Mild Steel – What Is It? 1.1.1

Substrate Description

Steel is derived from **iron**. **Iron ore** requires great thermal energy (around 1,500°C) to reduce to its metallic form of **iron**. The **iron** is then alloyed with **carbon** and metals such as nickel or tungsten to produce **steel**.

Steels are described as mild, medium- or high-carbon steels, according to the **percentage of carbon** they contain. **Mild steel** is an iron alloy that contains less than **0.25% carbon**.

Mild steel is very **reactive** and will readily revert back to iron oxide (rust) in the presence of **water**, **oxygen** and **ions**. The readiness of steel to oxidize on exterior exposure means that it must be adequately protected from the elements in order to **meet and exceed** its design life.

Prior to painting, new mild steel surfaces should be inspected for **millscale**, **rust**, **sharp edges**, **laminations**, **burr marks** and **welding flux**, forming or **machine oils**, **salts**, **chemical contamination** or **mortar splashes** on them, all of which must be removed.

Millscale

Millscale is a shiny, bluish iron oxide often present on the surface of the steel. It is produced by heat and pressure during manufacture. Millscale is often mistaken for a blue-toned shop primer or clean steel. Millscale is very difficult to remove by hand and must be completely removed during surface preparation for long-term corrosion protection. The presence of millscale is responsible for a significant proportion of coating failures and thus must never be painted over. For more information, please refer to Dulux Protective Coatings Tech Note 1.1.4 – Millscale.

Laminations

Laminations are sections of steel that had been raised (such as burr edges) and then flattened at some stage of the rolling process – either hot-rolled or cold rolled. If not removed, these may harbour contaminants that could cause subsequent coating failure.

Why Use Steel?

Steel is an **excellent choice** of building material due to its high flexural and compressive **strength**. It allows the design of much taller multistorey buildings and structures with wider spans because of its high **strength to mass ratio**. It is also lighter to transport, quick to erect and is versatile in design.

"Steel has **unique properties** which make it a leading contributor to **sustainable construction** and to the **long-term** environmental performance of buildings of all descriptions. And at the end of a building's life the recovered steel can either be **reused** or **recycled** into new steel products." – Australian Steel Institute (ASI), **www.steel.org.au**.

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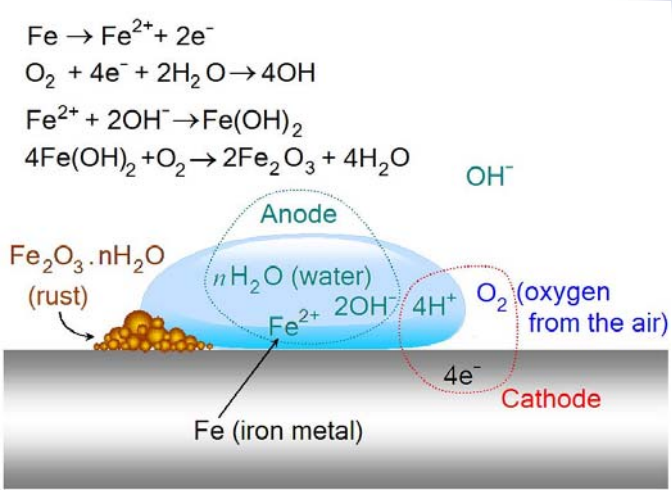
What Is Corrosion?

"The degradation of a material by electro-chemical reaction with its environment"

Why Does Steel Corrode?

Corrosion of steel is an electrochemical reaction that requires the presence of **water** (H_2O), **oxygen** (O_2) and **ions** such as chloride ions (Cl^-), all of which exist in the atmosphere. Atmospheric chloride ions are in greatest abundance anywhere near the coastline. This electrochemical reaction starts when atmospheric oxygen oxidises iron in the presence of water.



In addition, the atmosphere also carries emissions from human activity, such as carbon dioxide (CO_2), carbon monoxide (CO), sulphur dioxide (SO_2), nitrous oxide (NO_2) and many other chemicals.

Also, if **any two dissimilar metals** are in **contact** with each other, the more reactive metal will corrode in preference to the less reactive metal.

How Do We Stop Steel From Corroding?

There are three methods that may be used to protect steel from corrosion.

1. Passive Barrier Protection

Passive barrier protection works by coating the steel with a protective coating system that forms a tight barrier to **oxygen**, **water** and **salts** (ions). The lower the permeability of the coating system to water, the better the protection. Two-pack **epoxy** coatings and **chlorinated rubbers** applied at sufficiently high film builds offer the most successful corrosion protection through passive barrier protection.

2. Active Protection

Active corrosion protection occurs when a primer containing a reactive chemical compound is applied directly to the steel. The reactive compound disrupts the normal formation of anodes on the surface of the steel in some way. For example, inorganic zinc inhibitive pigments, such as **zinc phosphate**, offer active anti-corrosive protection to the steel substrate. Zinc phosphate ($Zn_3(PO_4)_2$) is only slightly soluble in water. It hydrolyses in water to produce zinc ions (Zn^{2+}) and phosphate ions (PO_4^{3-}). The phosphate ions act as **anodic inhibitors** by phosphating the steel and rendering it passive. The zinc ions act as **cathodic inhibitors**.

3. Sacrificial Protection (Cathodic Protection or Galvanic Protection)

The above-mentioned reaction between dissimilar metals can be used to protect steel against corrosion. The most widely used metal for the protection of steel is zinc. Zinc metal in direct contact with the steel substrate offers protection through the **preferential oxidation of zinc metal**. **Zinc** is a great choice in protecting steel, as not only does it **corrode in preference to the steel**, the **RATE** of corrosion is generally lower. This rate, however, is accelerated in the presence of ions such as chlorides in coastal locations.

Examples of coatings using this principle of sacrificial protection include inorganic zinc silicates, organic zinc-rich primers, metal-sprayed zinc, hot dip galvanising and electroplating.

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Which Form of Corrosion Protection is Right For Me?

Dulux Protective Coatings recommends the use of **inorganic zinc silicates** and **zinc-rich epoxy primers**. Please refer to PC Tech Notes 3.8.1 – Inorganic Zinc Silicates, and 3.8.2 – Organic Zinc Rich Primers for further information about how these products work.

Zinc phosphate primers also have their place in protecting steel from corrosion. Please refer to PC Tech Notes 3.10.2 – Duremax GPE Zinc ZP. Contact your Dulux Consultant as to which product is most suitable for your particular needs.

Steps to Protect Steel Against Corrosion

There are **two steps** to achieve corrosion protection of steelwork, namely, **surface preparation** and **coating application**. Correct execution of the surface preparation step is of paramount importance, as maximum performance of the coating system can only be achieved on a uniformly clean and well-profiled surface. The coating system then needs to be maintained.

Surface Preparation

The Australian Standard 1627 Series gives guidance on the selection of the appropriate methods for the preparation and pre-treatment of metal surfaces prior to the application of a protective coating.

AS1627.1 describes the procedure for removing oil, grease and related contamination. AS1627.4 describes the procedure for abrasive blast cleaning. For more details on our recommendations, please refer to Dulux Protective Coatings Tech Note 1.1.2 Mild Steel – Preparation and Painting.

Coating System

The type of coating system you choose largely depends on what environment your steelwork will be exposed to, and how you want the steel to look.

The more corrosive the environment, the greater the corrosion protection required. Protection is offered by a coating system comprising a combination of a suitable zinc-rich primer, an intermediate coating to offer additional film thickness and protection, and a finish that offer appropriate aesthetics and protection against UV rays, rain and other environmental conditions.

The **Australian Standard AS/NZS 2312:2002**, "**Guide to the protection of structural steel against atmospheric corrosion by the use of protective coatings**" offers a comprehensive guide to coating systems based on environment and topcoat type. Alternatively, **Dulux Protective Coatings** offers a project-specific specification writing service for you, which can save you considerable time and money.

Maintenance

Just as one is expected to maintain the paint finish on their car by regularly washing and occasionally polishing it, and repairing any mechanical damage or "wear and tear" using qualified auto refinish repair shops, structural steel requires maintenance to ensure that the coating system is kept in good condition to continue to protect the steelwork from premature degradation.

Regular maintenance scheduling must be carried out to identify and repair any problem areas to ensure that the coating system continues to offer corrosion protection and provide aesthetic appeal.

For more information, please contact the Dulux Protective Coatings Technical Consultant in your state.