Think Tank

Stephen F. Rudy, CEF
Enequist Chemical Co.
100 Varick Avenue
Brooklyn, NY 11237
718/497-1200
E-mail: sfrudy@aol.com

Beating Those Rusty Blues: Effective Rust Prevention

Fighting rust is a large part of the metal finishing business. Manufactured steel parts—whether stamped, formed, cut, or bent—are overwhelmingly subjected to specific plating and surface finishing operations. The requirements of any finish may include: aesthetics, wear resistance, performance, or shelf life, to name some common objectives.

Newly fabricated parts may sit a while before processing in a finishing cycle. It's that gap in time that can promote plater's "heartburn" and a case of the blues. Effective rust prevention is the plater's best medicine. Different types of rust inhibitors (or preventives), oil, solvent, or aqueous are used. The parts to be protected may be dry or wet. Application is by immersion, spray, brush on, or manual wiping.

Rust inhibitors are characterized by their chemical type, optimum use, and related properties. Targeted protection is based on the capability of each system to meet general or specific requirements, indoor or outdoor. Factors to consider for desired rust protection include: condition of base metal surface (*e.g.*, porosity, surface imperfections), activity, length of storage time, (usually on a temporary basis), and relative humidity. General information is given for a group of rust inhibitors.

Water-based Rust Inhibitor
Typical Operating Parameters & Application

From Concentrate	Makeup	Temperature	Time, min
Water	1-10% v/v	75-80 °F (24-82 °C)	1-5+
Powder	2-6 oz/gal (15-45g/L)	75-80 °F (24-82 °C)	1-5+

Oil Emulsified in Water
Film & Protection

Oil in Water, %	Film Characteristic	Salt Spray, ASTM B-117
5	dry to touch	20-24
10	slightly oily	40-50
20	oily	90-125

Types of Protection

Water-based Rust Inhibitors

Concentrated formulations are available in powder and liquid form. They are generally of equal effectiveness, based on intended use. A recommended weight of the powder is dissolved in water, or a volume of the liquid concentrate is diluted in water, to prepare either working solution.

The application is by immersion, spray, or manual. Parts may be fixtured on racks, loaded in barrels or baskets, or hand processed. After surface conditioning, the parts are not rinsed. The active rust inhibitor film dries on the metal surface as water evaporates. A common application is for temporary rust protection, such as occurs during in-plant storage or short-term inventory, before additional finishing or fabrication. Immersing the parts in hot water or a soak cleaner usually removes the rust inhibitor film prior to additional finishing, such as plating or painting. An excellent rust-protection treatment that may not be acknowledged occurs when parts are burnished to improve surface leveling and luster. Chromates, nitrites, amines, reacted borates, and phosphates are effective rust inhibitors. Because of related environmental considerations, non-hazardous inner transition metals, new specialty surfactants, and water-shedders meet or exceed the protection afforded by chromates, nitrites, and amines.

Water Displacing

Formulations based on this action are solvent types, containing rust inhibitors, oils, and surfactants. Concentrates are used at full strength, or are diluted with specific organic solvents. Evaporation and flash point considerations require this group of rust inhibitors to be used below 100°F (38°C). Cleaned parts are water rinsed, then conditioned in the rust inhibitor. Water is quickly displaced from the metal sur-

face (including deep recesses, pores, and fissures) by a protective, transparent film. This film becomes a very effective moisture blocker. Its thickness and drying characteristics are unique and controlled for preferred rust protection. This transparent film may be dry to touch, slightly oily, or non-tacky. Condition of the film determines degree of protection and related characteristics.

- Dry to touch. Thickness may vary from < 0.1 mil to 0.2 mil. By completely drying on the metal surface, a transparent, rust-preventive film forms an effective barrier. Approx. 50 hr per ASTM B-117 salt spray; one month per ASTM D-1748 humidity test.
- Slightly oily. Thickness approaches 0.2 mil. The film's condition allows it to flow, covering or "healing" any metal surface exposed by mechanical action (scratching, abrading, etc). Close to 100 hr per ASTM B-117; one month per ASTM D-1748.
- Non-tacky. Very thin, transparent protective coatings, < 0.05 mil to 0.10 mil. Corrosion protection noticeably decreases as the film gets thinner. Up to 100 hr per ASTM B-117 to < 20 hr; ASTM D-1748—from 30 days down to 20 days.

Popular applications of slightly oily dip solutions follow hot black oxidizing and zinc phosphate. This provides MIL SPEC-approved corrosion protection for the thin oxide coating and accentuates color of the black finish for black oxide and zinc phosphate. Some oils are non-conductive, thereby permitting their use on electrical parts and motors. The solvent content of the particular oil usually determines drying time. Optionally, smaller parts may be mechanically spin dried.

Water Emulsifiable

Formulations based on this action are oils that are fortified with corrosion inhibitors and special emulsifying surfactants. The concentrate is designed to be mixed with water, forming a stable emulsion. The rust inhibition characteristics of the protective film vary with ratio of the oil to water used to prepare the working solution.

Most of the water emulsifiable systems also include agents providing resistance to alkaline cleaner drag-in as a contaminant. Otherwise, the stable oil in water emulsion would be susceptible to breaking, rendering the working solution useless. The baths can be used from 75-165°F (24-74°C). Increasing solution temperature accelerates drying of parts. Dangerous solvent evaporation and ignition are avoided. Conditioned parts can be stored until ready for additional finishing. A suitable soak cleaner is required to remove the protective oily film, as part of an effective surface preparation cycle.

Waxy Emulsions

Waxy emulsions develop a clear, glossy, hard film on the steel metal surface. Phosphatized parts, black oxidized parts, and conversion coatings may also be treated in the waxy emulsions. The protective film provides some lubricity. Depending on solution makeup, the film thickness varies from 0.1 to almost 0.5 mils.

These concentrates, used full strength or diluted as the working solutions, are wax in water, stable emulsions. Surface conditioning can be accomplished by immersion, spray, or manual application. Typical operating temperature range is 70-85°F (21-29°C). Drying time is relatively short, facilitated by warm forced air or heated spin dryers. Because they are water-based, the wax emulsions do not have a flash point. ***P&SF***