

Reliability of coatings for steel

Protective coatings for steel are normally compared on the basis of coating life, first cost, and total long term cost. The 'reliability factor' of a coating should also be taken into account since it is crucial in determining the extent to which the apparent properties of a coating will be realised in practice, and hence the relative economics of the coating.

The reliability factor of a coating may be defined as the extent to which its optimum complex of physical-chemical and mechanical characteristics can be consistently realised during and after application.

There are numerous paint systems for steel and a wide range of possible specification and application variables. Together

these variables can substantially reduce the performance of a given system and therefore its economics. By contrast, the galvanizing process is simple, standardised and virtually self-controlling, governed mainly by the laws of metallurgy. As a result it is inherently reliable and predictable.

The table below summarises factors determining the reliability of typical paint systems for steel, and for galvanizing. The reliability factor for galvanizing is shown to be superior, mainly because it is not influenced by most of the variables which can reduce the ultimate performance of typical paint systems.

A more detailed evaluation of these factors is contained in the paper 'Reliability of hot dip galvanizing, compared with two paint systems and a duplex system' by Ing JFH van Eijnsbergen, available from Galvanizers Association of Australia.

Factors determining protective coating system reliability

An analysis of variables which determine the extent to which apparent properties of a coating system will be realised in practice. Draws on data from Australian Standard 2312 'Guide to the protection of iron and steel against exterior atmospheric corrosion'.

Variable	Paint systems – inorganic zinc, organic zinc, chlorinated rubber etc.	Galvanizing
Nature of steel	No effect	High silicon steels may increase coating thickness by 2 to 3 times, give rough surface finish, may result in brittle coatings.
Surface preparation	AS 2312 recommends abrasive blast cleaning or acid cleaning, rather than flame cleaning or wire brushing. Inadequate grit blasting can reduce paint durability 60 to 80%. Inadequate degreasing and rinsing can reduce life by a factor of 4. Inspection procedures are critical.	Degreasing, acid cleaning and rinsing are part of the galvanizing process. The steel surface must be properly prepared, otherwise no coating will form.
Process variables	Accurate formulation, careful mixing, continued agitation, correct thinning can be critical.	The minor variations possible in the galvanizing process have minimal effect on coating integrity.
Application	Coating build and uniformity variable with method of application, eg. spray, airless spray, brush or roller. Inspection at each stage is critical. Highly reactive blast-cleaned surfaces must be painted within hours.	Formation of coating during immersion is automatic, governed by laws of metallurgy.
Application conditions:		
1. Temperature	Satisfactory results may be difficult to achieve below air temperatures of 15°C or above 30°C.	Process not affected
2. Humidity	Dew and surface condensation prevent painting. Painting should not proceed when relative humidity exceeds 85%.	Process not affected.
3. Air quality	The presence of steam, fumes, exhaust gases, dust and grit are detrimental to good painting.	Process not affected.
4. Hot surfaces	High steel surface temperatures (eg painting in the sun) may interfere with paint application and curing.	Not applicable.
5. Uniformity of application	Paint film thins out at sharp corners and edges. Bolt holes generally not protected. Paint may not penetrate narrow gaps. Shadowed areas may receive less paint build.	Total coverage obtained by submersion of article in molten zinc. Coating is usually 50% thicker on sharp corners and edges.
Coating thickness	Critical to coating performance. Variable with number of coats and application method. Inspection and checking necessary at each stage.	Reaction between molten zinc and steel surface guarantees a standard minimum coating thickness. Mass and thickness of steel influences coating thickness (thicker steel = thicker zinc).
Coating adhesion	Depends on surface preparation, paint system type, time from surface preparation to first coat, curing time between coats.	Law of metallurgy; coating is bonded metallurgically to base steel.
Inspection	Imperative after surface preparation and at every coating stage to ensure quality. Thickness testing required.	Normally visual inspection and magnetic thickness testing after completion.
Curing time	Ranges from hours to days for safe handling, depending on paint system and application conditions, and up to several weeks to full coating hardness.	Coating is completely solidified within seconds of withdrawal from galvanizing bath.
Dimensional stability	Not affected.	Process may relieve locked-in stresses if incorrect design, fabrication and welding techniques are used.
Transport and erection damage	Possible damage in handling and transport.	Unlikely. Coating is tough and abrasion resistant. Delta alloy layer of coating is harder than base steel.
Welding damage	Extent of damage dependant on coating system. May require full surface preparation.	Localised damage may need repair. Restoration with organic zinc rich paint is general practice.