

# CHAPTER (1)

## INTRODUCTION

A very meaningful definition of corrosion is that "corrosion is a metallurgical process in reverse", figure 1.1. In conventional metallurgical industry, the bond between metal atoms and other elements in ores is broken, and pure metals are extracted. This process involves charging metal atoms with external amount of energy sufficient to shift valence electron to higher orbits. Corrosion is a reversed process in which these valence electrons loose the same amount of energy and returns back to the lower orbit by combining with other element in the form of ores.

Metal corrosion occurs in all environments in atmosphere, in water, underground and even in space. The historical tragic death of Captain Scott and his mission is attributed to corrosion of his reserve fuel containers buried in snow. Signs of corrosions were observed on some parts of space shuttle <sup>[1]</sup>.

Corrosion is classified into two main types: dry and wet. Dry corrosion occurs at elevated temperatures in presence of powerful oxidizer e.g., Oxygen and Sulphur. Wet corrosion occurs in presence of electrolytes (water solution of salts) and is responsible for about more than 99% of corrosion damage on earth. The mechanism of metal corrosion, in general, is well known and fully covered in specialised literatures.

In the case of wet corrosion, the natural potential (Redox) between metal and electrolyte is not the same allover the surface of contact. Metal atoms at points of lower potentials (anodes) tend to oxidize into positive

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<sup>1</sup> \* Number between raised square brackets refers to the reference(s) in the REFERENCES list

metals ions and depart to combine with negative ions in the electrolyte. In the same time to keep balance, positive ions from the electrolyte are attracted towards the metal and pick up abundant electrons in a reduction process. Points where this happens are called cathodes. In results, metal decay at anodes where oxidation occurs, and corrosion products are precipitated at cathodic points where reduction occurs, figure 1.2. Corrosion is associated with the development of micro/macro electric circuits in which current is transferred electronically through metal from cathode to anode, and by positive ions through the electrolyte from anode to cathode.

The rate of corrosion depends on chemical and physical properties of both metal and electrolyte. Corrosion damage can be mitigated using either/or both of two approaches:

- a) Passive approach in which the metal contact with electrolyte is eliminated e.g., by coating with an active material.
- b) Active approach – by converting the whole concerned metal body into a cathode relative to powerful external anode connected metallicity to it. Thus corrosion is confined to the external anode, which is much less valuable than the main metal and can be replaced periodically. This method is known as cathodic protection.

A third method applicable in limited cases depends on de-activating of electrolyte by some inhibitors. Figure 1.3 shows the different methods of corrosion control.

Application of cathodic protection for corrosion prevention involves replacing all local electric circuits on protected metal by one main circuit operating between the protected metal body and the external anode. Electric current in this substitute circuit is supplied from external source,

either by using an external anode of much lower Redox potential than the protected metal relative to electrolyte (sacrificial method) or by impressing DC current into the circuit from an external batteries or generators. These two methods are diagrammatically shown in figures 1.4a and 1.4b.

Application of cathodic protection in practice faces some problems, among which, is the so called shielding phenomenon. This happens usually with large structures, when the flux of positive ions originating from the anode is preferentially reduced in the nearer part of the structure leaving remote or hidden portion unprotected. This phenomenon can be observed in case of large diameter pipes, tank bottom, and particularly in steel sheet piles used in harbours.

Huge steel infrastructure such as bridges, pipe lines, marine ships, factories and harbor barriers are usually subjected to unfriendly environments which accelerate corrosion in many ways and decrease their service lives unless proper protection measure are effected. Corrosions in this context have heavy burdens on infrastructure safety, investment and the environment. Replacement of corroded steel structures set high pressure on the environment because scraping, recycling and producing substitute metals require high consumption of heat energy often produced from fuel with its known effects on environment.

This work is dedicated to the investigation of corrosion patterns on steel sheet piles with consideration of shielding phenomenon.

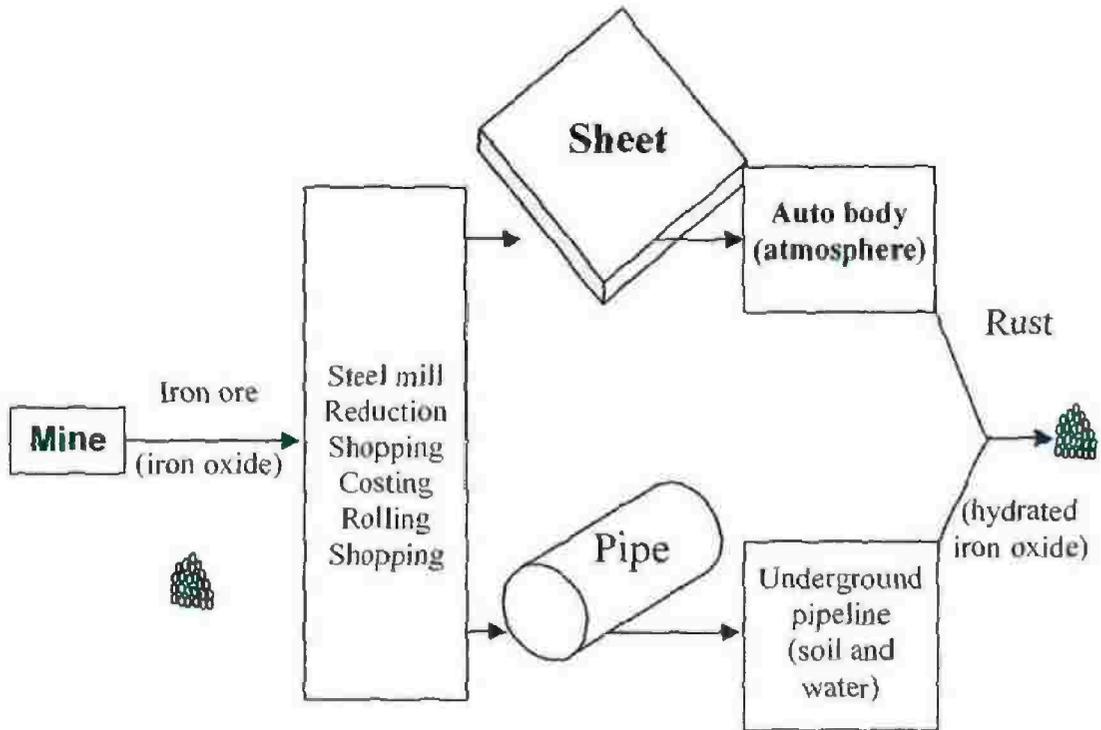


Figure 1.1 Metallurgy in reverse

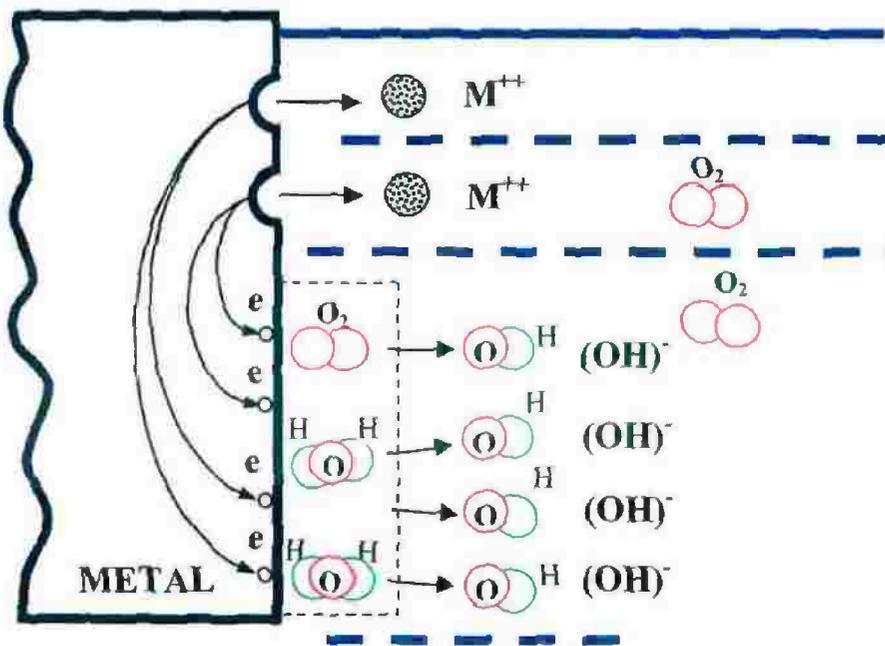


Figure 1.2 Corrosion mechanism

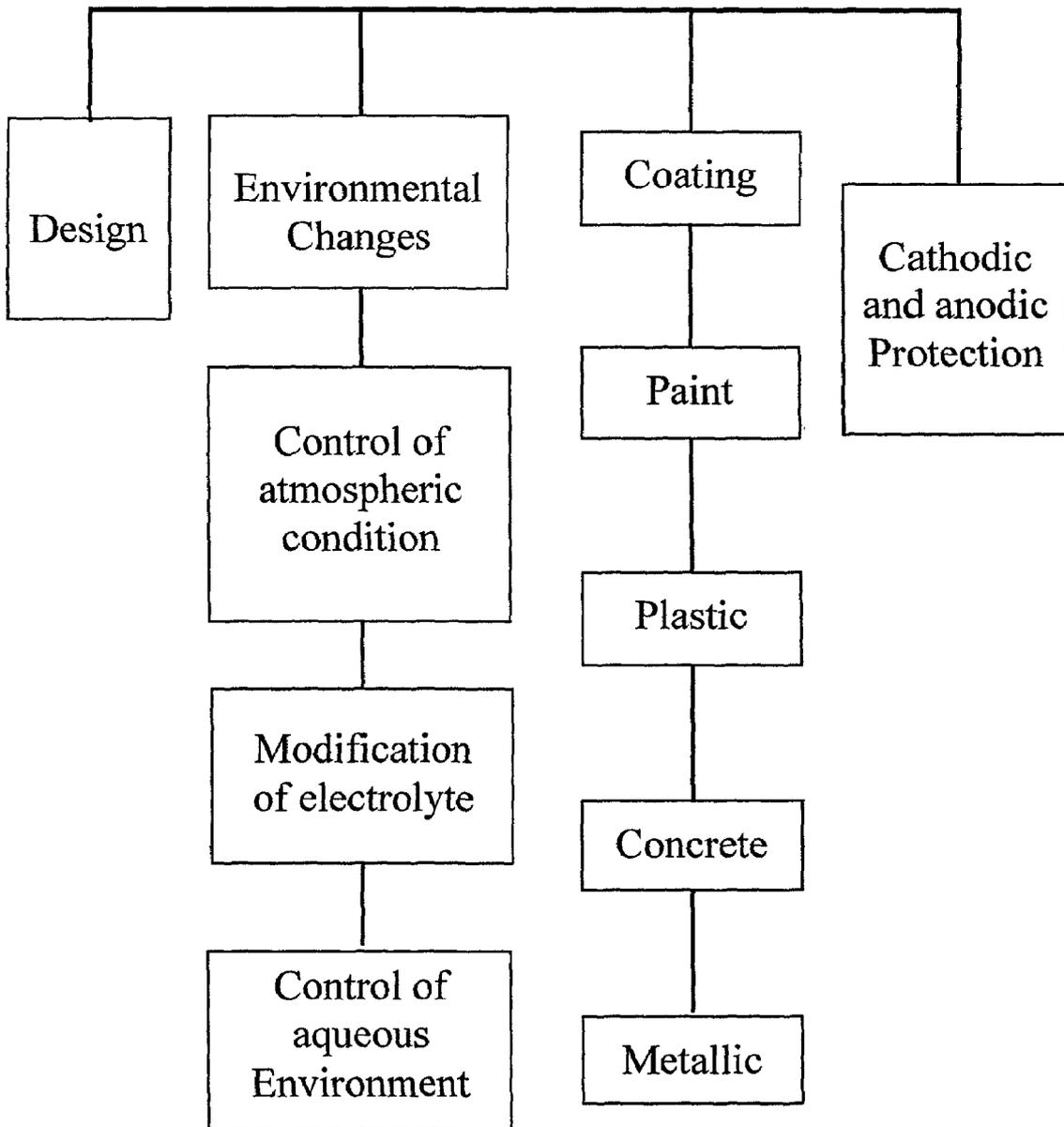
**Corrosion Control**

Figure 1.3 Methods of corrosion control

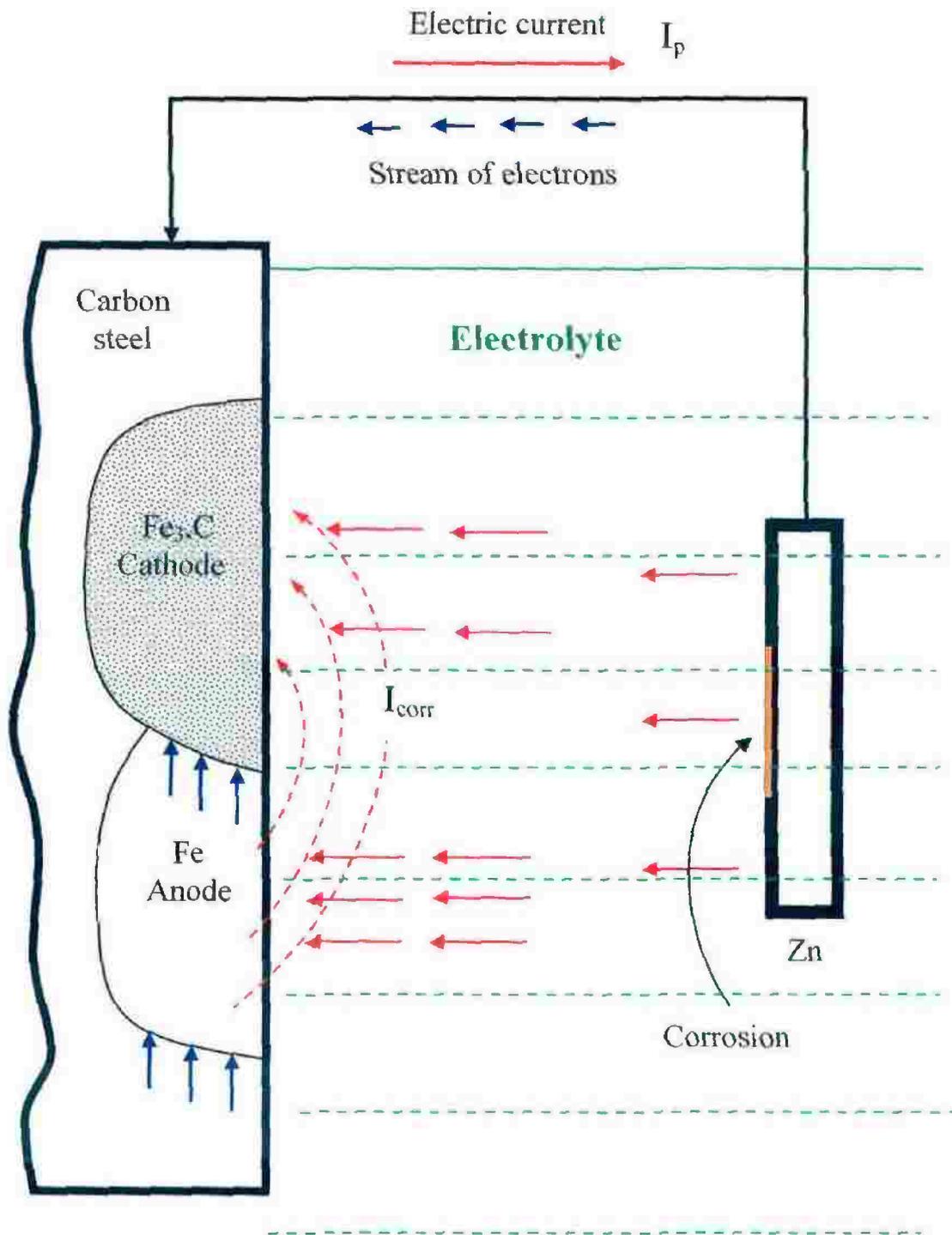


Figure 1.4a Cathodic protections with sacrificial anodes

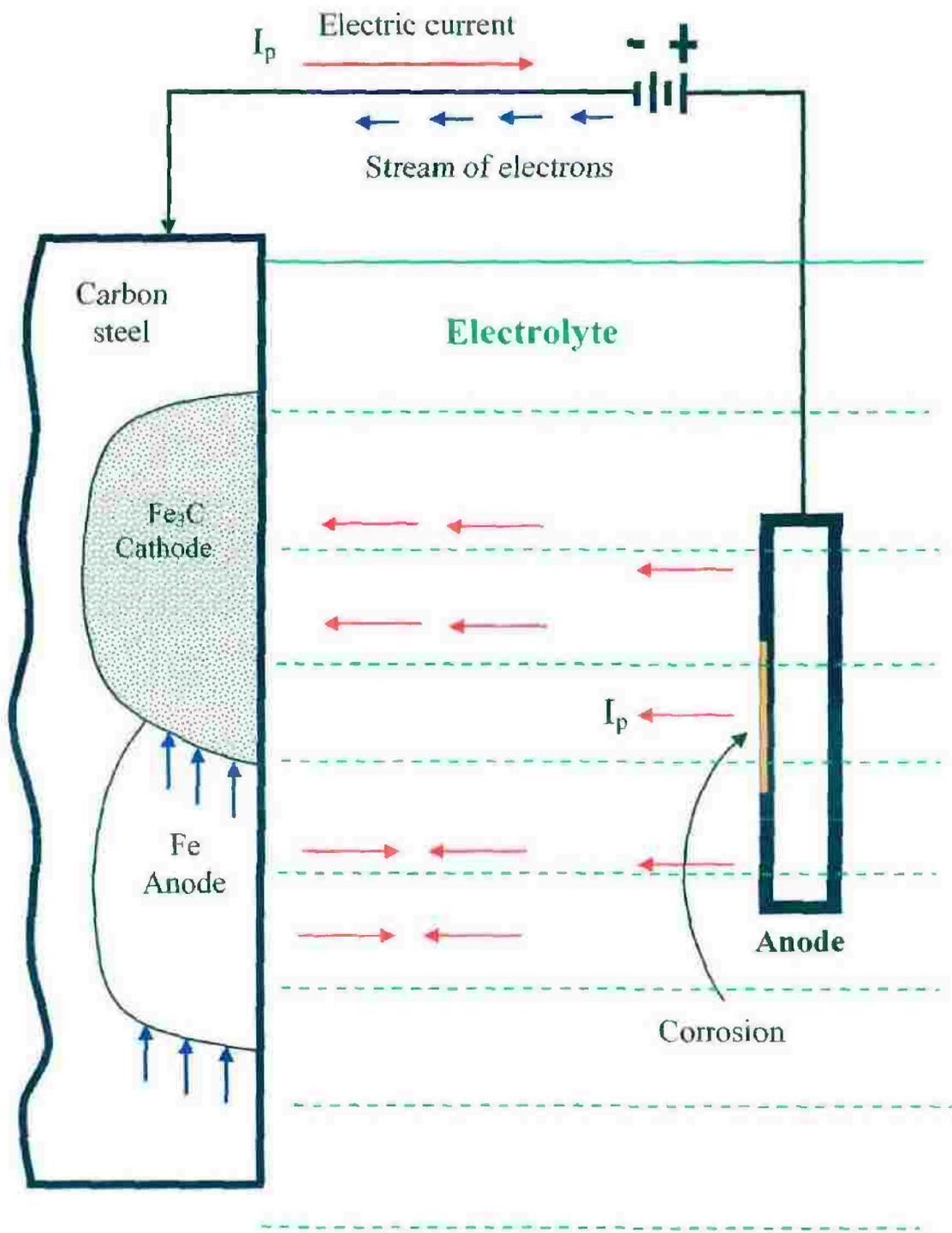


Figure 1.4b Cathodic protections with impressed current