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Resin Technologies for Industrial Maintenance Coatings

Performance and Sustainability Drive Development

By Cynthia Challener, CoatingsTech Contributing Writer

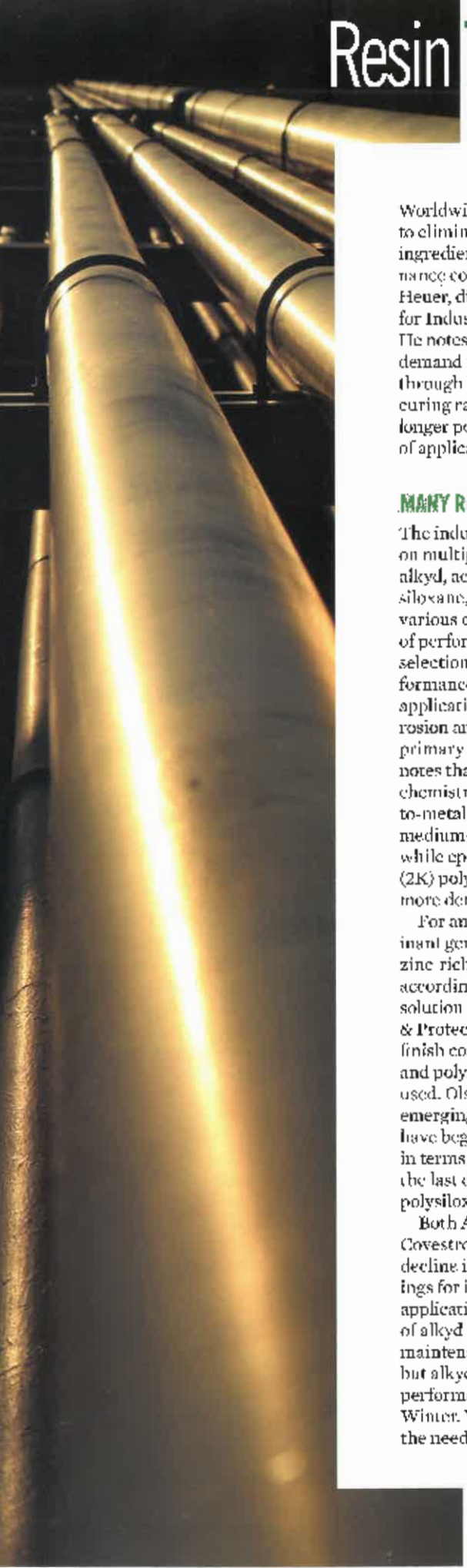
Industrial maintenance coatings are used to protect a wide variety of generally large structures from process tanks in the oil and gas industry to critical infrastructure such as bridges and water tanks. In many cases, the structures are exposed to harsh environments—corrosive chemicals, high heat, and/or extreme cold. As a result, performance remains the top differentiator. Sustainability is becoming an increasingly important issue, due to both changing regulatory requirements and end user expectations. Cost, as always, is a factor as well.

GROWING MARKET

The market for industrial maintenance coatings varies from segment to segment and region to region, but overall appears to be growing. "We have seen a rebound in the industrial coating market from a rather sluggish 2016," says Ahren Olson, marketing manager for Protective Coatings at Covestro. He points in particular to the oil and gas segment, which has seen a slight rebound from very poor years in 2015 and 2016. He notes that operators have found ways to reduce production cost, which has spurred renewed activity in drilling, and drill counts in North America are up drastically versus 2016. In the infrastructure segment in the United States, on the other hand, there is uncertainty, according to Olson. "The bridge and highway segment remains desperately underfunded by the federal government, and everyone continues to wait for new legislation and funding," he says.

When you examine the market more closely from a technology perspective, different rates of growth are also notable for waterborne vs solventborne coatings, with demand for water-based systems growing at a faster pace, according to Jon Cronin, sales director Coatings EMEA, DSM Coating Resins. "The market historically has been dominated by solventborne chemistries that provided superior corrosion protection, but market demand and environmental regulations have pushed chemistries toward lower VOC and waterborne technologies," agrees Shiona Stewart, industry marketing manager for Transportation, Industrial, Furniture, and Floor Coatings with BASF.

Constantly changing VOC regulations, in fact, have a direct impact on the industrial coatings market, according to Olson. As one example, U.S. states participating in the Ozone Transportation Commission have agreed to lower the allowable VOC content from 340 g/L to 250 g/L, and some have already begun to adopt the new rule. "Coating manufacturers have had to reformulate a multitude of coating systems in order to be within compliance," Olson says.



Worldwide, there are also movements to eliminate all potentially harmful ingredients from industrial maintenance coatings, according to Marco Heuer, director of applied technology for Industrial Coatings with Evonik. He notes that there is also increasing demand for broader application windows through the use of coatings with faster curing rates at lower temperatures and longer potlives, as well as various types of application equipment.

MANY RESIN CHEMISTRIES

The industrial maintenance market relies on multiple resin technologies, including alkyd, acrylic, epoxy, polyurethane, polysiloxane, and hybrids combining these various chemistries, based on the type of performance criteria needed. "Resin selection is dependent on a variety of performance criteria driven by the end-use application but overall resistance to corrosion and UV degradation tend to be the primary drivers," observes Stewart. She notes that acrylic and styrenated-acrylic chemistries are often utilized in direct-to-metal (DTM) applications in light- to medium-duty industrial applications, while epoxy resins and two-component (2K) polyurethane systems are used in more demanding environments.

For anticorrosive primers, the dominant generic types are epoxy-based or zinc rich (inorganic or organic) systems, according to Mike Winter, regional solution manager – Americas for Marine & Protective Coatings at AkzoNobel. For finish coats, he adds that polyurethane and polysiloxane systems are widely used. Olson observes that emerging resin technologies have begun to make headway in terms of acceptance over the last decade, including both polysiloxanes and polyaspartics.

Both AkzoNobel and Covestro have observed a decline in the use of alkyd coatings for industrial maintenance applications. "There is some use of alkyd coatings in industrial maintenance applications, but alkyds tend to have lower performance properties," notes Winter. VOC regulations and the need for longer lifetimes are impacting the use of alkyds, according to Olson. DSM, on the other hand, is seeing an increase in demand for its waterborne acrylic and alkyd dispersions compared to the demand for urethane hybrids and 2K systems. "While the performance of waterborne acrylics/alkyds is not yet equal to that of 2K systems, it often meets the expectations of our customers for many of their industrial maintenance applications, and these coatings have the added benefit of being user-friendly," Cronin says. Indeed, with VOC reduction an important trend, Heuer points out that high solids ultra-high solids and waterborne products are more often used today than in the past.

IMPROVING PERFORMANCE AND SUSTAINABILITY

"Price always matters, as does the need to decrease VOC content, but the main driver of new resin technology development is performance," asserts Cronin. Reduction of the VOC content of coating formulations has been, and continues to be, one of the main drivers in resin development, according to Winter. There are also, he adds, key performance drivers, such as improving the application of products, extending the application window, and increasing productivity through shortening of drying and over-coating times or reducing the overall number of coats required. "Performance, labor savings, faster return-to-service, and sustainability are the leading factors influencing resin development for industrial maintenance coatings," Stewart

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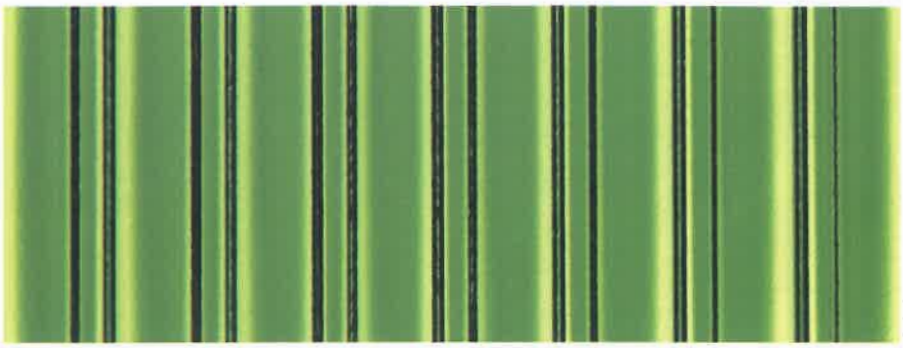
maintains. She notes, for instance, that improved corrosion resistance properties can extend the overall lifetime and protection a coating provides.

In addition to more durable and faster drying coatings (even at low temperature), Evonik has experienced growing demand for industrial maintenance coatings that are more tolerant to surfaces that are not perfectly pretreated, according to Heuer. There are several ways in which resin suppliers and coating manufacturers are working to develop industrial maintenance coatings with reduced overall cost-in-use, many of which meet other growing customer demands, according to Winter. Extending the life cycle of the coating system through improved performance, reducing the application costs by using fewer coats of paint or faster drying/overcoating, and/or simply finding alternative raw materials that may lower the cost of the final product are all being explored.

There is also a trend for global manufacturers to use maintenance coatings across their worldwide operations rather than to purchase local products for each region. "As a result, coatings producers need to develop formulations that can meet global registration requirements for raw materials," says Heuer. In addition, he notes that future regulations could significantly limit the options for innovation with respect to the design of new binder technologies and the formulation of maintenance coatings. In particular, 2018 is going to be a key milestone with regards to Registration, Evaluation and Authorization of Chemicals (REACH) registrations in Europe and finding out what raw materials will be available for product use, according to Winter.

As the market moves toward lower VOC systems and waterborne chemistries, meeting conventional solventborne performance becomes a challenge, according to Stewart. "It is a challenge with certain technologies to be able to reduce the VOC of the coating and produce a higher solids product that can still be applied at the same film thickness and without increasing the cost per square foot of the applied system," Winter comments. These challenges are particularly true for thin-film finishes, such as polyurethanes. The need to create lower VOC systems that offer the same performance has led to developments in older resin chemistries (epoxy, polyurethane) and the emergence of new technologies (polysiloxanes, polyaspartics), according to Olson.



RECENT DEVELOPMENTS

Advances in resin technology have been generally incremental, but more dramatic improvements have occurred in response to the changing regulatory environment and expectations of users of industrial maintenance coatings. Epoxy chemistry, an older chemistry, but one that still accounts for a significant amount of the industrial maintenance market, continues to be incrementally developed, according to Winter. He points to the development of ultra-high solids single-coat tank lining systems that can be sprayed with standard airless spray equipment rather than plural component spraying systems, yet still provide a high level of chemical resistance.

BASF has focused on advancing acrylic resin technologies. One recent example is a new hydroxyl functional acrylic resin dispersion for waterborne, 2K polyurethane, DTM coating applications that, according to Stewart, provide performance comparable to solventborne technologies. "Coatings formulated with this new resin exhibit excellent durability, flow, and leveling with the added benefit of low viscosity and low isocyanate demand," she says. The resin has an end-of-potlife viscosity increase indicator that signals the applicator to stop using the coating. BASF has also launched two new self-crosslinking resins for waterborne topcoats: one allows formulation of low-VOC coatings with early hardness development and gloss retention, and the other provides improved adhesion and resistance to chemicals and weathering degradation, according to Stewart. She also notes that BASF continues to invest in the development of technologies that enable faster cure, labor savings through the reduction of coating applications, and greater temperature curing flexibility to provide faster return-to-service of structures that are being coated/protected.

Hybrid resin chemistries are attracting attention in the industrial maintenance marketplace due to the need to reduce VOCs yet provide greater durability, according to Heuer. "The continuous innovation in/of hybrid resin systems is the most important area of research and development," agrees Cronin. "It is no longer about urethane, alkyd, or acrylic, but about combining the characteristics of each and strengthening them," he explains. "There is still room available to improve the performance of one-component systems. We are definitely not near the end of this journey," he adds.

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Evonik, for instance, has focused on the development of specialty resins based on silicone-hybrid technology. "With this technology platform, it is possible to create more low-viscous resins with high-solid contents that have a range of OH-functionality and offer non-isocyanate curing mechanisms. In addition, traditional processing and application equipment can be used with no need to invest in new manufacturing or application technologies," Heuer says.

For Covestro, emphasis has been placed on the development of polyaspartic resin and polyisocyanate technology

Resin Technologies

for more robust coatings with respect to application conditions. "Second-generation polyaspartic coatings are far more user friendly for applicators with increased potlife and lengthened recoatability without sacrificing speed of cure, in addition to exhibiting better water and corrosion resistance," notes Olson. He adds that these benefits have been validated by both coating applicators and coating manufacturers as these second generation polyaspartic products have been introduced into the market.

Polyaspartic technology from Covestro, according to Olson, has been documented to lower the cost of bridge maintenance painting by up to 20% while improving painting efficiency by up to 30%. "Funding remains a major concern in the bridge and highway segment, so increased maintenance of older existing structures has been a strong focus for the departments of transportation (DOT). There have been some early adopters of polyaspartic coating technology over the last decade; in just the last few years a number of states have initiated pilot projects to validate performance and cost metrics, and we expect this trend to continue," Olson comments.

Getting new technologies accepted by users of industrial maintenance coatings can be a challenge. "Introducing and embedding any new technology into industrial maintenance markets is a complex and lengthy process," Winter observes. "These coatings cover applications that can occur in freezing temperatures in the northern United States and Canada down to 100+ degree heat in the southern United States and Mexico. The development and testing efforts required to ensure that new technologies are robust to both in terms of application properties and their ability to protect the asset being coated in these wide ranging conditions takes significant effort," he explains. In addition, Winter notes that much of the customer base is quite conservative with respect to new technology, and it can take a while to build up the track record of performance needed to convince them to use a new technology on a project.

This fact may be driving another important trend in the industrial maintenance market. "We are seeing deeper collaborations between suppliers and customers in the value chain," says Cronin. "For example, coating companies no longer expect to get answers only from their raw material suppliers or their R&D departments. Different departments within companies work more closely together to look for solutions and also look further in the value chain. While this approach does not work for all companies, when it does, it accelerates the innovation process and offers a win–win situation for those involved," he remarks.

Looking forward, resin manufacturers are excited about the opportunities presented by biobased technologies. Covestro, for instance, is developing resins based on pentamethylene diisocyanate (PDI), its new biobased aliphatic isocyanate, and CO_2-based polyether polyols. DSM Coating Resins, meanwhile, has seen strong market pull for its new plant-based resin technology for coatings used in industrial applications. "It is not about 'what can we invent,' but 'what is the customer looking for,' " asserts Cronin. Olson agrees: "Developing new products is no longer a 'build it and they will come' philosophy; new product developments must be centered on solving a validated market need. This approach helps to ensure valuable resources are spent wisely." Plant-based resin technology is a good example of a market-pulled product that created and opened a whole new dimension of innovation opportunities, according to Cronin. It has also opened perspectives and different conversations both within and outside the value chain.*