General Introduction

INTRODUCTION

While Architects, Roof Plumbers and Builders may not need to fully understand the chemistry and mechanics of metallic corrosion, there should be an awareness of the many materials design, specification and installation combinations that have a potential to cause unsatisfactory material performance.

The most common factor leading to eventual material replacement is time. This statement recognises that all materials eventually suffer from some form of deterioration. While premature replacement of brittle building materials can be initiated by impact damage, and timber may rot or suffer from termite attack, the common reason for failure of metal products, is eventual corrosion.

Corrosion may be defined as the destruction or deterioration of a material because of a reaction with its environment. For steel, it is often the case of the iron endeavouring to return to the original hydrated iron oxide or iron oxide state. Although many other metals form their oxide when corrosion occurs, "rusting" is a term reserved for the corrosion of iron and steel.

All environments are corrosive to some degree. Such reactions are generally governed by the available moisture within the specific environment which can allow an otherwise benign environment to greatly assist the onset of corrosion mechanisms. Further contamination of the environment where acid products may exist or be derived from industrial or marine contamination, will only serve to expedite such reactions leading to the premature demise of the material.

BlueScope has endeavoured to take advantage of the natural galvanic protection associated with preferential corrosion of specific metallic materials when placed in contact with less active metals.

To achieve this effect, metallic coatings are applied to steel substrates for the purpose of increasing the corrosion resistance of the steel product. Some examples of applications for which metallic coatings are commonly applied to steel, for the prime purpose of providing corrosion protection are as follows:

1. Hot dipped zinc/aluminium/magnesium coating (ZINCALUME® steel) used for roofing, walling, rain water goods and numerous fabricated articles for interior/exterior use.

2. Hot dipped zinc coating (galvanized) used for structural purlin fabrication, fence posts, concrete decking and numerous articles for interior/exterior use within the building industry.

3. Electro deposited tin coating used in the canning industry.

There are two different types of metallic coatings; "active" (or sacrificial) coatings and "noble" (or cathodic) coatings. The terms active and noble indicate whether the metallic coatings are active (will corrode) or noble (will not corrode) compared with steel. Galvanized or ZINCALUME® steel coatings are active. Hot-dipped lead/tin coatings are noble, while tin coatings constitute a special case.

Tin is cathodic to steel on the outside of a tin plated steel container but usually active to steel on the inside. That is whether the corrosion potential of the metallic coating is more negative or more positive than the corrosion potential of steel in the same environment.

At defective areas in an active metal coating, the metal coating will corrode and sacrifice itself in an attempt to protect the steel substrate, where a defect in a noble metal coating will cause the steel substrate to corrode in an attempt to protect the metal coating. Noble metal coatings therefore must contain minimal porosity which may indicate a thick coating requirement or carefully controlled process parameters.

Two important qualities of an active metal coating are:

1. essential corrosion resistance.

2. ability to corrode in a controlled manner to sacrificially protect the steel base. (Sacrificial protection is also commonly referred to as galvanic protection. Refer Corrosion Technical Bulletin-02 Galvanic Protection)

When a metal is placed in a corrosive environment, cathodic and anodic areas form on the surface. These areas form localised corrosion cells and are usually microscopic in size. The chemically active sites such as surface defects, cracks in surface films, or grain (spangle) boundaries are where the corrosion or anodic reactions are initiated.

Metal dissolution (or corrosion) is expected to occur at these sites according to the following anodic reaction:-

$$M \Rightarrow M^{2+} + 2e$$

(M = Metal Ion)

When considering the surfaces of bare metals, cathodes are typically found at sites of lesser chemical activity such as within grain interiors. For corrosion to occur, the electrons made available from dissolution of the anodic metal are consumed by the adjacent cathodic reaction. The two main reactions at the cathodic site are:–

Reduction of hydrogen ions to produce hydrogen gas which will predominate in acid solutions:

$$2H^+ + 2e \Rightarrow H_2 \Uparrow$$

Or, in near neutral environments dissolved oxygen is reduced to form hydroxide by the following reaction:

$$^1/_2O + H_2O + 2e \Rightarrow 2OH$$
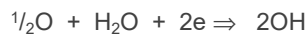
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