Hot-dip galvanization

From Wikipedia, the free encyclopedia
(Redirected from Galvanized steel)

Hot-dip galvanization is a form of galvanisation. It is the process of coating iron, steel or aluminium with a thin zinc layer, by passing the metal through a molten bath of zinc at a temperature of around 860 °F (460 °C). When exposed to the atmosphere, the pure zinc (Zn) reacts with oxygen \((O_2)\) to form zinc oxide \((ZnO)\), which further reacts with carbon dioxide \((CO_2)\) to form zinc carbonate \((ZnCO_3)\), a usually dull grey, fairly strong material that stops further corrosion in many circumstances, protecting the steel below from the elements. Galvanized steel is widely used in applications where rust resistance is needed, and can be identified by the crystallization patterning on the surface (often called a “spangle”).

Galvanized steel can be welded; however, one must exercise caution around the resulting zinc fumes. Galvanized steel is suitable for high-temperature applications of up to 392°F (200°C). The use of
galvanized steel at temperatures above this will result in peeling of the zinc at the intermetallic layer. Electrogalvanized sheet steel is often used in automotive manufacturing to enhance the corrosion performance of exterior body panels; this is, however, a completely different process.

Process

The process of hot-dip galvanizing results in a metallurgical bond between zinc and steel with a series of distinct iron-zinc alloys. The resulting coated steel can be used in much the same way as uncoated.

A typical hot-dip galvanizing line operates as follows:

- Steel is cleaned using a caustic solution. This removes oil/grease, dirt, and paint.
- The caustic cleaning solution is rinsed off.
- The steel is pickled in an acidic solution to remove mill scale.
- The pickling solution is rinsed off.
- A flux, often zinc ammonium chloride is applied to the steel to inhibit oxidation of the cleaned surface upon exposure to air. The flux is allowed to dry on the steel and aids in the process of the liquid zinc wetting and adhering to the steel.
- The steel is dipped into the molten zinc bath and held there until the temperature of the steel equilibrates with that of the bath.
- The steel is cooled in a quench tank to reduce its temperature and inhibit undesirable reactions of the newly-formed coating with the atmosphere.

Lead is often added to the molten zinc bath to improve the fluidity of the bath (thus limiting excess zinc on the dipped product by improved drainage properties), helps prevent floating dross, makes dross recycling easier and protects the kettle from uneven heat distribution from the burners. Lead is either added to primary Z1 Grade Zinc or already contained in used secondary zinc. A third, declining method is to use low Z5 Grade Zinc.

Steel strip can be hot-dip galvanized in a continuous line. Hot-dip galvanized steel strip (also sometimes loosely referred to as galvanized iron) is extensively used for applications requiring the strength of steel combined with the resistance to corrosion of zinc. Applications include: roofing and walling, safety barriers, handrails, consumer appliances and automotive body parts. One common use is in metal nails. Galvanised steel is also used in most heating and cooling duct systems in buildings.

Individual metal articles, such as steel girders or wrought iron gates, can be hot-dip galvanized by a process called batch galvanizing. Other modern techniques have largely replaced hot-dip for these sorts of roles. This includes electrogalvanizing, which deposits the layer of zinc from an aqueous electrolyte by electroplating, forming a thinner and much stronger bond.
History

In 1742, French chemist Paul Jacques Malouin described a method of coating iron by dipping it in molten zinc in a presentation to the French Royal Academy. In 1836, French chemist Stanislas Sorel obtained a patent for a method of coating iron with zinc, after first cleaning it with 9% sulfuric acid (H₂SO₄) and fluxing it with ammonium chloride (NH₄Cl).

Electrogalvanization

From Wikipedia, the free encyclopedia

Electrogalvanization is a galvanization process in which a layer of zinc is bonded to steel in order to protect against corrosion. The process involves electroplating, running a current of electricity through a saline/zinc solution with a zinc anode and steel conductor. Zinc electroplating maintains a dominant position among other electroplating process options, based upon electroplated tonnage per annum. According to the International Zinc Association, more than 5 million tons are used yearly for both Hot Dip Galvanizing and Electroplating.[1] The Plating of Zinc was developed at the beginning of the 20th century. At that time, the electrolyte was cyanide based. A significant innovation occurred in the 60’s, with the introduction of the first acid chloride based electrolyte.[2] The 80’s saw a return to alkaline electrolytes, only this time, without the use of cyanide. Compared to hot dip galvanizing, electroplated zinc offers these significant advantages:

- Lower thickness deposits to achieve comparable performance
- Broader conversion coating availability for increased performance and color options
- Brighter, more aesthetically appealing, deposits

History

Zinc plating was developed and continues to evolve, to meet the most challenging corrosion protection, temperature and wear resistance requirements. Electroplating of zinc was invented in 1800 but the first bright deposits were not obtained until the early 1930s with the alkaline cyanide electrolyte. Much later, in 1966, the use of acid chloride baths improved the brightness even greater. The latest modern development occurred in the 80’s, with the new generation of alkaline, cyanide-free zinc. Recent European Union directives (ELV/RoHS/WEEE)[3] prohibit automotive, other original equipment manufacturers (OEM) and electrical and electronic equipment manufacturers from using hexavalent chromium (CrVI). These directives combined with increased performance requirements by the OEM, has led to an increase in the use of alkaline zinc, zinc alloys and high performance trivalent passivate conversion coatings.
Processes

The corrosion protection afforded by the electrodeposited zinc layer is primarily due to the anodic potential dissolution of zinc versus iron (the substrate in most cases). Zinc acts as a sacrificial anode for protecting the iron (steel). While steel is close to \( E_{\text{SCE}} = -400 \text{ mV} \) (the potential refers to the standard Saturated calomel electrode (SCE), depending on the alloy composition, electroplated zinc is much more anodic with \( E_{\text{SCE}} = -980 \text{ mV} \). Steel is preserved from corrosion by cathodic protection. Conversion coatings (hexavalent chromium (CrVI) or trivalent chrmoim (CrIII) depending upon OEM requirements) are applied to drastically enhance the corrosion protection by building an additional inhibiting layer of Chromium and Zinc hydroxides. These oxide films range in thickness from 10 nm for the thinnest blue/clear passivates to 4 \( \mu \text{m} \) for the thickest black chromates.

Additionally, electroplated zinc articles may receive a topcoat to further enhance corrosion protection and friction performance.[4]

The modern electrolytes are both alkaline and acidic:

[edit] Alkaline electrolytes

[edit] Cyanide electrolytes

Contain sodium cyanide (NaCN) and sodium hydroxide (NaOH). All of them utilize proprietary brightening agents. Zinc is soluble as a cyanide complex \( \text{Na}_2\text{Zn(CN)}_4 \) and as a zincate \( \text{Na}_2\text{Zn(OH)}_4 \). Quality control of such electrolytes requires the regular analysis of Zn, NaOH and NaCN. The ratio of NaCN : Zn can vary between 2 to 3 depending upon the bath temperature and desired deposit brightness level. The following chart illustrates the typical cyanide electrolyte options used to plate at room temperature:

<table>
<thead>
<tr>
<th>Cyanide bath composition</th>
<th>Zinc</th>
<th>Sodium hydroxide</th>
</tr>
</thead>
<tbody>
<tr>
<td>Low cyanide</td>
<td>6-10 g/L (0.8-1.3 oz/gal)</td>
<td>75-90 g/L (10-12 oz/gal)</td>
</tr>
<tr>
<td>Mid cyanide</td>
<td>15-20 g/L (2.0-2.7 oz/gal)</td>
<td>75-90 g/L (10-12 oz/gal)</td>
</tr>
<tr>
<td>High cyanide</td>
<td>25-35 g/L (3.4-4.7 oz/gal)</td>
<td>75-90 g/L (10-12 oz/gal)</td>
</tr>
</tbody>
</table>

[edit] Alkaline non-cyanide electrolytes

Contain zinc and sodium hydroxide. Most of them are brightened by proprietary addition agents similar to those used in cyanide baths. The addition of quaternary amine additives contribute to the improved metal distribution between high and low current density areas. Depending upon the desired performance, the
Electroplater can select the highest zinc content for increased productivity or lower zinc content for a better throwing power (into low current density areas). For ideal metal distribution, Zn metal evolves between 6-14 g/L (0.8-1.9 oz/gal) and NaOH at 120 g/L (16 oz/gal). But for the highest productivity, Zn metal is between 14-25 g/L (1.9-3.4 oz/gal) and NaOH remains at 120 g/L (16 oz/gal).

**Acidic electrolytes**

**High speed electrolytes**

Dedicated to plating at high speed in plants where the shortest plating time is critical (i.e. steel coil or pipe that runs at up to 200 m/min (ft/min). The baths contain zinc sulfate and chloride to the maximum solubility level. Boric acid may be used as a pH buffer and to reduce the burning effect at high current densities. These baths contain very few grain refiners. If one is utilized, it may be sodium saccharine.

**Traditional electrolytes**

Initially based on ammonium chloride, options today include ammonium, potassium or mixed ammonium/potassium electrolytes. The chosen content of zinc depends on the required productivity and part configuration. High zinc improves the bath’s efficiency (plating speed), while lower levels improve the bath’s ability to throw into low current densities. Typically, the Zn metal level varies between 20 and 50 g/L (2.7-6.7 oz/gal). The pH varies between 4.8 and 5.8 units. The following chart illustrates a typical all potassium chloride bath composition:

<table>
<thead>
<tr>
<th>Parameters</th>
<th>Value in g/L (oz/gal)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Zinc</td>
<td>40 g/l (5.4 oz/gal)</td>
</tr>
<tr>
<td>Total chloride</td>
<td>125 g/l (16.8 oz/gal)</td>
</tr>
<tr>
<td>Anhydrous zinc chloride</td>
<td>80 g/l (10.7 oz/gal)</td>
</tr>
<tr>
<td>Potassium chloride</td>
<td>180 g/l (24.1 oz/gal)</td>
</tr>
<tr>
<td>Boric acid</td>
<td>25 g/l (3.4 oz/gal)</td>
</tr>
</tbody>
</table>
Typical grain refiners include low soluble ketones and aldehydes. These brightening agents must be dissolved in alcohol or in hydrotrope. The resultant molecules are co-deposited with the zinc to produce a slightly leveled, very bright deposit. The bright deposit has also been shown to decrease chromate/passivate receptivity, however. The result is a reduction in the corrosion protection afforded.

Business Fields

Initiated by the automotive industry, zinc alloy deposits (i.e. Zn/Co, Zn/Fe, Zn/Ni, Sn/Zn) are applied for all applications where the performance expectations exceed 6 years without a change in appearance, and 12 years without functional corrosion. Alkaline Zn/Ni (12-15% Ni) has a microhardness of 450 HV15 and can replace hard steel components for various equipment manufacturers. Besides automotive, the electrical, building, aerospace and fastener industries utilize zinc and zinc alloy electrodeposited coatings.

Plating

From Wikipedia, the free encyclopedia

For use in cooking, see Food presentation.

For use in microbiology, see Petri dish#Microbiology.

Plating is a surface covering in which a metal is deposited on a conductive surface. Plating has been done for hundreds of years, but it is also critical for modern technology. Plating is used to decorate objects, for corrosion inhibition, to improve solderability, to harden, to improve wearability, to reduce friction, to improve paint adhesion, to alter conductivity, for radiation shielding, and for other purposes. Jewelry typically uses plating to give a silver or gold finish. Thin-film deposition has plated objects as small as an atom (Citation needed), therefore plating finds uses in nanotechnology.

There are several plating methods, and many variations. In one method, a solid surface is covered with a metal sheet, and then heat and pressure are applied to fuse them (a version of this is Sheffield plate). Other plating techniques include vapor deposition under vacuum and sputter deposition. Recently, plating often refers to using liquids. Metallizing refers to coating metal on non-metallic objects.

Electroplating

Main article: Electroplating

In electroplating, an ionic metal is supplied with electrons to form a non-ionic coating on a substrate. A common system involves a chemical solution with the ionic form of the metal, an anode (positively charged) which may consist of the metal being plated (a soluble anode) or an insoluble anode (usually carbon, platinum, titanium, lead, or steel), and finally, a cathode (negatively charged) where electrons are supplied to produce a film of non-ionic metal.
Electroless plating, also known as chemical or auto-catalytic plating, is a non-galvanic plating method that involves several simultaneous reactions in an aqueous solution, which occur without the use of external electrical power. The reaction is accomplished when hydrogen is released by a reducing agent, normally sodium hypophosphite (Note: the hydrogen leaves as a hydride ion), and oxidized, thus producing a negative charge on the surface of the part. The most common electroless plating method is electroless nickel plating, although silver, gold and copper layers can also be applied in this manner, as in the technique of Angel gilding.

Specific cases

Gold plating

Main article: Gold plating

Gold plating is a method of depositing a thin layer of gold on the surface of glass or metal, most often copper or silver.

Gold plating is often used in electronics, to provide a corrosion-resistant electrically conductive layer on copper, typically in electrical connectors and printed circuit boards. With direct gold-on-copper plating, the copper atoms have the tendency to diffuse through the gold layer, causing tarnishing of its surface and formation of an oxide/sulfide layer. Therefore, a layer of a suitable barrier metal, usually nickel, has to be deposited on the copper substrate, forming a copper-nickel-gold sandwich.

Metals and glass may also be coated with gold for ornamental purposes, using a number of different processes usually referred to as gilding.

Silver plating
A silver-plated alto saxophone

For applications in electronics, silver is sometimes used for plating copper, as its electrical resistance is lower (see Resistivity of various materials); more so at higher frequencies due to the skin effect. Variable capacitors are considered of the highest quality when they have silver-plated plates. Similarly, silver-plated, or even solid silver cables, are prized in audiophile applications; however some experts consider that in practice the plating is often poorly implemented, making the result inferior to similarly priced copper cables.[1]

Care should be used for parts exposed to high humidity environments. When the silver layer is porous or contains cracks, the underlying copper undergoes rapid galvanic corrosion, flaking off the plating and exposing the copper itself; a process known as red plague.

Historically, silver plate was used to provide a cheaper version of items that might otherwise be made of silver, including cutlery and candlesticks. The earliest kind was Old Sheffield Plate, but in the 19th century new methods of production (including electroplating) were introduced: see Sheffield Plate.

Another method that can be used to apply a thin layer of silver to several objects, such as glass, is to place Tollens' reagent in a glass, add Glucose/Dextrose, and shake the bottle to promote the reaction.

\[
\begin{align*}
\text{AgNO}_3 + KOH & \rightarrow \text{AgOH} + \text{KNO}_3 \\
\text{AgOH} + 2 \text{NH}_3 & \rightarrow [\text{Ag(NH}_3)_2]^+ + \text{[OH]}^- \quad (\text{Note: see Tollens' reagent}) \\
[\text{Ag(NH}_3)_2]^+ + \text{[OH]}^- + \text{aldehyde} \quad (\text{usually glucose/dextrose}) & \rightarrow \text{Ag} + 2 \text{NH}_3 + \text{H}_2\text{O}
\end{align*}
\]

Rhodium plating

Rhodium plating is occasionally used on white gold, silver or copper and its alloys. A barrier layer of nickel is usually deposited on silver first, though in this case it is not to prevent migration of silver through rhodium, but to prevent contamination of the rhodium bath with silver and copper, which slightly dissolve in the sulfuric acid usually present in the bath composition.[2]

Chrome plating

Main article: Chrome plating

Chrome plating is a finishing treatment utilizing the electrolytic deposition of chromium. The most common form of chrome plating is the thin, decorative bright chrome, which is typically a 10-µm layer over an underlying nickel plate. When plating on iron or steel, an underlying plating of copper allows the nickel to adhere. The pores (tiny holes) in the nickel and chromium layers also promote corrosion resistance. Bright chrome imparts a mirror-like finish to items such as metal furniture frames and automotive trim. Thicker deposits, up to 1000 µm, are called hard chrome and are used in industrial equipment to reduce friction and wear.

The traditional solution used for industrial hard chrome plating is made up of about 250 g/L of CrO₃ and about 2.5 g/L of SO₄²⁻. In solution, the chrome exists as chromic acid, known as
hexavalent chromium. A high current is used, in part to stabilize a thin layer of chromium(+2) at the surface of the plated work. Acid chrome has poor throwing power, fine details or holes are further away and receive less current resulting in poor plating.

Zinc plating

See also: Galvanization, Hot-dip galvanization, Electrogalvanization, Bethanization, and Sherardising

Zinc coatings prevent oxidation of the protected metal by forming a barrier and by acting as a sacrificial anode if this barrier is damaged. Zinc oxide is a fine white dust that (in contrast to iron oxide) does not cause a breakdown of the substrate's surface integrity as it is formed. Indeed the zinc oxide, if undisturbed, can act as a barrier to further oxidation, in a way similar to the protection afforded to aluminum and stainless steels by their oxide layers. The majority of hardware parts are zinc plated, rather than cadmium plated.[3]

Tin plating

See also: Tinplate

The tin-plating process is used extensively to protect both ferrous and nonferrous surfaces. Tin is a useful metal for the food processing industry since it is non-toxic, ductile and corrosion resistant. The excellent ductility of tin allows a tin coated base metal sheet to be formed into a variety of shapes without damage to the surface tin layer. It provides sacrificial protection for copper, nickel and other non-ferrous metals, but not for steel.

Tin is also widely used in the electronics industry because of its ability to protect the base metal from oxidation thus preserving its solderability. In electronic applications, 3% to 7% lead may be added to improve solderability and to prevent the growth of metallic "whiskers" in compression stressed deposits, which would otherwise cause electrical shorting. However, RoHS (Restriction of Hazardous Substances) regulations enacted beginning in 2006 require that no lead be added intentionally and that the maximum percentage not exceed 1%. Some exemptions have been issued to RoHS requirements in critical electronics applications due to failures which are known to have occurred as a result of tin whisker formation.

Alloy plating

In some cases, it is desirable to co-deposit two or more metals resulting in an electroplated alloy deposit. Depending on the alloy system, an electroplated alloy may be solid solution strengthened or precipitation hardened by heat treatment to improve the plating's physical and chemical properties. Nickel-Cobalt is a common electroplated alloy.
Composite plating

Metal matrix composite plating can be manufactured when a substrate is plated in a bath containing a suspension of ceramic particles. Careful selection of the size and composition of the particles can fine-tune the deposit for wear resistance, high temperature performance, or mechanical strength. Tungsten carbide, silicon carbide, chromium carbide, and aluminum oxide (alumina) are commonly used in composite electroplating.

Cadmium plating

Cadmium plating is under scrutiny because of the environmental toxicity of the cadmium metal. However, cadmium plating is still widely used in some applications such as aerospace fasteners and it remains in military and aviation specs however it is being phased out due to its toxicity and corrosive properties.[4]

Cadmium plating (or "cad plating") offers a long list of technical advantages such as excellent corrosion resistance even at relatively low thickness and in salt atmospheres, softness and malleability, freedom from sticky and/or bulky corrosion products, galvanic compatibility with aluminum, freedom from stick-slip thus allowing reliable torquing of plated threads, can be dyed to many colors and clear, has good lubricity and solderability, and works well either as a final finish or as a paint base.[5]

If environmental concerns matter, in most aspects cadmium plating can be directly replaced with gold plating as it shares most of the material properties, but gold is more expensive and cannot serve as a paint base.

Nickel plating

The following text needs to be harmonized with text in Nickel electroplating.

Main article: Nickel electroplating

The chemical reaction for nickel plating is:[citation needed]

At cathode: \( \text{Ni} \rightarrow \text{Ni}^{2+} + 2\text{e}^- \)

At anode: \( \text{H}_2\text{PO}_2 + \text{H}_2\text{O} \rightarrow \text{H}_3\text{PO}_3 + 2 \text{H}^+ \)

Compared to cadmium plating, nickel plating offers a shinier and harder finish, but lower corrosion resistance, lubricity, and malleability, resulting in a tendency to crack or flake if the piece is further processed.[3]
Electroless nickel plating

Electroless nickel plating, also known as enickel and NiP, offers many advantages: uniform layer thickness over most complicated surfaces, direct plating of ferrous metals (steel), superior wear and corrosion resistance to electroplated nickel or chrome. Much of the chrome plating done in aerospace industry can be replaced with electroless nickel plating, again environmental costs, costs of hexavalent chromium waste disposal and notorious tendency of uneven current distribution favor electroless nickel plating.[6]

Electroless nickel plating is self-catalyzing process, the resultant nickel layer is NiP compound, with 7–11% phosphorus content. Properties of the resultant layer hardness and wear resistance are greatly altered with bath composition and deposition temperature, which should be regulated with 1 °C precision, typically at 91 °C.

During bath circulation, any particles in it will become also nickel plated, this effect is used to advantage in processes which deposit plating with particles like silicon carbide (SiC) or polytetrafluoroethylene (PTFE). While superior compared to many other plating processes, it is expensive because the process is complex. Moreover, the process is lengthy even for thin layers. When only corrosion resistance or surface treatment is of concern, very strict bath composition and temperature control is not required and the process is used for plating many tons in one bath at once.

Electroless nickel plating layers are known to provide extreme surface adhesion when plated properly. Electroless nickel plating is non-magnetic and amorphous. Electroless nickel plating layers are not easily solderable, nor do they seize with other metals or another electroless nickel plated workpiece under pressure. This effect benefits electroless nickel plated screws made out of malleable materials like titanium. Electrical resistance is higher compared to pure metal plating.

Corrugated galvanized iron

From Wikipedia, the free encyclopedia
Corrugated galvanised iron roofing in Mount Lawley, Western Australia.

A corrugated iron church (or tin tabernacle) in Kilburn, London.

Typical corrugated galvanised iron appearance. Note the large flake type patterns. Note also the repairing, when to steel is a galv cup head type bolt tightened from underneath.

Corrugated Duraluminium covering Ju52.

Corrugated galvanised iron (colloquially corrugated iron or palling (in Caribbean English), commonly abbreviated CGI) is a building material composed of sheets of hot-dip galvanised mild
**steel, cold-rolled** to produce a linear corrugated pattern in them. The corrugations increase the bending strength of the sheet in the direction perpendicular to the corrugations, but not parallel to them. Normally each sheet is manufactured longer in its strong direction.

CGI is lightweight and easily transported. It was and still is widely used especially in rural and military buildings such as sheds and water tanks. Its unique properties were used in the development of countries like Australia from the 1840s, and it is still helping developing countries today.

### History

Early manual corrugated iron roller. On display at Kapunda museum, South Australia

CGI was invented in the 1820s in Britain by Henry Palmer, architect and engineer to the London Dock Company. It was originally made (as the name suggests) from **wrought iron**. It proved to be light, strong, **corrosion**-resistant, and easily transported, and particularly lent itself to prefabricated structures and improvisation by semi-skilled workers. It soon became a common construction material in rural areas in the **United States, Chile, New Zealand** and **Australia** and later **India**, and in Australia and Chile also became (and remains) the most common **roofing** material even in urban areas. In Australia and New Zealand particularly it has become part of the cultural identity,[1][2] and fashionable architectural use has become common.[3]

For roofing purposes, the sheets are laid somewhat like tiles, with a lateral overlap of one and half corrugations, and a vertical overlap of about 150 mm, to provide for waterproofing. CGI is also a common construction material for industrial buildings throughout the world.

Wrought iron CGI was gradually replaced by **mild steel** from around the 1890s, and iron CGI is no longer obtainable - however, the common name has not been changed. Galvanized sheets with simple corrugations are also being gradually displaced by 55% Al-Zn coated steel[4] or **coil-painted** sheets with complex profiles. However CGI remains common.

[edit]Corrugation today

Today the corrugation process is carried out using the process of **roll forming**. This modern process is highly automated to achieve high productivity and low costs associated with labour. In the corrugation
process sheet metal is pulled off huge rolls and through rolling dies that form the corrugation. After the sheet metal passes through the rollers it is automatically sheared off at a desired length. The standard shape of corrugated material is the round wavy style, but can be easily modified to a variety of shapes and sizes by simply changing the dies [4].

Many materials today undergo the corrugation process. The most common materials are ferrous alloys but may also span to stainless steels. Copper and aluminium are also used. Regular ferrous alloys are the most common due to price and availability. Common sizes of corrugated material can range from a very thin 30 gauge (.012 inches = 0.305 mm) to a relatively thick 6 gauge (.1943 inches = 4.94 mm). Thicker or thinner gauges may also be produced.

Other materials such as plastic and fibreglass are also given the corrugated look. Many applications are available for these products including using them with metal sheets to allow light to penetrate below.

Pitch and depth

The corrugations are described in terms of pitch (the distance between two crests) and depth (the height from the top of a crest to the bottom of a trough). It is important for the pitch and depth to be quite uniform, in order for the sheets to be easily stackable for transport, and to overlap neatly when making a join. Pitches have ranged from 25 mm (1 inch) to 125 mm (5 inches). It was once common for CGI used for vertical walls to have a shorter pitch and depth than roofing CGI. This shorter pitched material was sometimes called "rippled" instead of "corrugated". However nowadays, nearly all CGI produced has the same pitch of 3 inches (76 mm).

Echo

Clapping hands or snapping ones fingers whilst standing next to perpendicular sheets of corrugated iron (for example, in a fence) will produce a high-pitched echo with a rapidly falling pitch. This is due to a sequence of echoes from adjacent corrugations.

If sound is traveling at 344 m/s and the corrugated iron has a wavelength (pitch) of 3” or .0762 m this will produce an echo with a maximum wavelength of that order, which corresponds to a frequency of 4500 Hz or so (approximately the C above top A on a standard piano). The first part of the echo will have a much higher pitch because the sound impulses from iron nearly opposite the clapper will arrive almost simultaneously.

Corrosion
Rusted corrugated steel roof

Although galvanising inhibits the corrosion of steel, rusting is inevitable, especially in marine areas - where the salt water encourages rust - and areas where the local rainfall is acidic. Corrugated steel roofs can last for many years if protected by a layer of paint.

Galvannealed

From Wikipedia, the free encyclopedia

Galvannealed or galvanneal is the result from the combined process of galvanizing and annealing to produce specialized sheets of steel. The galvanization is made through the hot-dipping (Hot-dip galvanizing) process and gives a very fine greyish matte finish. Galvanneal does not flake off its galvanized coating when formed, stamped, and bent. The very fine matte finish acts like a primer, allowing paint to adhere easily, and is very rust proof; only white to dark grey marks appear if it comes in contact with water. Galvanneal sheets offer good paintability, weldability, corrosion resistance, and formability. It is extensively used in the automotive, signage, electric equipment, and other industries requiring a metal with good paintability and long reliable service life. This steel process is produced by many steel mills and it is commonly referred by its trade name of Jet-Kote.