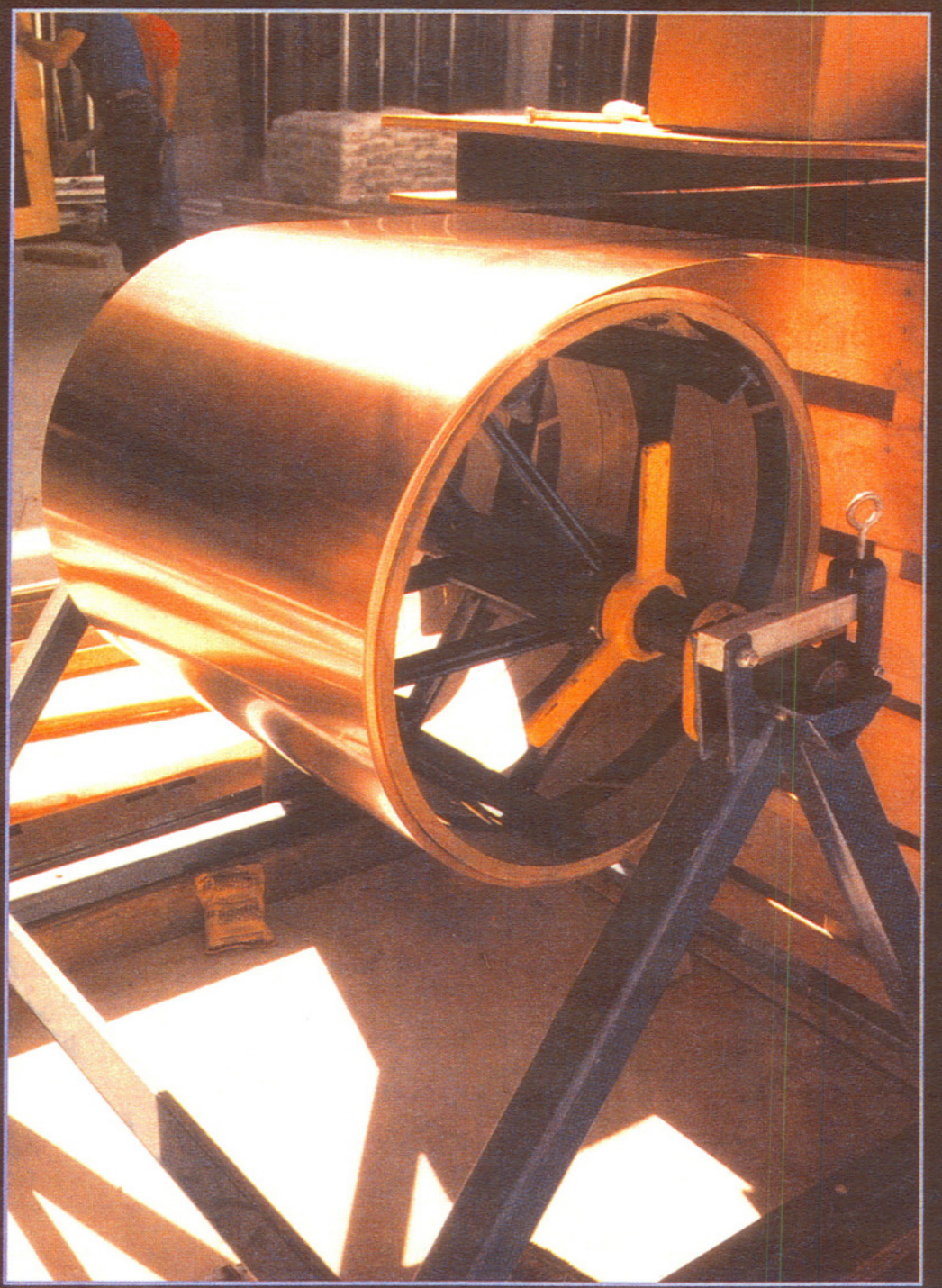
Weathering of Architectural Copper

by David Hunt



Weathering of copper is a chemical reaction. Architectural copper, i.e., roofing, begins to weather in the mill when its surface is first exposed to the atmosphere. It continues, usually for many years, until a mature, green patina covers the entire surface.

As with any chemical reaction, weathering depends on many factors and variables. Some are evident while others are not. Oftentimes a variable will change, or be changed, during fabrication or installation. This can cause unusual weathering and complaints. *(more on page 38)*

COPPER/*continued from page 36*

Copper may weather slowly; many weeks or months may pass with little or no apparent change. It may weather quickly, bringing dramatic color changes overnight. It may proceed in a "normal" manner for several months and then appear to stop. It can weather to a uniform, even color – or it may not. There may be radical color variations within or between sheets. Part of an installation, or sheet, may weather while other parts remain bright and shiny.

The expanding construction market, new tools and equipment, successful marketing campaigns, etc., all compound the problem of "unusual weathering." As more and more copper is specified and sold, more people (architects, contractors and building owners) are involved with copper roofs. Many have little or no knowledge of how copper weathers. They compare newly installed copper to older roofs or judge by what they think should happen. This can result in a dissatisfied owner, upset contractor and/or frustrated architect.

It's not that "the customer is right (or wrong)," but that the customer is uninformed. The following briefly reviews the weathering of copper. It explores several factors and variables that can affect both initial and long-term color.

Under ideal conditions, when copper is exposed to the atmosphere it tarnishes and turns dark as cuprous oxide forms. With time, cuprous and cupric sulfide conversion films are interspersed with the initial oxide film. As they build, the copper darkens appreciably. Continued weathering results in the conversion of the sulfide films to the basic copper sulfate (green) patina.

This is natural weathering. It is the result of a mild corrosive attack of the copper by airborne sulfur compounds, which combine with moisture. It will not occur in an atmosphere totally free of sulfur, a completely dry environment, or if the copper is protected from these elements.

The most commonly heard complaints about the weathering of copper are:

- Unusual or non-uniform initial weathering;
- Copper that does not turn green – only weathers to a black color.

Revere Copper Products Inc.

Many people are unaware of how long it takes to develop a full, green patina.

Initial Weathering

In its earliest stages of weathering, copper can exhibit shocking colors and/or patterns. In extreme cases, it can change from bright and shiny to mottled and dark literally overnight. Although unusual, this is natural.

As noted, sulfur compounds and moisture are necessary for patination to occur. Hydrogen sulfide and sulfur dioxide are present in all atmospheres. They occur naturally (i.e. volcanoes) and are also man-made (i.e. burning fossil fuels). When these compounds combine with moisture, they form dilute, oxidizing acids.

The longer the acids remain on copper, the greater the oxidation. Fog, dewfall, mists and sea spray generally remain on copper for extended periods. As a result, initial weathering and formation of patina occur quickest along the seacoast and in areas of high humidity. Rainfall usually runs off copper before the acids form and oxidation occurs. As a result, except for cleaning, rain has little direct effect on oxidation.

The first phase of weathering is the formation of extremely thin oxide films on copper. These are so thin that rainbow-hued interference colors are often seen. Although blacks and purples are most common, yellows, blues, greens, pinks, oranges and/or reds also can develop. With time and continued exposure, the oxide films build and thicken. With this, the interference colors fade and are replaced with more uniform russets or browns.

Oxidation cannot begin until the copper surface is clean and exposed. When sheet copper is first installed, its surface is usually protected by a film of residual rolling lubricants and/or anti-stain compounds. Until these films are removed or degrade, the copper surface is not exposed to the atmosphere and weathering cannot begin. Usually these films are removed slowly by rainfall or snow and the copper weathers uni-

In its earliest stages of weathering, copper can exhibit shocking colors and/or patterns.

formly. However, some natural events (i.e. heavy rainfall) can remove them rapidly.

Some power pan-forming equipment has composition rolls to pull metal through the forming rolls. The composition rolls can change the amount or pattern of residuals on the copper. They also can transfer oils from one metal to another. This can cause dark or light stripes or spots during initial weathering.

Extreme examples of unusual weathering are tiger stripes that are clearly defined by vertical seams. Possible reasons for this happening include:

- Mixing copper from two or more suppliers, or significantly different production dates from one producer.
- Mixing different products, i.e., pan forming coil and standard sheet copper.
- Installing some copper upside down (architectural copper has a "top" and "under" side).

Rolling copper is an art and a science. Lubricant suppliers tailor their products to meet the requirements of the copper mills. As each mill has different equipment and different ways of rolling copper, the lubricants are different. While all lubricants will eventually break down or wash off, the rate at which they do so varies from mill to mill and lubricant to lubricant. So long as the lubricants are on the copper, the copper is protected and little or no oxidation occurs.

In an early 1990s experiment, roofing copper that was produced by different brass mills was exposed to the atmosphere. When first exposed, differences in reflectiveness were obvious. As the copper weathered, differences in color developed – copper from one mill turned dark quickly while that from another remained salmon colored longer. After six months, the differences began to fade. After a year, it was impossible to tell one mill's copper from another based on color. Similar weathering can happen if different products (i.e. sheet and coil) from the same mill are mixed on a roof.

Hussey Copper Ltd.

Seen here is Harrah's Casino in New Orleans. The copper sheet used for this insulation had been treated under controlled processing to create the surface patina – without the natural 20-year-or-so wait.

The "top" and "under" (or reversed) side of architectural copper have different textures. This is the result of the upper and lower rolls being surfaced to a different RA (surface roughness) or "grit." Although the degree of difference is microscopic, it can affect initial weathering.

In most environments, within a year copper loses any initial discoloration and takes on a uniform brown, or bronze color. However, initial differences are not uncommon and should not be reason for concern.

Patina Takes Time

Many people are unaware of how long it takes copper to develop a full, green patina. When they see copper that is several years old but still black or dark brown, they conclude that "copper does not turn green here." This is incorrect. It takes many years to form naturally.

In areas conducive to the formation of patina, it usually takes at least 15 years before there is any evidence of green patina. In areas that do not have ideal conditions, it can take 50 or more years for green patina to form. Black copper is copper in a transitional phase. With sufficient time, it too will green.

Given time, there is nowhere on earth that copper will not eventually take on a green patina. It may take centuries, as in the case of Scandinavian churches above the Arctic Circle, or only a few years, as in an urban, industrial, marine environment. **CG**

David Hunt is manager of technical services for Revere Copper Products Inc., Rome, N.Y.