HDG DATASHEET: 1
Corrosion Protection Using Zinc

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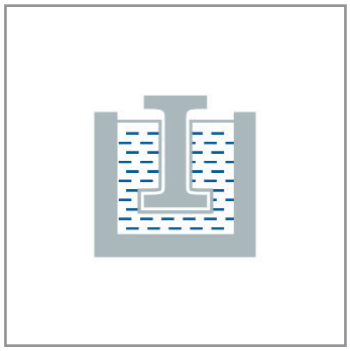
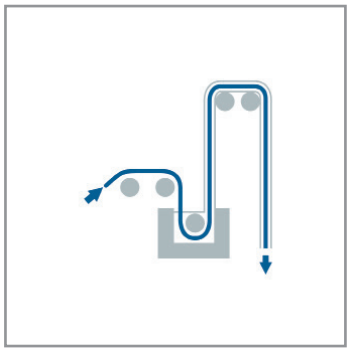
The various processes for protecting steel from corrosion using zinc and their characteristics



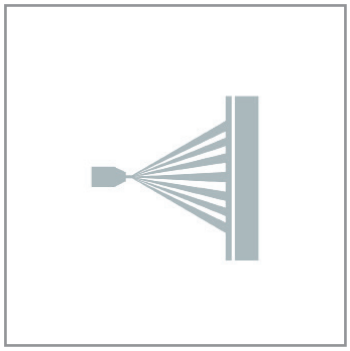
Batch Hot Dip Galvanizing (General Galvanizing)

A batch process in which prepared steel is immersed in molten zinc at around 450°C (galvanizing of fabricated articles in accordance with EN ISO 1461). A metallurgically bonded coating of zinc-iron alloy layers is formed with an outer layer of pure zinc. A typical coating thickness is 45-85 µm but thicker coatings can be produced on structural steelwork by grit blasting the steel prior to galvanizing. A coating thickness of up to 140 µm may then be specified. Use of a high silicon steel enables a still thicker coating of 200 µm to be specified. Hot dip galvanized coatings are simply specified, reproducible and easy to inspect: if the coating looks continuous and sound, it is so. The thickness can easily be checked without damaging the coating.



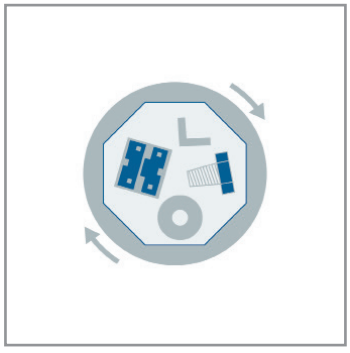
Continuous Galvanizing

The continuous hot dip galvanizing of steel strip (EN 10346), wire (EN 10244-2) and tube (EN 10240) involves passing the steelwork through molten zinc in an automated or semi-automated plant. Although alloyed with the base steel, the coating is generally much thinner than batch galvanizing (typically 7-42 µm on sheet, 5-30 µm on wire and 25-55 µm on tube) and is predominantly a zinc layer on the base steel. The hot dip galvanized sheet may be formed into a finished item as part of the production process.



Thermal Zinc Spraying

Grit blasted steel surfaces are coated with droplets of semi-molten zinc sprayed from a special gun fed by either zinc wire or powder (EN ISO 2063). The coatings aren't alloyed with the base steel and while the coating can be built-up to the required thickness (typically 50-150 µm) they are always slightly porous, which may require an organic sealant to be applied. The coating is always sensitive to shortcomings in the preparation of the steel and require a level of skill in their application, however they can not normally be applied to the inside of tubes and hollow sections.



Metallic Coating with Zinc Dust (Sherardizing)

A process by which suitably prepared small components are tumbled in zinc dust at an elevated temperature below the melting point of zinc under appropriate conditions to develop a coating (see EN 1SO 17668). Coatings are relatively thin (typically 15-30 µm) but are metallurgically bonded to the base steel and closely follow the contour of the steel parts.

Zinc Mechanical Plating

A process similar to sherardizing but conducted at a lower temperature (EN ISO 12683) whereby components are tumbled with zinc dust which is impacted on to the steel surface by glass beads to form a coating which is typically 5-25 µm in thickness.

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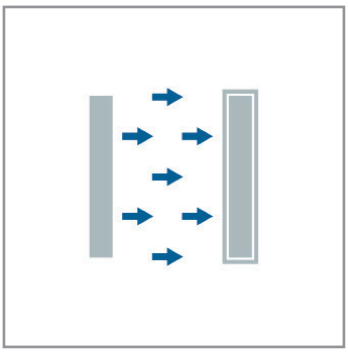
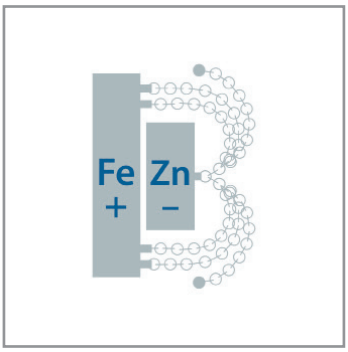
Zinc-Rich Painting

Process in which clean steel surfaces are coated using paints containing a high proportion of metallic zinc dust particles to develop a film which can conduct electricity. The formulation and application of the paint needs careful control for satisfactory performance. Paint films are comprised of zinc particles or flakes in an epoxy carrier and may be sensitive to poor surface treatment. Coating thicknesses may vary significantly from 10-120 µm.



Zinc Electro-Plating

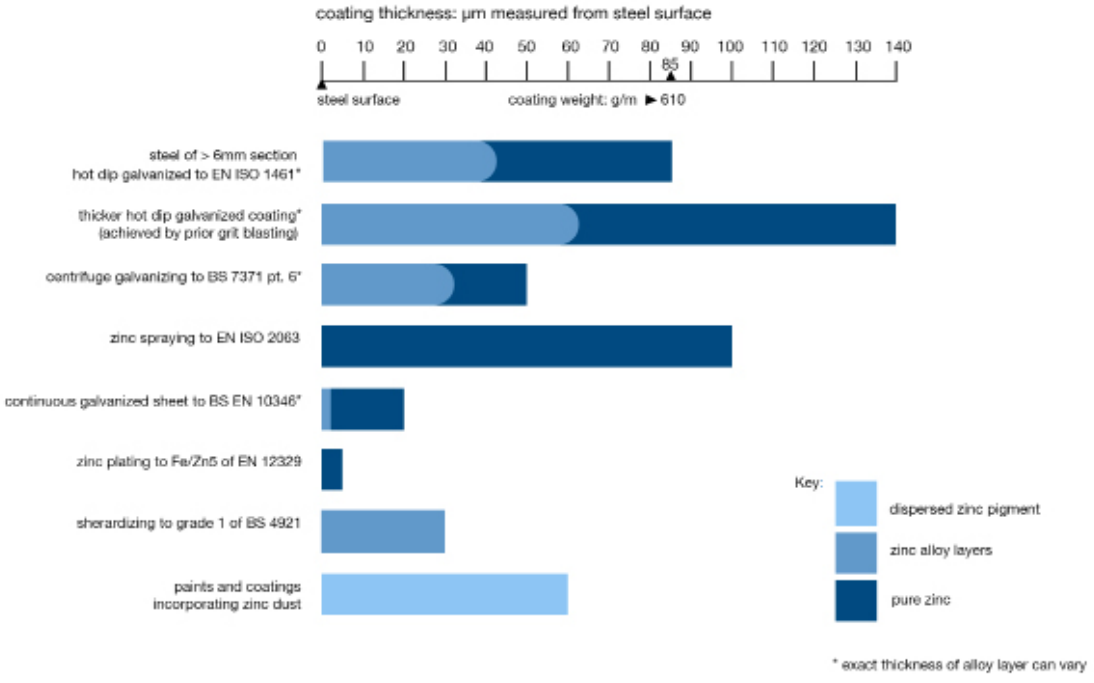
A zinc salt solution is used to electrolytically deposit a layer of zinc on a cleaned steel surface. Acid or alkaline electrolytes (some may contain cyanide) can be used (EN ISO 2081). Only very thin coatings are feasible (typically <12 µm), the coating being uniform but the process only being appropriate for small components (nuts, bolts and small bracketry).



Cathodic Protection

A method of corrosion protection for steelwork which is immersed in water or buried in soil, in which a zinc anode is connected to the steel component in the presence of an electrolyte. Specification of anodes are covered by ASTM B418 and the rate of anode consumption will depend strongly upon the service environment.

For a given environment, the life of a zinc coating is directly proportional to its thickness. Although zinc coatings can be applied by several different processes, only hot dip galvanizing provides a continuous, tough, metallurgically bonded coating of substantial thickness on internal and external surfaces. The bar chart below shows how widely the thicknesses of zinc coatings can vary and emphasises the need to be aware of those which may not give the lifetime and performance required. It is also important to ensure that all parts of a steel structure have equivalent protection, since premature failure of the coating on small parts (e.g. fasteners) can result in major structures requiring maintenance long before it would otherwise be necessary.



Note: Hot dip galvanized coatings are sometimes defined by weight of zinc per unit area. For instance, an 85 µm coating is equivalent to 610g/m². It is important to remember that when coating weights are specified for steel sheet, the weights include both sides of the sheet so that the life of the coating is half that for the equivalent coating weight specified in EN 10346.

Characteristics of different zinc coating systems

PROCESS	Normal coating thickness µm*	Alloying with the base	Composition of the coating	Processing method	After treatment	
					Normal	Possible
Hot Dip Galvanizing a) general galvanizing of iron and steel articles EN ISO 1461	45 - 140	yes	Zinc-iron alloy layers on base steel usually covered with an outer layer of pure zinc	Dipping in molten zinc		Passivation/ overcoating
b) continuous hot dip galvanizing - steel strip EN 10346	7 - 42	yes	Predominantly zinc layers on base steel	Passing through molten zinc		Oiling, phosphating and passivation
- galvanizing wire EN 10244-2	5 - 30	yes				Overcoating
- tubes EN 10240	25 - 55	yes				Overcoating
Thermal spraying - EN ISO 2063	50 - 150	no	Porous zinc coating on prepared steel surface	Spraying of molten zinc	Sealing of porous coating	Overcoating
Zinc plating (electrogalvanizing) - individual articles EN ISO 2081	5 - 25	no	Pure zinc or zinc alloy coating	Zinc deposition by electrical current in aqueous electrolyte	Passivation	Overcoating
- continuous process EN 10152	2.5 - 5	no	Pure zinc coating			
Metallic coatings With zinc dust a) Sherardizing EN ISO 17668	15 - 30	yes	Zinc-iron alloy coating	Diffusion of zinc onto steel below the melting point of zinc		Overcoating
b) Mechanical plating EN ISO 12683	10 - 20	no	Homogenous zinc coating possibly on intermediate layers of copper	Impacting of zinc powder by glass balls	Partial chromate treatment	Overcoating
Painting BS 4652 - Thin coat	10 - 20	no	Zinc dust pigment usually in an epoxy carrier	Deposit by brushing, rolling, spraying, or dipping	Top coating compatible with primary coating	
- Normal coat	40 - 80					
- Thick coat	60 - 120					
Protection	High purity zinc anodes (99.995%) can be used to sacrificially protect iron and steel structures that are immersed or in a buried environment. If the zinc anode is to function efficiently it is vital that it is always in good contact with the steel that it is protecting. The rate at which zinc anodes are consumed in sea water is about 12kg/ampere-year. On bare steel the average current density is about 0.10A/m^2. Therefore, to protect 100m^2 of bare steel requires approximately 120kg/year of zinc anodes.					

* Typical values

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