



Improving the Performance of Concrete Coatings

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As a cost-effective, sustainable material, concrete continues to find widespread use in residential, commercial, industrial, and transportation applications. Although cementitious materials have high strength, they also degrade upon exposure to the environment, and therefore must be protected. Several types of coatings—including those based on traditional single and hybrid resin systems, block fillers, penetrating and reactive sealers, and specialty elastomerics—provide that protection. The nature of concrete and its wide range of applications and conditions of use, however, pose some challenges to resin manufacturers and coatings formulators. At the same time, concrete coatings must meet expectations for ease of use, environmental compliance, and longer-lasting performance, and do so at a reasonable cost.

GENERAL TRENDS

Although concrete is used in a wide range of applications, several trends in end-user expectations cut across these disparate end-use categories. "Key demands for coatings used on all types of concrete surfaces include faster job installation times, improved performance, and more environmentally conscious systems," according to Adam Fasula, marketing manager for Epoxy Materials with Air Products & Chemicals. Faster job turnaround times are increasingly important for both applicators and end-users; installers require higher productivity, and end-users need quick return to service to minimize downtime.

"The interest in more environmentally friendly coating systems is driven by a combination of regulatory compliance requirements, growing consumer interest in more sustainable products, and a growing awareness of the impact of coating formulations on both installer and occupant health and safety," Fasula observes. The biggest change resulting from this trend has been a switch to low emission technologies, including waterborne and 100% solids systems (epoxy, polycarbamide, acrylic, polyurethane, etc.).

"Formulators are facing continual challenges to reduce volatile organic compounds (VOC) in their coatings while maintaining performance. New resins incorporating self-crosslinking technology with reduced coalescent but with excellent performance characteristics (high pencil hardness, better hot tire resistance, less tacky films, etc.) are a recent development designed to address this market need," comments Rich Stewart, North American marketing manager for Coatings with OMNOVA Solutions Performance Chemicals. Interest in water-based concrete coatings is also increasing because these systems offer additional advantages such as lower odor and less risk of fire, according to Leo Procopio, Technical Services group leader for Dow Coating Materials.

"Importantly, the performance of these systems has also continued to improve to the point that formulators have many good options for designing cost-effective and environmentally friendly products that also deliver the improved performance their customers demand," adds

Fasula. In recent years, advances in two-component, waterborne epoxy and urethane coatings for use on concrete have been of particular note, according to David M. Parish, staff scientist in the New Technology Group with Sherwin-Williams Protective & Marine Coatings. "Previous iterations of these systems, while affording the moisture vapor transmission capabilities to work well over concrete substrates, had neither the wear characteristics nor the chemical resistance of standard 100% solids or solventborne systems. More recent offerings, however, do have the required durability and resistance," he explains. He also notes that recent waterborne urethanes have overcome the issues with water in relationship to isocyanates, and that several types of systems have been introduced, encompassing everything from mortars to slurries to coatings.

Improved performance, in fact, translates to increased durability over a longer period of time, as well as the combination of different functionalities for achieving more than just protection and aesthetics. Laura Schreiner, senior R&D manager for Polyurethanes with Stepan Company, notes that there has also been an increase in the development and introduction of hybrid systems, such as urethane/acrylics, epoxy acrylics, polyurea/polyurethanes, and polyurea epoxies. These hybrids offer a balance of properties in coatings applications. Low-VOC, two-component hybrid systems that develop highly crosslinked film structures are attractive for commercial coating applications, where more aggressive cleaning of surfaces occurs. For instance, use of hybrid systems in hospitals allows the removal of stains and dirt without damage to the coating, according to Procopio.

Applicators of concrete coatings would also like to have the ability to coat these surfaces at lower temperatures—for example, down to 40°F. "The formation of good films and proper crosslinking at low temperatures are essential for the application of coatings at earlier times in the construction cycle, which enables new buildings to be brought into service more quickly," Procopio says. He adds that concrete coatings that perform at lower temperatures are part of a larger trend within the coatings industry to extend the application window of coatings.

In the do-it-yourself (DIY) segment, customers are looking for ways to refresh concrete surfaces so they can avoid the more expensive option of replacing an existing surface. As a result, there is growing demand for new resins and coatings that can be applied in high film builds and restore the aesthetics of outdoor living spaces. "On a concrete patio, for example," Procopio

explains, "such coatings need to fill small cracks, have the flexibility to withstand further cracking, and provide excellent abrasion and stain resistance."

Not surprisingly, cost-effective solutions are also expected. "Our coating customers continue to look for ways to improve their margins, and thus much of our efforts have been focused on helping them accomplish this goal while still meeting all of their performance and application-related requirements," says Timothy M. Kittler, Versatic's market manager for the Americas with Momentive Specialty Chemicals.



A MULTIFUNCTIONAL APPROACH

The industry continues to need products that offer multiple capabilities, according to Parish. He points to a recently introduced, unique, patented epoxy functional coating that acts as the primer, matrix resin, and topcoat all in one. "This material, although an epoxy in nature, has comparable UV resistance to a urethane and does not chalk, which is not typical of epoxy based systems," he says. It is also high-

solids but has a very low mixed viscosity, which allows for maximum concrete penetration, making it suitable for use as a primer, and maximum aggregate loading, whether decorative or functional. As a result, it requires lower levels of resin when used as a matrix resin for monolithic flooring systems.

In addition, Parish notes that because of its UV resistance and very high abrasion resistance, this material also functions well as a topcoat. "Furthermore, as a rapid-cure product, it allows for the complete primer, matrix, and topcoat system to be applied in a shorter time frame than previous epoxy based systems. All coating contractors would rather have more jobs in a given time frame than have to spend all of that time on one job site," states Parish.

THE CHALLENGES OF COATING CONCRETE

One of the major issues with coating concrete, which is unique to this substrate, is that the curing process generates moisture and alkaline conditions, according to Kittler. Typically, concrete must cure for close to 30 days prior to the application of any type of protective coating. The efflorescence of concrete is another challenge in terms of coating performance, Procopio adds. "There is a strong desire of end-users to be able to coat 'green' concrete surfaces much earlier—typically after only seven days, rather than having to wait 28-30 days for the



material to fully cure, particularly for concrete flooring. Developing a coating that is resistant to the water content and alkalinity of green concrete and still forms good films is a challenge," Procopio explains.

Resistance to hot tire pickup for one-component, low-VOC garage floor coatings is another remaining performance challenge. Two-component, low-VOC epoxy and epoxy/acrylic solutions can better withstand the damage caused by the pressure and heat of car tires resting on them, because of their crosslinked nature. However, more user-friendly, one-component systems with truly excellent resistance to the hot tire pickup that are also low-VOC remain a good target for coatings formulators, according to Procopio.

With respect to seamless floor coating systems, there is a need to reduce the installed cost so that they can compete with traditional flooring options (vinyl and carpet). The development of new resin chemistries that lead to improved aesthetics, increased formulating flexibility, and the ability to create new looks in seamless flooring are also needed to drive interest in these systems. "We also believe that improving the ease of use of thermosetting systems will be important for the future growth of these coatings, because it will enable our customers to grow their customer base by making it easier to train new contractors, especially contractors from other construction disciplines," Fasula remarks.

The epoxy-based primers for concrete surfaces that are typically used today also have limitations, such as brittleness and poor intercoat adhesion, according to Schreiner. She adds that there is also a general need for improved weatherability and higher bonding on both wet and dry concrete surfaces.

MEETING MARKET NEEDS WITH ADVANCES IN RESIN TECHNOLOGY

Resin manufacturers are tackling many of these challenges with the development of new technologies designed to meet both performance standards and demands for more environmentally friendly, highly functional, easy-to-use coatings for concrete that are still reasonable in cost.

The Versatic group at Momentive Specialty Chemicals is developing a primer to coat "green" concrete surfaces. The company has also introduced coatings for use on cementitious substrates such as stucco, exterior insulation, and finishing systems (EIFS). Its VeoVa™ monomer enhances coatings systems by improving their resistance to alkalinity, moisture, and efflorescence, according to Kittler.

In the waterborne area, several new resin chemistries are now available that provide the performance expected of solvent-based systems. Omnova's EBS (Emulsified Binding Technology) enables formulators to develop water-based coatings that combine the performance properties of solventborne systems with the applicability and easy cleanup of waterborne coatings, thus providing excellent penetration and adhesion properties at extremely low VOC levels, according to Stewart. For concrete sealers, Omnova's Hydropliolite WL resin imparts a solventborne wet look appearance and excellent adhesion to waterborne systems. Plitec SC55 and SA60 provide greater toughness and durability in water-based horizontal and institutional coatings, respectively, while acrylic Plitec EL 45, for use on vertical masonry surfaces such as EIFS, tiltups, and stucco, provides superior color retention and application properties even in high-humidity, low-temperature environments, according to Stewart. Omnova is also developing advanced stain- and odor-blocking resins for vertical concrete coatings and stain-resistant polymers for the protection of diamond-polished concrete flooring surfaces. Finally, the company is expanding its Mogadore, Ohio acrylic production capacity to meet the growing demand for its new coating resins.

Dow Coating Materials, meanwhile, has taken several different approaches to the development of low-VOC resins for concrete coatings. "Sustainability through science is a major theme across Dow and we can see that at work in Dow Coating Materials through our ongoing innovation in low-VOC and waterborne coating performance," Procopio asserts. The company has developed water-based, two-component hybrid materials that combine the advantages of epoxy and acrylic technologies. The resins contain glycidyl functionality and are crosslinked with amine hardeners, and as a result, have improved cure speeds, property development, and UV resistance. According to Procopio, the resins can be formulated at < 50 g/L and, in some cases, near-zero VOC, and they provide high levels of performance, including excellent hot tire pickup and chemical/solvent resistance. "We have also carried out a number of low-temperature application studies with these epoxy/acrylic hybrid resins and seen very good response in terms of final film properties," he adds. The hybrid resins are intended for use in garage floor, industrial floor, and institutional wall coatings. In addition, OUDRASperse waterborne epoxy dispersions are designed for use in low-VOC industrial flooring solutions. Dow's Bluewave mechanical dispersion process enables the production of epoxy dispersions without added solvents, facilitating extremely low coating VOCs.

The Paraloid B-66DMC solventborne acrylic resin from Dow Coating Materials, on the other hand, is formulated with the exempt solvent dimethyl carbonate, thus enabling the preparation of concrete sealers that offer the robust performance, aesthetics, and drying characteristics of high-VOC solventborne systems, but at VOC levels < 100 g/L, according to Procopio. In addition, because the resin is supplied in an exempt solvent, there is no need for coating manufacturers to dissolve solid grade resins at their facilities, which in turn saves customers time and energy. Paraloid B-66 DMC Resin is designed for use in sealers for patios and driveways constructed of poured concrete and concrete pavers.

Stegan, meanwhile, has recently introduced two new polyester polyols for two-component polyurethane concrete primers. "Polyurethane primers based on polyester polyols give improved weather ability and increased bond strength to wet and dry surfaces and also have a faster overall cure rate with acceptable working times," states Schreiner. She adds that they can also be used to eliminate brittleness and improve the moisture vapor transmission rate (MVTR) and intercoat adhesion of these systems.

Steganpol® PC-130-01 and Steganpol PC-160-01 polyols offer a combination of performance enhancements over other primers, according to Stegan, including improved weatherability, MVTR, wet and dry substrate adhesion, and intercoat adhesion. In addition, Stegan has recently expanded its polyester polyol product line with the acquisition of Bayer Material Science's North American polyester resin business.

Air Products focuses on curing agents, and has developed several new products with applicability for the formulation of concrete coatings. For solvent-free coatings, the company introduced the amine curatives Amicure IC-221, IC-321, and IC-322 for aliphatic isocyanates that offer faster cure, high UV stability, and reduced sheen. Its Ancamine 2739 reactive amine curative for epoxy resins, meanwhile, provides excellent water-spot and blush resistance in adverse cure conditions, while also meeting the most stringent emission require-

ments, according to Fasula. For water-based systems, Air Products has introduced new amine curatives and resin technologies, such as Anquamine 735, that enable the formulation of many different types of coatings, from primers that deliver better performance than solvent-based systems to thick-build flooring systems that can compete on cost with traditional low-cost flooring.



FOCUS ON INDUSTRIAL FLOORING

The need for rapid return to service is particularly strong for industrial flooring applications. At the same time, long-lasting performance under heavy use conditions is also required. "Our target customer is the industrial maintenance and repair organization, and always our biggest challenge is providing them with floor coatings that are easy to use and deliver the longevity that is required," states Scott Lancz, product manager for Rust-Oleum Industrial Brands. "Being able to provide coatings with shorter dry/cure times and thus allow for quicker return to service is critical. In addition, these customers are looking for improved formulas that can be applied to surfaces that haven't been fully prepped (for reduced preparation work and time) yet still perform as required," he adds. He notes that these coating characteristics are critical for any end-user application, but are even more important for industrial maintenance personnel, because they are constantly under pressure to repair without adversely affecting the daily business environment.

Therefore, Rust-Oleum Industrial Brands has been focusing on the development of industrial floor coatings that are easy to apply (roller as opposed to squeegee/back roll) with a quick return to service, and will be launching a Fast Flooring Program based on polyurea technology, according to Lancz. The company has also developed a rapid cure concrete patch product, called InstaPatch, that cures fully in 15 minutes and can be applied in temperatures well below freezing. In addition, the company's FastKote and FastKote UV floor coatings offer industrial strength flooring with a 24-hour return to full service. Finally, Lancz notes that in response to increasing interest in waterborne coatings for safety line striping, Rust-Oleum has introduced a single-component acrylic floor paint that provides bright lines with good durability, but that is removable with minimal effort when plans or designs change. ●