16 or 25 mm², stranded class 2 conductor to IEC 60228, rated 0.6/1 kV, e.g. PVDF/HMWPE dual insulation. Insulation and sheath selected for the soil (see Section 7).
3	Coke breeze	Calcined petroleum coke packed around wire and cable; lowers the anode-to-earth resistance and evens out current discharge.
4	Fabric jacket	Permeable, rot-resistant fabric holding the coke in place; resists bursting, puncture and abrasion.
5	Braided mesh	Polyester monofilament braid over the fabric jacket for mechanical protection.
6	Node	Factory connection between MMO/Ti wire and cable copper at intervals of not more than 5 m, insulated and sealed.

4 Model designation

Models are designated by type, wire diameter, cable size and coating, for example FA-1016α:

Code	Meaning	Options
FA / FApro	FA = standard flexible anode; FApro = breakpoint-locatable flexible anode (a break in the buried anode can be located with an anode fault locator)	—
10	MMO/Ti wire nominal diameter 1.0 mm	08 / 10 / 15 / 20 (0.8–2.0 mm)
16	Internal cable copper cross-section 16 mm²	10 / 16 / 25 mm²
α / β	Coating: α = IrO_2–Ta_2O_5; β = RuO_2–IrO_2	α for non-saline soil; β for saline or alkaline soil

Example: FApro-1525β = breakpoint-locatable type, 1.5 mm wire, 25 mm² cable, RuO_2–IrO_2 coating.

5 Rated output current and design life

MMO/Ti wire	25 years	30 years	40 years	50 years
1.0 mm	52 mA/m	43 mA/m	33 mA/m	26 mA/m
1.5 mm	78 mA/m	65 mA/m	49 mA/m	39 mA/m
2.0 mm	104 mA/m	87 mA/m	65 mA/m	52 mA/m

Ratings for IrO_2–Ta_2O_5 (α) coated wire. The rated output is the maximum continuous current per metre of anode for the stated design life; it must not be confused with the much higher current used in short-term tests. Design life is verified by accelerated life testing of the MMO/Ti wire to NACE TM0108 or ISO 19097-2. Ratings for β coating and 0.8 mm wire on request.

6 Technical data

Parameter	Requirement
Outer diameter	38 ± 2 mm
Linear mass	> 1.30 kg/m
MMO/Ti wire diameter tolerance	ISO 2768-1, class m (medium), or as agreed
Coating loading	≥ 6 g/m² (X-ray fluorescence, ASTM B568 or ISO 3497)
Maximum operating current density	100 A/m² of MMO/Ti wire surface, in coke backfill
Coating adhesion	no peeling after bending a 100 mm wire sample 180° around a Ø20 mm mandrel
Node spacing	≤ 5 m; position deviation ≤ 10 % of the spacing
Node contact resistance (wire to copper)	≤ 0.0009 Ω
Node sealing	IPX8 to IEC 60529: ≥ 0.1 MPa for ≥ 60 min, no water ingress
Coke breeze	calcined petroleum coke; fixed carbon ≥ 90 %; 98 % < 1.27 mm and 80 % > 0.254 mm; resistivity ≤ 0.06 Ω·cm
Fabric jacket	burst strength ≥ 500 N (width ≤ 140 mm); puncture strength ≥ 280 N; Martindale abrasion ≥ 100 cycles (ISO 12947-2)
Braided mesh	polyester monofilament, Ø ≥ 0.8 mm recommended; coverage ≥ 60 %
Working performance (type test)	15 days in 3 % NaCl at 100 A/m² of wire surface: output maintained, supply voltage within ± 10 %, nodes intact and dry
Minimum bending radius	≤ 150 mm with 10 mm² cable; larger cables per supply data sheet; confirmed by bending test
Joints	whole reels: max. 2 per 400 m; cut lengths: none below 100 m, max. 1 for 100–400 m; copper-to-copper resistance across a joint ≤ 0.01 Ω

7 Selection guide

Condition	Recommendation
Non-saline soil	α coating (IrO_2–Ta_2O_5); cable sheath HDPE or HMWPE
Saline or alkaline soil	β coating (RuO_2–IrO_2); fluoropolymer-insulated cable with HDPE sheath, or XLPE sheath
Groundwater above anode depth	low-permeability sheath, preferably PE
Service temperature below −15 °C	XLPE, PE or cold-resistant rubber sheath; avoid PVC
Service temperature above 60 °C	heat-resistant PVC, XLPE or EPR sheath
Severe termite risk	hard, termite-resistant outer sheath
Risk of third-party damage	breakpoint-locatable type FApro (in-line joints only, no tee joints)

8 Installation guidelines

- Check model, quantity, appearance, dimensions, electrical continuity, test documents and certificate before installation.

- Handle reels by forklift only from the flange sides, through the openings; never lift against the anode. Secure reels against rolling.
- Lay the anode parallel to the pipeline, at least 300 mm and at least half the pipe diameter from it, level with the pipe bottom (Figure 3). Keep it slack in the bed and allow 2–5 % extra length for settlement.
- The anode must not touch buried metal. Where it crosses pipelines, earth electrodes or other anodes, protect it with an insulating sleeve.
- Do not drag the anode. If the fabric jacket is damaged and coke leaks, seal the damage before laying.
- The minimum laying temperature depends on the cable sheath (table below). Below it, pre-warm the reel indoors at about 25 °C (no open flame) and lay within 2 h. Do not lay above about 40 °C ambient.
- Corner radius at least 16 × the anode outer diameter (when there is no parallel cable on the inside of the bend).
- On slopes of 20°–50°, fix the anode every 15 m (≤ 30°) or every 10 m (> 30°) with insulating material.
- Backfill with sieved soil. Under tank bottoms keep at least 50 mm of sand below the anode and do not use vibratory compactors.
- Station areas: lay in segments of not more than 300 m, each with its own cathode return point; bond parallel pipelines.
- Armoured internal cable: earth the steel tape armour at both ends during installation.

Typical minimum ambient temperature for laying, by cable sheath (guidance; observe the cable manufacturer's limits):

Internal cable sheath	Minimum laying temperature
Plastic-insulated sheath	0 °C
Lead sheath with steel-tape armour	−7 °C
PVC insulation, PVC sheath	−10 °C
Rubber insulation, PVC sheath	−15 °C
Rubber or PVC sheath	−15 °C
Cold-resistant sheath	−20 °C

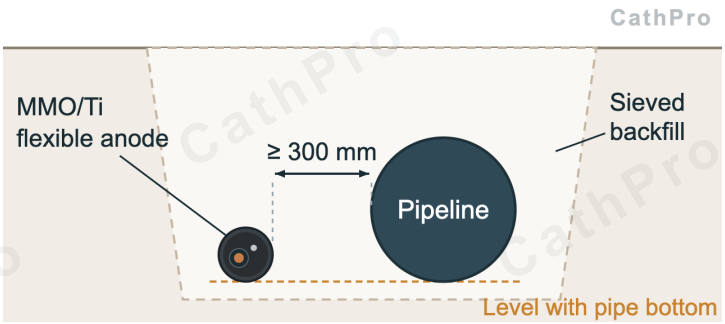


Figure 3 – Laying parallel to a pipeline: clearance ≥ 300 mm and ≥ half the pipe diameter, anode level with the pipe bottom

Typical minimum clearances to other facilities, parallel run (guidance; the project design and local regulations govern):

Facility	Minimum clearance
Protected pipeline	≥ 300 mm, anode level with the pipe bottom
Control cables; power cables ≤ 10 kV	≥ 100 mm
Power cables > 10 kV	≥ 250 mm
Building foundations	≥ 600 mm

Facility	Minimum clearance
Tree trunks	≥ 700 mm
Overhead line poles ≤ 1 kV / > 1 kV	≥ 1 m / ≥ 4 m
Roads	≥ 1.5 m
Electrified railways, AC / DC	≥ 3 m / ≥ 10 m

Lay the anode on the side of the protected pipeline away from unprotected pipelines and earth electrodes. At cable crossings keep at least 500 mm.

9 Inspection and quality documents

- Inspection lot: up to 5000 m of the same material, production line and size.
- Every lot: appearance, outer diameter, linear mass, and the accelerated life test report of the MMO/Ti wire (NACE TM0108 or ISO 19097-2).
- Orders of 5000 m or more: in addition, three reels are sampled (10 m from the end of each) for node contact resistance, node sealing (IPX8), braid coverage, bending radius and 15-day working performance. If one sample fails, the sampling is doubled; if a failure recurs, the lot is rejected.
- Type testing: for new products, after major changes in design, material or process, after more than one year out of production, when routine results differ significantly from the last type test, and once a year.
- Each delivery is accompanied by a certificate of conformity, an inspection certificate (EN 10204 type 3.1 on request), a reel length list and a packing list. Witness or third-party inspection on request.

10 Packing, marking and storage

- Wound on reels, wrapped in foam film and waterproof plastic film; export packing suitable for sea freight.
- Typical reel lengths 500 m and 700 m; other lengths on request. Typical packages: 500 m reel approx. 1.4 × 1.1 × 1.5 m, net 650 kg, gross 720 kg; 700 m reel approx. 1.6 × 1.1 × 1.7 m, net 910 kg, gross 990 kg.
- The product is marked with trademark and model. Packages show product name and model, manufacturer, batch, quantity, production date and handling symbols (no-forklift side, stacking mass limit, do not stack, direction of rotation).
- Store in a safe, ventilated, dry and cool place, away from hazardous goods; secure reels against rolling.

11 Ordering information

1. Model, e.g. FA-1016α or FApro-1016α.
2. Total length, reel lengths and segment requirements.
3. Design life and rated output per metre; soil conditions (saline or not), groundwater level, service temperature, termite risk.
4. Accessories: in-line joints, tee joints, end seals, insulating sleeves, lead cables (type, size and length).
5. Applicable project specification, witness or third-party inspection, document list.

12 Referenced standards

- ISO 15589-1 Cathodic protection of pipeline systems — Part 1: On-land pipelines
- ISO 19097-2 Accelerated life test method of mixed metal oxide anodes for cathodic protection — Part 2: Application in soils and natural waters
- NACE TM0108 Testing of catalyzed titanium anodes for use in soils or natural waters
- ASTM B863 Titanium and titanium alloy wire; ASTM B568 and ISO 3497 Measurement of coating thickness by X-ray spectrometry
- IEC 60228 Conductors of insulated cables; IEC 60529 Degrees of protection provided by enclosures (IP code)

- ISO 2768-1 General tolerances; ISO 12947-2 Abrasion resistance of fabrics by the Martindale method — Specimen breakdown
- API RP 651 Cathodic protection of aboveground petroleum storage tanks; AMPP SP0193 External cathodic protection of on-grade carbon steel storage tank bottoms
- EN 10204 Metallic products — Types of inspection documents

Jiaozuo Huayu Magnesium Co., Ltd. (CathPro) · No. 218 Hetang Road, Middle Section of Heshuo Avenue, Wuzhi County, Jiaozuo, Henan Province 454950, China · sales@cathprocp.com · www.cathprocp.com

Data in this sheet are typical values for information. Final requirements are those of the approved project data sheet and purchase order. © 2026 Jiaozuo Huayu Magnesium Co., Ltd. All rights reserved.