Journal of Architectural Coatings

REPRINTED FROM THE APRIL/MAY 2006

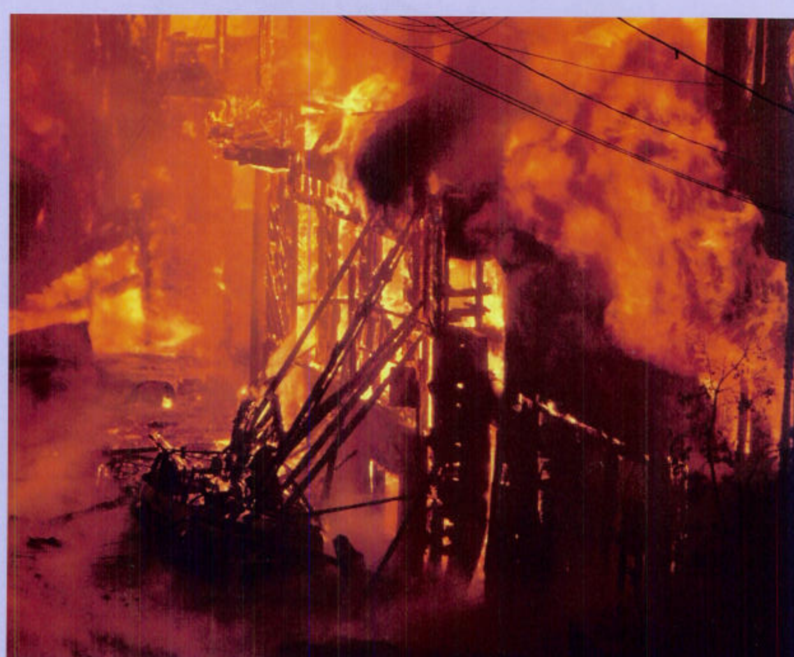
Fire-Protection Coatings

Heightened protection demands, advances in technology combine to take application of materials into new realms

Intumescents: Origin and evolution

By Ian Rowell, International Paint LLC

The use of intumescent coatings to protect commercial structures from fire is gaining significant momentum in the U.S. building industry. In considering the economic advantages, offsite-application capabilities, and superior fire-protection benefits of intumescents, valuable insights can be gained from looking at how this coating technology has evolved in commercial uses in Europe over the last 30 years.



Intumescent coatings first gained acceptance as a viable industrial fireproofing material in the 1970s, when global oil companies discovered that these coatings could protect steel from extreme-heat fires, including hydrocarbon-generated blazes, explosions, and jet fires that are caused when leaking high-pressure hydrocarbon gases ignite to produce intense, erosive jet flames that can reach speeds of 335 mph and temperatures in excess of 2,000 F.

This intumescent technology, developed by International Paint LLC and known by the brand name Chartek™, consists of mesh-reinforced epoxy-based fireproofing that offers superior adhesion to steel surfaces, a high level of durability, and corrosion protection from the harsh conditions of offshore and chemical environments. As a result, this technology has been used widely on offshore oil rigs and globally in the petrochemical industry.

International Paint recently introduced a modified version of the technology tailored for use in architectural applications, known by the brand name Interchar®.

Intumescent basics

The unique chemistry behind intumescent coatings involves a complex

process in which the solid applied and cured coating is converted into a highly viscous liquid when exposed to heat. Endothermic reactions are initiated that result in the release of inert gases with low thermal conductivity. These gases are trapped inside the viscous fluid, where crosslinking reactions take place among the polymer chains. The result is an expansion, or foaming, of the coating, in some cases up to eight times the initial thickness of the coating film, that forms a low-density, carbonaceous insulating char.

The layer of char absorbs a large part of the heat generated by the fire, thus maintaining the load-bearing strength of the protected structure within the critical limit established by the specified rating. The level of protection of the structure is determined by the thickness of the applied coating film.

During the 1980s, European architects increasingly began incorporating exposed steel in their designs, which eventually paved the way for a dramatic increase in the use of steel in commercial structures in Europe and the UK. To accommodate the aesthetic requirements of exposed steel designs, a new generation of thin-film intumescent coatings was developed that could provide a high level of fireproofing efficiency, but with the benefit of faster dry times, enhanced durability, and offsite-application capability.

As exposed steel designs gained popu-

(Above): Illustration of "charring" process on steel beam when epoxy intumescent is exposed to heat.

(Left): Interchar used at the Nan Ya Plastics, Corp. factory expansion in Taiwan. Photos courtesy of International Paint LLC

larity, British Steel, one of the UK's largest steel manufacturers, recognized the existence of the opportunity to compete with or even displace concrete as the dominant building material for commercial structures. British Steel launched an aggressive, 15-year-long strategy to increase steel's estimated 40% market share. A major component of that strategy involved the use of fabrication shop-applied fireproofing to capture greater cost and production efficiencies. By avoiding the complex set-up and labor costs associated with applying

Thin-film epoxy intumescent fireproofing can be applied in as little as one-coat

fireproofing on-site, builders and owners could provide better fire protection, reduce construction costs, and speed up the building schedule. Today, it is estimated that as much as 70% of the commercial structures in Europe and the UK are constructed with steel, with pretreated intumescent fireproofing applied in the fabrication shop accounting for a significant part of the market.

In the U.S., a different development direction

In the U.S., increased commercial use of intumescent fireproofing has occurred more deliberately, mostly due to differences in fireproofing codes and the formulation of materials that meet these codes.

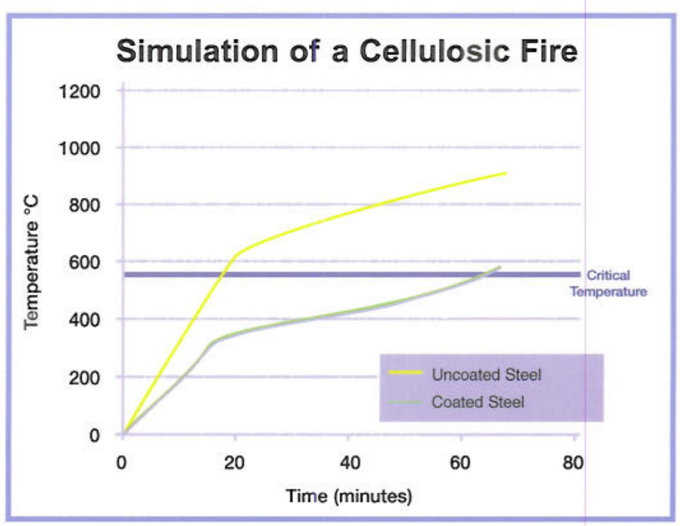
For example, the intumescent technology used to meet Europe's one-hour fire-rating minimum does not correlate, in economic terms, to the use of the same technology in the U.S. market. In the U.S., this coating must be applied three to four times thicker, in multiple application steps, in order to achieve the two-hour fire-rating requirement for structures.

Fabrication shop-applied epoxy intumescent fireproofing offers superior adhesion to steel surfaces.

Nevertheless, the U.S. building industry has seen a dramatic increase in exposed-steel designs over the last 15 years, and the need for fireproofing that accommodates these design preferences is driving new intumescent technology advances.

Another driving force behind advances in intumescent fireproofing is heightened safety awareness regarding high-rise buildings and other public structures. Since the tragic events of Sept. 11, 2001, regulatory agencies and other groups have called on the industry to re-evaluate existing fireproofing standards and materials. Passive fireproofing protection such as cementitious, fibrous, and composite materials provide protection of structures from cellulosic-induced fires, but are not well suited for application to exposed structural steel. Nor do they protect against the intense heat of hydrocarbon fires that can quickly undermine the load-bearing strength of the steel structure once temperatures reach 650 F.

Indeed, in September, 2005, after a two-year investigation into the World Trade Center collapse, the National Institute of Standards and Technology (NIST) issued a report calling for the building industry to re-examine everything from structural design issues, to building codes, to the fireproofing materials specified for commercial steel structures. Two of the 30 recommendations made in the report called for fire-



proofing that can be applied in the fabrication shop to ensure quality and consistency, as well as the development of fireproofing materials that possess enhanced adhesion and durability characteristics, such as intumescents.

A variety of intumescent coatings based on acrylic, vinyl, and polyvinyl acetate resins have been used for many years in the U.S. for architectural applications. Epoxy-based intumescents, however, can be applied in as little as one coat, offer high levels of fire protection, corrosion resistance, and durability, and possess the adhesive and cohesive strength to withstand the impact of flying debris generated by explosions.

The recently introduced thin-film epoxy intumescent technology for architectural applications discussed here represents a modification of earlier epoxy-based intumescent coatings products, and is designed to offer the aesthetic versatility required for architectural applications, combined with anticorrosion and extreme-heat fire protection. The coating can be applied in the fabrication shop in as little as one coat, and provides a durable barrier coat over the steel beam.

The technology in practice

This epoxy-based intumescent coating can be directly applied to the steel surface, and can function as a single-coat system. In cases where color or enhanced aesthetics are important, topcoats are applied. Recommended topcoat materials include polyurethane and polysiloxane chemistries, although epoxy topcoats can be used in cases where UV exposure is not a consideration. The choice of topcoat also hinges on the required durability capabilities.

Topcoats also provide the desired gloss and smoothness to the finish in cases where these aesthetic features are important to the design objectives. The spray-applied epoxy intumescent coating itself cures to a stipple-type finish, although a smoother surface can be obtained with back-rolling.

Typical applied film thicknesses are in the range of 120 mils, but this will vary depending on the type of steel member. Thicker films are specified for load-bearing columns, while a cross-structure support beam would receive a lower mil thickness.

Looking ahead

As architectural designs and safety issues create new demands on the building industry, intumescent technology will continue to evolve to help architects and builders retain greater design flexibility, reduce construction costs, and help keep steel structures from collapsing prematurely in scenarios of extreme heat. JAC