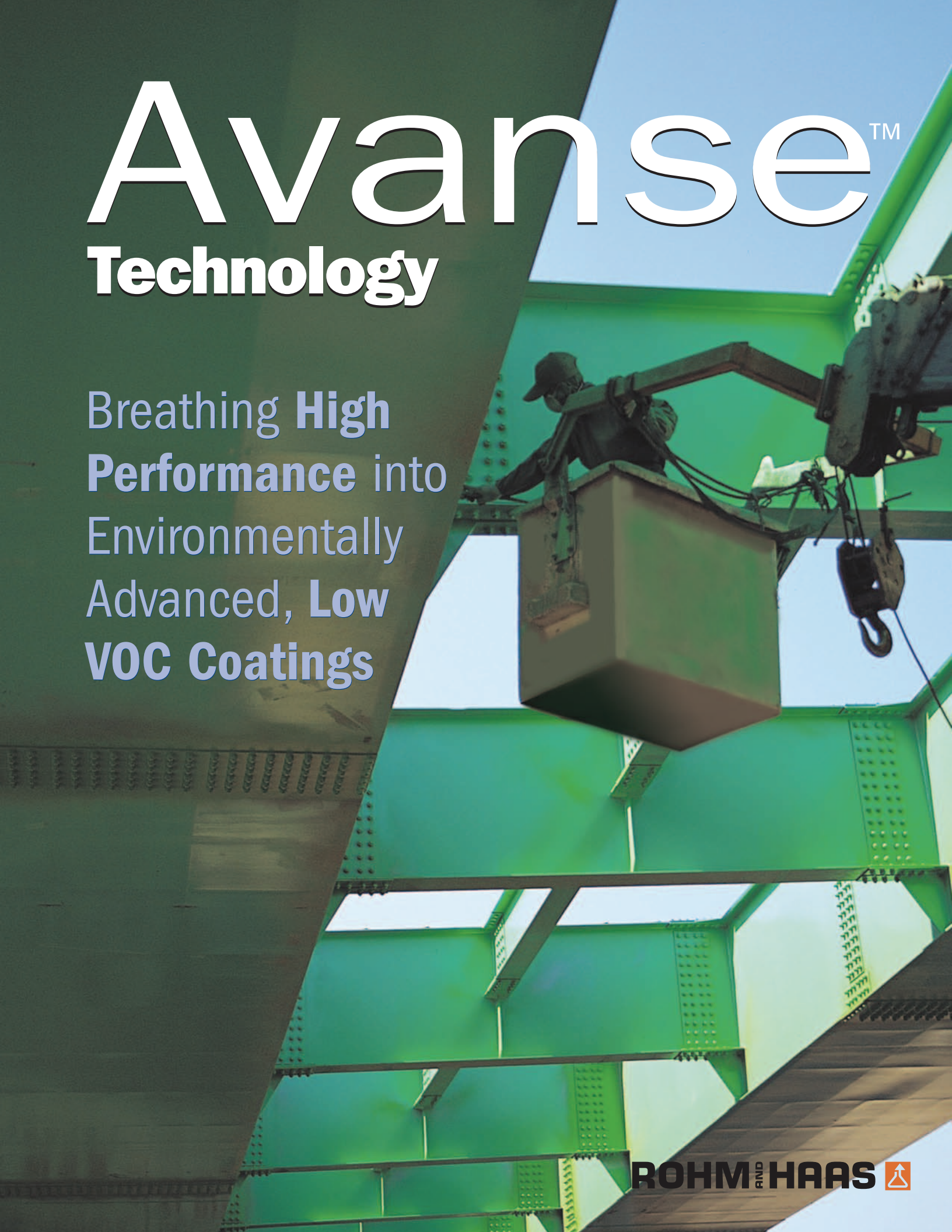
Avanse™ Technology

Breathing **High Performance** into Environmentally Advanced, **Low VOC Coatings**



ROHM AND HAAS

A well-traveled commuter bridge spans an air-polluted urban area. A salt-sprayed lighthouse faces the wind-blown Pacific coast. A hurricane-battered oil rig rises from the Gulf of Mexico. An industrial chemical tank bakes under the sun in the port of Houston. All require coatings that endure longer and shine brighter. But shouldn't these coatings also be environmentally advanced?

Now, such coatings can exist. AVANSE™ MV-100, a revolutionary, first-of-its-kind, high-performance, environmentally advanced waterborne acrylic latex polymer developed by specialty materials company Rohm and Haas, makes such coatings possible, and keeps promises to help structures like these endure.

Putting people and environment first

Customers, both industrial and governmental, increasingly demand coatings that emit lower levels of volatile organic compounds (VOCs). Solventborne coatings that release high levels of VOCs as chemical gases can damage the environment and have a detrimental effect on human health. As a result, states have been amending regulations to ever lower acceptable levels of VOC emissions. Consumers, too, are driving change.

"Environmental regulations have put pressure on the industry to develop coatings with lower environmental impacts and with health and safety in mind," says Timothy Wood, PhD, Rohm and Haas global technology director for Industrial and Construction products. "We have been developing products to protect surfaces for a long time and have been pioneers in developing waterborne coatings to protect against corrosion. Now, we are making new waterborne coatings not only more durable, but also more environmentally advanced."

The history behind the drive toward lower VOC emissions in coating products began with The Clean Air Act in 1963, which became federal law in 1970. Through the 1970s and into the 1980s, new technologies had to be developed to keep pace with ever-lowering VOC regulations set by the U.S. Environmental Protection Agency (EPA). By the mid 1990s, some states, Illinois for example, were pushing their own regulatory requirements. Many were more rigid than those of the federal government and focused on the health and welfare of industrial workers.

More than a trend, VOC regulations are targets to be met and even surpassed by new and better science. "Rohm and Haas is committed to developing products that are consistently ahead of the regulatory curve and products that anticipate stricter regulations," says Wood.

Avanse is a high-performance coating that stands up to tough industrial needs, with the additional benefit of being environmentally advanced.

In response to all of the above concerns, Rohm and Haas developed AVANSE MV-100, a resin for industrial coatings that is a high-performance, environmentally advanced waterborne acrylic binder for coating surfaces — concrete or direct-to-metal (DTM) — that meets new environmental regulations for VOC emissions.

Assuring improvements in worker safety

VOC emissions from AVANSE MV-100 are well within the newest safety standards.

This waterborne solution required a fresh start

How did scientists develop a waterborne technology compatible with 21st century environmental and health standards, while inventing a new coatings technology to meet the protective, aesthetic and durability demands of industry?

They did it by starting over!

The secret in making waterborne coatings with a competitive edge over solventborne coatings was to be found in a new beginning, in the very nature of the resin used as the major component in making the coating's film base.

Waterborne x solid resin = lower VOCs

Scientists knew that the first step in making superior waterborne coatings was to identify ways to make high molecular weight resins without high viscosity. The solution was found in acrylic latex polymers where a high molecular weight polymer is synthesized in the form of nanometer-sized particles and dispersed in water (a nanometer is one billionth of a meter). This allows for delivery of a high molecular weight resin in a low viscosity medium.

"Solventborne coatings are made by simply depositing a resin dissolved in solvent onto a surface, and allowing an evaporation process to make the film," says Rohm and Haas chemist Leo Procopio, PhD. "Film formation for waterborne products is more complicated because the resin in waterborne coatings is present as very small, spherical latex particles. When water evaporates from the film during the film formation process, the spherical latex particles form a closely packed layer."

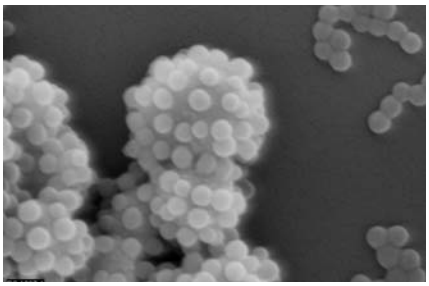
The individual particles, says Procopio, eventually meld as the polymer chains in the particles diffuse across the particle boundaries and become entangled, forming a continuous film. Each latex particle is comprised of multiple high molecular weight acrylic polymer chains. Molecular weight turns out to be one of the key differences between solventborne and waterborne products.

"Solventborne resins must start out at lower molecular weight," says Procopio. "Otherwise, they would either not dissolve in the solvent, or the resulting viscosity would be too high for application as a paint."

Because they start at lower molecular weight, solventborne resins must also undergo a process that Procopio calls molecular "crosslinking."

At the molecular level, crosslinking is the formation of new chemical bonds between polymer chains. It's a process that occurs after the paint film is applied and allows the solventborne resins to increase their molecular weight after the paint dries.

"This is a physical characteristic that impacts durability and chemical resistance," adds Procopio.



A high power microscopic image of Avanse latex particles adsorbed onto the surface of a titanium dioxide particle

However, because crosslinking is necessary in solventborne paints, many of the coatings are "two-component" coatings; that is, they are supplied in two parts which must be mixed immediately prior to use and must be used up within a relatively short period of time before they must be discarded. Waterborne coatings don't need to undergo crosslinking to form a tough film, and are one-component coatings easy for the applicator to use. They also have a very long shelf life.

"Some waterborne resins, such as those based on the new AVANSE MV-100, do contain a crosslinking mechanism to further improve on their properties," explains Procopio. "Scientists have found a way of incorporating this mechanism into a one-component coating. This maintains the ease of use and low VOC emissions."

"It's important to think about worker exposure, to consider the person who works for a contractor or the city or state, the individuals actually applying the coating," says Andy Swartz, Rohm and Haas' global technology manager for Industrial Finishes. "If you've ever painted with a solvent-based product, you know how bad the odor can be." That offensive odor is often a tell-tale sign of high VOCs.

Swartz is quick to point out that, in general, waterborne acrylic coatings not only are easier on the environment in terms of VOCs, but also offer fewer negative overall impacts on the workers applying the coating. For example, the potential flammability of some solventborne coatings makes them not only dangerous to work with, but dangerous to dispose of properly. Compared to solventborne products, cleanup with AVANSE MV-100 is easier because the coating is water-based and less hazardous to workers.

Emissions regulations that solvents can no longer meet

According to Wood, in recent years, the state of California has been among the most aggressive in the nation in requiring greatly lower VOC emissions, lower than what typical solventborne coatings can meet. Solventborne technologies — which today represent 80 percent of the applied coatings used for covering industrial steel and concrete structures — do offer good durability records, but are plagued by high VOC emissions levels. Many simply cannot meet the new, lower VOC requirements.

In 2006, for example, the California South Coast Air Quality Management District

lowered VOC levels for industrial coating to 100 g/L, or 100 grams per liter of liquid. Some other waterborne products on the market, while better than solventborne coatings in terms of VOCs, still carried double the new limit, with over 200 g/L. AVANSE MV-100, however, met the new California requirements and, as a result, was recently listed in a new specification from the California Department of Transportation as a preferred industrial waterborne, low VOC coating for painting steel bridges.

At the global level, Swartz says that industrial environmental standards and "green thought processes" in Western Europe and in North America are leading the charge toward safer waterborne coating technologies. He sees similar trends globally, as other nations and many companies become more concerned about the environment and worker health and safety.

Delivered in one package: durability, ease of use and higher gloss

Making a new waterborne coating with high performance capabilities — complete with higher gloss, better barrier capabilities and improved durability — was a challenge Rohm and Haas scientists readily accepted.

Rohm and Haas developed AVANSE MV-100 to be a high-performance, low VOC binder technology applicable in a variety of light to mid-duty industrial maintenance segments, particularly in primers, topcoats and direct-to-metal coatings. It offers a better option when compared to traditional materials such as alkyds, polyurethanes and epoxies — lower VOC emissions and lower odor combined with high performance and corrosion resistance. Paints formulated with AVANSE technology are well suited for concrete and metal surfaces.

"AVANSE MV-100 enables paint manufacturers to offer state-of-the-art products and systems that have a positive environmental profile," explains Shruti Singhal, North American marketing manager for Traffic Marking and Industrial Finishes.

"We also needed the product to be a heavy-duty, multi-functional coating. At the same time, we had to deal with the perception that waterborne coatings were inappropriate for metal surfaces, that they were light-duty products not suited for demanding industrial uses."

Durability against the elements

True enough. Early waterborne polymers made in the 1980s and 1990s *did* perform well for light- to medium-duty uses, such as on highway overpasses or on non-metal surfaces not exposed to especially harsh elements or industrial abuses. But to be successful for more demanding, heavy-duty uses, a new waterborne coating for direct-to-metal (DTM) applications had to be developed — one with the guts of a solventborne coating, one with superior barrier capabilities, and one that, in addition to having a good VOC profile, was easy to use and easy to clean up.

How durable are waterborne coatings?

AVANSE MV-100, unique to waterborne coatings, was developed in such a way that it tested well in heavy-duty situations. It tested so well that one might say technical innovation triumphed so that waterborne coatings "proved their mettle in protecting metal."

As it turned out, the long sought after enhanced durability came from the same science that gave AVANSE MV-100 its better corrosion protection qualities, qualities based on a waterborne acrylic technology that aids adhesion and protection in direct-to-metal (DTM) applications.

According to Rohm and Haas chemist Leo Procopio, PhD, better coating properties of AVANSE MV-100 are the result of unique interaction between latex polymer particles and pigment particles. Interactions of AVANSE MV-100 with titanium dioxide — the most common pigment in coatings — results in improved distribution of the pigment throughout the dried paint film. The result — paint films that use TiO_2 more efficiently have better barrier properties for corrosion resistance, and higher gloss and durability.

Perhaps the toughest hurdle wasn't technology-based, but instead the long-standing perception that a waterborne coating could not stand up to the harsher elements, especially water.

"It seemed counter-intuitive to use a waterborne coating in DTM applications, because metal's interaction with water *causes* corrosion," says Wood. "But we have long been in the business of protecting metal surfaces and knew how to go about it."

The TiO_2 advantage

The challenge involved developing a new technology that affected the microscopic structure of the paint film. That was achieved by constructing composite particles through a tightly controlled process of adsorbing latex particles onto the pigment surface. The TiO_2 advantage helped here.

"Titanium dioxide plays two opposing roles in durability when a coating is exposed to the elements," says Leo Procopio, PhD, one of the chemists deeply involved with the project. "TiO_2 acts as a catalyst in the presence of water, oxygen and light to generate free radicals that can break down the polymer base. But it also protects the polymer because it absorbs damaging ultraviolet light and converts it into harmless energy (heat). This prevents UV light from affecting the polymer's backbone."

The improved distribution of TiO_2 in coatings based on AVANSE MV-100 resins appears to benefit the second mechanism, so that the TiO_2 more effectively shields the underlying polymer from the harmful UV light. The durability of the coating, as measured by chalking, fading and loss of gloss, is therefore improved.

While coatings based on other polymers may use TiO_2, the composition of AVANSE MV-100 was specially developed to ensure that the TiO_2 is more uniformly distributed. Once more, the pigment particles in this product are better and more evenly spaced, says Procopio, resulting in an enhanced film structure with better hiding ability, enhanced gloss and gloss retention and advanced anti-corrosion properties. Another plus, superior pigment dispersion, means less TiO_2 is needed to obtain good hiding, and low VOC capability cuts down on the need for other film-forming agents, all of which could lead to lower manufacturing costs.

Better performance metrics add up

"One of the biggest pluses with AVANSE MV-100 technology comes through enhanced barrier properties, which give coatings better corrosion resistance and durability," says Singhal. "Better solvent resistance and weathering with outdoor exposure means the coating will last a long time. Its durability is a long-term cost saving aspect many industrial users have found attractive."

According to Singhal, coatings formulated with AVANSE MV-100 stand up and last where environmental stresses are constant — such as in coastal environments that must cope with wind, driving rain and salt spray, or on storage tanks that in the course of their lives may often be splashed with solvents and battered by the elements.

Also, the clean, bright look offered by AVANSE MV-100 is related to its ability to resist dirt pickup.

"Dirt pickup resistance is hard to achieve in low VOC paints," says Procopio. "That's because the polymers are softer in lower VOC-emitting waterborne coatings."

AVANSE MV-100 achieves better dirt resistance — as well as better solvent resistance — owing to what Procopio calls an "oxidative cure" mechanism. The oxidative cure is a crosslinking reaction that increases the already high molecular weight of the polymer. The oxidative curing process is also accelerated with UV light. The crosslinked polymer better resists damage from chemicals and solvents as well as more effectively resists dirt particles sticking to its surface.

Generally, even early waterborne acrylics were known for their excellent durability and resistance to weathering. As an *advanced* waterborne polymer, AVANSE MV-100 has met and exceeded that performance and, for that reason, better serves the industrial maintenance needs for which it was designed.

In short, Rohm and Haas scientists have found a way to control both the wet paint and dry film structure of waterborne latex coatings in such a way as to lower VOC levels further than what waterborne coatings offered previously and to enhance durability, gloss, adhesion, corrosion resistance, and ease of use at the same time.

A highly beneficial discovery

Rohm and Haas scientists were successful where others had previously failed because they have found a way to control the wet paint and dry film structure of waterborne latex coatings in such a way as to lower VOC levels farther than what waterborne coatings offered previously. And in doing so, they were able to enhance durability, gloss, adhesion, corrosion resistance and ease of use. They accomplished this through the design of a self-crosslinking polymer with the unique ability to associate with pigment surfaces, leading to a more efficient and beneficial use of the TiO_2 component.

"AVANSE MV-100 was designed specifically for industrial maintenance — for bridges, chemical storage tanks and steel beams in DTM applications. But it can also be used to paint other surfaces such as concrete," summarizes Procopio. "Used either as a primer, midcoat or a topcoat, it allows paint manufacturers to use a single resin across multiple product categories. It represents not only a more environmentally advanced technology, but also a higher performing resin that should allow waterborne coatings to be used in more demanding applications where only solventborne paints were previously applied." ▼

AVANSE™ MV-100

THE NEW STANDARD IN WATERBORNE TECHNOLOGY

HIGHER PERFORMANCE

ENHANCED GLOSS, BETTER HIDE, IMPROVED CORROSION PROTECTION, LOWER VOC

From the leader in coatings innovation comes Rohm and Haas's AVANSE™MV-100 resin. This high-performance waterborne acrylic binder is designed for use in low-VOC industrial maintenance coatings for metal and concrete surfaces. Now you can formulate at levels below 100 g/L and offer a more environmentally-advanced choice compared to traditional solventborne materials, such as alkyds, epoxies, and polyurethanes. AVANSE™ MV-100 resin enables paint manufacturers to offer state-of-the-art products and systems that have an advanced environmental profile with the performance attributes to match.

FOR MORE INFORMATION OR TO CONTACT US, PLEASE VISIT
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