Fighting Fastener Corrosion

by Jefferson Kolle

DR. PASCAL KAMDEM

What'll you have with that wood preservative: Hot-dip galvanized, polymer coated, or stainless steel?

Deck building used to be simpler. At the lumberyard, you'd load up on CCA-treated 2-by stock for the floor system, 6x6s for the posts, and whatever the budget allowed for the decking — anything from 1x6 pressure treated to more-expensive 1x4 Doug fir. Buying hardware and fasteners was straightforward too. Inside the lumberyard, you'd load up on nails, nuts, bolts, screws, and maybe joist hangers. And you'd be good to go.

Buying lumber and fasteners is no longer so straightforward. Since CCA was withdrawn from the residential market in 2004, new preservatives have taken its place. The corrosiveness of some of these chemicals has in turn spawned new types of corrosion-resistant hardware, which have left deck builders wondering which ones work best and if the best ones are worth the money.

A Little Chemistry

According to Dr. Pascal Kamdem, professor of wood science and technology at Michigan State University, chromated copper arsenate (CCA) pressure-treated wood was phased out because European countries objected to the chromium, while concerns in the United States centered around the arsenic. "Chemical companies wanted a pressure-treating formula that would be acceptable worldwide, so they got rid of both objectionable chemicals."

One of the benefits, however, of the chromium and arsenic in CCA was that they slowed the corrosion of fasteners and hardware. Though the two main replacements for CCA

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Figure 1. Many new wood treatment chemicals are more corrosive than the old CCA. Hardware that once could be depended on to last for decades now may degrade in only a few years.

— alkaline copper quaternary (ACQ) and copper azole (CA) — work about as well as their predecessor at resisting rot, problems with corrosion of deck hardware surfaced early on (**Figure 1**). Not only do ACQ and CA lack corrosion-inhibiting chromium and arsenic, they have much higher concentrations of copper than CCA — not a bad thing to ward off most fungal growth, but just awful if you happen to be a less noble metal than copper. Also, some ACQ and CA formulas contain ammonia; those are even more corrosive.

The "retention level" of treatment chemicals is another factor to look out for — wood that's treated for ground contact contains more preservative than wood that's intended for aboveground use, and therefore is more likely to cause corrosion.

This chemical stew boils down to one thing: The pressure-treated wood you're using wants to eat your hardware for lunch. A study done by Simpson Strong-Tie found that ACQ is twice as corrosive to metals as CCA, and some other studies have found it to be three times as corrosive.

Copper actually isn't corrosive in a dry, inert environment, but what deck is never wet? And when water contacts ACQ- or CA-treated wood, it lifts copper ions from the preservative. As the copper-tainted water seeps onto metal hardware, a galvanic reaction causes the hardware to corrode. Without revisiting high school chemistry, suffice it to say that a galvanic reaction is good for only one of the two metals in the mix — and in the case of copper and steel, galvanized or not, the latter loses (**Figure 2**). In other words, on your carefully built deck, the copper-impregnated wood wins, the steel fasteners lose, and — possibly — your deck falls down. To protect fasteners and hardware from corrosion, manufacturers are taking

Figure 2. In the presence of an electrolyte, the copper in treated wood chemically attacks steel. This nail was bright and shiny when placed in a salt solution with a piece of copper. Twenty four hours later, the water is tinted and rust has settled to the bottom of the container.

Figure 3. Shiny, electroplated fasteners (top, in photo) don't hold up to the more-active copper in preservatives such as ACQ and CA. Look for their dull-gray, hot-dip galvanized cousins (bottom, in photo).

Figure 4. Framing hardware is stamped from galvanized sheet, and the edges are raw steel. Galvanization offers some protection to the edges, but it's imperfect, as evidenced by the light layer of rust on this joist hanger.

Figure 5. Coated in molten zinc after they're threaded, hot-dip bolts grow to a larger diameter. To accommodate this, hot-dip nuts are threaded oversize. Standard nuts don't fit hot-dip galvanized bolts.

several tacks.

Sacrificial Zinc

Galvanizing works sort of like the candy coating on a Tootsie Roll pop. As you suck on the pop — no biting allowed — the candy that surrounds the chocolate nugget in the center dissolves. Once the candy coating is gone, it's curtains for that nugget. On galvanized-steel fasteners and hardware, zinc is like the candy coating; it gets eaten away by the copper in treated wood.

The way that corrosion resistance is measured on galvanized products is to weigh them before and after submergence in a corrosive medium to find out how much of the zinc has oxidized. Because of the sacrificial nature of the zinc, thicker coatings give longer-lasting protection to steel than thin ones.

The thinnest zinc layers are found on bright, shiny electroplated hardware (**Figure 3**). The copper in pressure-treated wood will eat through electroplated zinc almost as fast as you scarfed down that bag of Doritos at lunch. Electroplating is a quick and inexpensive process that does little more than keep the rust off the stuff while it glints at you from the bins saying, "Buy me. Buy me." Don't.

Steel fasteners that have been hot-dip galvanized, on the other hand, are not shiny, or at least they aren't by the time you see them. Instead, they are a dull gray sharkskin color, and sometimes the surface is rough, almost crusty. Rough and crusty is good; it means the zinc layers are thicker.

Galvanizing can occur at different times in the manufacturing process: Pre-coat dipping is done to sheet steel before it's cut and stamped into hardware — joist hangers, for instance. And post-coating is done after the piece is formed, most often on heavier-gauge steel with thicker edges. While it may seem as though post-coating would do a better job covering the stamped-and-cut edges, it's not necessary on the light-gauge steel used for joist hangers and the like (**Figure 4**). According to Ed Sutt, manager of engineering, fastener development, at Simpson Strong-Tie, "The zinc coating will chemically migrate to bare steel and give protection to bare, thin edges."

If you've ever tried to spin a non-galvanized or even an electroplated nut onto a hot-dip bolt, you probably didn't succeed — because the hot-dip coating increases the size of the threads. To allow for the thickness of the coating, the threads on the nuts are tapped oversize before they're dipped. Only a hot-dip nut will work on a hot-dip bolt (**Figure 5**).

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Figure 6. An alternative to hot-dip galvanization is to polymer-coat electro-galvanized steel. The polymer on this connector keeps water off the steel, preventing the galvanic reaction that causes corrosion.

Figure 7. The new generation of thinner ledger screws gain their strength from heat treatment. Hot-dip galvanization would negate this, so most such screws are polymer coated.

A final note on zinc-galvanized fasteners and hardware: Manufacturers won't guarantee how long their products will last in pressure-treated wood, for two reasons. The first is that copper will never stop corroding the sacrificial zinc. It's always a one-way death match. Second, other environmental (meaning chemical) conditions can accelerate the corrosion. Take two identical decks — one on the sunny, south side of a house in Nebraska and the other on the damp, shady side of a house on the coast of Rhode Island, across the bay from an acid-manufacturing plant — and you can guess which one will have the longer-lasting hardware. In fact, the presence of lawn fertilizer and pet urine can have a significant effect on longevity.

And if you do find fasteners with a so-called lifetime warranty, read it carefully: It probably states that the manufacturer will replace corroded fasteners or hardware for free. It would be cold comfort to return to the site of a collapsed deck armed only with a box of free bolts.

Organic Polymer Coatings

Hardware and fastener manufacturers have developed polymer coatings as an alternative to hot-dip galvanizing to protect against corrosion. Sold under a variety of brand names, such as USP's Gold Coat, GRK Fasteners' Climatek, or Simpson Strong-Tie's Quik Guard and TufCote, these proprietary formulas feature organic polymers that, unlike zinc, don't react chemically with copper ions and so don't sacrifice themselves (**Figure 6**). Instead, they provide protection by keeping water — and dissolved copper — from touching the steel. Think of the polymer coatings as being like the plasticized paper wrapper that covers the Tootsie Roll pop; it keeps your saliva from touching the candy coating.

Most polymer coatings are applied on top of a layer of galvanizing. Manufacturers use the coatings because they are less expensive than thicker and more numerous layers of zinc galvanizing, according to wood science professor Dr. Pascal Kamdem, who has tested numerous polymer coatings for USP, Phillips, The Home Depot, and Crown Bolt, among others. He says, "The important thing to look for is the number of layers of waterproof polymer coatings. More are always better." Citing a conflict of interest, Kamdem refrained from revealing which coating held up best in his university corrosion tests.

Polymer-coated screws have a few advantages over hot-dip galvanized ones. Some have an especially slippery top coat to make them easier to drive into wood. Also, most threaded fasteners are heat-treated to increase their strength, but when they're subsequently hot-dip galvanized, the high temperature (around 860°F) of the molten zinc in the galvanizing tank takes the temper out, lessening their strength. Not being subjected to those extreme temperatures means that polymer-coated decking screws and the new style of polymer-coated, thinner-diameter, self-drilling lag screws (**Figure 7**) — getting popular for attaching ledgers to rim joists — retain their strength.

A final plus is that polymer coatings don't tend to clog the drive hole in the head of a screw. How many old-style galvanized screws have you chucked after pulling them out of your nail bag to find the Phillips slots clogged with a little ball of zinc?

Stainless Is Painless, Until You Have to Pay For It

No one denies that stainless steel is the gold standard for the hardware and fasteners used in today's pressure-treated woods. Nickel and chromium are alloyed with steel to make stainless steel resistant to corrosion throughout; thus it doesn't depend on a coating. Simpson Strong-Tie, a company that makes various galvanized and polymer-coated — as well as stainless steel — hardware and fasteners, defers to stainless as the go-to material when you're unsure about the wood you're using or when the fastener will be exposed to a harshly corrosive environment, such as near an ocean. Their literature says: "If you suspect this or are uncertain, use stainless steel."

Easy to say when you're selling the hardware, but not as easy when you're paying for it. Any manufacturer's stainless steel products will cost more than its coated-steel ones. For instance, Titan Metal Werks, a fastener manufacturer, charges about $25 for 400 of their ACQ-rated (zinc coated with a polymer topcoat) #6-by-2-inch SplitStop screws. In contrast, the same size and number of stainless screws costs about $66. Greg Greenlee, director of engineering at USP, says, "Depending on the hardware or fastener, stainless steel can cost five to ten times as much as other products."

Simpson's Ed Sutt says that while stainless steel does cost more, the price may be worth it. "When you consider the total cost of a deck," he says, "the hardware, even when it's stainless, is a small percentage."

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Figure 8. Trust the hardware manufacturer, not the wood treater, to provide information on whether a product will work with a particular preservative. Hardware manufacturers continually perform accelerated weathering tests to ensure durability.

Don't Mix and Match

Mixing and matching metals and coatings is not a good idea. If you choose hot-dip zinc-galvanized connectors, use fasteners and hardware with the same coatings. The same goes for polymer coatings or stainless steel. If you use one type with another, there's a possibility the different metals will start their own corrosive reactions — the exact thing you're trying to prevent. For instance, because stainless steel will degrade galvanized steel, especially in a marine environment, don't install galvanized joist hangers with stainless steel nails.

Greenlee recommends buying the top-rated hardware for the job at hand, regardless of whether you're using different types of pressure-treated wood on a deck. "If all your fasteners can handle ground-contact wood (the most corrosive of all types because it has the highest levels of copper), it won't matter if you use them on less-corrosive material, even if it's a little overkill." Still, how do you know what the wood is rated for and whether a fastener is compatible?

Manufacturers of the new chemicals and coatings are required to label their products. All pieces of pressure-treated wood should have a label (usually stapled to the end grain) that indicates its intended usage as well as the chemicals used as the preservative. And the same goes for the hardware and fasteners. Manufacturers with proprietary brand names for their coatings label their boxes with statements about the corrosion resistance of their products.

Unfortunately, you need to be careful about what information you rely on. Glenn Mathewson, a former deck builder who is now a building inspector in Westminster, Colo., tells a story of a builder who used lumber treated with a micronized-copper preservative. Micronized copper uses a less soluble form of the metal that isn't supposed to leach out of the wood, and is therefore said to be less corrosive. The wood-treating company told the builder he could use hardware that was G-90 galvanized, instead of G-185. Mathewson balked: "When you're trying to decide if a certain piece of metal will withstand the chemicals in a certain type of pressure-treated wood, look at what the hardware manufacturer states, not what the wood treater says."

Codes and Standards

For years, hardware and fastener makers have been diligent about testing their products for structural integrity (**Figure 8**). Greg Lindsay, general manager at Portland Bolt in

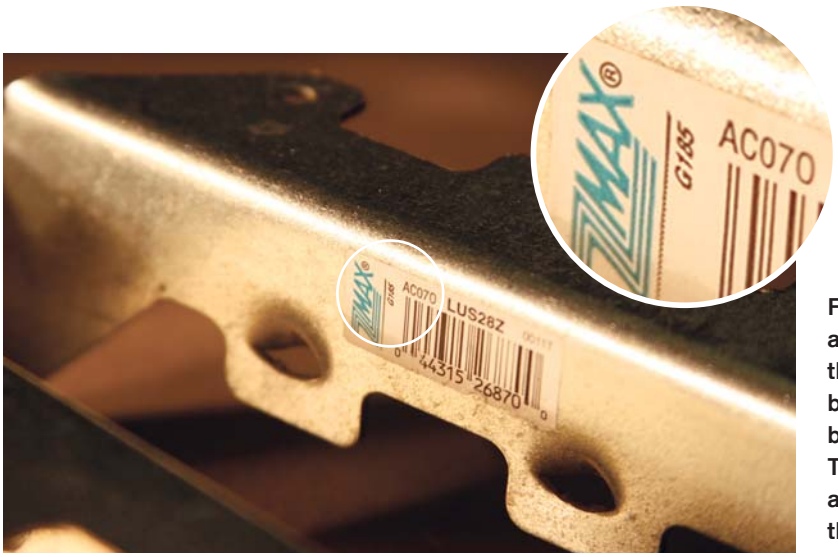

Figure 9. On galvanized steel, copper attacks the zinc coating instead of the underlying steel, but this only buys time. Eventually the zinc will be used up and the steel exposed. Thicker zinc coatings last longer and are indicated on hardware labels by the phrase G-185.

Portland, Ore., says, "It's real unlikely that you'd ever find fasteners out in today's market that wouldn't pass a structural test."

And now there are criteria for corrosion resistance as well. The thickness of a galvanized coating is measured by an American Society for Testing and Materials (ASTM) standard, based on the amount of zinc by weight that coats the steel.

For ACQ- and CA-treated wood, you need hardware with a G-185 coating (**Figure 9**), which signifies 1.85 ounces of zinc per square foot. (The measurement "1.85 ounces per square foot" is somewhat misleading. It actually applies to a 1-foot-square piece of steel sheet, which of course has two faces, meaning that half that amount of zinc is on each side.) Metal meeting past standards of G-90 and lower just won't stand up to the corrosiveness of ACQ and other chemicals.

Fasteners also are subject to standards regarding thickness, adhesion, and finish of galvanized coatings. The applicable standards for fasteners are ASTM A153 or the newer ASTM F2329.

The International Code Council-Evaluation Services (ICC-ES) develops tests for building products' code compliance, which are then administered by ICC-accredited, third-party testing laboratories. Manufacturers can now have their products corrosion-tested based on ICC-ES AC-257: *Acceptance criteria for corrosion-resistant fasteners and evaluation of corrosion effects of wood treatment chemicals*. It's a sort of umbrella standard for fasteners and hardware that are meant to be used with treated lumber.

AC-257 references the ASTM A153 standard as a benchmark. So, if a fastener meets ASTM A153, it also satisfies AC-257 and the local inspector should accept it. Several manufacturers have already gotten approvals and will usually mention it on their Web sites and in their literature.

Michael O'Reardon, a regional manager for ICC-ES, says, "By the middle of summer '09, you'll be able to go to www.icc-es.com and search by the hardware company's name to see which of its products have an Evaluation Service Report that refers to AC-257."

But what about the bins of nuts, screws, and bolts at the lumberyard with no specific brand name? When it comes to galvanized fasteners, you know to avoid anything shiny (because it might be just electroplated zinc) and to look for the dull, gray, crusty fasteners. To be sure, Mathewson says to ask a salesperson because "the fastener should have come in some kind of packaging that will say whether it has a zinc coating in accordance with ASTM A153."

It's likely that your building department is going to be a stickler about the metal you want to use to hold your deck together. On the question of whether a piece of hardware will pass code, Mathewson's points out that it's up to your building inspector. "It doesn't matter what the pressure-treating wood company says, and it doesn't matter what the hardware maker says. The codes all say that 'final acceptance is up to the building official.'" ❖

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