Technical Seminar for Cathodic Protection to GOGC Design Unit Specialists

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WITHIN THE JURISDICTION OF THE MINISTRY OF ENVIRONMENT, ENERGY & CLIMATE CHANGE

MINISTRY OF ENVIRONMENT ENERGY & CLIMATE CHANGE

CP with Galvanic Anodes

Galvanic-anode systems should be considered when the current demand is low. They are more adapted for small-diameter pipelines, short lengths (a few kilometres) of quality-coated larger diameter pipelines, and in low resistivity electrolytes (where the anode is installed), water, swamps or marshes.

CP with Galvanic Anodes

- if no power for impressed current is available;
- for temporary protection of newly laid pipelines;
- for temporary protection of existing pipelines;
- if maintenance of the electrical equipment associated with an impressed current is impractical;
- for localized (hot-spot) protection to supplement impressed-current systems (e.g. in the case of a complex structure or anodic areas such as next to an isolating joint);
- where remote groundbeds for impressed-current systems cannot be provided;
- in the thaw-bulb at locations where the electrolyte around the pipeline can freeze (permafrost);
- under thermal insulation where external impressed current system cannot be effective due to the electrical isolation supplied by the thermal coating;
- when a shielding effect can prevent the cathodic protection current from reaching the pipeline

CP with Galvanic Anodes

Typical electrochemical parameters for zinc anodes used in soils

Parameter	Zinc anode
Open circuit potential (mV versus saturated Cu/$CuSO_4$)	-1 100
Practical electrochemical capacity (A·hr/kg)	780
Practical consumption rate (kg/A·yr)	11,2

Zinc anodes, even with backfill, should not be used if the resistivity of the soil is higher than 50 Ω.m, unless the engineering evaluation or field test confirms that the design requirements can be met.

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When installed in soil for pipeline applications, zinc anodes shall be used with anode backfill, except when soil contains chlorides or sulphates

CP with Galvanic Anodes

In environments where carbonates, bicarbonates or nitrates dominate, the potential of the zinc become very noble due to the presence of passivating surface films. This effect can reduce the zinc anode efficiency. This phenomena doesn’t appear if the electrolyte contains sulphates or chlorides.

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Typical electrochemical parameters for magnesium anodes used in soils

Parameter	**Alloy M1** mass %	**Alloy M2** mass %
Open circuit potential (mV vs. sat. $Cu/CuSO_4$)	-1 500	-1 700
Practical electrochemical capacity (A.h/kg)	1 100	1 100
Practical consumption rate (kg/A.Year)	7,5	7,5

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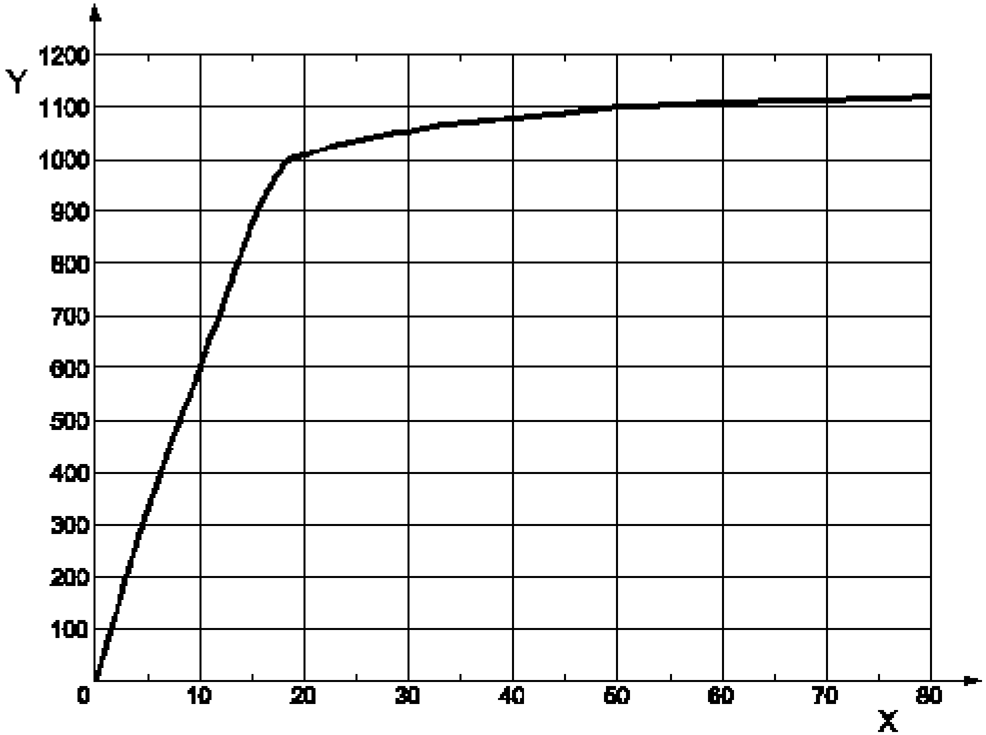
Magnesium anode, even with backfill, should not be used if the resistivity of the soil is higher than 100 Ω.m unless the engineering evaluation or field tests confirm that the design requirements can be met.

CP with Galvanic Anodes

Current capacity of magnesium alloy versus current density



CP with Galvanic Anodes

Design

$$m = I_{\mathrm{cm}} \times t_{\mathrm{dl}} \times \frac{8\,760}{u \times \varepsilon}$$

$$m = n \times m_{\mathrm{a}}$$

$$I_{\mathrm{f}} = \frac{I_{\mathrm{cf}}}{n}$$

$$I_{\mathrm{af}} = \frac{E_{\mathrm{c}} - E_{\mathrm{a}}}{R_{\mathrm{a}}}$$

CP with Galvanic Anodes

Design

$$R_{a/b} = \frac{\rho}{2\pi L_a}\left[ln\left(\frac{4L_a^2 + 4L_a \cdot \sqrt{h_a^2 + L_a^2}}{D_a \cdot h_a}\right) + \frac{h_a}{L_a} - \frac{\sqrt{h_a^2 + L_a^2}}{L_a}\right]$$

$$R_{a/b} = \frac{\rho}{2\pi L_b}\left[ln\left(\frac{4L_b^2 + 4L_b \cdot \sqrt{h_b^2 + L_b^2}}{D_b \cdot h_b}\right) + \frac{h_b}{L_b} - \frac{\sqrt{h_b^2 + L_b^2}}{L_b}\right]$$

$$R_a = R_{a/b} + R_{b/s}$$