Fire Protective Coatings: An Overview

By Beth S. Pollak

Structural steel often needs to be fire protected for use in residential and office buildings, schools, airports, and other structures. Here's a closer look at some of the different coatings available and how they perform.

Conventional Coatings (SFRMs)

One way of providing passive fire protection for structural steel is through the application of spray-applied fire-resistant materials (SFRMs), also known as conventional coatings. During a fire, SFRMs expand and insulate structural steel to prevent failure that results from rapidly rising temperatures. Generally, they are available in two types: cementitious coatings and sprayed-fiber coatings.

Cementitious wet-mix products are mixed with water to form a slurry. The slurry is pumped under pressure to a nozzle, where the pressure atomizes it and carries it to the steel substrate. Cementitious products generally are available as gypsum plaster-based coatings or Portland cement-based coatings

Sprayed-fiber products, used mostly outside the United States, are pneumatically pumped dry to a nozzle. In the nozzle, they are wetted with high-pressure water that carries the coating to the substrate.

Typically, cementitious and sprayed-fiber products are hidden from view, above a room's ceiling or behind its drywall.

According to Phil Zanghi, fire protection product manager for W.R. Grace, medium-weight densities of the coatings are most commonly used. "People generally use the minimum required by the codes, so it's only when you have other needs—like exterior water exposure—that you use a higher density," he said.

Higher density rapid-rise coatings also help protect against petroleum fires, in which temperatures rise quickly.

Intumescent Coatings

Intumescent coatings provide passive fire protection as well. They consist of thin chemical films that swell and expand when exposed to high temperatures to form a durable, adherent, fire-resistant foam layer. This layer provides an insulating barrier during a fire.

In contrast to conventional coatings, intumescents appear more paint-like when applied to structural steel, giving them greater potential for aesthetic and architectural applications when applied to exposed steel members.

UL designates intumescent coatings by usage, in three categories: 1) Interior conditioned space, with controlled temperature and humidity conditions; 2) interior unconditioned space, with variable temperature and humidity; and 3) exterior spaces that are permanently exposed to the elements.

Interior intumescent coatings are typically known as thin-film intumescent coatings. Thin films are available as either water-based or solvent-based coatings. According to Russell Fruge of Pittsburgh Plate Glass (PPG), thin films offer architects and engineers the ability to take full advantage of their aesthetic license. "If they have to go with drywall, or box the structure in with cement, they lose the sharp, straight-edged look of the structural members," Fruge said. "The thin-film offering gives architects a new tool in their arsenal so steel can be exposed to sight."

The premium prices sometimes associated with thin-film coatings are offset by the value of the product, according to Fruge. "Sprayed fibers are cheap, and they have their place on the market, but they are not suitable for exposed areas," he said. "For a little more money per square foot installed, you can go to thin films and not worry about the additional cost of walling-in the structure."

Tim Riley, a regional fireproofing manager for Carboline Co., adds that using thin-films can also save valuable leasable space for building owners. "When you work with conventional fire-protection materials, you have to cover the fire-protection up somehow," he said. "Using a column cover can double the footprint of the column."

Exterior Intumescent Coatings

Exterior intumescent coatings, known as mastic coatings, are for use in heavy industrial environments, or when steel is located on the outside of a building and still needs a fire rating. Examples are stadiums, theme parks, petrochemical plants, offshore drilling platforms, and certain high-rise buildings. Also, for locations with tight space restrictions like elevator shafts, intumescent coatings offer a thinner alternative to conventional cementitious fire protection.

Many mastic coatings offer strong impact resistance and durability. "With our mastic coating, you'd almost have to use a sledgehammer and a chisel to get it off of the steel," Fruge said.

Exterior products are permanently exposed to the elements, and must meet a weathering program for intumescent materials. In order to list with UL, they have to withstand rain, wind, humidity, UV-exposure, and other elements.

According to Riley, some organizations are testing fire-protective coatings for their ability to withstand explosions and other extreme circumstances like terrorist attacks. "Designers of buildings that could be targets, especially ones that are overseas, are requesting blast-test information for fire-protective materials."

Coating Thickness

The thickness of a coating for structural steel depends on the size of the steel member, the fire-protection rating required for the steel or assembly, and the protection the coating itself provides.

Designers can measure the amount of fire-protection required for steel member by using what's called the "fire triangle." One side of the triangle is the W/D ratio of the assembly, where W is the weight of the steel, and D is the heated perimeter of the structural steel exposed to a fire situation measured in inches; the second side is the required hourly rating for the assembly; and the third side then is the amount of fire-protection material required.

"As measured at UL, the required thickness of intumescent materials increases on a curvilinear basis," Riley said.

Zanghi says that cementitious coatings generally require no more than two to three coats, providing up to 1" of thickness in one pass.

Thinner coats are recommended when using intumescent coatings for a better appearance. For intumescents, each coat is generally about 5-10 mil thick, according to Riley.

Most intumescent products are designed for less than 200 mil of coating, but current thicknesses for full coats range from about 30 mil to 400 mil.

Topcoats and Drying Time

Drying time depends on the temperature and humidity of the environment—the ideal is 50° F with no more than 50% humidity.

Topcoats are available in a range of colors. In general, topcoats are not required for interior use if the humidity does not exceed 70% and if the temperature is below 70° F. However, moisture is still a concern. Some interior coatings are susceptible to moisture, which can diminish some of their fire protective properties.

To retain their effectiveness, topcoats need to be periodically maintained. They also need to be compatible with the intumescent coating they are protecting. "Sometimes primers and topcoats are chemically incompatible with intumescents," Riley said. "Water-based products might not be able to accept an epoxy, and you won't have proper adhesion."

"This could jeopardize fire endurance in the long term," he continued. "Architects and contractors should specify correctly and follow the manufacturer's instructions."

More information on fire protection is available in AISC's *Design Guide 19: Fire Resistance of Structural Steel Framing.* ★

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