Selecting the right enclosure material

Enclosure material selection is always a complex question to answer as it depends on so many things. Who hasn't bought a cheaper product and found, to their dismay that it didn't last. The worst is that you cannot simply look at a product and see the quality behind its first impressions. Additionally with the growing importance of global warming and environmental issues the old 'throw-away' idea is starting to be questioned.

Selecting the right material can be confusing with enclosures available in a variety of materials including plastic, steel, aluminium or stainless steel and varying thicknesses and grades.

To help you select the right enclosure material we have created the below guide.

Selection Guide

One of the most influential factors in selecting enclosure material is the location of enclosure, the options below will point you in the direction of the appropriate material.

Location, Location, Location

What is the installation location of your enclosure?

Indoor location with no gas, chemical contaminants or fine dust present:

Generally any enclosure material would be suitable, an enclosure choice would be based more on the type of equipment going inside and the IP rating (protection from dust and water ingress) rather than the material used. Based on cost the most appropriate material would be plastic or zinc coated steel. For more information on plastic see page 2, for more information on zinc coated steel see page 3.

Indoor or Outdoor location with gas, chemical contaminants or fine dust:

If the location is exposed to gas or other chemical containments 316 Stainless Steel is generally suitable. However chemicals can react differently to various materials, if you know the chemical the enclosure will be exposed to view our chemical resistance table located on the last page of this guide for specific chemical suitability. If the enclosure is exposed to fine dust, 316 Stainless Steel would be the most suitable option to avoid possible corrosion.
If the area is classified as hazardous, (potentially explosive atmosphere) an explosion proof or flame proof enclosure may be required. These are typically made from high grade stainless steel but you will need to ensure the enclosure is certified for hazardous areas. For more information on stainless steel see page 5, for information on other materials please see relevant sections below.

Outdoor location (non coastal) with no gas, chemical contaminants or fine dust:

Aluminium or zinc coated steel enclosure could be suitable. Please see aluminium section on page 4 and zinc coated steel section on page 3 for more information. Plastic enclosures can also be used in an outdoor environment although there is often a staining in the plastic due to UV exposure. This can also affect the life of the enclosure.

Coastal Outdoor location with high salt deposition:

The use of metal enclosures along the Australian coast is common, but frequently incorrect materials selected on price, fail due to corrosion. Typically the corrosion is caused by chloride attack from salt water. This can dramatically affect mild steel, and even lower grade stainless enclosures. Generally 316 stainless steel is the most suitable for coastal areas but this will be dependent on the salt deposition of a particular area. AS2699.1 specifies that stainless steel should be used for structures in areas where there is salt deposition of over 60mg/m2/day. Aluminium also offers a high degree of corrosion resistance. For more information on how to check the salt deposition in your area see stainless steel section on page 5, for more information on aluminium see page 4.

Outdoor location with high salt deposition (non coastal):

These areas are subject to a high risk of corrosion which can dramatically affect mild steel, and even lower grade stainless enclosures. Generally 316 Stainless Steel would be recommended for these areas. AS2699.1 specifies that stainless steel should be used for structures in areas where there is salt deposition of over 60mg/m2/day. Aluminium also offers a high degree of corrosion resistance. For more information on how to check the salt deposition in your area see stainless steel section on page 5, for more information on aluminium see page 4.

Material Overview

Plastic

Plastic enclosures are generally made from Polyester, Polycarbonate and Noryl materials. Noryl won't dissipate harmful gases in the event of fire. Compared to other plastics Polyester enclosures will perform best in outdoor environments. There are some chemicals that react negatively to metals where plastic enclosures are more suitable. To find out which chemicals are most suited to plastic enclosures see the chemical resistance table on the last page of this guide.

Benefits

- Cost-effective
- Variety of styles available for ease of use

Applications

- Cable terminations in domestic, commercial and light industrial industries
- Commonly used in chemical environments like chlorine affected areas

Zinc Coated Steel

Iron ore is today, the most widely used and mined mineral. Arguably there is no one in the world today that doesn't benefit from steel, the major product manufactured from iron. Size for size steel is the most economical structural material available, being some 25 times stronger than plastic. Steel is used throughout industry to support almost every structure.

Unfortunately steel has a tendency to corrode prolifically if left to its own devices. Fortunately science has found something of an answer in applying a layer of Zinc to the steel, which reduces the extent to which it rusts. The zinc acts as a sacrificial anode and protects the steel from corroding; - the thicker the layer of zinc the better the protection ability. Australia has some of the harshest environmental conditions in the world and therefore B&R only make steel enclosures from zinc plated steel. This ensures the best protection possible and gives a very cost-effective solution to many applications. B&R also powdercoat paint most of their enclosures which brings additional corrosion protection and a better aesthetic aspect.

Benefits

- Zinc coating on steel affords the steel protection for many years, with known examples of enclosures being almost 30 years old and still going strong
- Very structurally strong
- For heavier duty applications such as mining a thicker grade of steel can be used to further improve structural integrity

Applications

- Domestic metering enclosures.
- Industrial automation.
- External and internal switchboards for shopping centres and multi-residential high rise buildings.
- Mining applications that require a robust construction in areas not affected by corrosion.
- Road side cabinets for traffic control
- Data racking equipment in data centres.

Aluminium

When corrosion becomes a concern aluminium can be considered in place of steel. Although aluminium is not as structurally strong as steel it can be compensated for by using a thicker grade of aluminium. Aluminium oxide is a whitish layer that forms on the surface and which has the effect of preventing oxygen from interacting with the internal aluminium and stopping corrosion. Also aluminium is non-ferrous (not magnetic) and therefore does not suffer from eddy-current build up.

Although aluminium is good against corrosion it is not as strong as steel due to its lower density. This also means that aluminium is much lighter than steel which can bring additional benefits. It must be said however that aluminium is somewhat more expensive than steel and therefore cost efficiency needs to be more closely considered.

Benefits

- The oxide layer on aluminium affords it excellent corrosion resistance
- The light weight of aluminium also makes installation of enclosure a little easier
- No eddy-currents help with enclosures that have high currents flowing through them. This is why very often aluminium gland plates are used.

Applications

- Coastal region applications
- Generally aluminium is not suitable for large/high current main switchboards due to cost and structural strength
- Mining applications that require a degree of corrosion protection, but robust construction not essential
- Road side cabinets for traffic control

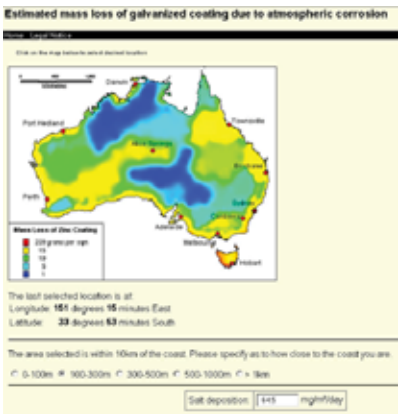
Stainless Steel

According to the Australian Stainless Steel Development Association (ASSDA) “all stainless steels have a high resistance to corrosion. This resistance to attack is due to the naturally occurring chromium-rich oxide film formed on the surface of the steel. Although extremely thin, this invisible, inert film is tightly adherent to the metal and extremely protective in a wide range of corrosive media. The film is rapidly self repairing in the presence of oxygen, and damage by abrasion, cutting or machining is quickly repaired.”

Most suppliers are cagey about recommendations as they are not aware of the particular circumstances of the installation. However there are some good independent guidelines to use. AS2699.1 specifies that stainless steel should be used for structures in areas where there is salt deposition of over 60mg/m2/day.

To find out what the salt deposition rate is in your area probably the best resource is http://www.ingal.com.au/cms.htm the Industrial Galvanisers website. You have to set up a user account, but this gives you access to their database of salt deposition information accessed via a map(see image 1 to the left).

Image 1: salt disposition map



The salt deposition is shown on the map for a particular location. However care should be taken as there can be local effects such as rough seas in a particular area that can add further to the salt deposition. If this is the case it is worth designing on the safe side and picking stainless steel.

As an alternative to this map you can consult ASSDA’s (Australian Stainless Steel Development Association) stainless steel in architecture guide on the web at http://www.imoa.info/_files/stainless_steel_selection_sw.html or http://tinyurl.com/67exv9. This takes you through a more structured approach, but is not so localised, and can require additional information from a manufacturer in particular on surface finish of an enclosure. B&R Enclosures for example manufacture specifically for Australian conditions and finish their 316 stainless steel enclosures to a maximum Ra of 0.4 µm (required in the calculations). Through experience B&R have found that lower grades of stainless steel (such as 304) do not perform well in Australian conditions.

Benefits

- The chromium rich oxide layer film offers excellent corrosion protection
- Structurally stronger than Aluminium
- High aesthetic appeal over a prolonged period

Applications

- Coastal region applications
- All mining applications
- Road side cabinets for traffic control
- Wet areas including food processing, water treatment, dairies and breweries

Note: This paper is for guidance only and does not constitute a definitive recommendation. When looking at the materials you should always take into account particular conditions at the site. The best indication of material requirements is often to look existing metal surfaces to see how they are performing.

Chemical Resistance Table

Decisions on the most appropriate material of construction will depend on various factors. A major consideration is the resistance properties of materials to various chemicals and environments. Other factors such as size, cost and performance must also be weighed to determine the most effective enclosure solution.

Ratings

A **Substantial resistance** – the preferred material of construction
B **Moderate resistance** – satisfactory for use under most conditions; very slight swelling of elastomers
C **Questionable resistance** – use with caution
D **Severe effect** – not recommended for use

	Non-metal			Metal			
Chemical	Noryl	Polyester	Polyurethane	Mild Steel Uncoated	Aluminium	304 Stainless Steel	316 Stainless Steel
Acetic Acid (<20%)	A	A[1]	B	D	B	B	A
Ethyl Alcohol	A[1]	A	D	A	B	A	A
Aluminium Chloride	A	A	-	D	D	D	C[1]
Aluminium Sulphate	A	A[1]	A	D	B[1]	B	B[2]
Brine	A	A	-	D	B	C	C
Carbonic Acid	A[1]	A	-	B[3]	B[1]	A[1]	A
Chlorinated Water (sat.)	C[1]	A	D	D	D	C	C
Chlorine (dry gas)	B[1]	A	D	B	C[1]	-	B
Diesel Oil	A	A	B	B	A[1]	A[1]	A[1]
Ethanol	A[1]	A	C	A	B	A	A
Ferric Chloride	A[2]	A	A	D	D	D	D
Ferric Sulphate	A[2]	A	B	D	B[1]	B	B
Formaldehyde 40%	A	A	C	D	B	A[1]	A
Fuel Oil	B	A	B	B	C[1]	A	A
Hydrochloric Acid (<10%)	A	A	D	D	D	D	D
Hydrogen Sulphide (dry)	-	A	-	B	B	C[1]	A
Lime	-	A	A	B	A	A	A
Lubricating Oils	C[1]	A	A	B	A[2]	A[2]	A[2]
Magnesium Hydroxide	A[2]	-	A	B	C[1]	B	A[1]
Milk	A[2]	-	D	D	A	A	A
Nitric Acid (<20%)	B[2]	C	D	D	D	A	A
Mineral Oil	A[1]	A	A	B	A	A	A
Phosphoric Acid (30%)	A	A	A	D	C	D	C
Sodium Bicarbonate	A	A	A	B	D	A	A
Sodium Hydroxide (20%)	A	A	A	B	D	B	B[2]
Sodium Hypochlorite	A	-	-	-	D	C	C
Sulphur Dioxide	A	A	-	B	B	D	A
Sulphuric Acid (5-10%)	A	A[1]	-	D	D	D	B
Water, Acid, Mine	-	-	-	-	D	B	B
Water, Distilled	A	A[1]	A	B	A	A	A
Water, Fresh	A	A[1]	A	B	B	A	A
Wine	A[2]	-	-	D	C[1]	A	A

1. Ambient only (22°C)
2. Satisfactory to 48°C
3. Air free

Please note that B&R accepts no responsibility for the data contained in this table. As with all corrosion issues it is vital that particular plant and site conditions are taken into account when selecting materials.