Taking action against Hot-Dip Galvanizing Pollution and discussing its limitations. Is there an alternative?

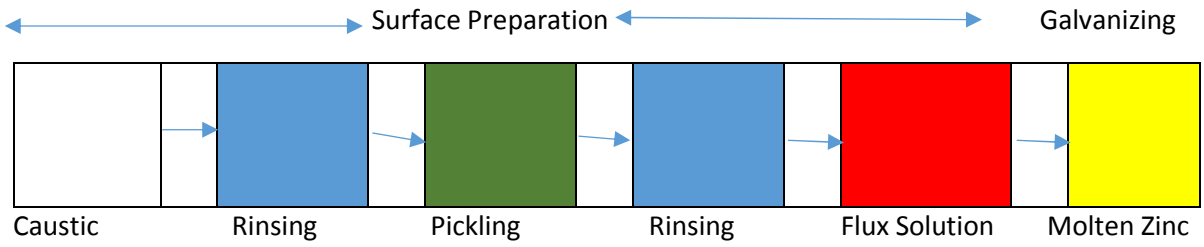
Background

Every year corrosion cost the country billions. Corrosion also, known as rust, is a natural process that occurs when steel is exposed to the environment. It can be slowed however, with a protection technique called galvanizing, which is the coating of steel with a layer of zinc to slow the corrosion process. Zinc is used to protect steel because the zinc layer rust more easily than steel but also rust much slower than steel. Therefore, the underlying steel remains safe from rust for many years. Galvanizing obviously have its benefits and is used extensively but is it safe to expose our environment with its waste and hazardous elements it contains? Is there an alternative to galvanizing, maybe not in all applications but surely there must be. In this study we are looking at galvanizing and its hazardous effects versus a coating called Rust Grip developed Mr. Joseph Pritchett of Superior Products International of the United States of America.

Pollution and safety hazards of Galvanizing

Sources of waste of all the different cleaning and rinse baths used during galvanizing present many opportunities for waste. With each cleaning process the dilute got less efficient at cleaning the steel. Once the efficiency is compromised, the cleaner is disposed of, usually off-site. A significant quantity of zinc waste occurs in the form of top dross and skimming's in the galvanizing tank. During the removal of these skimming's, however, large amount of zinc is also removed and is normally transported off-site as waste.

Steps of the galvanizing process.



Galvanizing steps indicating different waste material.

The galvanizing tank is also a significant source of air pollution due to the extremely high temperature of the bath. When the item to be galvanized is dipped into the tank, the liquid in the galvanizing bath volatiles and escape into the air as smoke. This smoke is primarily ammonium chloride, but it also contains zinc oxide. Majority of the on-site releases were emitted into the air, but some also washed into the local water supply as storm water.

It is a well-known fact that hot dip galvanizing contains hazardous lead (Ph.) and other hazardous minerals such as chromium, manganese, antinomy, copper, nickel, zinc, cadmium etc. these minerals are all toxic to humans and animals and is well research and documented. However this practice is ongoing since 1700 up till today. Fact is that when humans work with galvanizing whether it is with hot dip galvanizing process or any other form such as grinding, welding, cutting of galvanizing products people get in touch with it or inhale it, causing various health conditions even if the processes is within the exposure limits and health effects.

One can ask yourself that what happens with these hazardous materials if the galvanizing is completely rusted of, where did these materials go? Obviously it is heavy materials, and will go straight down into our earth's soil. Imagine since the 1700's when it was first introduced and how it escalated throughout the centuries. Just think of the millions and millions of galvanized sheeting being introduced throughout the world that has corroded away and donated these hazardous elements into our soil that then transfer into the food we eat.

Hot Work

"Hot Work" is defined as any temporary operation involving open flames or producing heat and/or sparks. This includes, but not limited to: brazing, cutting, grinding, soldering, torch-applied roofing, and welding. These activities is hazardous because they pose a unique combination of both safety and health risks to a lot of workers in most industries.

Exposure limits and Health Effects

Trace Metal	Respirable Dust	Total Dust	Action Level	ACGIH	Health Effects
Lead	- - -	**0,05mg/m³**	**0,03mg/m³**	**0,5mg/m³**	**Increased blood pressure, digestive problems, kidney damage, nerve disorders, sleep problems, muscle and joint pain.**
Aluminium	**5mg/m³**	**15mg/m³**	- - -	**1mg/m³(r)**	**Nervous systems and respiratory issues, Impaired lung function and fibrosis.**
Chromium	- - -	**0,005mg/m³**	- - -	**0,5mg/m³**	**Irritation eyes and skin, lung fibrosis.**
Manganese	- - -	**5mg/m³**	- - -	**0,2mg/m³**	**Forgetfulness and nerve damage, Parkinson, lung embolism and bronchitis, weakness.**
Antimony	- - -	**0,5mg/m³**	- - -	**0,5mg/m³**	**Irritation to skin, eyes, nose, throat, mouth, headache, nausea, cramps.**
Copper	- - -	**1mg/m³**	- - -	**1mg/m³**	**Irritation to eyes, nose, pharynx, metallic taste, liver and kidney damage.**
Nickel	- - -	**1mg/m³**	- - -	- - -	**Allergic asthma, cough, shortness of breath, decreased smell, lung damage.**
Zinc	- - -	**15mg/m³**	- - -	**2mg/m³**	**Metal fume fever, chills, muscle ache, dry throat, cough, weakness, blurred vision, low back pain, chest tightness, decreased pulmonary function.**
Cadmium	- - -	**0,005mg/m³**	**0,0025mg/m³**	**0,01mg/m³**	**Cough, chest tightness, substernal pain, headache, chills, muscle aches, difficult breathing, could be a potentially an occupational Carcinogen.**

Conditions effecting steel during Hot- Dip galvanizing

In contact with conducting aqueous solution, zinc behaves as a cathode whereas steel act as an anode. In this way, even bare carbon steel areas are protected. However, at temperatures around

60 C° a polarity reversal occurs such that any exposed steel preferentially to zinc. For this reason, galvanized tubes **are not recommended for hot water systems,** especially in soft water areas.

The presence of certain types of bacteria can also result in the rapid corrosion of galvanized tube in cold water conditions. Generally soft water conditions are more corrosive than hard water conditions.

Galvanized tubes should not be used with in contact with copper based alloy tubing, fittings or washers, due to possible galvanic corrosion action.

Galvanized sheeting exposed to heat conditions is also exposed to high heat conditions especially in very hot area's where it can get up to more than 80 C° this will have the same reversal effect as one see that how quickly these sheeting corrodes which make it costly and high maintenance.

Deformation and stress during Hot Dip Galvanizing Process

Hot Dip Galvanizing of thicker sheeting, structural materials etc. having a deformation effect of these materials due to the heat process through which it must go. The reason is that the materials undergo stress because of the heat application and should actually be stress relieved. Stress relieving is a very expensive process and time consuming. Most products that undergo Hot Dip Galvanizing never even undergo this process and companies must either panel beat it or bent it to fit, building structures with steel under stress, is not recommendable.

Failures of Hot-Dip Galvanized Steel Products

There were three basic embrittlement mechanisms observed when hot-dip galvanized steel structure failed. It is:

- Liquid metal embrittlement
- Hydrogen embrittlement and
- Strain ageing embrittlement

The liquid metal embrittlement caused by zinc and cadmium was studied by Arrata at el in liquid Cd, Zn and Cd + 5% Zn, Cd + 50% Zn alloys. The authors identified that liquid metal influences the plasticity of steels. The ductility decreases with increasing Zn content. The plasticity was associated with the actual fracture mechanism from transcrystalline to intercristalline. They also observed that the fracture associated with the liquid metal embrittlement takes place when the minimum stress level and or deformation is applied.

Friehe a Hankle also identified that iron is more susceptible to intercrystalline liquid metal embrittlement at 475°C than the killed and also not killed steel. Japanese authors also supposed that liquid zinc embrittlement is caused by diffusion of zinc along the primary austenitic grain boundaries due to thermal and residual stresses.

It is also a kwon fact that after the preparation of steel for hot dip galvanising and a period of time is taken before put into the galvanising tank, microscopic rust form onto the surface of the steel exposed to the atmosphere. This means rust get encapsulated by galvanise and it starts growing underneath causing the live span of galvanise to fail significantly.

Cost of Galvanizing

Obviously in continuous production processes galvanizing is done at much lower cost than individual production cost, but looking at the waste material that got lost, transporting of these materials off-site and the controls of dumping, it actually becomes more costly. A general cost factor for structural

and other individual pieces are priced per kilogram and prices become more if the piece is heavy. The current rate is between R7 and R8/Kg of the material to be galvanised.

Taking steel reinforcing for example, going into huge concrete structure to enforce it is an already corroded item, galvanising them would be very costly. Civil Construction Engineers use it in their design corrode as it is. These reinforced structures should stand for over a hundred years, how long will it take for the already corroded reinforcing to last during the duration of the building? Will it bring the strength of the concrete down? Is it still safe? We don't even know about these facts.

The need for Hot-Dip Galvanizing

Whatever we say, it is also a fact the galvanizing will still be done especially in the continuous production systems. Yes if we look at Rust Grip as an alternative it can currently be used instead of galvanising especially with structures, smaller items, custom made structures welded together and so on, but let us look at Rust Grip, a product being researched and patented by Mr. Joseph Pritchett, president of Superior Products International of the USA for its rust protection and strengthening properties of material it gets in contact with.

Rust Grip, a SPI USA manufactured product

Rust Grip is a touch, one-part, moisture cure polyurethane coating that absorbs atmospheric moisture to cure. Rust Grip is loaded with a metallic pigment for strength and is also resistant to chemical solvents and acid splash. Upon curing, Rust Grip provides protective coating film of superior adhesion and flexibility, and is resistant to abrasion and impact. Rust Grip can be used as a primer or as a one-coating system. It is patented to encapsulate lead based paints and other toxic materials, including asbestos. It can be applied over power washed rust. A light to medium surface rust is preferred as the profile. Rust Grip is silver-grey in colour and contains no lead or chromate and increase tensile strength of steel with 6 780 psi after 3 weeks. Rust grip have a live span of over 50 years, no rusting no blistering. No ignition, smoking, tested for 96 Hrs hot surface performance tested at 147°C for smouldering or colour change and no spread of flames, class "A" Non-combustible. Evaluating degree of rusting on painted surfaces rated 9 out of 10 and rated 10 excellent for corrosive environments.

Typical uses

- Good acid and very good alkali resistance
- As a coating to encapsulate rust, lead-based paint and other hazardous materials such as asbestos.
- As a protective coating on metal, concrete, wood, etc. to ad strength and prevent rust and deterioration.
- As a one-coat system on new or existing bridges, oil platforms, roofs, and other commercial/industrial surfaces with minimal surface preparation.
- As a moisture protective membrane to stop moisture penetration, containment, and mold and mildew.
- As a protection on fencing materials such as posts, stays, gates etc. can be easily maintained.
- As sheet metal strengthening agent that will increase strength but still be flexible for example on sheet metal tiles, gutters etc.
- Rust protection on steel structures, welded steel structures (no deformation) added strength.
- Can be used on steel where stainless steel is required. Rust Grip E when application is under water.

- As rust protection on steam pipes, no sand blasting is required can only high pressure washed and can be done in situ.
- Transport trailers, parts, structures etc. will have no deformation or stress.

Cost

Considering cleaning, transport and other savings like no deformation, stress relieving apart from material and labour costs Rust Grip is not only a more superior product but will also be much cheaper.

Conclusion

Looking from a safety, price, deformation and other influences of hot-dip galvanizing, Rust Grip can take over a large part of the galvanizing industry. By doing it, a reduction in contamination of air, soil and health of people in a large scale, one should seriously think of using Rust Grip.