



TECH FRONTIERS

Corrosion prevention of bare metal in transit

Proper packaging of metal products for export is a critical process that is often overlooked by exporters, resulting in damaged consignments that the buyers refuse to accept. This article discusses developments in materials for corrosion-free packaging

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PACKAGING is the science, art, and technology of enclosing or protecting products for distribution, storage, sale, and use. A general observation is that product packing follows traditionally accepted/copied methods without any

Corrosion Horoscope

A Guru is someone who reads a person's horoscope and makes predictions about their future such as time to marriage, life's riches, longevity, etc. Similarly, corrosion horoscope is the art of reading

the packaging system of a company's metal products going into transit, and the prediction that the product will actually reach the customer in a good, clean and sparkling condition.

Figure1: Export consignments travel long distances over raging international waters, battling a range of temperatures through different atmospheric conditions



scientific basis or analysis of real time requirement. Unfortunately, packing is also the first to take a hit when cost cutting measures are implemented ruthlessly. In order to achieve significant cost reductions, packing materials are stripped to their bare minimum with just enough to cover goods in transit. These decisions, unfortunately, are taken without any sound technical backing and reasoning. When disaster strikes, the bare minimum packing gives way to corrosion, and the company ends up paying a hefty price, usually losing its hard earned credibility in the process.

This happens to every company

Take the example of a typical machined auto component company that sends a large consignment to the US for the first time. A lot of effort, multiple trips to the US, and several rounds of negotiations and sampling have gone into winning the order. Most companies strive to upgrade from delivering local orders to exporting international orders. Finally, when the product exits the company

premises, all worries about the condition it should reach the customer leaves along with it, although the intention is not to deliver bad quality material. But, alas, the customer receives corroded material, is very unhappy, and threatens to cancel all further orders. The company, then, goes into damage control mode and tries to convince the customer that they employed the best protection available, for the consignment.

After detailed discussions with the customer, the company is surprised to know that the majority of their consignment was corroded. Why? Because international consignments travel over raging international waters, battling a range of temperatures through different atmospheric conditions, and cover a longer duration before it reaches the customer.

Similarly, different types of products require different types of protection under various conditions. Only a scientific packing approach that can be standardised can offer optimal protection. Just like a doctor stress tests a patient to determine the condition of their heart, a

company should perform a rapid test on their packing material, to check for behavioural changes in the protection.

What exactly is corrosion?

Corrosion is the constant destruction of metal in service by chemical or electrochemical action. In simple terms, it is the natural tendency of metals to go back to its original state, i.e. the oxide ore from wherein it was extracted. Global losses due to corrosion every year stands at a whopping \$828 billion, which translates to approx. 2-5 percent of the GNP of any country. (Source: NACE)

Why and what are VCIs?

VCI stands for Volatile Corrosion Inhibitor – it is an intelligent mixture of special chemicals called corrosion inhibitors that constantly vaporise and create gases which have anti-corrosive properties.

Scientists all over the world are engaged in developing the most effective solutions for corrosion. Traditionally used anti-corrosives such as oils, coatings, paints, varnishes, etc are messy and

difficult for the end-user. GeNext VCIs with their dry, non-messy approach and cost-effectiveness are considered the best solution for bare metals.

Like naphthalene balls, VCIs vaporise from solid to gas, and encompasses the metal to form a mono-ionic bonded layer on its surface, protecting it from corrosion. Scientifically synthesised VCI mixtures are those which have high and low vapour pressures along with different vapourisation temperatures so as to cover a wide range of temperatures that the consignment may be exposed to. Some VCI chemicals will contain high vapour pressures to enable immediate deployment on wrapping over metal surfaces while low vapour pressure ones will act on longer time horizons. The mixture also consists of certain levels of acid absorption capabilities to protect from pollutants and airborne acidic radicals. Safepack's VCIs are intelligent and scientifically driven to include all of these properties to offer maximum protection to metals travelling in the most difficult of conditions.

How does a VCI work?

Figure3 shows a metal surface consisting of nasty reactive, and corrosion causing anodic and cathodic nodes. When such a metal is enclosed in a VCI atmosphere, vaporised VCI molecules dissociate by process of hydrolysis using atmospheric moisture (which otherwise aid corrosion) to form healing An-ions and Cat-ions. These healing anions and cations neutralise oppositely charged cathodic and anodic reactive nodes, thus making the metal noble and inert, free from corrosion. This protective barrier re-heals and replenishes itself through further condensation of the vapour for the duration of transit.

Contact protection is when direct contact is established between, say, VCI paper and product whereas most vital protection is vapour protection where the paper does not touch the product but the chemical in the VCI vaporises to protect

Figure2: Safepack VCI metal wraps



the metal surface from distance.

How to choose the right VCI

A pizza comes in a nice box that keeps it hot and fresh. Although the pizza is the end consumption product, the box is what keeps its contents safe during delivery. Similarly, a VCI paper or woven fabric is just a plate – a carrier – on which vital chemicals are made available to ensure prevention of rust. Most companies focus only on the appearance, construction, and grammage of the packing material, but overlook the protection capabilities, the performance and quality of the chemicals used, and its contact and vapour phase protection.

The primary characteristics for VCI product packing is to ensure no corrosion losses, no physical damages, consistent packing material, and its recyclable/eco-friendly elements to avoid legal non-compliance fines and prosecutions.

An ordinary 'Me Too' VCI (characterised by irrational copying of packing by multiple parties without any scientific basis) will barely pass one contact stress cycle test whereas the right type of VCI will pass minimum three vapour phase and three contact stress cycles.

Consider an example from Safepack's audit of one of the top steel manufactur-

ers in the US. Before shipping, Safepack created a list of glaring gaps in their packaging that would definitely result in the consignment reaching its destination in a damaged condition. Figure3 shows actual customer images of what happens when a company does not prioritise packing technology. Safepack's experience in auditing 400+ global companies has thrown up an astonishing result wherein majority of the companies do not analyse, check, and benchmark the VCI wrapper/system they deploy. Without in-depth knowledge of a wrapper's protection, possibility of unpredicted, unmeasured, and inbuilt corrosion is high. According to Safepack's research, VCI is the most popular, non-messy, non-polluting technology used globally to prevent transit corrosion.

VCI rust protection technology is delivered on different carriers such as wrap-around, attaches, package, disperse, migrate, dip, inject, brush, fog, etc. Popularly used products are paper, plastic, powder, tablets, stretch film, foam product, oil/water base, steel wraps. Woven fabric, liquid concentrates, aerosol sprays, powders, tablets, foams, emitters (for electronic products), absorbent, non-ferrous range, desiccant, etc are some of the different types of world renowned VCIs that

Figure3: The outcome of not prioritising packing technology



Safepack has developed expertise in. Each option comes with its own equilibrium of cost, risk, and protection.

A little can go a long way

This saying holds true even for packing. Many a times, companies skimp investing a little extra in a scientific-driven approach to packing because their regular packing got them through thus far, and believe it will continue to work for them further. It only takes one severe incident to expose serious gaps in their packing standards and quality control. Post this; they are under pressure to relook their packing technology, and under financial strain, they ask experts to offer solutions like a semi-VCI to keep costs down. Unfortunately, VCI technology is pretty black and white and does not allow for grey areas.

How to differentiate between good and bad protection

A superior VCI packing can be differentiated from an inferior one through a simple test. Take two mason jars – one marked as contact, and the other as vapour. Suspend two metal plates from their tops, and fill them with 30 ml of water. In the contact jar, wrap the metal with package paper, and in the vapour jar, surround the metal with VCI paper without any contact between metal and



paper. Seal the jars, and using an industrial oven, replicate atmospheric temperature changes of eight hours of heating followed by 16 hours of cooling, and repeating the cycle a few times similar to

the conditions of a consignment in transit. Pull out the jars and check the results. More often than not, metal wrapped in ordinary steel wrap will show signs of corrosion after two or three cycles,

whereas the metal wrapped in VCI (like Safepack's) will have no corrosion even after five cycles.

Once rust protection stress test for the VCI is done, duration of the protection needs to be tested. Every time a consignment reaches the customer, the amount of corrosion affected should be recorded so as to improve the packing for the next delivery. This will ensure consistent quality of consignment delivery. The longevity of any packing is always a function of the available VCI molecules in the packing, the amount of metal packed, and the duration of the packing.

In addition, environmental laws and safety have to be taken into consideration for VCIs. Safepack's extensive research and development has led to new offerings of 100 percent biodegradable and compostable anti-corrosive products. This green approach is already being adopted by majority of the companies across the world and may soon become the norm.

Steps to follow for effective packing

Safepack suggests a list of tasks that, if followed diligently by the packaging department, will yield the best results for your products delivery and earn your customers' trust:

1. Clean exposed areas of product and ensure it is free from fingerprints – which are very corrosive.
2. Cleaned product must be packed immediately and is not to be touched with contaminated hands during inspection.
3. Coated (non-printed) side of the VCI should face the metal that is to be protected with no polythene, etc in between.
4. Metal surfaces are to never be in direct contact with wooden crates or wooden pallets. Special care is to be taken to not use wet wood in packing as they leach corrosive acidic juices.
5. Excellent protection against corrosion is assured if quality VCI paper is not more than 30 cm from the metal.
6. Air tight packing is not required but for

best results the packing should preferably be closed.

7. Safepack multi-metal protector VCI emitters are recommended to prevent the oxidation of critical and soldered joints and corrosion of critical electrical/electronic panels and components.

8. Where water flooding is suspected a waterproof packing is suggested. If box design permits, a slight slope in the box top should be provided so that the excess water flows down by gravity.

9. Safepack recommends maintaining an inventory of VCI wrappers for only one year although in the original packaging, their shelflife extends to two years. Store in dry and cool place, and avoid direct sun rays and heat.

10. Hot metal objects should not be packed immediately and must be allowed to cool below 50°C before packing in VCI wrappers.

11. After uncasing, any goods packed in Safepack VCI should go for further process immediately. In case a long-term gap is inevitable then a light coating of oil is recommended to prevent corrosion during such unprotected transitions.

12. Paper shredding used traditionally as packing material has been found to be 99 percent acidic and must be avoided.

How expensive is good quality packing?

Very few organisations take pains in comparing the quality of packing and understanding its implications. For example, a 4000 mm wide wrapper offers complete tucking into coils without any risky joints. Plastic film VCIs are very versatile whereas paper VCIs are most effective due to their fibres that allow for immediate chemical protection. Consider this, a 500 micron polythene allows 1 g of water vapour to permeate through it in 24 hours whereas a foil packing allows only 0.05 g of water vapour in the same duration. This translates to almost 150 percent improvement in performance and can be used in highly critical applications

such as export of complex machinery etc.

So how much more expensive are superior wrappers? Just Rs30 (\$0.45) per 15 tons of coil, which translates to an increase of Rs2 (\$0.003) per ton, and is equal to 0.004 percent of the value of the total steel being packed. The tangible benefits of using superior packing include dramatic reduction in rust related claims (average of 2 percent of total shipments), and reduced rusted trim losses at customer end.

The intangible benefits are many including increased quality perception, customer satisfaction, and many such long-term gains. Corrosion is a natural process affecting metals; therefore anyone claiming to offer 100 percent corrosion protection is surely misleading.

Conclusion

Globally, packing errors by companies are widespread and the underlying causes are similar. Companies use makeshift methods (*jugaad*) of packing such as using smaller coating machines that create split coatings on multiple sheets, then laminating it, causing gaps and edge corrosion. Some use poor recycled paper which may have acidic radicals that form pitting in metals. The automotive and steel industry has been purchasing packaging products as a commodity rather than an investment, and sellers are only too happy to oblige, under pressure to maintain customer orders. These lead to poor customer experience and massive cumulative losses across the world.

Prevention is better than cure; unfortunately, with corrosion there is no cure if it isn't prevented in the first place. Safepack advocates that an intelligent buyer of packing must adhere to the following important points to ensure high quality product delivery and customer satisfaction:

1. A self-identified corrosion protection level with relevant testing capabilities to attain specific outcomes.
2. Physical properties such as puncture

resistance, tensile, extensibility, bursting strength, moisture and water permeability, etc.

3. Environmental compliances such as ROHS, TRGS, REACH, listed negative chemical use, etc. to avoid legal issues.

About Safepack

Safepack is into research and solutions for corrosion protection of ferrous and non-ferrous metals. As part of their research, they have travelled across the globe, visited and worked with more than 300 steel and auto parts companies, and offered suggestions to cure the corrosion cancers of their metals. Safepack continuously performs proactive research to come up with findings that are independent of market trends.

Safepack started its business in anti-corrosives in the early 1980s. Like any normal Indian company at the time, they believed that the best option would be to import technology from Europe. However, by 1992, Safepack realised that they don't have full access to the technology, have been sold inferior material, and were given unsatisfactory support. They,



then, decided to build their own VCIs. In the land of NCL (National Chemical Laboratory), Pune with access to 2000+ PhDs at the time and a good background in chemical engineering, the foundation was laid, of the company that Safepack would come to be known today.

Safepack has a great team that is continuously and dedicatedly working to keep corrosion out of the industry. As part of its corporate social responsibility, Safepack is constructing a school for the village near its factory, has been op-

erating a computer school for around 2700 students every year, and also supports 270 tribal schools in the region. In the fight against Covid, Safepack has developed input substitute material for 2,60,000 PPS dress material. Safepack has a very illustrious customer base across the globe, from Japan to the US along with European and Japanese distributors.

Safepack is happy to offer free tests for comparative testing and evaluation of corrosion horoscope of any organisation's current transit packaging.

