EPA Announces Green Chemistry Award for UV Primer

By Bradley Richards

In June 2005, the U.S. Environmental Protection Agency (EPA) announced that a UV-curable primer for the automotive refinish market was a recipient of this year's Presidential Green Chemistry Challenge Award.

In conferring the award, the EPA, in partnership with the American Chemical Society, the chemical industry and the broader scientific community, recognized that UV-curable coatings could be cleaner, cheaper and smarter chemistry choices for end users. In addition, developing safer, environmentally friendly chemicals and processes results in several benefits such as reduced waste, eliminating costly end-of-the-pipe treatments, safer products, and reduced use of energy and resources, improving the competitiveness of chemical manufacturers and their customers.[1]

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The Needs of the Market[2]

For more than a decade, the automotive refinishing market has dealt with increasingly stringent regulation of volatile emissions. Various regulations require solvent level reduction in coatings in an effort to reduce VOCs (volatile organic compounds) that lead to smog creation. At first the conversion from older lacquer technologies to newer technologies, such as two-component urethanes, permitted reduction in volatiles, as well as improving the quality of the finished product. One obstacle to meeting the more recent regulations was creating resins at lower viscosities without sacrificing the performance of the coating. In automotive refinish repair, the coating used to repair a vehicle must perform at the same level as the original equipment manufacturer's (OEMs) standard, but cure at much lower temperatures.

After intense research and development, BASF developed a primer that can cure in minutes by visible and UV-A energy. The product offers improved performance properties compared to the current conventional urethane technologies

in areas such as crosslinking speed (ability to process the next step); reduction in the steps of the full coatings process; corrosion control and the ability to fill in a single layer; and durability.[3] This UV-A curable primer can be cured with terrestrial sunlight. The simple industrial process in body shops, however, may require the use of inexpensive UV-A lamps that are now available and meet Underwriters Laboratories' standards for safety.

Furthermore, the primer has a much lower level of organic solvents, thus reducing volatile emissions (VOCs) significantly. The VOC content is lower than required by southern California, while product properties ensure the primer is acceptable in all portions of the U.S. market. The one-component nature of the product reduces hazardous waste (whereas disposal of unused material is a typical necessity with two-component products due to their limited pot-life) and minimizes cleaning of equipment (which typically involves solvents). The acrylate-based technology allows less complex and less costly personal protective equipment (PPE) than the traditional isocyanate-based coatings. This increases the probability that small body shops will purchase and use the PPE.

Documentation of Potential Life-Cycle Impact

Eco-efficiency is a methodology developed that assesses the environmental and economic impacts of products and processes over their life cycle. Since its introduction in 1996, more than 270 analyses have been completed, on products ranging from vitamins to basic chemicals. The methodology of eco-efficiency analysis is based upon the ISO14040 standards for life-cycle analysis, and contains additional enhancements to allow an assessment and detailed understanding of total environmental and economic impacts of a product from its production through its use to its final disposal.

BASF conducted an eco-efficiency analysis to compare the environmental impact and costs of traditionally cured automotive primers versus its new UV-cured technology. The results demonstrated that UV-cured technology is the most eco-efficient. It has the lowest total environmental impact and, in liquid (non-aerosol) form, the lowest cost. Coating formulations, physical properties, and application and curing techniques were considered, along with life-cycle inventory data from a recognized public database for upstream components, including feedstocks and fuels. The study was certified by an independent third party, Dr. David Shonnard, professor of Chemical Engineering at Michigan Technological University. The results of the study were presented at the RadTech e|5 conference, May 2004, in Charlotte, N.C.[4]

Award Criteria

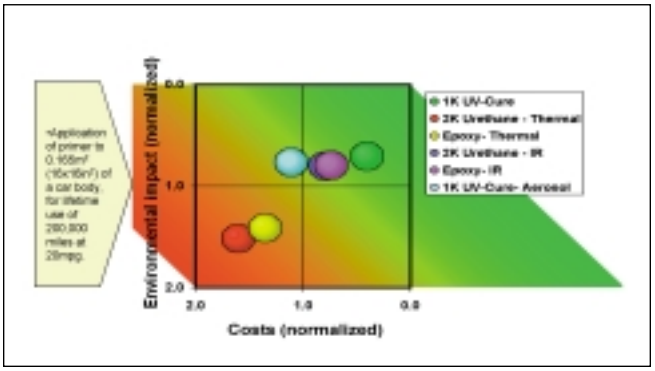
A nominated technology must prevent pollution at its source and have a significant chemistry component.

This UV-cured primer technology offers low VOC content, high coverage, fewer preparation steps prior to application, and unlimited shelf life. This means lower VOC emissions during application (as well as greatly reduced emissions from the energy normally used for curing), less coating material needed to cover the same surface, simpler and safer handling, and less coating material wasted during the application process. Applications in repair facilities over the past year have shown that UV-curable primers need two-thirds less material than conventional primers and that waste is reduced from 20% to nearly 0%.

Most of the conventional refinish coatings commercially available consist of two-component (2K) materials. These coatings have been standard in the industry for more than 20 years and have been popular because of their chemical resistance, exterior durability and speed of cure. Some of the limiting factors of 2K materials are high VOC content, limited pot life, waste generation and narrow application windows. Another concern with 2K materials is that if the coating is under-cured in any of the steps, there could be factors such as adhesion loss, dieback, swelling and

FIGURE 1

Eco-efficiency portfolio



The U.S. EPA awards Presidential Green Chemistry Challenge Award to BASF for UV-curable primer for automotive refinish.

appearance imperfections that may not become apparent for several days. When this happens, the repairs usually have to be repeated, thus using more materials and time, thus generating more emissions and waste.

With UV-curable technology being introduced in automotive refinish applications, the issues of time, waste and consistency can be overcome. UV-cured technology assures the user that a repair has been done correctly, in a relatively short time, and with minimal waste.

A nominated chemistry technology should offer human health and/or environmental benefits.

The eco-efficiency analysis methodology scientifically assesses and aggregates life-cycle environmental impacts into six categories: energy consumption, raw materials consumption, emissions (air, water and solid waste), health effect potential, risk potential and land use. These results are consolidated with a series of weighting factors into an overall environmental impact, which is combined with an overall economic impact on the eco-efficiency portfolio. This methodology was used to compare the UV-cured primer in liquid and aerosol form to the traditional 2K urethane and epoxy coatings, cured either thermally or using infrared (IR) light. The eco-efficiency portfolio for these primers used in repairing small-surface-area damage on automobiles (Figure 1) shows that the UV-cured primer technology in liquid form is the most eco-efficient alternative. The aerosol form of the UV-cured primer has higher cost and slightly greater environmental impact due to the propellant, but it facilitates use of the product in body shops that do not have sophisticated application equipment.

As the ecological "fingerprint" of different technologies shows (see Figure 2), the UV-cured primer has a greatly reduced environmental footprint in terms of emissions, energy consumption, resource consumption and land use.

Finally, the UV-cured primer provides advantages in risk potential, which considers the probability and severity of incidents occurring while producing and handling the product. The non-aerosol UV-cured coating has a simpler production process than the urethane and epoxy coatings. During use, it needs only one coat, and the preparation and cleaning of equipment are greatly reduced. The aerosol UV-primer has similar advantages and enables use of this product in body shops that do not have sophisticated application equipment, but the propellant does increase the risk.

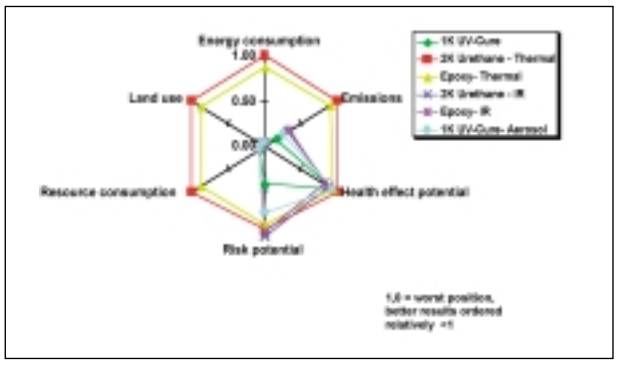
In summary, the UV-cured primer technology provides multiple environmental advantages—reducing the impact on the environment as well as reducing the health and safety concerns for the employees producing and handling the materials.

A nominated chemistry technology must be generally applicable to a large and broad-based segment of chemical manufacturers, users or society at large.

The market for refinish coatings in North America exceeds $2 billion for both collision repairs and for

FIGURE 2

Ecological footprint



commercial vehicle applications. With more than 50,000 body shops in North America, the market for UV coatings is everywhere. Most rural cities will have two or three collision shops, not counting large commercial accounts, which use refinish materials to paint buses, motor coaches, trains, public transportation vehicles and auxiliary automotive products. Eighty percent of body shop businesses are family owned and operated, and most operate a single location. These small operations could benefit both by increased productivity and profitability from the use of UV coatings, thus allowing them to compete with larger shops. Because little or no investment is needed to cure the UV primer, the technology is very attractive. In each larger shop or multi-dealership location, there may be 20 to 30 employees who could use UV coatings and benefit from the advantages. About 20% of the shops are large operations, accounting for more than one-quarter million people.

When the UV primer was launched in the refinish workplace, the technology was introduced in forums, presentations, and comprehensive training sessions to help body shops use the products efficiently, and safely and to realize the full benefits of the technology. BASF also developed informational brochures to further develop the knowledge of the workforce about UV coatings. Further, company representatives assisted RadTech in preparation of *The Refinish UV Safety Guide*, which BASF distributes at its training centers.

Conclusion

By developing an automotive refinish coating that can be cured by ultraviolet light, BASF has introduced a technology that greatly reduces environmental impact while increasing efficiency. The low VOC content of this technology reduces the amount of solvents emitted into the air compared to conventional primers currently being used. The use of sunlight or a UVA lamp eliminates the need for bake ovens to cure the current primers, thus reducing the large quantities of energy needed for curing and reducing associated emissions, fossil fuel consumption and costs. In addition, the simpler application process minimizes risk and reduces the use of cleaning solvents and the generation of waste material. Today, UV-curable technology is a real-world commercial application that is leading the industry for time saving, energy-efficient, low-VOC, high-performance primers.

References

1. EPA publication 744-F-05-001, April 2005.
2. Excerpts from 2005 Green Chemistry Challenge nomination documents.
3. Laginess, T. "UV Primer in Refinish: How Does it Compare?" *RadTech Report,* November/December 2004, pp. 56-59.
4. Wall, C. et al. "The Ecological and Economic Benefits of UV-Curing Technology," *RadTech Report,* March/April 2004, pp. 25-29.

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