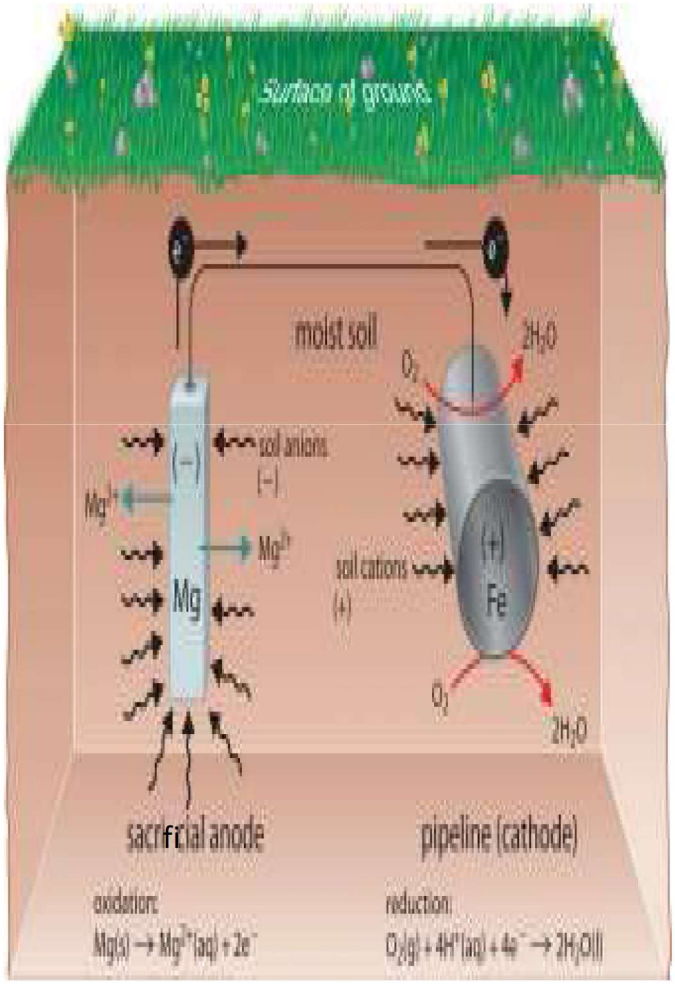
Cathodic protection

- Principle: Forcing the metal to be protected to behave as cathode – prevent corrosion.
  - Sacrificial anodic protection
  - Impressed current cathodic protection

Sacrificial anodic protection

- Metal structure to be protected is connected through a piece of wire to more anodic metal.
- Metal structure and anode must be in contact with the electrolyte(moist soil and water).
- All corrosion concentrated at more active anodic metal and cathodic metal is protected.
- Zn, Mg, Al – can be used as sacrificial anode.



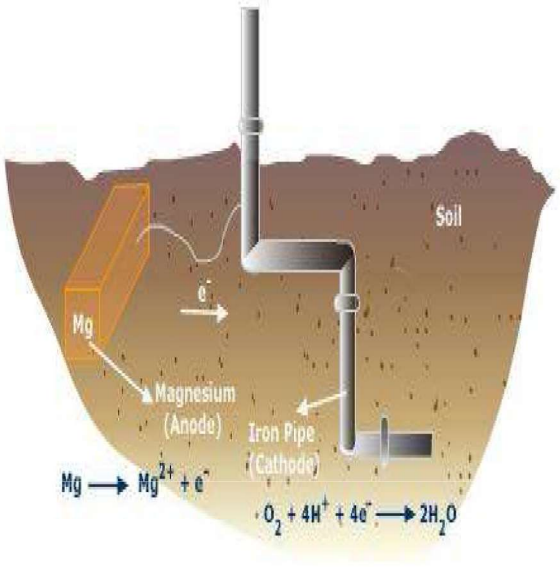
- It is employed in protection of
- Buried pipelines
- Underground cables
- Marine structures
- Ship-hulls
- Water-tanks etc.

Advantages of sacrificial anodic protection

- No external power is required
- Easy to install and anodes can be readily added
- Minimum maintenance and uniform distribution of current
- Effective use of protective current

Limitations

- Limited driving potential and current output
- Poorly coated structure may require many anodes
- Can be ineffective in high-resistivity environment
- Installation can be expensive if installed after construction.



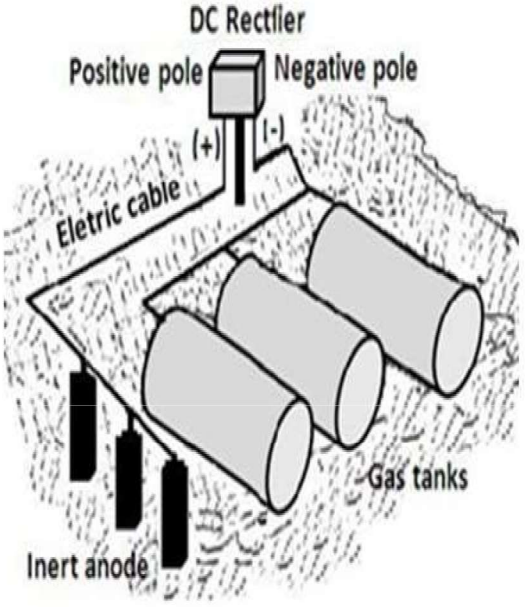
Oil rigs use blocks of Al at the foot of every Fe pillar to prevent corrosion

Impressed current cathodic protection

- In this method, an impressed current is applied in the opposite direction to nullify the corrosion current and convert the corroding metal from anode to cathode.
- Connecting negative terminal of the battery to the metallic structure to be protected.
- Positive terminal of battery is connected to an inert anode like graphite or platinised titanium.
- Corrosion metal become cathodic and corrosion prevented.
- Impressed current is obtained from DC source.
- Anode buried in backfill containing mixture of gypsum, coke, sodium sulphate to increase electrical contact between itself and surrounding soil.

It is employed in protection of

- Water tanks, buried water or oil pipes, marine piers, laid-up ships etc.



Electrolytic reactions:

Cathode

$2\,H_2O + 2\,e^- \rightarrow H_2 + 2OH^-$

Inert anode

$2\,OH^- - 2\,e^- \rightarrow H_2O + \frac{1}{2}\,O_2$

Advantages

- Can be designed for a wide range of voltage and current.
- Large areas can be protected by single installation. But require periodic inspection and maintenance.
- This method is useful for protection of large structure for long-term operation.

Limitations

- May increase the corrosion of adjacent pipeline or an adjacent metal structure because of stray (leaked) currents.
- Require periodic inspection and maintenance costs
- Chemical reactions occurring at the surface of the protected structure may cause problem.
- Overprotection can cause coating damage.
- Require external power, resulting in monthly power costs.

Sacrificial anodic method	Impressed current method
No external power supply is necessary	External power supply must be present.
This method requires periodical replacement of sacrificial anode.	Here anodes are stable and do not disintegrate.
Investment is low.	Investment is more.
Soil corrosion effects are not taken in to account.	Soil corrosion effects are taken in to account.
This is most economical method especially when short-term protection is required.	This method is well suited for large structures and long term operations.

Anodic protection

- Principle of anodic protection: Metal to be protected from corrosion is made 'more anodic'. An external impressed DC is applied to anode part, which makes it more anodic. A protective oxide film formed which protects the surface from further corrosion.
- A potentiostat maintains metal at constant potential w.r.t reference electrode (calomel). potentiostat has 3 terminals. One is connected to structure to be protected, other to auxiliary cathode (Pt), and third to a reference electrode.
- This technique is only applicable to metals which exhibit active-passive behavior eg, Ti, Al, Ni, stainless steel, Cr etc., (and these metals cannot afford cathodic protection since these readily get passivated).
- Limitations: This method is applicable for only those metals which passivate.
- During anodic protection corrosion does take place but at a very slow rate (i.e corrosion rate is not zero)
- Applications: Stainless steel containers used for transporting corrosive chemicals (eg. conc. acids) are protected from corrosion.