

# CIMCOOL<sup>®</sup>

## Technical Report

Milacron Marketing Co. | Consumable Products Division | Cincinnati, Ohio 45209

## CORROSION CONTROL

### INTRODUCTION

Heat removal is one of the most important functions of a metalworking fluid. Effective heat removal yields good tool life and dimensional accuracy of parts. Water has greater capacity for removing heat than oil. However, water alone in contact with freshly machined metal leads to corrosion. Thus, corrosion is a problem faced by every manufacturer of water diluted metalworking fluids.

The term "rust" applies only to iron and steel. The term "corrosion" is more appropriate because this also includes non-ferrous metals.

### Definition

Corrosion is the partial or complete wearing away, dissolving, or softening of any metal substance by chemical action.

### Theory

Most corrosion is electrolytic in nature. By placing two pieces of dissimilar metal in a glass of acid, or even tap water, you form a battery cell. A meter connected across the metal electrodes registers current and voltage. Connect the electrodes to each other, a short results, and one of the metals is eaten away. This is bimetallic corrosion which occurs when two metals contact each other in the presence of a conducting fluid.

Even if the two metals are similar, the liquid surrounding one of them can be made different. When you place two identical pieces of iron in water and air bubbled around one, you produce a current. The same phenomenon occurs when a drop of water stands on a piece of cast iron. The drop absorbs oxygen from the air which surrounds it. Since the oxygen diffuses into the drop at a finite rate of speed, there is a stronger concentration of oxygen at the outer edge of the metal surface around the rim of the drop than exists at the center of the drop. Again, the result is an

electrolytic chemical action. Iron ions go into solution at the center and hydroxides form at the rim of the drop. The two come together and if conditions are just right, a ring of rust occurs.

If something could be dissolved or dispersed in the droplet of water that would attach to the metal surface and provide a protective film between it and the water, then the electric current would stop and so would the corrosion. This is exactly what corrosion inhibitors do. The film of polar and passivating inhibitors are only molecules thick, but they stop the corrosion.

### CAUSES AND CORRECTIVE ACTIONS:

#### Seasons when Corrosion Occurs

Corrosion can occur at any time during the year, but normally it occurs more often during July, August, and September when the temperature and the relative humidity are high. This applies to the Eastern and Midwestern areas of the United States. Corrosion is not usually as much a problem in the arid states such as Colorado, New Mexico, Arizona, Utah and California because the relative humidity is usually low.

As temperature increases, the rate of all chemical reactions also increases. This includes corrosion. High temperature in the presence of moisture and oxygen in the atmosphere is the reason corrosion happens more in the summertime.

The moisture condenses on the part and acts as an electrolyte to form a galvanic cell. If the concentration of the fluid, which provided rust protection during the fall and winter months, does not provide protection when the humidity climbs, an adjustment in the concentration is necessary. If the concentration of 1:30 was adequate during the fall and winter, then the concentration may need to be increased to 1:25 or to the point where rust is no longer seen. If the customer objects to increasing the concentration of his central system mix for reasons such as foam and potential skin problems, it may be necessary to increase rust protection with the use of additives or go to a double mix. The additives used depends upon the type

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of metal(s) involved, customer's chemical restrictions, additives available, and the fluid used.

## pH

The pH of a metalworking fluid is a factor in controlling corrosion. A high pH, greater than 9, will protect ferrous metals but will affect the corrosion control of non-ferrous metals, such as aluminum, brass, and bronze.

When the pH is low in an individual machine, the easiest solution to the problem is to dump, clean and recharge with a new mix of CIMCOOL product at the recommended concentration.

If treating a central system mix which is being used on ferrous metals, adjust the pH with either Additive 63 or LC to between 8.8 and 9.2. Note: If the mix or surrounding area has an "ammonia" odor is Contact your local CIMCOOL Technical Service Specialist or CIMCOOL Technical Services at 1-513-458-8199 before making any additive additions. Also note these additives are very alkaline and excessive use or misuse may lead to skin irritation.

If treating a central system mix which is being used on non-ferrous metals, contact your local CIMCOOL Technical Service Specialist or CIMCOOL Technical Services at 1-513-458-8199.

If non-ferrous metals are being machined or ground with a clear synthetic-type fluids and staining or pitting is a problem, check the Product Information Sheet to determine if the product is applicable to non-ferrous metals.

## Water

Chemicals in the water used to makeup and maintain the mixes can increase the rate of corrosion. All water contains ions, some of which are aggressive and can cause corrosion of most metals.

Waters that contain more than 50 ppm chloride, more than 75 ppm sulfate, or 25 ppm nitrate are considered aggressive waters. Chlorides, sulfates, and nitrates cause corrosion by breaking down the protective barriers on the surface of the metal, opening the way to corrosion. Continuous addition of water increases the sulfate, chloride, and nitrate content of the water in a central system, thus making it more aggressive the longer it is used.

If aggressive water is suspected, take a sample of the water and have the CIMCOOL<sup>®</sup> Laboratory complete a water analysis. When a central system fluid is suspected to cause corrosion, submit a sample of the mix for ion

determination. If the chloride, sulfate, or nitrate content is higher than the acceptable limits, have the customer change sources of water. It may be necessary to change to a blend of deionized or distilled water and the customer's regular water. A change to another CIMCOOL metalworking fluid with superior corrosion control may also be an answer.

Many desirable properties of metalworking fluids can be literally destroyed by chemical reaction with dissolved water solids. The most familiar example of this is the effect of "water hardness" which is essentially the calcium and magnesium content of the water.

The divalent ions react with soaps, wetting agents, and emulsifiers to form compounds with limited solubility. The formation of these insolubles deplete rust inhibitors which result in rusty parts and machines. Hard water is any water greater than 250 ppm. The higher the hardness, the more prone the fluid is to corrosion.

Conductivity is another means of determining the how much dissolved ions are in the mix. Higher conductance promotes corrosion, mix instability, residue, and other problems. Conductivities of greater than 4 MilliSiemens per cm are considered high.

If the chloride, sulfate, or nitrate content is higher than the acceptable limits, have the customer change sources of water. It may be necessary to change to a blend of deionized or distilled water and the customer's regular water. A change to products which are less affected by water hardness or conductivity is another approach.

## Bacteria

High bacteria counts in the metalworking fluid mix can lead to corrosion.

Bacteria consume metalworking fluid components which can lower the mix pH. They also produce mild organic acids which lower the pH of the fluid and the corrosion resistance of the fluid. Also if left unchecked, bacteria can split emulsions.

If an individual machine's mix has a high bacteria count, the easiest solution to the problem is dump, clean with either CIMCLEAN 30 or 40 mix at the recommended concentration, rinse with fresh water, and recharge with a new CIMCOOL mix at the recommended concentration. If it is impractical to dump the charge, add Triadine 20 for every 25 gallons of mix.

In a central system, use preventive measures including the correct use biocides and/or microbicides to prevent and control bacterial growth.

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## Lean Concentration

All ingredients in a CIMCOOL metalworking fluid are designed to be effective are designed within a specified dilution range.

If the fluid becomes leaner than the specified range, the leaned out ingredients may not be able to perform their designed jobs. This also applies to the rust inhibitors which may not be able to protect the newly ground or machined parts from corrosion.

Check the fluid concentration frequently and routinely. Titration methods are the best method of concentration determination. Add concentrate to obtain the recommended dilution. In individual machines, do not attempt to balance the fluid with the use of additives. Dump and recharge.

## Extended In-Process Time

Normal in-process rust protection, provided the CIMCOOL product is used at the recommended concentration, is up to 72 hours.

CIMCOOL products provide in-process rust control for a variety of metals from high alloy steels to cast iron. At the proper concentration, a customer could reasonably expect 48 hours protection for cast iron and 72 hours for high alloy steels.

If the customer expects corrosion protection beyond these time limits, then use a longer term rust preventive. Recommend a CIMGUARD product depending upon the conditions.

## Process Procedures

Parts sometimes corrode when stacked one on top of the other or when contacting each other in tote bins. This is caused by the fluid acting as an electrolyte and forming a galvanic cell between the two parts. This happens very readily with cast iron. In fact, with stacked cast iron (depending upon the quality iron) it is sometimes difficult to control rust for more than several hours.

Placing a fiber spacer between the stacked layers of parts can eliminate this condition. Do not use cardboard as the spacer because of its high content of sulfur. If using paper or similar materials, be sure they are the vapor phase inhibiting (VPI) type or they could promote rust. Enclosed tote bins retain moisture and promote corrosion. Use a

wire basket for parts or drill holes in the bottom of the tote bins to drain the fluid. If possible, use plastic tote pans or plastic covered wire baskets.

## Fingerprint Corrosion

Parts sometimes corrode after being touched by human hands.

Material handling can cause corrosion in the design of fingerprints in the newly ground surfaces of the metal parts. This is more prevalent with some people with more acidic skin conditions and on highly finished parts with low Ra finishes. Use of a fingerprint neutralizing rust preventive, such as CIMGUARD 10, corrects such fingerprint corrosion.

## Dirt Recirculation

Small metal particles in a metalworking fluid are referred to as "dirt".

Swarf deposited on the part and not properly washed away forms a galvanic cell and rust will occur underneath the swarf. Correct the dirt recirculation in an individual machine by having the machine dumped, cleaned with a CIMCLEAN 30 or 40 mix at the recommended concentration, rinsed with fresh water, and charged with a fresh CIMCOOL mix at the recommended concentration.

In a central system, dirt recirculation could mean a malfunction of the filter. Refer to the article "Filter Problems" in the "Problem Solving" section of this manual. To help settle swarf, select the settling aid or clarifying agent compatible with the fluid and filter system.

Check the pressure at the coolant nozzle to determine if the lack of coolant pressure is causing the swarf to build up on the fixtures of the machine and the workplace. The normal coolant pressure is 20 psi.

## Bimetallic Corrosion

Bimetallic corrosion is the corrosion of two different metals in contact with each other. An example is when you clamp an aluminum workpiece to a cast iron fixture or table.

Bimetallic corrosion occurs when a transfer of electrons from one metal to another takes place with the cutting fluid acting as a conductor.

The solving of bimetallic corrosion is the problem of getting a nonconductive material between the two different metals.

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This may require switching to a fluid that has better bimetallic corrosion. In general, this would be a high oil containing fluid, such as a premium soluble oil.

## Spontaneous Combustion

Spontaneous Combustion is the ignition of substances apparently without any direct cause. Spontaneous combustion when organic materials are present sometimes causes fires. When large quantities of metal fines become soaked with relatively small amounts of oils are exposed to air, they may ignite at some point. The presence of moisture frequently aids spontaneous combustion. At times steam may be seen rising from the metal chips.

Heat can be produced by the reaction between newly cut chips and cause a fire to start if enough organic material, i.e. oil, is present. The newly cut chips expose nascent material which is reactive under certain conditions. Chips of the same material form heat by oxidation. Unlike materials can form hydrogen gas which, if confined (in the chip pile), can smolder and even ignite. The type of metalworking fluid used can help aid or retard the reaction.

Reduce or eliminate the amount of metalworking fluid remaining on the chips by blowing the chips dry (if possible) or by centrifuging. Spread the chips over a large area or circulate air throughout the chip/swarf pile. Recommend a metalworking fluid with a high mineral oil content or adjust the concentration richer if a soluble oil type fluid is already in use. Contact your local CIMCOOL Technical Service Specialist or CIMCOOL Technical Services at 1-513-458-8199 if additional assistance is required.

## Broken Emulsion

Rust can happen if an emulsion breaks, in which case the instability of the emulsion will make the rust inhibitors ineffective.

If the emulsion appears watery and the sample shows stratification, the emulsion may be unstable or broken. To solve this problem in individual machines, the best solution would be to dump, clean the machine with CIMCLEAN 30 or 40 at the recommended concentration, rinse with fresh water, and recharge with a CIMCOOL metalworking fluid mix at the recommended concentration.

Emulsions that are unstable because of extremely cold water can often be restored by circulating the coolant pumps and allowing the mix to warm to room temperature.

If the emulsion is broken because of improper mixing, instruct the customer to add the concentrate to the water. When making a double mix with CIMCOOL metalworking fluids, thoroughly mix the semi-synthetics and soluble oil type fluids first then slowly add the synthetic type fluid. If possible, predilute the fluids with a proportioner or similar device prior to adding the mix.

Broken and unstable emulsions may also be caused by hard water or excessive bacterial contamination. It is important to determine the cause of the broken emulsion before taking corrective action.

When dealing with a central system, it may be possible to use an additive which is an emulsifier to re-emulsify the product. If time permits, send samples to the CIMCOOL<sup>®</sup> Laboratory for tests. If time does not permit, then run jar tests on site to determine what additives to use and the proposed dilution ration.

## Corrosive Atmosphere

When corrosion occurs after the in-process time, the cause may be a corrosive atmosphere. Heat treat departments may exhaust corrosive fumes. One of the most corrosive is sulfur dioxide fumes which will quickly corrode metal surfaces. Cement dust will also quickly corrode metal surfaces.

Ventilation of the metal removal area is the only answer to corrosive fumes. Get rid of the fumes and you get rid of the rust. Sometimes increased concentration of the fluid helps, but ventilation is still the answer. If the corrosive atmosphere cannot be corrected, then use a long term rust preventive.

## Additives

The following lists shows many of the CIMCOOL additives that can boost corrosion protection. The determination of which one to use depends upon the fluid in use, restrictions, etc.. Care should be taken when using these additives to protect against misuse or overuse. Refer Contact your local CIMCOOL Technical Service Specialist or CIMCOOL Technical Services.

Inhibitor 42 - is the least effective of the ferrous corrosion inhibitors. It is used at 1:1000 to 1:2000.

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Inhibitor 50 - is the second most effective of the ferrous corrosion inhibitors. It is used at 1:500 to 1:1000.

Inhibitor 56 - is the most effective of the ferrous corrosion inhibitors. It is used at 1:500 to 1:1000.

Inhibitor AL - is an aluminum corrosion inhibitor. It is used at 1:1000.

Inhibitor C - is a copper corrosion inhibitor. It is used at 1:25,000 to 1:40,000.

Inhibitor CO - is a cobalt leaching inhibitor. It is used at 1:250 to 1:2000 in carbide grinding systems to precipitate out dissolved cobalt from a mix.