Compatibility of galvanized coatings with various media

Compatibility of galvanized coatings with various media is summarised in the table below. Further specific information is available from Galvanizers Association of Australia.

Aerosol propellants		excellent
Acid solutions	weak, cold quiescent strong	fair not recommended
Alcohols	anhydrous water mixtures beverages	good not recommended not recommended
Alkaline solutions	up to pH 12.5 strong	fair not recommended
Carbon tetrachloride		excellent
Cleaning solvents	chlorofluorocarbon	excellent
Detergents	inhibited	good
Diesel oil	sulphur free	excellent
Fuel oil	sulphur free	excellent
Gas*	towns, natural, propane, butane	excellent
Glycerine		excellent
Inks	printing aqueous writing	excellent not recommended
Insecticides	dry in solution	excellent not recommended
Lubricants	mineral, acid free organic	excellent not recommended
Paraffin		excellent
Perchlorethylene		excellent
Refrigerants	chlorofluorocarbon	excellent
Sewage		excellent
Soaps		good
Timber preservatives: Copper-chromium-arsenic, freshly treated After drying is completed Boron		 poor excellent excellent
Trichlorethylene		excellent

*Chromate passivation is recommended because moisture may be present.

Sewage treatment

Galvanized coatings perform extremely well by comparison with other protective coatings for steel in the severely corrosive conditions prevailing in most sewage treatment operations. As a result galvanized steel is used extensively in sewage treatment plants throughout the world.

In contact with building materials

Galvanized coatings give invaluable protection to steel used in all sections of the building industry. The slight etching action upon galvanizing by mortar, concrete and plaster ceases after setting.

When galvanized steel products and fasteners are installed in direct contact with unseasoned timber it may be necessary to protect them by the application of a suitable paint.

Care should be taken that galvanized products are stored and transported under dry ventilated conditions as discussed above right.

In contact with timber preservatives

Timbers freshly treated with acidic preservatives of copper-chromium-arsenic type, such as Celcure, Copas and Tanalith, can be severely corrosive to metallic building materials, including galvanized coatings. Once the timber has dried out the preservatives become fixed, and the performance of galvanized coatings in contact is excellent, even when the timber is again wetted. Galvanized coatings also perform well in contact with boron-treated timbers.

Transport and storage

New galvanized products should be handled, transported and stored with the normal care given to any other surface-finished building material. New galvanized steel surfaces which have not yet developed the patina of protective insoluble basic zinc carbonates which normally contributes to the long life of aged coatings are highly reactive and susceptible to premature corrosion under poor conditions of exposure.

Transport should be under dry, well ventilated conditions. When stored on site, material should be covered where possible and raised clear of the ground on dunnage or spacers. When shelter is not possible material should be stacked to allow drainage of rainwater. Storage in contact with cinders, clinkers, unseasoned timber, mud or clay will lead to surface staining and in severe cases, premature corrosion.

Clearance for ventilation between stacked galvanized products is necessary under damp or humid conditions to avoid the possibility of wet storage stain and the development of bulky white corrosion product. Attack on the galvanized coating producing white corrosion is caused by the retention of condensation or run-off water between contacting surfaces under conditions of restricted air circulation. The attack is frequently superficial despite the relative bulkiness of the corrosion product but may be objectionable because of appearance. In severe cases corrosion product should be removed as described on page 44 to allow the natural formation of protective basic zinc carbonate film.

Where galvanized products are likely to be stored or transported under poor conditions the galvanizer can, on request, apply a simple chromate treatment which will minimise wet storage stain. Under severe conditions chromating should not be relied on and new galvanized products should be packed carefully and protected for shipment and storage.

Continuously galvanized sheet steel products designed for outdoor exposure are normally given a carefully controlled chromate treatment during manufacture. This treatment provides excellent resistance to wet storage staining and against early dulling during initial outdoor exposure. Care should nevertheless be taken to see that sheet and coil is kept dry while awaiting fabrication or erection.

Galvanic corrosion

Galvanic or electrolytic corrosion with resulting rapid consumption of the zinc coating is likely if a galvanized article is installed in contact with brass or copper, particularly in a moist environment. Contact between aluminium or cadmium and galvanized surfaces is normally satisfactory.

Galvanic corrosion occurs for the same electrochemical reasons as those by which zinc provides cathodic protection for steel as explained on page 10, but the rate of consumption of zinc coatings by galvanic corrosion may be extremely high.

A guide to compatibility of metals and alloys in contact is given opposite.

Galvanized surfaces in contact

For maximum corrosion resistance under conditions of extreme humidity, overlapping galvanized surfaces should be isolated from each other by the application of an inhibitive jointing compound such as Dulux Foster C1 Mastic or equivalent. Alternatively a suitable paint may be used. Galvanized surfaces in contact with other materials may also require isolation.

Galvanized members in contact with aluminium conductors may require the use of an electrical conducting compound such as Denso Densal Electrical Jointing Compound or equivalent at joint faces to repel moisture and inhibit corrosion. Galvanizers Association of Australia can make recommendations.

Copper and copper alloys

Galvanic corrosion requires electrical contact in the presence of an electrolyte and cannot occur in the absence of these factors. However run-off water from copper surfaces frequently contains small quantities of dissolved copper, sufficient to cause attack and rapid deterioration of zinc coatings through chemical deposition of copper.

Where use of copper or brass together with galvanized steel in the presence of an electrolyte cannot be avoided, precautions should be taken to prevent electrical contact between the dissimilar metals. Joint faces should be insulated using non-conducting gaskets or mastics and connections should be made with insulating grommet-type

Galvanic corrosion of galvanized coatings in contact with other metals

	Environment				
	Atmospheric exposure			Immersed	
Contacting metal	Rural	Industrial/urban	Marine	Fresh water	Sea-water
Aluminum and aluminum alloys	0	0 to 1	0 to 1	1	1 to 2
Aluminum bronzes and silicon bronzes	0 to 1	1	1 to 2	1 to 2	2 to 3
Brasses including high tensile (HT) brass (manganese bronze)	0 to 1	1	0 to 2	1 to 2	2 to 3
Cadmium	0	0	0	0	0
Cast irons	0 to 1	1	1 to 2	1 to 2	2 to 3
Cast iron (austenitic)	0 to 1	1	1 to 2	1 to 2	1 to 3
Chromium	0 to 1	1 to 2	1 to 2	1 to 2	2 to 3
Copper	0 to 1	1 to 2	1 to 2	1 to 2	2 to 3
Cupro-nickels	0 to 1	0 to 1	1 to 2	1 to 2	2 to 3
Gold	(0 to 1)	(1 to 2)	(1 to 2)	(1 to 2)	(2 to 3)
Gunmetals, phosphor bronzes and tin bronzes	0 to 1	1	1 to 2	1 to 2	2 to 3
Lead	0	0 to 1	0 to 1	0 to 2	(0 to 2)
Magnesium and magnesium alloys	0	0	0	0	0
Nickel	0 to 1	1	1 to 2	1 to 2	2 to 3
Nickel copper alloys	0 to 1	1	1 to 2	1 to 2	2 to 3
Nickel-chromium-iron alloys	(0 to 1)	(1)	(1 to 2)	(1 to 2)	(1 to 3)
Nickel-chromium-molybdenum alloys	(0 to 1)	(1)	(1 to 2)	(1 to 2)	(1 to 3)
Nickel silvers	0 to 1	1	1 to 2	1 to 2	1 to 3
Platinum	(0 to 1)	(1 to 2)	(1 to 2)	(1 to 2)	(2 to 3)
Rhodium	(0 to 1)	(1 to 2)	(1 to 2)	(1 to 2)	(2 to 3)
Silver	(0 to 1)	(1 to 2)	(1 to 2)	(1 to 2)	(2 to 3)
Solders hard	0 to 1	1	1 to 2	1 to 2	2 to 3
Solders soft	0	0	0	0	0
Stainless steel (austenitic and other grades containing approximately 18% chromium)	0 to 1	0 to 1	0 to 1	0 to 2	1 to 2
Stainless steel (martensitic grades containing approximately 13% chromium)	0 to 1	0 to 1	0 to 1	0 to 2	1 to 2
Steels (carbon and low alloy)	0 to 1	1	1 to 2	1 to 2	1 to 2
Tin	0	0 to 1	1	1	1 to 2
Titanium and titanium alloys	(0 to 1)	(1)	(1 to 2)	(0 to 2)	(1 to 3)

Key 0 Zinc and galvanized steel will suffer either no additional corrosion, or at the most only very slight additional corrosion, usually tolerable in service.
1 Zinc and galvanized steel will suffer slight or moderate additional corrosion which may be tolerable in some circumstances.
2 Zinc and galvanized steel may suffer fairly severe additional corrosion and protective measures will usually be necessary
3 Zinc and galvanized steel may suffer severe additional corrosion and the contact should be avoided.

General notes: Ratings in brackets are based on very limited evidence and hence are less certain than other values shown. The table is in terms of additional corrosion and the symbol 0 should not be taken to imply that the metals in contact need no protection under all conditions of exposure.
Source: British Standards Institution.

fasteners. The design should be arranged so that water flows from the galvanized surface onto the brass or copper surface and not the reverse.

Cathodic protection of damaged areas

Where continuity of a galvanized coating is broken by cut edges, drilled holes or surface damage, small areas of exposed steel are protected from corrosion cathodically by the surrounding coating as discussed on page 10. No touch up is necessary, and cathodic or sacrificial protection continues for many years. In service, zinc corrosion product tends to build up in coating discontinuities, slowing the rate at which the surrounding coating is consumed in protecting a damaged area.

Practical examples of this cathodic protection phenomenon include exposed cut edges in galvanized steel roofing and cladding, and the uncoated internal threads of certain fasteners.

In standard building practice cut edges in galvanized sheet are not treated in any way and when failure of the coating finally occurs after long exposure, corrosion normally is relatively uniform across the sheet surface without concentration at edges or fastener holes. Similarly, the uncoated internal threads of large galvanized nuts are protected from corrosion by the zinc coating on mating bolts and studs.

When substantial coating damage has occurred to a galvanized coating during handling, fabrication or erection, coating repairs are necessary as detailed page 45.

Comparative properties of coatings*

The following tables provide a useful assessment of the properties and characteristics of various coatings for steel in a range of applications and environments.

	Key	Galv-anizing	Paint	Bitumen	Vitreous enamel
Corrosion protection	**(1)**	A	B	B	B
Electrochemical protection	**(1)**	A	D	D	D
Durability in atmosphere	**(1)**	A	B	C	A
Durability in water	**(1)**	B	B	A	A
Adhesion	**(1)**	A	B	B	A
Resistance to damage	**(1)**	A	C	C	D
Resistance to abrasion	**(1)**	A	C	C	A
Size limitations	**(2)**	B	A	A	C
Risk of deformation	**(2)**	B	A	A	B
Inspection possibilities	**(1)**	A	B	B	C
Initial costs	**(3)**	B	B	B	C
Maintenance costs	**(3)**	A	C	B	A

	Key	Galv-anizing	Zinc spraying	Zinc plating	Zinc rich paints	Mech-anical plating
Alloying with base steel	**(1)**	A	D	D	D	D
Durability of coating	**(1)**	A	A	C	C	B
Cathodic protection	**(1)**	A	A	A	C	B
Resistance to mechanical damage	**(1)**	A	B	C	C	C
Resistance to abrasion	**(1)**	A	B	C	C	C
Piece size limitations	**(2)**	B	A	C	A	C
Risk of deformation	**(2)**	B	A	A	A	B
Ease of inspection	**(1)**	A	C	C	C	C
Initial costs	**(3)**	A	B	C	B	B
Maintenance costs	**(3)**	A	A	D	B	C
Suitability for painting	**(1)**	B	B	B	B	B

Key	**(1)**	**(2)**	**(3)**
	A Very good	A None	A Very low
	B Good	B Little	B Low
	C Poor	C High	C High
	D Very poor	D Very high	D Very high

*R. Thomas, 1980 (modified).

Galvanized coatings for buildings and structural steel

A vital factor to be taken into account in the assessment of coating systems for buildings and structural steel is the relative effectiveness of coatings. No protective coating applied to a structure after completion can provide the same protection as a galvanized coating which covers the entire surface of all components, automatically protecting areas to which later access may be difficult or impossible.

When steel members, fascias and other components which are to receive a final decorative or protective coating are galvanized, no surface deterioration will occur during storage, handling, erection or waiting time until completion of the project. Galvanized coatings can save considerable time and cost which might otherwise be necessary for rectification of damaged or corroded surfaces.

Exposed frame structures. Open frame industrial steel structures which are not protected by roofing or cladding are particularly vulnerable to corrosion. Normally they are sited in industrial areas and frequently, maintenance access is difficult.

In these circumstances no other coating system matches the economy/performance of galvanized coatings. Even in the most severe atmospheres a duplex system of galvanizing-plus-paint will usually provide the best practical balance between cost and the longest possible maintenance-free operating period. The galvanized coating provides a stable base for the paint film, ensuring far longer coating life, and the metallic zinc protects the steel in areas where the paint film may be damaged through impacts or abrasion in service. The synergistic effect gained from the galvanizing-plus-paint combination is discussed on page 65.

Internal steelwork in industrial buildings. Galvanized coatings are ideal for many structures which house industrial processes; in structures where the humidity of contained air is high, as in breweries, paper manufacture and sewage treatment; and in food processing and other areas where cleanliness is essential. Whether used alone or in combination with paint coatings as discussed above, galvanized steel will provide very low total long term cost, with longer maintenance-free service periods.

Galvanized lintels or arch bars

Once rusting begins in a lintel or arch bar, it cannot be stopped. The exposed surface may be repainted but there is no treatment for concealed areas.

The advance of corrosion may continue until the expansion of steel corrosion products causes cracking of brickwork and ultimately, serious structural damage. In the paper ‘Arch bars and angle lintels for brick walls’ Australia’s Department of Housing and Construction Experimental Building Station points out that:

‘Arch bars and angle lintels are vulnerable to corrosion. Cracking of brickwork because of the build-up of rust is very common and is a more serious consequence of corrosion than is the deterioration of the lintel itself. However, hot-dip galvanizing (zinc coating) is so readily available that it could well be adopted as standard practice for all arch bars...’

Australia’s Model Uniform Building Code Section 47-7 discusses suitable corrosion protection for lintels as being ‘... not less effective than galvanizing’. Galvanizing provides practical, economic protection for lintels in all external applications and is particularly valuable near the sea coast.

Galvanized lintels are widely available in stock lengths and sections coded to user needs.