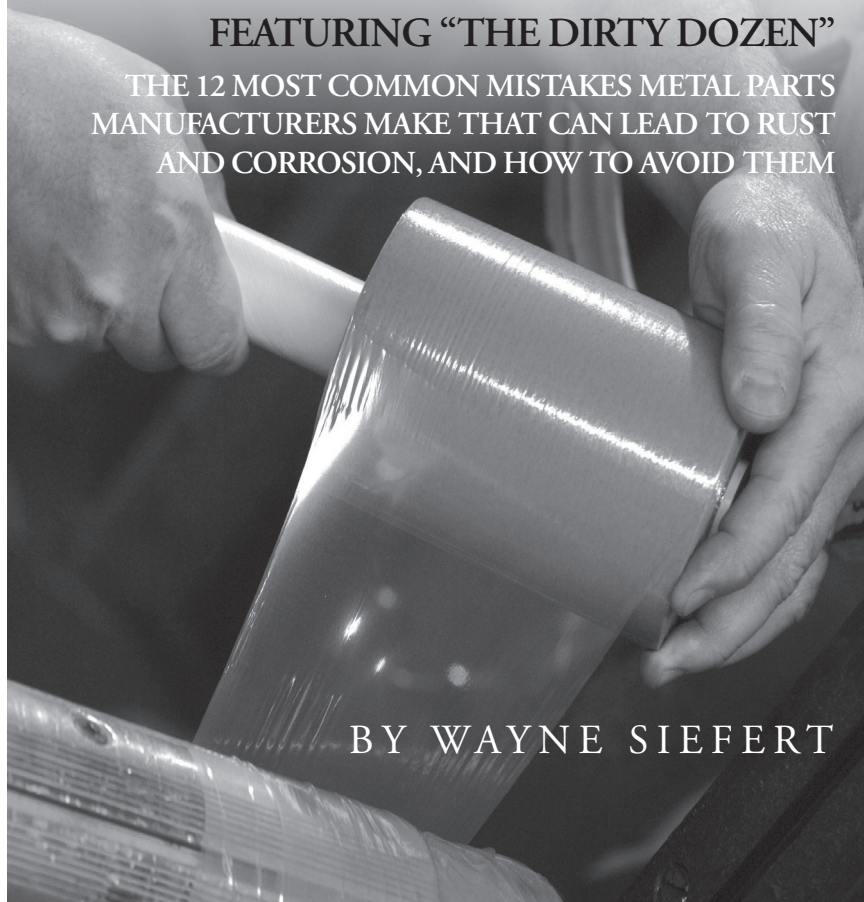


A COMPLETE GUIDE TO **Rust**
Prevention
using
VCI

FEATURING "THE DIRTY DOZEN"

THE 12 MOST COMMON MISTAKES METAL PARTS
MANUFACTURERS MAKE THAT CAN LEAD TO RUST
AND CORROSION, AND HOW TO AVOID THEM

BY WAYNE SIEFERT



This book is dedicated to all of my customers, who are the sole basis for my success in the anti-corrosion packaging industry. I am thankful for their support and loyalty, and I dedicate this book to them and wish them all the success in the future. Their support and loyalty is truly appreciated. They are the heart and soul of this country, and every day they prove that manufacturing in the United States is alive and well!

I want to thank my family and friends for their support during the time I spent writing this book. Without their encouragement this book would not have been possible. I want to especially thank Mike Capuzzi, and my friends at GKIC Philly who gave me the idea to write this book. If you want to grow your business, you owe it to yourself to check out www.GKIC-Philly.com

My friend and colleague, Clint Graham, helped me with the technical and chemistry chapters in the book. He is a talented and bright professional, and it is always a pleasure to work with Clint. He has a way of explaining difficult technical issues in a way that all of us can understand. Clint is the former Technical Director for Daubert VCI.

Finally, I would like to thank my graphic designer and editor, Laura Williams of Jiminate. Her expertise has made this book as beautiful as it is useful. Her patience during this process helped me maintain my sanity, and her professionalism is evident in the final outcome of this book. I highly recommend her for any project you may be considering. Check out her work at www.jiminate.com

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1

INTRODUCTION TO VCI

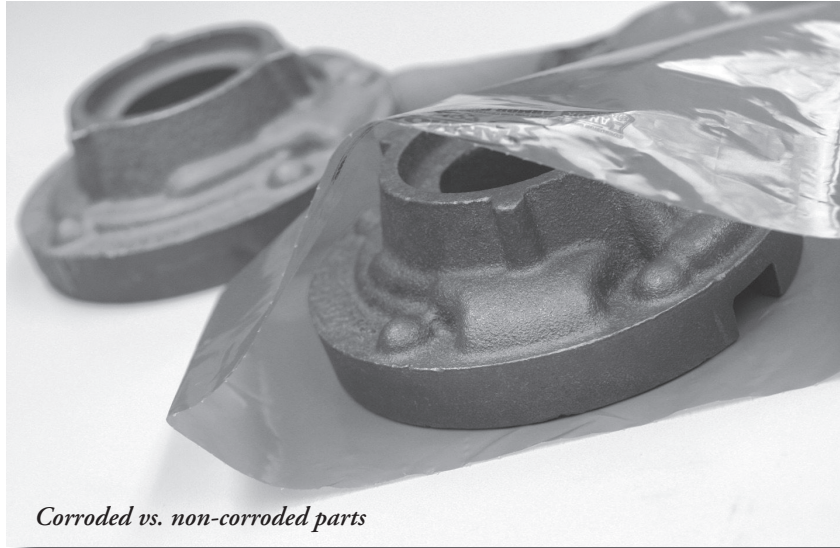


Okay, So Just What is VCI?

VCI is an abbreviation for Vapor Corrosion Inhibitor or Volatile Corrosion Inhibitor. (Also known as VpCI's or Vapor Phase Corrosion Inhibitors.) These corrosion inhibiting compounds are coated on paper or polyethylene



bags, and have sufficient vapor pressure to release molecules into the air. Due to their polarity, the VCI molecules are attracted to the surface of metal, just like a magnet. VCI molecules move from the paper or film directly to the surface of metals. When these compounds come in contact with metal surfaces they form a very thin molecular layer of protection. This thin layer effectively inhibits corrosion on the metal surface by preventing air



and moisture from coming in contact with the surface of the metal. Proper VCI packaging products work well in both the contact and vapor phase. This means that they provide protection against corrosion whether the metal is in direct contact with the VCI, or if it is merely in close proximity to the VCI. Unlike other methods of rust prevention, these corrosion inhibiting vapors have the ability to reach into intricate, recessed surfaces that would be otherwise hard to reach with traditional rust prevention products such as oils and greases.

VCI products are environmentally-friendly, cost-effective, and simple to use. These advantages, along with many others make VCI products an excellent choice for corrosion inhibition, eliminating the need for messy grease, oils, protective coatings, and other ineffective methods.

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WHY METALS RUST



From Wikipedia

“Corrosion means the breaking down of essential properties in a material due to chemical reactions with its surroundings. In the most common use of the word, this means a loss of electrons of metals reacting with water and oxygen. Weakening of iron due to oxidation of the iron atoms is a well-known example of electrochemical corrosion. This is commonly known as rusting.”



In many cases, rust can happen to metal tools and parts that are exposed to moisture and oxygen over time. Metal corrodes, or “breaks down” due to chemical reactions caused by the atmosphere and surroundings. Oxidation of iron atoms weakens metals. When metal reacts with water and oxygen over a period of time, it loses electrons, and this loss results in the iron becoming weak, corroded, and rust covered. Fork truck or lift truck exhaust, heat treatments, and other by-products from the metal

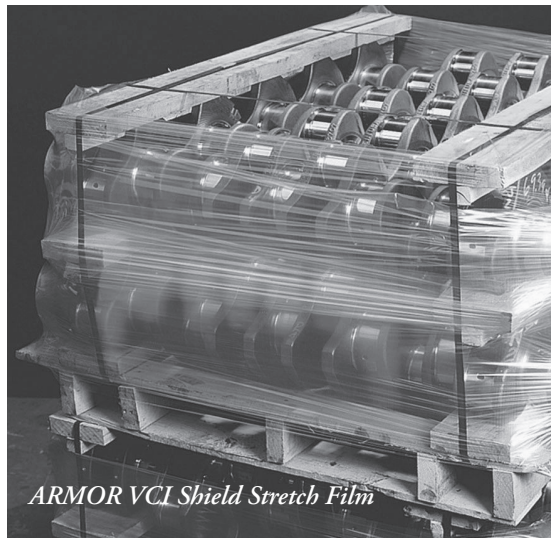
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manufacturing process, especially sulfurous gases, acid vapors, and ammonia gases can also contribute to rust. Those processes and environmental changes such as humidity, fluctuations in temperature, long periods of time spent in storage, and transportation accelerate the rust.

Surfaces of most of the metals rust and corrode due to moisture, water, acids, salts and other contaminants that are always present in our atmosphere. Corrosion, rust, and deterioration of metal surfaces also take place when they are exposed to gases containing sulfur, acid vapors and ammonia gas. Common culprits include by-products of the manufacturing process, by-products from heat treating, and fork truck exhaust.

The corrosion process is often accelerated when metal products are exposed to environmental changes such as fluctuations in temperature and humidity which often happens during product transportation, overseas shipments or long term storage.

Corrosion begins when an electrolyte (water, oxygen, humidity) is present on the surface of a metal. When this happens, electrons then flow from



high-energy areas of the metal to low energy areas in a loop, through the electrolyte. The corrosion process results in the formation of oxidation on the metal surface. VCI (Volatile Corrosion Inhibitors) slow or stop this reaction by passivating the surface and inhibiting or depressing the electro-

chemical mechanism that triggers oxidation, i.e. the current flow from anode to cathode.

Electrical current attempts to flow from the anode through the electrolyte into the cathode but cannot, because of the VCI's presence. Simply put your metal parts inside a VCI poly bag, or wrap your parts in VCI paper. The VCI chemistry migrates from the paper or poly and deposits on all of the metal surfaces of your parts. VCI molecules attach themselves to a metal surface to form an invisible, thin film, only a few molecules or even one molecule thick, to protect metal from attack. Used properly, VCI products can work for several years to prevent corrosion from occurring on the metal surface.

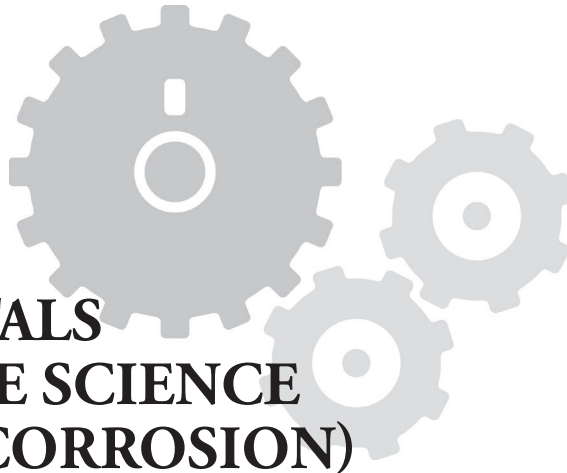
Corrosion is a natural, electrochemical process that causes metal to rust, weaken and eventually break down. Rust and corrosion are unsightly, dangerous, and costly to metal parts manufacturers.

Rust preventative VCI paper and VCI poly Bags prevent rust and corrosion that can lead to waste, and part failure. Corrosion is responsible for damage to automobile electronic parts, computer parts, mobile phones and more. During production, storage, or shipping, corrosion protection is equally important.

Green Packaging, Inc. carries a complete line of VCI paper, VCI poly bags, VCI poly sheeting, VCI emitters, VCI impregnated foams, VCI wire, VCI netting, VCI corrugated, and many other VCI devices for prevention of corrosion on virtually any type of metal.

Visit www.Green-VCI.com/book for more information and a special offer.

3



WHY METALS RUST (THE SCIENCE BEHIND CORROSION)

Very few of us are experts in chemistry. For most of us, Chemistry was that course that we struggled through in high school and are now happy that we don't have to think about. Even if we made it through with a good grade it was a long time ago. We simply don't use it every day. Very few of us have glowing memories of our time in chemistry. Because we need some kind of technical base on which to talk about corrosion and corrosion inhibitors, the following few pages will try to break down the complexities of inhibitor chemistry so that we can talk clearly about how to select and apply these products.

1 H Hydrogen 1.0079																	2 He Helium 4.0026									
3 Li Lithium 6.941	4 Be Beryllium 9.0122											5 B Boron 10.811	6 C Carbon 12.0107	7 N Nitrogen 14.0067	8 O Oxygen 15.9994	9 F Fluorine 18.9984	10 Ne Neon 20.1797									
11 Na Sodium 22.9897	12 Mg Magnesium 24.305											13 Al Aluminum 26.9815	14 Si Silicon 28.0855	15 P Phosphorus 30.9738	16 S Sulfur 32.065	17 Cl Chlorine 35.453	18 Ar Argon 39.948									
19 K Potassium 39.098	20 Ca Calcium 40.078	21 Sc Scandium 44.9559	22 Ti Titanium 47.867	23 V Vanadium 50.9415	24 Cr Chromium 51.9961	25 Mn Manganese 54.938	26 Fe Iron 55.845	27 Co Cobalt 58.9332	28 Ni Nickel 58.6934	29 Cu Copper 63.546	30 Zn Zinc 65.409	31 Ga Gallium 69.723	32 Ge Germanium 72.64	33 As Arsenic 74.9216	34 Se Selenium 78.96	35 Br Bromine 79.904	36 Kr Krypton 83.798									
37 Rb Rubidium 85.4678	38 Sr Strontium 87.62	39 Y Yttrium 88.9059	40 Zr Zirconium 91.224	41 Nb Niobium 92.9064	42 Mo Molybdenum 95.94	43 Tc Technetium (98)	44 Ru Ruthenium 101.07	45 Rh Rhodium 102.9055	46 Pd Palladium 106.42	47 Ag Silver 107.8682	48 Cd Cadmium 112.411	49 In Indium 114.818	50 Sn Tin 118.71	51 Sb Antimony 121.76	52 Te Tellurium 127.6	53 I Iodine 126.9045	54 Xe Xenon 131.293									
55 Cs Cesium 132.9055	56 Ba Barium 137.327	57 La Lanthanum 138.9055	58 Ce Cerium 140.116	59 Pr Praseodymium 140.9077	60 Nd Neodymium 144.24	61 Pm Promethium (145)	62 Sm Samarium 150.36	63 Eu Europium 151.964	64 Gd Gadolinium 157.25	65 Tb Terbium 158.9253	66 Dy Dysprosium 162.5	67 Ho Holmium 164.9303	68 Er Erbium 167.259	69 Tm Thulium 168.9342	70 Yb Ytterbium 173.04	71 Lu Lutetium 174.967										
87 Fr Francium (223)	88 Ra Radium (226)	104 Rf Rutherfordium (261)	105 Db Dubnium (262)	106 Sg Seaborgium (266)	107 Bh Bohrium (264)	108 Hs Hassium (277)	109 Mt Meitnerium (268)	110 Ds Darmstadtium (271)	111 Rg Roentgenium (272)	112 Uub Ununbium (277)																
												89 Ac Actinium 227.03	90 Th Thorium 232.0381	91 Pa Protactinium 231.0369	92 U Uranium 238.0289	93 Np Neptunium (237)	94 Pu Plutonium (244)	95 Am Americium (243)	96 Cm Curium (247)	97 Bk Berkelium (247)	98 Cf Californium (251)	99 Es Einsteinium (252)	100 Fm Fermium (257)	101 Md Mendelevium (258)	102 No Nobelium (259)	103 Lr Lawrencium (260)

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Above you will see what is called a periodic table of ALL known elements (atoms) to mankind. Now look at the shaded elements on the chart. The shaded elements are ALL called metals! I am almost certain, however, that when you were thinking of metal and corrosion, you were thinking only about Fe, the element iron, and its alloy steel but as you see there are many metals with varying characteristics, one of them the different conditions under which it will corrode (or not). We'll talk a bit more about this in a bit.

As metals, these elements have many common characteristics. For instance, almost all of them in their pure form will have a metallic luster or shine. They are generally solid at room temperature. They are malleable and ductile, properties which make them useful to us. They can conduct both heat and electricity. They can combine with other metals to form alloys with metallic characteristics and they 'want to' form positive ions (Don't space on me! This just means that they lose electrons.)

Each electron particle lost has a negative (-) charge and inside each atom are particles called protons which are each positive (+) charged. Now an atom can never lose or gain protons, BUT it can lose or gain electrons. When an atom loses or gains an electron, it is no longer called an atom. It becomes an ion.).

Because metals form positive ions they all will react with oxygen under some conditions. Oxygen, by the way, forms negative ions, simply because it 'wants to' gain electrons. Remember, when Oxygen gains these electrons it is no longer an atom. It is a negative ion. Now just so we have similar terminology we will call all negative ions (atoms that gain electrons) anions. Those positive ions that lost electrons, we'll call them cations. I use the fact that cation has a 't' in it to remind me that cations have a positive (+) charge. I think you see the connection.

When a metal reacts with oxygen we call that oxidation. Under the conditions of pressure and temperature found here on earth, we find that only one of these elements can be found as a pure metal. All of these other metals, if found naturally at all, are found only in an oxidized state. Gold of course is that odd

bodkin that can be found as a pure metal. Part of the value we put on gold is due to the fact that we don't have to put any effort (or money) into purifying it.

Ok. Blah Blah Blah. Electons...oxidation...ions...have I lost you yet? What does all this mean. Economically, it means that for us to get a pure metal we have to spend a lot; I mean a LOT of money. We have to go out and spend money to dig into the ground and dig until we find an ore (a metal combined with oxygen in that oxidized state we just bored you with). Then we have to move it to a plant where we heat it until the bonds between the oxygen and the metal break and we can separate the pure metal from the oxygen. After all of this we find that we need to spend even more money to process the metal into finished product in any one of thousands of products. Do we cast it? Do we roll it? Have you heard of sintering or forging?

A term that I want you to think of now is the word "alloy". Even when we limit our discussion to only one metal like iron, we have to come to the quick realization that there are literally thousands of alloys of iron out there. Now, an alloy is simply a blend of several metals that has been developed to give the overall metal certain characteristics that will make it more 'useful' to us. Steel, after all, is a very useful material that we use in a variety of applications. We have found more uses for steel as we have learned how to change its properties for different uses. Do we want to pound it into sheets? Do we want to draw it into a wire? Maybe we just want it to be strong in a casting for structural support. Then again maybe we want it to have some bending characteristics so we can use it in a spring? Do we want our steel to have a high or low melting point? Do we want it to be harder so it will keep a sharp edge longer? Finally, do we want it to resist corrosion more than other alloys? For us to use steel in so many applications we have to make different alloys of steel, each with different properties.

For instance we know that by alloying steel with chromium (Cr) we are able to increase corrosion resistance (you've heard of stainless steel). We also know that by adding Manganese (Mn) we improve the ability to harden

steel. Nickel (Ni) toughens steel alloys. Phosphorous (P) can improve machinability, Silicon (Si) can help strengthen some alloys, Titanium (Ti) helps harden steels, Tungsten (W) improves abrasive resistance and hardness, and I could go on and on. What you need to know is that having so many types of metal with different characteristics requires some deep thought when trying to package and protect those parts. On top of this, we find that we get similar changes in character in other metals when alloyed so we have various bronzes, brasses, copper alloys, nickel products, etc. Some are very expensive and fit very specialized applications others are manufactured for their low cost benefits. Some are made because they resist sparking, others because they machine easily, others because they withstand harsh environments.

So do you think we're done? Have we taken all variables affecting metal part construction into account? No. There are also manufactured metals with metal coatings on them. You've heard of galvanized steel haven't you? Instead of mixing metals together in an alloy, there are times that we simply put a metal on the surface of another. For instance, the galvanized steel we just talked about is simply steel with a layer of zinc coating the surface. We'll talk a little more about the corrosion cell later, but for now you just need to know that we sometimes use these metal coatings BECAUSE they rust easily. At least it rusts more easily than the metal below that they are protecting. Zinc dipped, zinc coated, zinc spray, zinc baths, etc.; no matter how the coating is applied, the zinc is there as a sacrificial metal. This means that as long as the coating metal is corroding, the steel metal below the coating remains intact. It will not rust. As a result of this unusual phenomenon, we can take entire ships and bridges that are made of steel and electronically wire them to blocks of a 'sacrificial metal' to prevent them from corroding. This form of protection used on large construction projects is called 'cathodic' protection.

The diversity of metal products today is staggering and in order for us to really comprehend the true problem of preventing corrosion we have to face up to the fact that there are literally thousands of metal products out there. Also, we have to realize that all of them need corrosion protection,

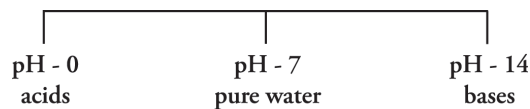
even galvanized steels. It doesn't matter if that zinc coating is there to corrode. Your customer doesn't want it to be corroded when it arrives at the receiving dock. With so many metals available in so many alloys and constructions, you need an expert available to help you insure that your metal parts are protected. Green Packaging, Inc. has worked to help prevent corrosion in thousands of applications and we are here to help you with your corrosion protection needs.

Water and pH

Now that we've learned (or relearned) some things about how metals behave, let's look at what goes on at the surface of a metal when corrosion occurs. The first thing we need is a little water. Water is a wonderful material that helps support life, but as far as keeping a metal in its pure state, we want as little water on our metal as we can get. The formula for water is H₂O which can also be thought of in terms of the two most important ions in chemistry. They are H⁺, the hydronium ion and OH⁻ the hydroxyl ion. If you know a little about chemistry you know that in pure water you should have an equal number of H⁺ ions and OH⁻ ions. Right? They are all attached to each other. However, if you happen to get some extra H⁺ ions then you have an acid. If you get more OH⁻ ions then you have a base. Wasn't that easy? Using the pH scale that has been developed for this, pure water would have a pH of 7. Acids would have a pH less than 7 and bases would have a pH greater than 7. Hydrochloric acid has the formula of HCl and dissociates (comes apart) in water and floats around as two ions, H⁺ (see this hydronium ion that is not matched up with an OH⁻ ion?) and Cl⁻. The addition of this H⁺ makes the solution an acid. On the other side, a very common base is NaOH, or sodium hydroxide and when it is placed in water it increases the OH⁻ concentration in the solution making it more basic.

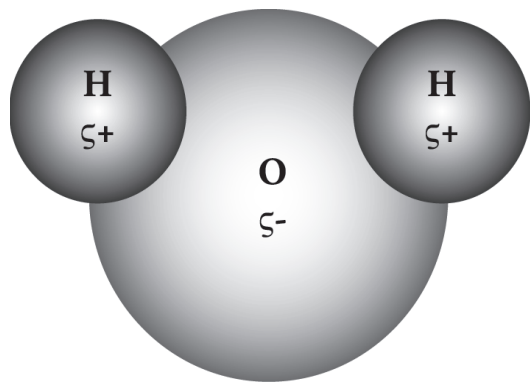
The ability of water to separate chemicals that have ionic bonds is a unique characteristic. It is the result of the polarity of the water molecule. Many chemicals have polarity and the polarity of some inhibitors helps to bind

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them to metal surfaces, but the polarity of water is rather strong. Take NaCl, common table salt. Without water present it requires almost 800 degrees C (about 1475 degrees F) to get NaCl to become a liquid. At this temperature the energy from the heat source is just beginning to separate the Na⁺ from the Cl⁻ ion. The attraction of the positive and negative particles is very strong! But you place a tablespoon of NaCl in water and it immediately dissolves allowing those ions to move through the fluid unattached! This is because of where the electrons like to 'hang out' on the water molecule. Oxygen really 'likes' electrons. As a result the electrons which are moving at near the speed of light spend most of their time hovering around the oxygen atom in the molecule. There is nothing wrong with this, but it concentrates a lot of negative charge in this area. Also, since it doesn't spend very much time around the hydrogens, the protons here cause this area of the water molecule to be positively charged. Below is a diagram of a water molecule with the charge distribution shown.

Just like a strong magnet, water is able to take molecules and separate them with ease and whenever an ion becomes dissolved in water (which is almost always because we have to use a special process to get deionized water) we call that ion an electrolyte.



The Corrosion Cell

At this point we need to talk about a corrosion cell. This is simply a model of an area on a metal part that is undergoing corrosion. The term 'cell' is used only because what is

happening here is very similar to what is happening inside a battery with the movement of electrons through the metal. More on this later, but first we have to imagine that there is water on the part because the corrosion will not take place as long as there is no water on the surface. Remember, only two things are needed to allow metal to rust and that is an electrolyte and an electron pathway and the pathway is always there. It's your metal part!

Once water, even pure water, has landed on your part, it will dissolve any residue on the surface and immediately give you the electrolyte. From here the chain reaction of events is immediate and quick. Any H^+ ion will react with the pure metal on the surface and with the help of water; your pure metal will dissolve into the electrolyte. This area is called an anode and the longer it is allowed to go on the deeper that 'pit' becomes. The metal ion now travels to an area nearby where there is an excess of OH^- and reacts immediately to form an iron oxide that deposits on the metal forming the telltale 'rust' product that we see in corrosion. On iron this is usually Fe_2O_3 (but can be other iron oxides under anaerobic or other extreme temperature or pressure conditions.)

This cell will now continue unstopped until one of two things happens. The first thought is horrific. That is when all of the pure metal that you paid so much to mine, purify, alloy, form, and package for your customer is gone. The other is in the event that the corrosion product covers up the metal to the point that moisture and oxygen cannot get through to fuel the cell. Let's consider this in our next section.

The Oxide Layer

Ok. So we are pretty sure that purified metals will corrode, but do they do this all the time? Why do some metals corrode quickly while others corrode slowly? How can some metals sit in water and NOT corrode? Big metal boilers can last for years. These are all great questions and will help you to understand why metals may not show corrosion for a while. Imagine that you have a block of metal and you cut through it. You are going to cut through

pure metal that has never been exposed to moisture or oxygen since it was purified. Immediately! Instantaneously! When the air hits those atoms of metal that are on the surface you just created, those atoms will corrode and become an oxide. From here on, whether the layers of atoms below that will corrode depends on how stable that top 'oxide layer' is. The oxide layer of a cast iron is rather weak and will dissolve easily in an electrolyte and help propagate the corrosion of the next layer of atoms.

If by chance the top layers of oxide are stable then we say that the surface is 'passivated' and the corrosion will stop. Ideally to keep a metal part 'looking' new, you want this to happen rather quickly. Inhibitors bind to the surface of a metal and help this oxide layer to become stable. Aluminum is a metal that easily forms a very strong oxide layer on its surface. As a result it takes longer periods of time and harsher environments to cause aluminum to corrode. It is why aluminum can be used in siding applications on a house. The stability of other metals and their many alloys differ widely. Stainless steel and cast iron are both mostly iron, however one corrodes faster and with more certainty than the other.

Now I've talked about a lot of things and if you are asleep or just panicking because you don't understand all of this then we can assure you one thing. There are solutions to corrosion problems and these solutions have been tried and tested the world over. At Green Packaging, Inc. we pledge you the safest, greenest, and most effective solutions to your corrosion problems. And after those problems are solved we are committed to working with you to make sure those problems never return.

4



THE OLD-FASHIONED WAY...TRADITIONAL USE OF OILS TO PREVENT RUST

Traditional corrosion inhibiting oils and greases are not only costly, messy, and harmful to the environment, but when your customers receive their parts, the oils and greases require removal. Often, the removal of these oils requires the use of solvents, and of course, additional labor. These solvents are also hazardous to the environment, and hazardous to employees' health.

Often the removal of these oils requires the use of solvents, and of course, additional labor. These solvents are also hazardous to the environment, and hazardous to employees' health.

Corrosion is a natural, electrochemical process that causes metal to rust, weaken and eventually break down. Rust and corrosion are unsightly, dangerous, and costly to metal parts manufacturers. Some foundries, machine shops, metal stamping companies, metal forming companies, metalcasters, and other metal parts manufacturers still use messy Rust Preventative (R.P.) Oils to prevent corrosion and rust on their parts. The oils create a barrier between the metal surface and the elements in the atmosphere (oxygen, moisture, salt, contaminants, etc.) that cause corrosion. One problem with R.P. Oils is that 100% coverage of the part is necessary in order for complete

protection. If there are areas of the part that are not completely covered with oil, the part is then susceptible to corrosion and rust. It is especially difficult to apply oils to metal parts with recessed areas, holes, and hard to reach areas.

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In some applications, R.P. Oils can be effective against corrosion, but they are also costly not only in terms of dollars, but they are also costly in terms of their ill-effects on the environment and your employees' health.

Here are just 7 reasons why R.P. Oils are so costly:

1. Applying rust preventative liquids by spraying, brushing or dipping is extremely labor-intensive
2. Disposal of empty drums and oil-soaked rags is very expensive
3. Storing flammable R.P. oils in your plant can dramatically increase insurance premiums
4. R.P. Oils pollute lakes, streams, and groundwater
5. R.P. Oils contain Volatile Organic Compounds (VOC's) which are harmful to the earth and employee's health



6. Common spills of R.P. oils often lead to employee slip and fall accidents

7. Many R.P. oils contain carcinogens

There is a modern, clean, dry, effective way to prevent rust and corrosion, and their many costs. The solution is VCI Paper and VCI poly bags. VCI paper and VCI poly products are

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a unique line of environmentally-friendly vapor phase corrosion inhibitors. Rust inhibiting chemicals are coated or impregnated into paper or polyethylene. When metal parts are packaged in VCI paper or VCI poly, the rust inhibitor chemicals migrate off of the paper or poly and deposit on the surface of the

metal parts. VCI technology works on a molecular level. The rust inhibitor molecules completely cover all surfaces of the metal (including hard to reach places) and prevent oxygen and moisture from causing corrosion and rust on the metal.

Green Packaging, Inc. carries a complete line of VCI paper, VCI poly bags, VCI poly sheeting, VCI emitters, VCI impregnated foams, VCI wire, VCI netting, VCI corrugated, and many other VCI devices for prevention of corrosion on virtually any type of metal.

Visit www.Green-VCI.com/book for more information and a special offer.

5

THINKING IN NEW WAYS



Small Question, Big Solution

George A. Daubert most likely never imagined how a simple idea, acted upon over 75 years ago, would materialize and grow to such a grand scale. We are, of course, speaking of George's contributions of corrosion prevention, adhesives and specialty lubricants.

As the owner of a gas station located next to a Chicago truck stop, George was one day approached by a customer who expressed a need for something to protect his steel coils from rust. Presented with that opportunity, George's wheels began to turn in search of a solution. It is this quick and honest response to customer-service that is still very much in place today in honor of George.

George Daubert heard a client base that cried out for support, and provided them with a solution. George mixed a rust preventative with oils to create a solution that coated and provided protection to metal of all types. The product was such a success, that George was able to sell the solution to the local steel industry. Ultimately, he founded his own business, "Nox-Rust Chemical Company" with "Daubert's Nox-Rust" now as a well-known industry term.

George Daubert discovered that metals could simply be wrapped or covered with VCI paper, and the metal would remain corrosion and rust-free.



George Daubert found a new, more effective, environmentally-friendly method of corrosion inhibition. VCI paper eliminates the need for messy oils and greases. Note the rust-free brake part protected with VCI paper on the left, and an identical part unprotected on the right, full of rust and corrosion. Which part would your customers like to receive? (Photo courtesy of Metalforming Magazine)

Daubert then experimented with mixing his rust preventatives with volatile chemicals which could transport the rust preventatives from a carrier to the surface of metals. He noticed that his tools that were close in proximity to the rags that were soaked in this mixture remained rust-free! VCI (Volatile Corrosion Inhibitor) was born! He further experimented with his mixture by coating it on a carrier (paper). Tools and metals within 12” of the paper were protected! Now, metal parts would not need to be coated with thick, messy oils and greases. Metals could simply be

wrapped or covered with VCI paper, and the metal would remain corrosion and rust-free.

In the 1940’s, Washington, in the midst of World War II, caught wind of George’s corrosion solution. Parts being shipped to Europe could now be protected, using VCI technology instead of oils and greases. VCI was also used to safely ship spare parts to troops, and to protect equipment and armaments in the field.

As “Daubert’s Nox Rust” grew, protection ranged from the marine and automotive industries to farm equipment and heavy trucks. Each industry has specific rust-protection needs, specific industry parts where George’s idea provides them with solutions.

As “Daubert’s Nox Rust” grew, protection ranged from the marine and automotive industries to farm equipment and heavy trucks.

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Again, the quick response to the needs of customers is always of utmost importance with such a vast line of products to offer.

An idea that started in the 1940's is now the standard procedure for metal parts manufacturers and metal parts fabricators around the world. Today, the military, as well as the automotive, marine, transportation, aerospace, HVAC, heavy equipment, powdered metal, metalcasting, metal stamping, spring and coil, gear, precision machining, firearms, precision machining, and general industrial industries all continue, even today, to benefit from the use of VCI, specialty coatings, and corrosion preventatives. To think it all started with George Daubert, a small question and a big solution.

Green Packaging, Inc. carries a complete line of VCI paper, VCI poly bags, VCI poly sheeting, VCI emitters, VCI impregnated foams, VCI wire, VCI netting, VCI corrugated, and many other VCI devices for prevention of corrosion on virtually any type of metal.

Visit www.Green-VCI.com/book for more information and a special offer.

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HOW VCI WORKS (THE SIMPLE EXPLANATION)

The Simple Explanation

Corrosion is responsible for damage to fabricated metal parts, and also in automobile electronic parts, computer parts, mobile phones and more. During production, storage, or shipping corrosion protection is very important. Corrosion inhibiting packaging can guarantee that metal components meet required levels of purity before assembly or further processing.

Corrosion is a result of oxidation, moisture or destructive elements coming in contact with the metal surface. Many materials that protect against corrosion such as oil, grease or paint are harmful to the environment and costly to apply. VCI (Vapor Corrosion Inhibitor) technology works on a molecular level to protect metal surfaces against corrosion and oxidation.

VCI works by creating an invisible molecular protection layer on metal surfaces. The corrosion inhibitor migrates out of the packaging products (including film, foam, paper, tablets, etc), and into the packaging environment where metal parts are packaged. This environment is subsequently saturated with the corrosion inhibitor and a thin molecular protection layer adheres to all metal surfaces. VCI technology works on a molecular level to prevent corrosion and rust on all surfaces of the metal, including recessed areas, holes, and “nooks and crannies”.

Metal parts come in many different shapes, weights and sizes. For this reason VCI packaging technology is available in different forms such as film, foam, paper, emitters, powders, and liquids.

VCI Packaging Film:

VCI corrosion protection film can be used in bags, covers, and simply as film. Film VCI packaging can be used to pack large machines, pallets, and bulky parts that need to be wrapped for protection. Film can also be used to package large machines for transport.

Metal parts come in many different shapes, weights and sizes. For this reason VCI packaging technology is available in different forms such as film, foam, paper, emitters, powders, and liquids.

VCI Packaging Foam:

VCI corrosion protection foam comes in various sized pieces and can be added to non-corrosion protected packaging. It is especially useful when placed inside electrical cabinets, boxes, crates, or hermetic packages. Combining VCI packaging film and foam enables faster saturation of the corrosion inhibitor so that high-tech components are quickly protected from corrosion.

VCI Packaging Paper:

VCI paper can be used to wrap metal parts, interleaved between layers of parts, or draped over parts. Sheets of VCI paper can be placed inside wooden crates or boxes.

VCI Packaging Emitters, Powders, Tablets and Liquids:

VCI emitters can be used in closed cabinets to protect electrical parts. VCI powder can be added to a closed system, especially water systems. VCI tablets can be placed in small packages. VCI liquids are also available for coating metal parts.

Methods of VCI packaging can be combined to provide the longest and most effective degree of protection metal parts manufacturers need. Consult

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a VCI packaging specialist to ensure that metal parts are adequately protected from environmental factors like salt, moisture, air, temperature, and other elements.

It is very important to package metal materials immediately when they are manufactured because after they are corroded no VCI packaging material can repair them.

Green Packaging, Inc. carries a complete line of VCI paper, VCI poly bags, VCI poly sheeting, VCI emitters, VCI impregnated foams, VCI wire, VCI netting, VCI corrugated, and many other VCI devices for prevention of corrosion on virtually any type of metal. Visit www.Green-VCI.com/book for more information and a free offer

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HOW VCI WORKS: THE TECHNICAL STUFF (THE SCIENCE BEHIND VCI)

We've talked at length about corrosion and how it presents itself in metals. Corrosion, simply, is the natural reaction of pure metals with oxygen. We've learned that this reaction is immediate and continuous unless the corrosion cell which perpetuates the reaction is stopped. Let's look at corrosion inhibitors in general and VCI's specifically in more detail.

A corrosion inhibitor in general is any chemical that can stop corrosion. However, this definition is quite broad and there are literally hundreds of chemicals that have been used at one time or another as an inhibitor in some form of application. There are nitrite chemistries, mono, di, and tri-amine chemistries, benzoates, molybdates, triazoles, phosphates, gluconates, thiourea, carboxylic acids of varying molecular weight, on and on, etc., ad nauseam. Let's just stop because we can't name them all. Not all of them are the safest or the best but in a world of companies desperate to stop costly corrosion many so-called solutions have come forward. A recent Google search found a listing of 762 listings for corrosion inhibitors manufactured solely in China. The fact is, there are so many applications for inhibitors, so many types of metals and alloys to protect, that many chemicals have been studied and used for this purpose. A good, highly effective inhibitor has great value.

Moreover, there are many ways in which an inhibitor can accomplish its goal. For instance there are inhibitors that bond to the metal surface (both

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volatile forms and non volatile forms), oxygen scavenging inhibitors, water soluble inhibitors, cathodic protecting inhibitors, inhibitors that perform by strengthening the oxide layer and inhibitors that neutralize attacking acids. The real question is: what works best for you and your metal parts? Green Packaging, Inc. is committed to helping you find the right solution to your corrosion problems; and Green Packaging, Inc. has years of experience analyzing packaging needs and selecting the products that can solve your problems effectively, economically, and in an environmentally responsible way.

The VCI packaging materials supplied by Green Packaging, Inc. are selected because they employ formulations that use more than one and sometimes many of the mechanisms for inhibiting that we have mentioned. We offer products of value that have been impregnated with chemicals that slowly volatilize and fill packing air spaces.

- » These chemistries can neutralize acidic gases in the air space that may be present from other manufacturing-related operations.
- » Some of the chemistries can scavenge oxygen. This doesn't mean that they have the ability to remove all the air from a package. What it means is they reduce the amount of oxygen that can be dissolved in water. Remember, the electrolyte has to be present with oxygen in it for corrosion to occur.
- » Some inhibitors deposit on metal surfaces, attracted to the electrons on the surface, providing barrier properties to oxygen and moisture
- » Some inhibitors perform by passivating the metal surface and strengthening the oxide layer on the surface of the metal.

Green Packaging, Inc. has years of experience analyzing packaging needs and selecting the products that can solve your problems effectively, economically, and in an environmentally responsible way.

Good corrosion inhibitors will employ a range of chemistries and mechanisms to accomplish their goal. In fact with today's electronic products and the use of ever more exotic alloys and metal combinations, today's average metal part needs several chemistries and mechanisms to insure their effectiveness.

Once again there are many inhibitor chemicals out there, some of them specific to steel alloys, some of them specific to other specialty metals. For example



the effectiveness of benzotriazole on copper and copper alloys is excellent, yet some companies try to tout it as an inhibitor for other metals even though its effectiveness on other metals is much less effective, especially when compared to the performance of other inhibitors. Once again, in many of today's applications, just one

inhibitor isn't going to cut it anyway. Contact Green Packaging, Inc. for a full assessment of your metal corrosion issues and the right VCI packaging product(s) to protect your metal parts from corrosion damage.

Now we have discussed inhibitors and we have mentioned that some of them behave by volatilizing to reach the metal. These products have, of course, the unique name of VCI or Volatile Corrosion Inhibitor. VCI's are of sufficient molecular weight that they have the characteristic of being a solid at room temperature but with a high enough vapor pressure that they can immediately vaporize into a gaseous state.

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Vapor Pressure is a measure of a material's tendency to escape its solid or liquid form and become a gas. If vapor pressure is high then it is considered to be more volatile. A fact of nature is that as temperature increases the vapor pressure of solids and liquids increase, so with VCI's the chemistries become available at a higher concentration in warmer temperatures. This is exactly when those chemicals are needed most, because higher temperatures can accelerate corrosion.

VCI chemicals are a unique class of corrosion inhibiting compounds, which have sufficient vapor pressure to release molecules from the compound into the air. When equilibrium is reached inside the packaging environment, the air inside is completely saturated with corrosion inhibiting vapors, keeping your parts free of corrosion. This environment effectively disables the mechanism by which corrosion and the corrosion cell can form. The result is metal parts that are clean, dry, corrosion-free, and ready to be used without the need for cleaning or removal of messy oils and greases.

Green Packaging, Inc. carries a complete line of VCI paper, VCI poly bags, VCI poly sheeting, VCI emitters, VCI impregnated foams, VCI wire, VCI netting, VCI corrugated, and many other VCI devices for prevention of corrosion on virtually any type of metal. Visit www.Green-VCI.com/book for more information and a free offer.

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THE COST OF CORROSION...



...To Metal Parts Manufacturers

How much money is rust costing YOUR company?

According to the National Association of Corrosion Engineers, last year, corrosion and rust cost American Industry \$360 Billion Dollars! Of that amount, nearly 30 Billion Dollars was lost by American Metal Parts Manufacturers. What can you do to prevent this tremendous loss?

How much is rust costing your company? Let's think about it...if rusted parts go out to your customer, here are just a few of the costs:

- » Return transportation
- » Re-working the parts i.e. sandblast, acid wash
- » Scrapping the parts
- » Labor in sorting and cleaning parts

More importantly, add to this the damage to your company's reputation in the eyes of your customers who receive your rusted parts. Your customers may even stop buying metal parts from your company, if they continue to receive rusty parts from you!

VCI packaging can reduce corrosion (and all of the associated costs) of metal parts in the storage and shipping process. VCI technology uses

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environmentally friendly corrosion inhibitors that are coated on packaging paper or polyethylene. These materials are used to package metal parts so that the corrosion inhibitor chemicals completely cover all surfaces of the metal. This prevents oxygen and moisture from causing corrosion and rust on the metal.

There are several VCI packaging products, designed for different types of metal. These include VCI paper, poly bags, and foam. VCI packaging works because very small amounts of the inhibitor are continually released by evaporation into the enclosed air space in the package and then settles on the metal surfaces to form an invisible thin film of protection from corrosion.

An expert in VCI technology like Green Packaging, Inc. can help your company solve even the most complex corrosion and rust issues. They can provide a complete corrosion-inhibiting solution that is designed for your specific application.

If rust seems to be a never-ending issue in your company, you owe it to yourself (and your bottom line) to contact Green Packaging, Inc. They can solve your rust and corrosion issues once and for all by using Rust Preventive VCI paper as they have done for hundreds of other companies. For more information about VCI Packaging, Rust Preventative Paper or any other VCI product, visit www.Green-VCI.com/book.

SPECIAL OFFER FOR OUR READERS: Free Corrosion Consultation

The experts at Green Packaging, Inc. are uniquely qualified to solve corrosion and rust problems companies in these industries, as well as others. No matter how small or how large your corrosion and rust issues are, you can count on Green Packaging, Inc. to solve your problems using the most effective products.

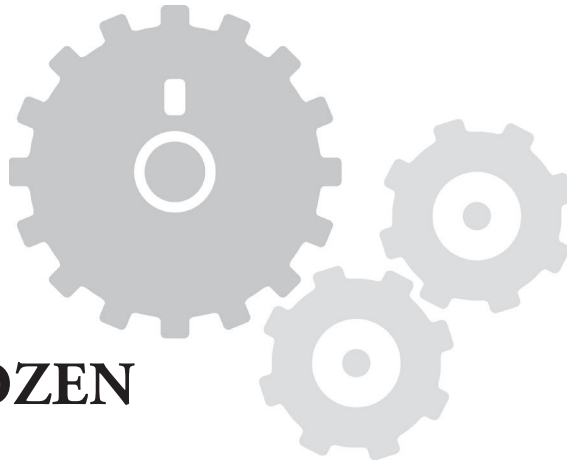
Green Packaging, Inc. offers a no-charge corrosion consultation to review your operations and to determine if there are procedures that can be implemented

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to help you prevent corrosion. Sometimes, the solution is as simple as having workers wear gloves when handling metal parts; and sometimes it is a more complicated solution integrating changes in handling, cleaning and packaging procedures. You can be sure that the recommendations Green Packaging, Inc. makes will end your corrosion and rust problems once and for all. Visit www.Green-VCI.com for details.

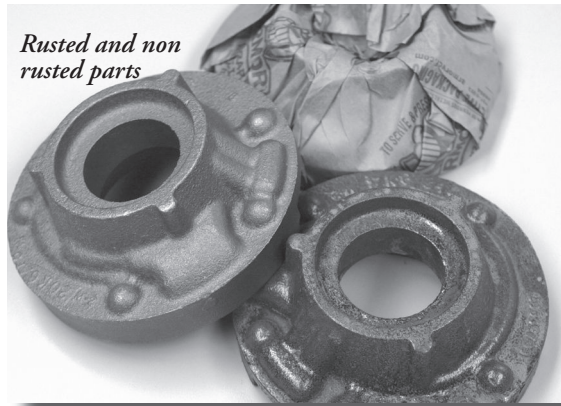
9

THE DIRTY DOZEN



The 12 most common mistakes that metal parts manufacturers make that can lead to rust and corrosion (and how to avoid them)

I have compiled this list after 20 years of corrosion consultations with hundreds and hundreds of metal parts manufacturers and fabricators. From local precision machine shops to foundries, to powder metal parts producers, to aircraft engine manufacturers. From Mom and Pop shops to Multi-National industrial giants. I have logged hundreds of thousands



Rusted and non rusted parts

of frequent flier miles, and during all of these travels, I have noticed one thing that all of these companies have in common: improper handling of metal parts in one form or another. Some companies were guilty of one or two of these mistakes, while

others were guilty of many more (or even all) of these mistakes. I have identified the 12 most common mistakes that metal parts manufacturers make that can lead to rust and corrosion. I call them “The Dirty Dozen”.

So, here they are listed in order, and then in a bit more detail:

1. Not wearing gloves when handling metal parts
2. Having metal parts in direct contact with: wood crates, pallets, corrugated boxes, etc.
3. Leaving metal parts uncovered and unprotected inside the plant
4. Storing metal parts in manufacturing or heat-treatment areas
5. Failure to completely dry metal parts after they come out of cleaning solution
6. Failure to keep metalworking fluids clean
7. Failure to use deionized or distilled water in cleaning fluids and metalworking fluids
8. Improper pH of metalworking fluids and wash water
9. Improper atmospheric conditions inside the plant
10. The improper use of Rust Preventative oils
11. Using the wrong type of VCI product
12. Not using enough VCI

Let's explore one hypothetical scenario.

Company XYZ produces metal parts for use in the consumer lawn and garden industry. A small start-up, they are about to grow exponentially larger overnight. They have secured a very large parts supply contract with a major heavy equipment manufacturer. They immediately triple their production workforce to meet the demands of this new contract. The products ship out in their entirety a week ahead of their expected arrival date. Yet, this is not the story's end or the successful end they had hoped to achieve.

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Many months later, XYZ Company receives a call from the major heavy equipment manufacturer. The metal parts ordered under the contract, which are now being pulled out of months of storage, are being opened to find rust prevalent on most of their parts. They need the parts replaced immediately. XYZ Company suffers from this request on many levels. They have additional transportation costs, the expense of re-working or sandblasting the parts, possibly scrapping the parts, and the labor costs of sorting and cleaning the parts, and remanufacturing many of the parts that were lost to rust. Most importantly, add to all of these costs the damage to XYZ Company's reputation in the eyes of their customer who received their rusted parts.

Green VCI products perform on a molecular level, creating a barrier on the surface of the metal that moisture, oxygen, electrolytes and contaminants cannot penetrate. This molecular layer of VCI protects the metal substrate from rust and corrosion

Using VCI products will eliminate the possibility of rust forming on metal parts. VCI products perform on a molecular level, creating a barrier on the surface of the metal that moisture, oxygen, electrolytes and contaminants cannot penetrate. This molecular layer of VCI protects the metal substrate from rust and corrosion. VCI poly bags and VCI paper are simple to use, and extremely effective at preventing moisture, oxygen and contaminants from causing rust on your valuable metal parts.

How are you contributing to your own rust issues? According to the National Association of Corrosion Engineers, last year, rust and corrosion cost American Industry \$360 Billion Dollars! Of that amount, nearly \$30 Billion Dollars was lost by American metal parts manufacturers. You can be sure that the recommendations that Green Packaging, Inc. makes will end your corrosion and rust problems once and for all. Let's look at some of the most common rust-causing culprits, twelve total, that we'll call "*The Dirty Dozen*".

THE DIRTY DOZEN

1. **Gloves, Gloves, Gloves!!**
2. **Wood is NOT Good!**
3. **Cover Up!**
4. **If You Can't Stand the Heat...Stay Out of the Heat Treat Area!**
5. **Dry Up!**
6. **Keep It Clean!**
7. **Water is Water is Water – Right? No.**
8. **It Doesn't Take a PhD to Adjust the Ph.**
9. **Keep Your Cool!**
10. **Oil is SO 1990's!**
11. **The Right Stuff**
12. **Finally! Use Enough VCI!**

1) Gloves, Gloves, Gloves!!

Our hypothetical Company, XYZ Company, recently shipped out rusted parts to a major heavy equipment manufacturer. Looking back over this large order, XYZ Management feel that they may have found one reason that the parts became rusted. It seems that both management and employees found that they could work, they thought, faster and more efficiently without wearing the gloves that the company handbook stated must be worn at all times. It seemed such a hassle to have to constantly put them on and take them off. While neither management nor XYZ's employees never once had the intention of costing XYZ Company thousands, it has indeed happened.

Are you or your employees guilty of touching metal parts with your bare hands? If so, you are not alone! This is the number one cause of excessive



and unnecessary rust on metal parts. It's also one of the most simple in the list of "The Dirty Dozen" to remedy. Acids, oils, and contaminants on human hands can cause and accelerate corrosion. Corrosion is not only unsightly; it can damage the structural integrity of metal parts. For highly machined metal parts, even a small amount of corrosion can

render the parts unusable. We have seen many, many instances where rust formed on metal parts in the exact design of a fingerprint! As an interesting side note, women's hands actually are worse than men's hands when it comes to causing rust.

There is, however, a simple solution. All employees who handle metal parts including production workers, inspectors, and packaging personnel should

own and wear gloves when handling metal parts. A very small decision on your part to outfit yourself, as well as the others that you work with, in gloves can provide you savings now and for years to come. Simple solution: wear gloves...every time! XYZ Company had certainly learned a good lesson. After the shipment of rusted parts was reviewed, dissected and discussed, a decision by both management and employees was reached. New gloves were issued that very week to each and every one in the company. Now, any metal part that is touched is safely touched by a gloved hand.

2) Wood is NOT Good!

You produce expensive metal parts that are in high demand. You also have a need to protect these parts from rust as you ship them out to your many customers. As a business owner, you make important decisions on a daily basis. Making a decision about how your parts will ship out to your customers is one of crucial importance.

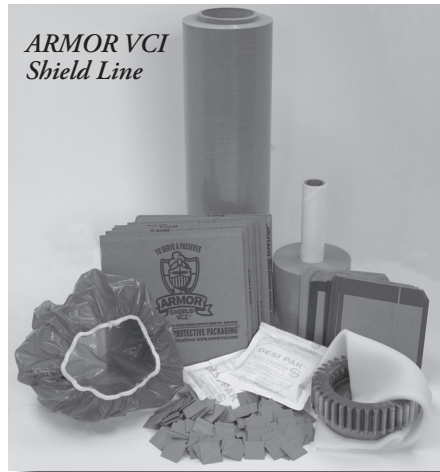
XYZ Company has once again received a complaint from a customer about rusted parts. They have been packing their parts for shipment to their customers in corrugated cartons. The metal parts were in direct contact with the sides of the corrugated carton. Those parts that were in contact with the carton became rusted.

Do you use any of the following; corrugated cardboard cartons, wooden pallets, crates, or boxes, untreated paper or plastic? If so, did you also know that each of these can contain moisture, acids, and chlorides that can cause corrosion? This is often called “contact corrosion”. In this manner, parts that come into contact with the wood, cardboard, or paper will have rust or corrosion where that direct contact occurred.

Allow VCI to provide you the solution; line your boxes and crates with a VCI poly bag or VCI paper. These create an effective barrier between your metal parts and the wood products that cause rust.

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What this means for you and your company is that your parts are at risk for sporadic rust. With this development, some parts in your shipment are rusty and some are simply rust-free. If you have ever had a customer call to complain about sporadic rust on their shipped parts, follow up with a few questions. Were just some of the parts rusted? Was the rust located on parts that were touching the box?



Once you have even one customer with this scenario, make them be the last. Allow VCI to provide you the solution; line your boxes and crates with a VCI poly bag or VCI paper. This will create an effective barrier between your metal parts and the wood products that cause rust.

XYZ Company has now begun to wrap all metal parts going out to every one of their customers in VCI paper, or they line their cartons with VCI poly bags before packing parts in them. With VCI paper and VCI poly bag protection, they now deliver their metal parts to their clientele in pristine condition.

3) Cover Up!

Hundreds of dollars' worth of rusted parts. This is the dilemma that XYZ Company was faced with recently. Metal parts that were going through the plant waiting for secondary operations or waiting to be cleaned, or packaged were left uncovered. They also had parts in their warehouse that had been stored uncovered. To make matters worse, XYZ Company has big, positive

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changes on the horizon that they should be focusing on, rather than this costly mishap.

Have you ever been guilty of this common mistake, leaving metal parts uncovered in the plant? Leaving metal parts uncovered and unprotected while they are in your plant is never a good decision. You may have parts waiting for secondary operations, perhaps others in queue for additional machining, drilling, tapping, or other operations. You may have parts that are waiting to be cleaned, packaged, inspected, or shipped. In any of these instances, deciding to leave those parts uncovered and unprotected provides an environment that makes those parts susceptible to corrosion from the plant atmosphere and forklift exhaust. Chlorides, sulfides, and oxides from fork truck exhaust all contribute to corrosion of metal parts. Parts that are left out and exposed to the plant atmosphere, even for a short period of time can become rusted. So, during lunch breaks, overnights, weekends, and summer shut-downs, always make sure that metal parts are covered or draped with VCI paper or VCI poly.



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If this type of rust seems to be a never-ending issue in your company, you owe it to yourself (and your bottom line) to contact Green Packaging, Inc. They can solve your rust and corrosion issues once and for all by using VCI rust preventive products. Starting today, make the sound decision to cover



all your metal parts with VCI paper or VCI poly bags. This will protect them from oxygen and contaminants that are in the plant atmosphere, leaving you and your customers with rust-free metal parts.

Although it takes a little extra time, XYZ Company now always keeps all metal parts covered in either VCI paper or VCI poly. Taking this extra step allows XYZ to keep all their parts clean, dry and rust-free.

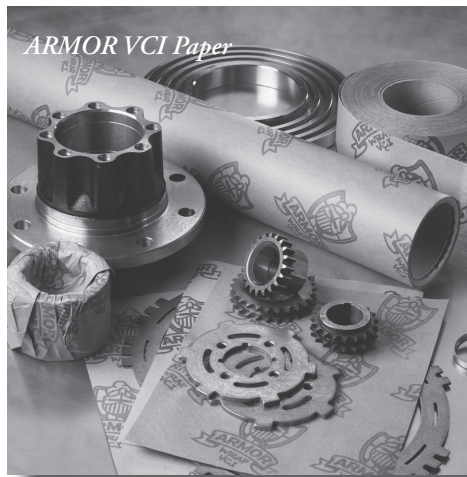
4) If You Can't Stand the Heat...Stay Out of the Heat Treat Area!

Let's once again, visit our hypothetical Company XYZ who produces metal parts for use in the consumer lawn and garden industry. They have grown since we last visited them, securing even more solid contracts for their metal parts. Because of their solid sales growth, they have begun to look at moving to a much larger facility. While that upcoming move is being considered, they have currently run out of storage space. Unfortunately, due to this lack of space, they have been storing their metal parts near their manufacturing areas, especially in their heat-treat processing areas. They were unaware that the heat treating process causes by-products that can cause corrosion on metal parts.

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Choose to protect your metal parts by covering them with VCI paper or VCI poly bags to protect them from manufacturing processes and heat treat by-products. When metal parts are packaged in VCI paper or VCI poly, the rust inhibitor chemicals migrate off of the paper or poly and deposit on the surface of the metal parts. VCI technology works on a molecular level. The rust inhibitor molecules completely cover all surfaces of the metal (including hard to reach places) and prevent oxygen and moisture from causing corrosion and rust on the metal.

Once XYZ Company realized that by storing their metal parts near their manufacturing areas, especially in their heat-treat processing areas, they were accelerating and causing corrosion on their metal parts, they immediately took action. They covered all products in VCI paper or VCI poly storage bags while in transition for their move. This decision kept all parts safe and rust-free.



5) Dry Up!

After their move to their new larger facility, XYZ Company had the opportunity to hire many new employees. Unfortunately, these new employees have immediately gotten into some very bad work day habits – the stacking of wet metal parts.

The fifth most common mistake in “The Dirty Dozen” is not allowing metal parts to dry after taking them out of cleaning solution. Stacking metal parts

on top of each other or packing them in boxes after taking them out of the cleaning solution without thorough drying is a recipe for rust. After washing parts, make sure that metal parts are not stacked on top of each other. No parts should be placed or packed into boxes until all parts are completely dry. Wet parts can rust when stacked on top of each other because the fluid will act as an electrolyte and form a galvanic cell between the two parts.

To ensure that rusted parts are not a part of your company's inventory, make sure to always dry metal parts thoroughly by placing them in a wire basket to allow the parts to air dry. Vibratory action, forced air, and heat can dry the parts more quickly. Once dried, you can then stack your metal parts. If

Dirty metalworking fluids and dirty cleaning solutions contain small metal particles. These contaminants are called "swarf". If any of the contaminants remain, a galvanic corrosion cell can form on your parts, and corrosion will occur underneath the swarf.

you are placing the parts into boxes, provide the next level of rust protection by additionally packaging the parts quickly into VCI paper or VCI bags. The VCI molecules reach all recessed areas of your parts for complete corrosion protection.

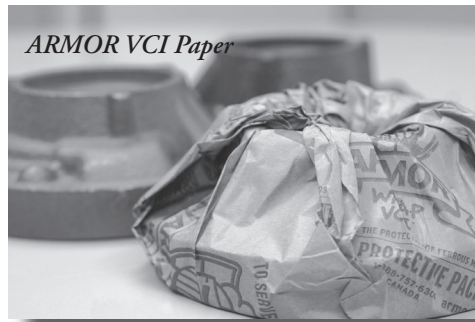
XYZ Company recently held a brief meeting with all new employees to remind them not to stack wet metal parts. Luckily, all parts with rust from this matter were located before being shipped out to any new or existing clients. To date, they have had no further instances of rusted parts from this wet stacking issue.

6) Keep It Clean!

"Swarf" is something that plagued XYZ Company in the past. Upon the receipt of a rather large, rush order for metal parts, employees trying to keep up with the demand of production, were negligent in keeping cleaning solutions clean. The result? Corroded metal parts and mandatory overtime work by all, as well as a huge added expense for XYZ Company.

It's easy to overlook this next step necessary by all to help avoid rusted parts. Dirty metalworking fluids and dirty cleaning solutions contain small metal particles. These contaminants are called "swarf". If these contaminants end up on your metal parts, they must be properly washed away. If any of the contaminants remain, a galvanic corrosion cell can form on your parts, and corrosion will occur underneath the swarf.

Always keep your metalworking fluids and cleaning solutions clean and free of dirt and swarf. Fluids and solutions should be checked on a regular basis, and kept free of contaminants that can cause corrosion. Even a small amount of



corrosion can render the parts unusable. Your customers may reject your parts and return them to you for scrap or re-work. This process is not only costly in terms of money, but also in terms of your company's reputation.

There is a policy now in place at XYZ Company that states fluids are to be checked at the top of every hour. With this simple company-wide change, everyone can rest easy knowing that clean fluids will in turn keep metal parts clean company-wide.

7) Water is Water is Water – Right? No.

Now that cleaning fluids at XYZ Company are in tip top clean shape, they have another fluid causing rust. It's the water that they use to clean their metal parts. They are about to have the water tested.

The 7th most common mistake: using public water sources for cleaning fluids and for water-based rust inhibitors. Public water can contain high chlorine

levels, and can contain other chemicals that can cause corrosion. The pH of public water can also vary greatly. Proper pH plays an important part in preventing rust and corrosion on metal parts.

It seems like a simple decision to make on your part. Consider switching from public water to distilled or deionized water. For water-based rust inhibitors, consider a ready-to-use product like Dry Coat Rust Preventative (See Chapter 17). Once applied, the clear protective coating will dry-to-touch within 30 minutes at ambient conditions. It does not attract dirt or dust on metal parts such as other sticky or tacky products. Dry Coat can be applied by dip, spray or flowcoating. It is ideal for small or large parts.

For XYZ Company, testing was indeed informative. They found that they had water with a very high chlorine level. They have now switched to distilled water for all their production needs with excellent results.

8) It Doesn't Take a PhD to Adjust the pH.

So, now that the cleaning fluids have been adjusted and maintained in our hypothetical XYZ Company, a new dilemma has come to light. It is now the pH level in their cleaning solutions that is causing corrosion. It has been caught early on so that the damage has been minimal, but they do need to remedy it right away.

So you think an old dog can't learn new tricks? Here are some new tricks that you'll soon master as they will help to protect you bottom line. It's another common mistake, improper pH of cleaning solutions. Failure to maintain proper pH levels in your cleaning solutions can quickly lead to corrosion. Proper pH levels depend on the type of metal parts you are producing. For



ferrous parts, you should maintain a pH level of at least 9.0. For non-ferrous metal parts such as copper, and alloys like brass and bronze, a pH level of 7.0 – 7.5 should be maintained. Once you commit to adopting these simple rules for your own use, their daily implementation will become commonplace in your work place.

Remember to always regularly check and correct pH levels of all your cleaning solutions. Adjust according to the manufacturer's instructions. Following these steps to the letter and you'll overcome any rust issues caused by water in no time.

pH levels in cleaning solutions are now being monitored daily by the staff at XYZ Company. It's a daily task that takes just a few moments and yet saves the company thousands of dollars!

9) Keep Your Cool!

Since XYZ Company has moved to their new building, rust on their metal parts has been sporadically occurring especially during the warm weather months. There have been many corrections made to their daily manufacturing process to eliminate this rust. Now it seems that it is the fault of the facility itself. Metal parts have been packaged in high humidity conditions, with the worst of results: rusted metal parts.

The 9th most common mistake is the failure to maintain proper temperature in manufacturing and shipping areas. For every 10 degree Celsius increase in the temperature of your metal parts, corrosion rates can double. Fluctuations in temperature can cause metal pores to open. Temperature fluctuations can also cause condensation to form on your parts. Condensation becomes an electrolyte, allowing corrosion to occur. High humidity can cause electrolytes

Even if you are producing parts in low temperature, low humidity months, they may sit on your shelf or your customer's shelf for months, which means they have been susceptible to great fluctuations in temperature, causing condensation and forming rust and corrosion.

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to form on the surface of metal parts, enabling the corrosion cell to form, and allowing corrosion to propagate.

When you package your parts in high humidity, you lock that atmosphere into your packaging. Even if you are producing parts in low temperature, low humidity months, they may sit on your shelf or your customer's shelf for months, which means they have been susceptible to great fluctuations in temperature, causing condensation and forming rust and corrosion.



There are multiple means that you can employ to making this common problem one that no longer affects you and your customers. First, maintain lower temperatures and lower humidity levels by installing climate controls, air conditioning and/or dehumidifiers. Second, continue to use rust inhibiting VCI paper and VCI bags year-round throughout your operations. This includes in-process parts that are waiting in queue for secondary operations, or waiting to be packaged. Always cover in-process parts with VCI to keep them rust-free.

Climate controls have now been installed into the new building that XYZ Company now occupies. This has given the facility an even and constant temperature in which to produce their vast array of metal parts. If this is not possible in your plant, it is especially important to keep all metal parts protected with VCI paper and VCI poly. Get those parts into VCI immediately!

10) Oil is SO 1990's!

Our hypothetical Company XYZ has more trouble today. They have finally conceded that by using Rust Preventative Oils or R.P Oils, they are creating a messy, labor intensive, and an environmentally unfriendly workplace.



Today, they have determined, is the day of change for them. Instead of continuing to use R.P. Oils, the traditional method of preventing rust and corrosion, they are switching to the more effective VCI packaging.

By making this move they save costs and provide better working conditions for all in the following areas:

- » Lower labor costs: They simply place parts in a VCI bag or wrap them in a sheet of VCI paper. No coating, spraying, dipping or brushing necessary.
- » No longer any need for messy oils and greases.
- » VCI protects their parts better than R.P. Oils. VCI molecules reach all recessed areas of their parts for complete corrosion protection.

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- » Their customers receive their products in a clean, dry state.
- » VCI protected parts can be used immediately with no need for removal of oils and greases. VCI molecules evaporate into the air when parts are removed from VCI packaging.
- » They create a more environmentally-friendly company.
- » No employee health and safety issues as with oils. No more slip and fall accidents.
- » No disposal fees (VCI is completely repulpable and recyclable).
- » Lower insurance costs (due to no flammable liquids).

By making the switch from R.P Oils to VCI paper or VCI poly bags, or Dry Coat water-based rust inhibitor liquid, Company XYZ has created an even more satisfied customer base. Additionally, company and employee morale has been improved, creating a more efficient workforce. Breaking away from industry standards will serve them well now and into the future!

11) The Right Stuff

Although XYZ Company has been carefully wrapping their metal parts for the utmost in protection against rust, it has none the less occurred once again. They ordered VCI paper from a different supplier, and that supplier sent the wrong type of VCI paper.

The 11th most common mistake: using VCI products improperly. This can include using a VCI paper designed for non-ferrous metals on ferrous metal parts. Some VCI manufacturers incorrectly state that one VCI formulation will work for every application. This is simply not true. For instance, VCI Paper for ferrous metals is designed to protect steel parts such as wires, cast metals, springs, bearings, and stampings. VCI Paper for non-ferrous metals is designed to protect non-ferrous metals such as copper, aluminum, brass,

and bronze. VCI multi-metal papers prevent corrosion on ferrous AND non-ferrous metals and multi-metal products like zinc, aluminum alloys, copper alloys and dissimilar metal components such as circuit boards. Most VCI products are coated on only one side, but all of Green Packaging's VCI papers are coated on BOTH sides. Make sure the VCI papers you purchase are impregnated with VCI on both sides. This avoids confusion about which side to place against the part when packing, as well as the ability to interleave the paper within a pallet of parts so that less paper is required in the packaging.

It is always recommended that you and your company follow the manufacturer's instructions when using VCI products. It is also advisable to consult with a VCI expert like Green Packaging, Inc. to design a VCI system for your specific application and help you implement the usage of VCI products properly.

XYZ Company has begun to purchase their VCI product from a new supplier, Green Packaging, Inc. They were provided the proper VCI products for their needs, instructed on how to use it properly and have learned that this product is coated with VCI on both sides. By making this switch, they are once again able to provide the best product possible to their customers.

12) Finally! Use Enough VCI!

Once again, Company XYZ has blundered. In an attempt to save costs, they have not been using enough VCI product. They have tried to create overall savings by using less VCI paper and less VCI poly than required to create a sufficient level of protection for their metal parts.

The most accurate formula they should follow is to use at least 1 square foot of VCI paper or VCI poly for every 1-3 square feet of metal surface. This can also be looked at as using at least one square foot of VCI for every cubic foot of void space. Once they follow this new formula, Company XYZ immediately sees those overall savings become a reality in the amount of rusted parts saved by correct implementation of VCI throughout their entire product line.

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Our hypothetical Company XYZ has found, through much trial and error, new ways to best protect their metal parts by consistently using VCI products. Your company has an advantage. You know that the easiest way to prevent rust is to call on an experienced VCI provider, like Green Packaging, Inc. VCI products continue to solve corrosion and rust problems for XYZ Company, and for thousands of companies with a variety of end products. From aerospace to HVAC equipment manufacturers, from electronics to sintered metal parts, VCI protects metal parts from rust and corrosion. Green Packaging, Inc. specializes in solving complex corrosion issues for these industries and many others. No matter how small or how large your corrosion and rust issues are, you can count on Green Packaging, Inc. to solve your problems by using the most effective and environmentally friendly VCI products.

So, as you can see, our hypothetical XYZ Company had been making a lot of mistakes in the handling of their metal parts. They were able to remedy these mistakes by calling in an expert like Green Packaging, Inc. XYZ Company (and your company) can save thousands of dollars by maintaining proper metal handling procedures. If your company is experiencing rust and corrosion issues, contact Green Packaging, Inc. so they can end your rust problems once and for all. In order to maintain good, year-round habits, XYZ Company has posted a copy of “The Dirty Dozen” for all to reference.

Green Packaging, Inc. offers a no-charge corrosion consultation in your facility to review your operations and to determine if there are procedures that can be implemented to help you prevent corrosion and rust. Sometimes, the solution is as simple as having workers wear gloves when handling metal parts; and sometimes it is a more complicated solution integrating changes in handling, cleaning and packaging procedures. You can be sure that the recommendations Green Packaging, Inc. makes will end your corrosion and rust problems once and for all. Visit www.Green-VCI.com for details.

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CHOOSING THE RIGHT VCI PAPER

Volatile Corrosion Inhibitor (VCI) paper or film when wrapped around iron, steel, or cast iron parts provides excellent rust protection and is especially useful when shipping or storing these metal parts. Many companies that ship metal parts rely on VCI paper and VCI poly bags to protect their expensive parts from corrosion and rust. These companies include foundries, machine shops, and manufacturers of gears, bearings, firearms, stampings, and heavy



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equipment. They have found that using VCI paper or VCI poly bags during storage and shipping eliminates rust. VCI paper is coated with rust inhibiting chemicals. These chemicals vaporize into the air around the metal parts protecting them from rust and corrosion. VCI paper used in shipping metal parts eradicates the need for airtight packages.

Look for environmentally safe VCI paper approved by the US military.

Choose the Right Paper for your Metal

Choose a VCI Paper Coated on Both Sides

Look for environmentally safe VCI paper.

With all those chemicals vaporizing, is VCI paper healthy for the environment and your employees' health? Not all VCI papers are alike in this respect. When purchasing rust inhibiting VCI paper, make sure to inquire whether the papers are environmentally safe, fully recyclable and repulpable, biodegradable and non-toxic. Some VCI papers contain heavy metals or other chemicals that can harm the environment. Some VCI paper formulations include the use of chemicals that can be harmful to the environment and your employees' health. Always

choose VCI papers, like the ones recommended by Green Packaging, Inc., that are healthy for the environment and your employees.

Choose a VCI paper that is approved by the US military.

Not all VCI papers are approved on the prestigious Qualified Product List (QPL) for Military specification MIL-PRF-3420. When choosing VCI paper, it is important to check to ensure that the paper is approved on this list.

Choose the Right Paper for your Metal.

Different types of VCI papers are specifically manufactured to provide the best rust protection for each particular metal. There are VCI papers designed specifically for different types of metals, and for length of time to be protected. There are huge differences in metal composition and one VCI paper cannot meet all metal protection needs for every metal. For instance, VCI Paper for ferrous metals is designed to protect steel parts and wires, die casting, springs,

bearings, and stampings. VCI Paper for non-ferrous metals is designed to protect non-ferrous metals such as aluminum, copper, brass, and bronze and other alloys. VCI multi-metal papers prevent corrosion on metal parts that are composed of several different ferrous and non-ferrous metals and multi-metal products like zinc, aluminum alloys, copper alloys. Multi-Metal VCI papers will also prevent galvanic corrosion on parts with dissimilar metal components such as circuit boards.

Choose a VCI Paper That Matches Your Application

Some companies incorrectly state that one VCI paper can work for all applications. This is simply not true. Choose a VCI paper based on your application. A wax-coated VCI paper will serve two additional purposes (in addition to rust prevention). It will keep any excess oil and grease on the part inside so it will not leach out and ruin the outer box. The wax also keeps moisture away from the part. Wax coated VCI paper will also conform to the part better, and stay in place when you wrap the part. Poly coated VCI papers provide extra puncture resistance (useful for heavy or sharp parts) and will also be a very effective moisture barrier, keeping moisture away from the part. Reinforced VCI paper would be an excellent choice for very large and very heavy parts. Reinforced, poly coated VCI paper is an excellent liner for crates and wooden boxes, especially if they are being shipped by sea.

Choose a VCI Paper Coated on Both Sides

Make sure the VCI papers you purchase are impregnated with VCI on both sides. This avoids confusion about which side to place against the part when packing, as well as the ability to interleave the paper within a pallet of parts so that less paper is required in the packaging.

Green Packaging, Inc. carries a complete line of VCI paper, VCI poly bags, VCI poly sheeting, VCI emitters, VCI impregnated foams, VCI wire, VCI netting, VCI corrugated, and many other VCI devices for prevention of corrosion on virtually any type of metal.

Visit www.Green-VCI.com/book for more information and a special offer.

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VCI vs. RUST PREVENTATIVE OILS



Rust and corrosion contribute to waste—of both metal parts and money for businesses and consumers. Rust and corrosion are both unsightly and can greatly damage and weaken the structural integrity of metal parts, causing them to become unusable.

Some metal parts fabricators and metal forming companies use rust preventative oils instead of rust preventative paper to prevent metal pieces and parts from corrosion and rust. The R.P. oils act as a barrier or coating between the metal and the elements, shielding parts and pieces from salt, moisture, air, gases, and contaminants. These R.P. oils are effective in preventing rust and corrosion, but have negative side effects.

Let's compare R.P. oils to a rust preventative paper alternative.

R.P. Oils: Both time consuming and labor intensive to apply rust preventative oils, usually by spraying, dipping, or brushing on metal parts.

Rust Preventative VCI Paper: VCI paper and VCI poly bags are easy to use and require very little labor, as parts are simply wrapped in VCI paper or placed in a VCI poly bag and remain corrosion-free for years.

R.P. Oils: Rust Preventative oils pollute groundwater, lakes, and streams.

Rust Preventative VCI Paper: VCI paper and VCI bags are clean, dry, and safe for the environment. They contain no harmful chemicals and are completely safe to use.

R.P. Oils: To effectively dispose of storage containers and R.P. oil soaked items can be very costly.

Rust Preventative VCI Paper: rust preventative VCI paper is completely 100% recyclable, and VCI poly bags can be reused and/or recycled.

R.P. Oils: These oils can take a toll on employee health (they're known to contain carcinogens), VOC's, and cause slip and fall accidents. Also, rust preventative oils are flammable and dangerous to store in your plant.

Rust Preventative VCI Paper: The VCI bags and VCI paper, recommended by Green Packaging, Inc., have no harmful VOCs. The packaging is effective in that rust preventive paper bags are pre-coated with rust inhibiting chemicals, which migrate off the paper onto the metal surface. These molecules cover the entire metal surface and prevent moisture and air from corroding and rusting parts. No mess, no danger to employees.

If your company is still using out-dated corrosion inhibitors such as oils and greases, now is the time to switch to environmentally-friendly, clean, dry VCI products. VCI products are used by 90% of the Fortune 500™ industrial companies. Shouldn't your company be using VCI, the modern, safe, effective method of corrosion prevention?

Contact Green Packaging, Inc. to investigate the possibility of switching from oils and greases to VCI paper and VCI poly bags. Visit www.Green-VCI.com/book for a special offer.

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VCI PAPER vs. VCI POLY

Paper or Plastic?

That's a question that you most often hear when shopping at your local grocery store. But it also is a question you can ask regarding VCI products.

From strictly a corrosion inhibitor standpoint, paper has been a better inhibitor of rust due to the way that the VCI is topically coated onto the paper, and is very quickly released into the air and onto the metal product. VCI papers have been in existence for more than 50 years, first adopted by the United States Military. VCI paper, because of paper characteristics and the immediate availability of the VCI, is able to protect a part quicker coming off of a paper, than it is off of polyethylene. This is not to say that VCI poly is not an excellent product or that it does not have its place. However, from a pure rust inhibitor issue, paper has proven to be slightly more effective especially in terms of quick protection for metal parts. This is particularly important for metal parts that are porous such as cast iron, and for metals that are susceptible to flash rust or quick corrosion.

VCI poly film has several advantages over VCI paper as a corrosion inhibiting packaging medium. The biggest advantage of VCI poly is that it provides a moisture barrier in addition to corrosion inhibiting properties. VCI poly bags also offer ease of usage by simply placing a metal product into a treated VCI poly bag. VCI poly bags provide long-term protection against rust and corrosion, 5 years or longer. VCI poly bags are also transparent, so products

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can be easily identified, inspected, inventoried, etc. without removing them from the VCI. This is something that cannot be done with VCI paper.

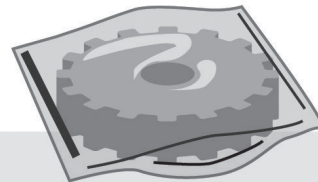
So the question still is, which is better, paper or poly, and the answer is...it depends! It depends on your specific application, your needs, your priorities, and your preferences. Green Packaging, Inc. will determine the best and most effective VCI products for your exact application. In some cases, the best solution is a combination of VCI paper and a VCI poly bag. This combination will give you the best of both worlds...immediate AND long-term protection with a moisture barrier.

INDIVIDUAL PACKAGING RECOMMENDATIONS:

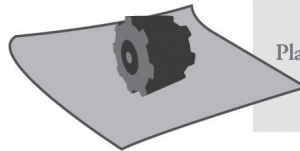
Small Individual Parts

Selecting between VCI paper and VCI bags is sometimes a decision based on a distribution cycle, packaging, production, line constraints, marketing quantity, and ergonomics.

Adequate sealing methods include heat seal, tape, staples or fold over. If parts are shipping export or require long term storage, a complete seal is necessary and folding film over will be inadequate



Place gear or individual parts inside Poly VCI bag and seal for best protection or wrap completely in VCI paper



These recommendations are based upon professional recommendations in conjunction with our customers. Since every situation is different, it is recommended to conduct a "real life" test shipment for best results.

Green Packaging, Inc. carries a complete line of VCI paper, VCI poly bags, VCI poly sheeting, VCI emitters, VCI impregnated foams, VCI wire, VCI netting, VCI corrugated, and many other VCI devices for prevention of corrosion on virtually any type of metal.

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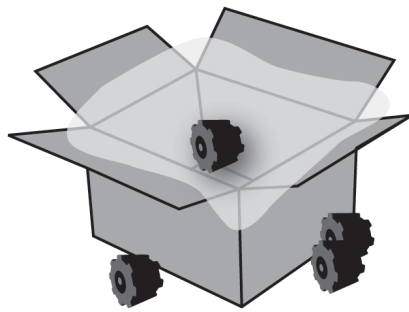
THE MANY ADVANTAGES OF USING VCI POLY BAGS

- » VCI poly bags create a moisture barrier, protecting your metal parts from moisture. Moisture is one of the main causes of corrosion.
- » VCI poly bags prevent dust and contaminants from affecting your parts. Dust and contaminants in the air can often accelerate corrosion.
- » Metal parts, electronic components, and equipment made out of ferrous or non-ferrous metals, packaged in VCI bags may not require any other additional packing.
- » VCI poly bags are transparent so parts inside can be inspected, inventoried, etc. without the need of opening the VCI packaging.
- » VCI poly bags can withstand temperature from -60 degree F to 200+ Degrees F.
- » VCI bags can be manufactured to your exact size specifications. Or you can choose from dozens of stock size VCI bags.
- » VCI poly material is 100% recyclable.
- » VCI poly bags are economical and they can even be re-used.
- » VCI poly material is water, oil, and grease resistant.
- » VCI poly bags have high tensile strength making them extremely tear resistant and puncture resistant.

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- » VCI poly bags provide excellent corrosion inhibiting properties, and can prevent corrosion on all types of metals, including carbon steel, chrome, stainless steel, copper, brass, aluminum, silver, silicon steel and galvanized steel.
- » VCI poly bags are easy to use and require very little labor, as parts are simply placed in a VCI poly bag and remain corrosion-free for years.

BULK PACKAGING RECOMMENDATIONS: Small Quantity of Parts in a Box

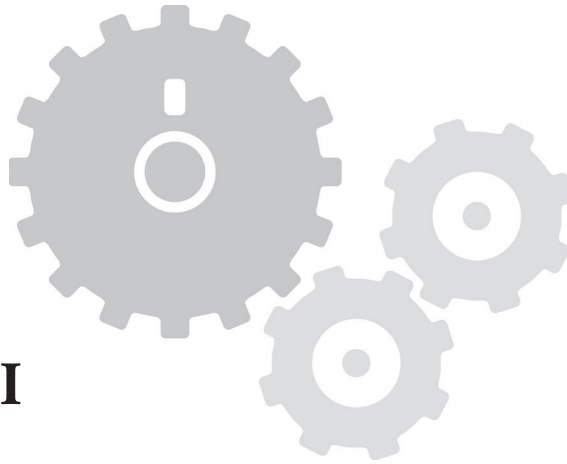


For a small quantity of parts inside a box, simply line the box with a poly VCI bag. When packing is completed, close and seal the bag immediately to contain VCI vapors inside of the pack. Adequate sealing methods include heat seal, tape, twist tie, staples or folding the bag over. For export or longer term storage, seal bag as outlined as opposed to simply folding over.

These recommendations are based upon professional recommendations in conjunction with our customers. Since every situation is different, it is recommended to conduct a "real life" test shipment for best results.

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TIPS ON USING VCI



One of the biggest reasons why metal parts become rusted is because of improper handling of those parts while they are in your plant. Metal parts should never be left exposed to the air in your plant. Contaminants in the air, fork truck exhaust, and by-products of your manufacturing process can all contribute to accelerating rust and corrosion.

Metal parts that are in-process or waiting for secondary operations should be covered with VCI paper or placed in a VCI bag for corrosion protection. By keeping your parts protected with VCI, you will prevent the contaminants in the air, and corrosion-causing elements (oxygen, salt, moisture, etc.) from affecting your parts. It's important to remember that VCI's will completely evaporate when parts are removed from the VCI, so no cleaning or removal is necessary, even if the parts are to be welded or painted.

Packaging personnel should always wear gloves while handling metal parts. Parts should be clean and free of fingerprints before wrapping. Package your clean products in VCI as quickly as possible.

The unprinted side of VCI paper should face the metal, unless you are using one of the VCI papers recommended by Green Packaging, Inc. All of the papers recommended by Green Packaging, Inc. are coated on both sides. This eliminates confusion on the plant floor.

The metal part should be no more than 12 inches from the VCI product. The closer the VCI is to the metal, the better the corrosion protection. As

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a general rule, use 1 square foot of VCI paper or film for every 1-3 square feet of metal surface. Use at least square foot of VCI for every 1 cubic foot of void space. Use VCI to separate metal from acidic packing materials such as corrugated boxes and wooden pallets in order to prevent corrosion at the contact points. The duration of protection depends on the type of VCI paper or VCI film and the packing method used. Packages may be opened and resealed without affecting the corrosion protection. (Avoid touching metals with bare hands during the inspection). Inventory no more than a six month supply of VCI packaging. Store unused VCI in a cool, dry place, away from direct sunlight. For best results, Green Packaging recommends testing the VCI product for compatibility prior to use. We provide this service for our customers at no charge.

One final suggestion is to make sure that your metal parts are not in direct contact with wooden pallets, wooden crates, and corrugated boxes. Moisture, acids, and chlorine that is common in these products can all accelerate corrosion, especially in those areas where the parts are in direct contact with the wood or corrugated. This is known as contact corrosion, and it will be prevented if you create a VCI barrier between your parts and the wood or corrugated. Simply place a sheet of VCI paper or VCI poly sheeting between the parts and the wood or corrugated, or line corrugated boxes with a VCI poly bag or VCI paper.

By following these simple procedures outlined above, you will greatly reduce the likelihood of corrosion and rust affecting your parts, your bottom line, and your reputation.

Here is a review of proper VCI and metal handling tips:

- » Packaging personnel should always wear gloves while handling metal parts.
- » Parts should be clean and free of fingerprints before wrapping.
- » Package your clean products in VCI as quickly as possible.
- » The unprinted side of VCI paper should face the metal.
- » Metal parts should be no more than 12 inches from the VCI product. The closer the VCI is to the metal, the better the corrosion protection.
- » As a general rule, use 1 square foot of VCI paper or film for every 1-3 square feet of metal surface.
- » Use at least square foot of VCI for every 1 cubic foot of void space.
- » Use VCI to separate metal from acidic packing materials such as corrugated boxes and wooden pallets in order to prevent corrosion at the contact points.
- » The duration of protection depends on the type of VCI paper or VCI film and the packing method used.
- » Packages may be opened and resealed without affecting the corrosion protection. (Avoid touching metals with bare hands while inspecting).
- » Green Packaging, Inc. recommends inventorying no more than a six month supply of VCI packaging
- » Store unused VCI in a cool, dry place, away from direct sunlight.
- » For best results, Green Packaging, Inc. recommends testing the VCI product for compatibility prior to use. Green Packaging, Inc. provides this service for their customers at no charge.

BULK PACKAGING RECOMMENDATIONS:

Bulk Engines in Returnable Dunnage

Selecting between VCI paper and VCI bags is sometimes a decision based on a distribution cycle, packaging, production, line constraints, marketing quantity, and ergonomics.

ARMOR Shield® Desiccants

Be sure to lay down ARMOR Poly® VCI bag FIRST to prevent moisture from getting into package from bottom holes in dunnage.



Be sure to seal top of bag completely

ARMOR Wrap® VCI paper

Engines

These recommendations are based upon professional recommendations in conjunction with our customers. Since every situation is different, it is recommended to conduct a "real life" test shipment for best results.

Green Packaging, Inc. carries a complete line of VCI paper, VCI poly bags, VCI poly sheeting, VCI emitters, VCI impregnated foams, VCI wire, VCI netting, VCI corrugated, and many other VCI devices for prevention of corrosion on virtually any type of metal.

Visit www.Green-VCI.com/book for more information and a special offer.

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USING VCI ALL YEAR LONG

We recommend using VCI paper and VCI bags year-round, to ensure that your parts remain rust-free. Even if you are producing parts in low temperature, low humidity months, they may sit on your shelf or your customer's shelf for months, which means they have been susceptible to great fluctuations in temperature, causing condensation and forming rust and corrosion. The simple solution is to continue to use rust inhibiting VCI paper and VCI bags year-round throughout your operations. This includes in-process parts that are waiting in queue for secondary operations, or waiting to be packaged. Always cover in-process parts with VCI to keep them rust-free

Many metal parts manufacturers and fabricators typically use VCI paper and VCI bags only in the warm, humid months of spring and summer. While it is important to protect your metal parts from rust and corrosion during those warm months, it is equally important to provide VCI protection for your parts during the cold winter months.

There are several reasons for using VCI products during the winter months. Here are some of them:

Your parts are packed indoors at room temperature. When you ship those parts by truck, they are subject to much colder weather, and then when your parts are delivered to your customers, they go back indoors to room temperature. These fluctuations in temperature will cause condensation to form on your parts, causing them to be susceptible to corrosion and rust.

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Proper packaging with VCI products will prevent rust and corrosion even in the midst of condensation.

While your parts may be shipped to your customer in January or February, they may end up on your customer's shelf until June or July, and will at that time be subject to higher temperatures and high humidity. These conditions will cause condensation and rust to form. Again, the proper use of VCI packaging will prevent rust from forming.

If you use VCI products only for part of the year, your employees can get out of the habit of using VCI products, and could ship parts during summer months without VCI protection. By using VCI products to protect your parts all year long, every shipment, your employees get in the good habit of protecting every shipment all year long, and eliminating rust and corrosion all year long.

Green Packaging, Inc. carries a complete line of VCI paper, VCI poly bags, VCI poly sheeting, VCI emitters, VCI impregnated foams, VCI wire, VCI netting, VCI corrugated, and many other VCI devices for prevention of corrosion on virtually any type of metal.

Visit www.Green-VCI.com/book for more information and a special offer.

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VCI: A BETTER ENVIRONMENTAL CHOICE

Buying VCI products serves two purposes: You are protecting your metal parts from corrosion AND protecting the environment at the same time. VCI Papers are made from 100% recycled kraft paper, are repulpable, recyclable, and biodegradable. VCI poly products are recyclable, and some are biodegradable.

Choosing a VCI paper or VCI poly from Green Packaging, Inc. is a more environmentally-friendly choice than using petroleum-based rust preventative oils and greases. Green Packaging, Inc. VCI products are completely non-toxic. In fact, most of the VCI chemistry used in our products is actually food grade preservatives.

Unlike many of our competitors' VCI products, Green Packaging, Inc. carries a line of VCI products that do not contain phosphates, silicones, chromates, or any other heavy metals.

VCI products are the natural choice for sustainable, earth-friendly corrosion inhibiting packaging. VCI products are healthy for the environment, your employees and your customers.

VCI paper and VCI poly products are a unique line of environmentally-friendly corrosion inhibitors. Rust inhibiting chemicals are coated or impregnated into paper or polyethylene. When metal parts are packaged in VCI paper or VCI poly, the rust inhibitor chemicals migrate off of the paper or poly and deposit on the surface of the metal parts. VCI technology works on a molecular level. The rust inhibitor molecules completely cover all surfaces of the metal

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(including hard to reach places) and prevent oxygen and moisture from causing corrosion and rust on the metal.

Green Packaging, Inc. VCI papers (rust inhibitor paper) are environmentally safe, fully recyclable and repulpable, biodegradable and non-toxic. Compare to traditional methods (using oils and greases) VCI papers are an excellent environmental choice.

Green Packaging, Inc. carries a complete line of VCI paper, VCI poly bags, VCI poly sheeting, VCI emitters, VCI impregnated foams, VCI wire, VCI netting, VCI corrugated, and many other VCI devices for prevention of corrosion on virtually any type of metal.

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DRY COAT™ RUST PREVENTATIVE



Dry Coat™ Rust Preventative is a water-based liquid RP for ferrous metals. This water-based product is a significant advancement in corrosion prevention technology that replaces solvent and oil-based corrosion inhibitors. Once applied, the clear protective coating will dry-to-touch within 30 minutes at ambient conditions. It does not attract dirt or dust on metal parts such as other sticky or tacky products. It is nonhazardous and easily washes off using mild detergents or common metal cleaning solutions. Dry Coat™ is safe to use on ferrous metals,

stainless steel and will not harm most elastomers or plastics.

Application/Usage:

- » Can be applied by dip, spray or flowcoating
- » Ideal for small parts in large quantities such as nut and bolts, fasteners or hardware
- » Works well for export equipment or machinery

- » Gears, pipes, flanges, cast iron, ferrous metals
- » Odd shaped parts that cannot be placed into a bag or wrapped with paper
- » Provides indoor protection up to one year (not recommended for outdoor use unless combined with other VCI products that contain VCI and UV inhibitors)

Product Features/Advantages/Benefits:

- » A superb and safe water based rust preventative
- » Dries to the touch-no sticky, messy liquids to clean up

Dry Coat™

Rust Preventative Liquid: Dries to the touch!

- » Keeps parts clean and free from corrosion
- » Displaces water and oil from metal surfaces
- » Saves time and money compared to other wrapping methods
- » Replaces hazardous oils, flammable solvents, sticky RPs
- » Formulation is non-toxic and environmentally friendly
- » Ready to use product, VOC free
- » Removes easily, if needed, with mild detergents or cleaners
- » Valued ARMOR brand is a trusted name that means reliability, service and confidence

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METAL RESCUE™ RUST REMOVER



If you forgot to take advantage of all of the rust prevention tips included in this book, and you have rusty parts sitting in your warehouse or shop, we would like to introduce you to rust's worst enemy: Metal Rescue™. Metal Rescue™ is safe on everything EXCEPT rust! This revolutionary liquid metal rust remover is easy, clean and safe to use. It utilizes a unique and selective chelating agent to remove rust (iron oxide) without posing any health, safety or environmental concerns. No acid involved in the whole metal rust removal process - it's fully environment friendly!

Product Features/Advantages/Benefits:

- » Easy to use, virtually no labor involved (no scrubbing, dipping, brushing or other agitation)
- » Just soak the part in a plastic container for 10 minutes – 24 hours
Depending on the severity of the rust
- » SAFE: no acids, no caustics, no health risks, non-toxic, safe on skin

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- » Environmentally friendly: Safe for most drains or sewer systems (check local laws for compliance)
- » Cost-effective: Most efficient, easiest and safest way to remove rust
- » Does not compromise any mechanical properties or functionality
- » Valued ARMOR brand is a trusted name that means reliability and confidence
- » Can be used in conjunction with other VCI products
- » Product is available for immediate use upon removing from liquid
- » After de-rusting, place part inside an VCI product for shipping or storage

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CONCLUSION



In conclusion, as we have seen in this book, there are many different types of metals, all with unique characteristics. All of these metals require different forms of corrosion protection. There are also a wide variety of methods to prevent corrosion on these metals. As discussed in this book, we recommend VCI products to prevent rust and corrosion on virtually all types of metals and alloys.

VCI products are the safe, effective way to prevent rust and corrosion on metal parts. VCI products are environmentally-friendly, easy to use, economical, and extremely effective in preventing rust and corrosion on fabricated metal parts.

Green Packaging, Inc. sells many different brands of VCI products, but we recommend ARMOR VCI products. Since 1979, ARMOR WRAP® papers have been the industry standard for VCI paper technology. From the best-selling ferrous protection paper in the automotive industry, ARMOR WRAP® 30R, to the versatile ARMOR WRAP® MPI Multi-Metal paper, ARMOR offers more than 12 kinds of VCI impregnated papers for specific packaging applications and metals. All papers are available in cut sheets, rolls and paper bags with wax, poly coating and reinforcement for the most challenging applications.

Recently, VCI poly bags have become increasingly popular for a variety of reasons cited in Chapter 13 of this book. Armor VCI polyethylene films come in a variety of forms to suit various packaging needs. The broad lines of high performance Armor VCI polyethylene products includes bags, sheets, rolls,

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tubes, auto bags, elastic bonnets, gusseted liners and shrink film, in addition to other custom VCI poly products. Armor VCI films are transparent and heat sealable and provide the combined benefit of moisture barrier and anti-corrosion protection in a simple to use form.

This book was written to educate metal parts manufacturers about rust and corrosion. The information we provide is intended to help them avoid problems that rust and corrosion present in the manufacturing, storing, and shipping of metal parts. The information presented in this book is a product of 20 years' experience in the industry, and all opinions and statements made in this book are those of the author and not ARMOR Protective Packaging. Green Packaging, Inc. is a distributor of ARMOR VCI products, but is not affiliated with ARMOR in any other way. Green Packaging, Inc. is a family-owned, privately-held company that markets corrosion and rust inhibiting products to metal parts manufacturers in North America.

We encourage your feedback, comments and questions. Please contact us by e-mail: info@Green-VCI.com, or call us toll-free 1-855-4-NO-RUST (1-855-466-7878)

Thanks for reading; I hope that the information presented in this book was informative and useful to you.

Wayne Siefert, *President*
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A recognized leader in anti-corrosion packaging

About Green Packaging, Inc.

Green Packaging, Inc. has a unique philosophy about selling VCI corrosion inhibitors. Most companies that sell VCI products also sell traditional packaging materials like bubble wrap, tape, strapping, and even janitorial supplies. Green Packaging, Inc. specializes in VCI corrosion inhibitors. Our expertise goes back over 20 years, and our knowledge about VCI products is second to none in the industry. We are experts in the field of corrosion inhibition and we specialize in solving complex corrosion problems for manufacturers all over the country.

We offer a consultative, multi-faceted approach to design a unique, powerful corrosion inhibiting system for your specific application. There is no “one size fits all” approach at Green Packaging, Inc. We will meet with you to discuss your situation, and we will learn about your business, your industry, your corrosion problems, and your corrosion inhibiting needs. In return, we will educate you not only about our Green VCI products, but we will also educate you about changes that you can make to your processing that can reduce or eliminate corrosion and rust. Many times, our suggestions can reduce the amount of corrosion you are experiencing without even selling anything. Minor changes such as wearing gloves when handling metal parts can reduce rust and corrosion.

- » Green Packaging, Inc. offers a no-charge corrosion consultation
- » Green Packaging, Inc. offers state-of-the-art accelerated corrosion testing in our labs at no charge
- » Green Packaging, Inc. provides free samples

The experts at Green Packaging have solved corrosion problems for some of the largest metal parts manufacturers in the world. We are experts in the field of corrosion inhibition and we specialize in solving complex corrosion problems with environmentally healthy solutions.

Our prices are lower than conventional methods and we have an extensive inventory of corrosion inhibiting VCI papers, VCI polyethylene, and non-toxic, environmentally-friendly, water-based liquid corrosion inhibitors and rust removers.



About
the Author:

*Wayne
Siefert*

Wayne Siefert has more than 25 years of experience in the packaging industry, the last 18 of which he has specialized exclusively in corrosion-inhibiting packaging. Wayne served as Northeast Regional Sales Manager for Daubert VCI, a leading manufacturer of VCI products, and then worked for 10 years as the Director of Sales and Marketing for a distributor of VCI products.

Since 2007, Wayne has been President and founder of his own company, Green Packaging, Inc. and Green-VCI.com, a recognized award-winning leader in the field of anti-corrosion packaging, solving corrosion and rust issues for hundreds of the country's leading Metal Parts Manufacturers, Foundries, Metal Stampers, Heavy Equipment Manufacturers, Spring Manufacturers, Powdered Metal Parts Producers, and many others with eco-friendly VCI products.

Wayne Siefert is a sought-after speaker as an authority on corrosion prevention.

Wayne is a life-long resident of Bucks County, PA. When he is not helping customers solve corrosion problems, he enjoys traveling, reading business books, working in his back yard, and spending time with his family and friends.

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Customer Testimonials

You guys have been awesome. Green Packaging, Inc. has proven to be of great value and a class leading supplier. Keep supporting us with the great products and great service that you have been.

George J. Schauer, *Production Control Manager*
Stein Seal Company

I want to thank you for the rush job you did on this last order. I would also like to let you know that these VCI Large Blue Bags have done an excellent job of protecting the castings we store and ship to our customers. This has enabled us to control rust issues due to weather and climate changes. Thank you for your service.

Armand D. Gustafson, *Shipping Manager*
Unicast Company

I would like to thank Wayne Siefert and Green Packaging, Inc. for helping our company with a rust issue we had this past summer. He came in, explained and helped us look into any possible culprits throughout our entire process. His experience and knowledge alone, gave us the tools we needed. He also gave us a better understanding of how rust start and how to prevent it from happening again. The products that were recommended to eliminate the problem are excellent and were fairly priced. We are looking forward to continuing our relationship with Green Packaging, Inc. in the future.

Ralph D'Aries
Buell Automatics, *Rochester, NY*

Wayne Siefert's wealth of knowledge, ability to explain his business and easy-going manner has made working with him a truly pleasant experience.

John Zeiger
ZYGR INsites