Inorganic Zinc Silicates 3.8.1

What Are Inorganic Zinc Silicates?

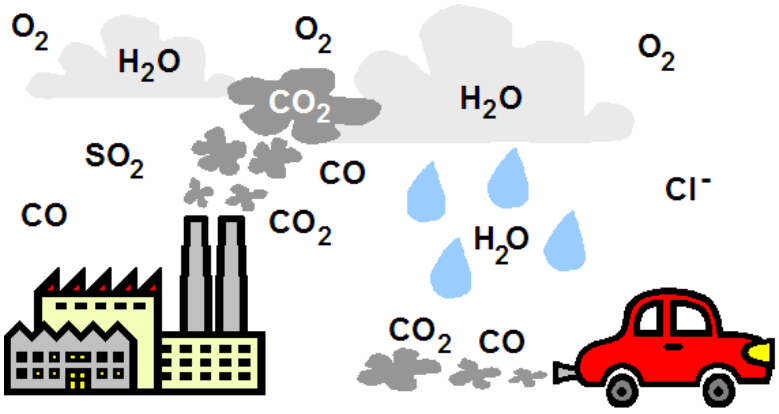
Inorganic zinc silicates are coatings comprising metallic zinc held in a glassy silicate matrix. The zinc metal provides galvanic corrosion protection to the mild steel substrate, whilst the porosity of the coating provides voids that contribute to ongoing protection to the mild steel.

Compared with hot dip galvanising, inorganic zinc silicates provide superior galvanic corrosion protection to steelwork, particularly in corrosive coastal environments. To understand how Inorganic Zinc silicates work and why they offer superior corrosion protection, particularly in coastal environs, you need to understand some environmental corrosion chemistry. Here's how it works.

Environmental Corrosion Chemistry

Corrosion of metals, such as steel and zinc, requires the presence of **water** (H_2O), **oxygen** (O_2) and **ions** such as chloride ions (Cl^-), all of which exist on the atmosphere. Atmospheric chloride ions are in greatest abundance anywhere near the coastline.

In addition to these, 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.



Mechanism:

CO_2 acts as a **weak acid** thus:

$H_2O + CO_2 \rightarrow H_2CO_3$ (Carbonic Acid)

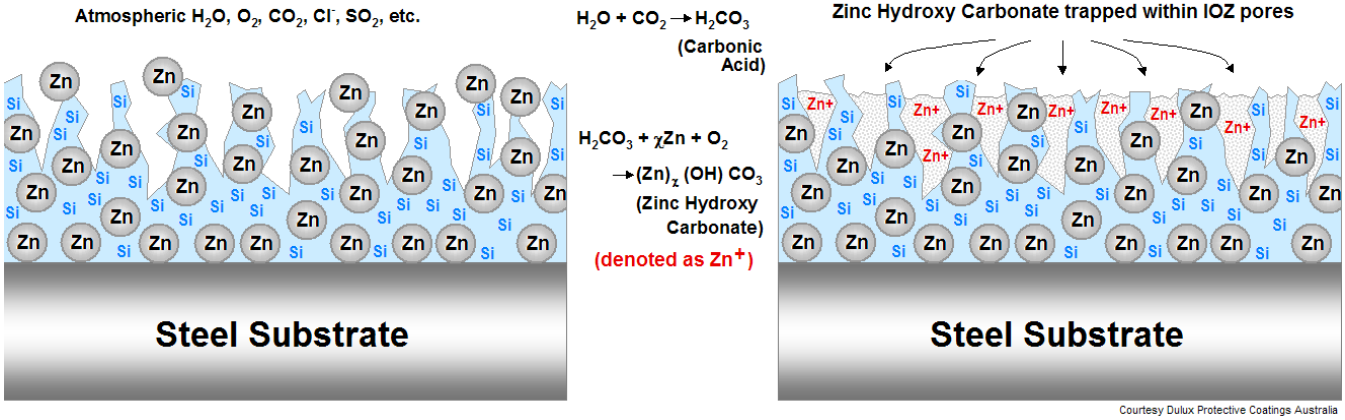
The carbonic acid then reacts with the **zinc metal** on the surface of the IOZ matrix:

H_2CO_3 (Carbonic Acid) + χ**Zn** + $O_2 \rightarrow$

$(\mathbf{Zn})_\chi (OH)\ CO_3$
(**zinc hydroxy carbonate** - **insoluble**)

The insoluble and inert **zinc hydroxy carbonate** product then gets **locked** into the surface pores of the IOZ, creating an **effective barrier** to further oxidation. The zinc hydroxy carbonate is symbolised as Zn^+ in figure 2 below.

DIAGRAM OF ZINC BEHAVIOUR IN INORGANIC ZINC SILICATES



Courtesy Dulux Protective Coatings Australia

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If the steelwork is coated, then the zinc hydroxy carbonate barrier **greatly prolongs** the life of the coating system by providing **stability** in the substrate. This longevity is not provided by the zinc metal, but by the **pores** and the stable **zinc hydroxy carbonate particles** locked within.

HDG and electrolytically applied zinc do **not** have this porosity, and therefore cannot produce a barrier with their initial zinc corrosion products. These corrosion products simply delaminate from the surface, so zinc depletion continues at the same rate. Subtle difference in behaviour – big difference in performance, particularly in the case of coated steelwork, where the coating may be pushed off by the increasing volume of zinc corrosion products on the surface of the zinc.

When Should You Use IOZ?

IOZ primers should be used for all steelwork that:

- Is intended for use in **moderate to severe coastal areas**
- Is intended for structures with very **long service lives**, such as buildings, public spaces and infrastructure
- Requires an extremely tough coating, particularly for friction-grip bolting
- Is too large or long to fit in a hot dip galvanizing bath
- Can be properly prepared by abrasive blast cleaning (Refer to Dulux Protective Coatings Tech Note 1.1.2 – Mild Steel Surface Preparation)
- Where long term corrosion performance is required in a single coat

Advantages of IOZ Primers

The advantages of IOZ primers over other forms of galvanic corrosion protection are:

- The cured film is harder and more damage-resistant than HDG steel.
- Highly effective galvanic corrosion protection with more effective use of zinc metal than HDG.
- Waterborne/low VOC technology IOZ is available for projects governed by "green" guidelines.

When Should You Not Use IOZ?

Good surface preparation of steelwork is absolutely essential for the IOZ primer to perform as designed. IOZ is **not appropriate** for steel that:

Cannot be abrasive blast cleaned, such as thin-gauge steel or tubular steel, as the surface profile of the steel must be sufficient to provide a good mechanical key for the coating to adhere to.

Cannot be prepared and coated in shop under controlled atmospheric conditions.

Is limited to brush or roller application, and therefore **cannot be applied by spray**.

Is to be exposed to **acidic** and **certain chemical environments**. (Consult Dulux Protective Coatings)

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IOZ is not suitable for touch-up of damaged hot-dip galvanised steel, whereas an organic zinc-rich primer such as **Dulux® Metalshield® Cold Galv Primer** is. (Tech Note 3.8.2 – Organic Zinc Rich Primers)

IOZ may be somewhat of an "over-specification" if the structure to be coated is only temporary (for example, constructed for a special event), and may be adequately protected from corrosion by a fast cure, single-pack zinc phosphate primer. Having said that, however, many such structures have in fact become permanent (such as the Eiffel Tower in France)!

Disadvantages of IOZ Primers

- Certain coating types, such as alkyd enamels, cannot be applied directly over IOZ coatings (although this can easily be rectified by changing the coating to another resin type).
- Higher applicator skill is required to spray IOZ than some other types of anticorrosive primers.
- Longer cure time and overcoat time compared with other types of anticorrosive primers. Typically IOZ's take 24 hours to cure for recoat; other paint chemistries operate on faster recoat times.
- Curing of IOZ's typically rely on the weather conditions. Products like Zincanode® 304 and Zincgalv® 75 require humidity to cure, while Aquagalv® will cure below 50% relative humidity.
- Must be applied between the minimum and maximum recommended dry film builds; less and the dry film will not fulfill AS2312 requirements and may compromise corrosion protection. Greater than the maximum recommended dry film build may cause mud-cracking and/or delayed curing.

Current IOZ Products

Dulux Protective Coatings currently manufactures three inorganic zinc silicates:

- **ZINCANODE® 304** (as used at the Edith Cowan University WA)
- **ZINCGALV® 75**
- **AQUAGALV®**

AQUAGALV® is a **second-generation water-borne** inorganic zinc silicate, and has a **total VOC content** less than **10 grams per litre**.

Further Reading

For a comparison of the processes of applying HDG and applying IOZ, particularly from an ESD point of view, please refer to Tech Note **2.3.4 - ESD and Corrosion Protection**.

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