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# Sacrificial anodes or impressed current?

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Cathodic protection works by supplying electrons to a structure until its potential is driven low enough that dissolution of iron is no longer favourable. The structure becomes the cathode of a deliberately created cell. There are two ways to supply the current.

## The criteria are the same either way

The system is judged on the potential achieved at the structure, not on the current delivered. The criteria in common use are a structure-to-electrolyte potential of -850 mV or more negative against a copper/copper sulphate reference in soil, and -800 mV or more negative against a silver/silver chloride reference in seawater. For anaerobic conditions with sulphate-reducing bacteria, -950 mV is normally applied.

There is also an upper limit. Polarising a coated structure more negative than about -1100 mV generates hydrogen at the surface, which disbonds coatings and, on high-strength steels, risks embrittlement. Over-protection is a real failure mode, and it belongs almost entirely to impressed current systems.

## Sacrificial anodes

A more anodic metal is connected to the structure and consumed. Zinc, aluminium alloys and magnesium are the practical choices, with open-circuit potentials of roughly -1.05 V, -1.10 V and -1.5 to -1.7 V against silver/silver chloride respectively. The driving voltage is fixed by the couple and is small, which constrains both the current output and the distance over which it will travel.

## Impressed current

A rectifier drives current from inert or semi-inert anodes to the structure. Current demand is essentially not a constraint, so large or poorly coated structures become protectable. The costs are operational: power, monitoring, and someone competent to interpret readings and adjust output. Current discharged from an impressed current system can also pick up on nearby buried structures and cause interference corrosion.

| | Sacrificial | Impressed current |
|---|---|---|
| Driving voltage | Fixed, a few hundred mV | Adjustable, tens of volts |
| Current capacity | Limited | Effectively unlimited |
| Power required | None | Continuous |
| Over-protection risk | Very low | Real, requires control |
| Interference risk | Low | Requires assessment |
| Main operating cost | Anode replacement | Power, survey, maintenance |

*Cathodic protection does not replace coating. The coating does the bulk of the work and the cathodic protection handles the defects. A system sized on the assumption of a good coating, applied over a poor one,*

*will run out of anode long before the design life.*

## Standards and further reading

1. ISO 15589-1 — Cathodic protection of pipeline systems: on-land pipelines.
2. EN 12473 — General principles of cathodic protection in seawater.
3. NACE SP0169 — Control of external corrosion on underground or submerged piping.
4. DNV-RP-B401 — Cathodic protection design.