Paint and Coatings—

New Trends Respond to Environmental Concerns

A description of what has happened in coatings development for the past several years would in large part revolve around technologies to control and eliminate pollution.

The continuing tightening of regulations regarding emissions of volatile organic compounds (VOCs) has been accompanied by regulations on removal of lead-containing paints and disposal of paint and coating waste material. These developments have influenced the direction of coatings and paints technology development and they will continue to shape it in the future. Federal, state, and local regulations all are involved.

New Formulations

"Formulations have been changed to reflect a changing regulatory environment," says L.D. "Lou" Vincent, director of coating services for Corrpro Companies, Inc. (Houston, Texas).

Vincent explains that to reduce VOCs, new formulae for waterborne alkyds, epoxies, polyurethanes, and acrylics have come on the scene, sometimes with solvent that is entirely water and other times using an emulsion or a small amount of hydrocarbon.

In spite of large usage of these products, there is controversy regarding their performance. "For aesthetic purposes, the waterborne acrylics have proven most popular. In this case, their performance is truly superior to alkyds in color and gloss retention," says Vincent. But in the case of epoxy emulsions for industrial protective coatings, "the performance is still considered to be below that of solvent-borne epoxies," he adds.

Another approach to decreasing VOCs is to incorporate higher amounts of solid resins, the formulation being tailored to specific environments. With the advent of regulations limiting VOCs, manufacturers' data sheets reflect the change in solids content of epoxies and polyurethanes that has occurred—rising from between 42 and 55% to 60 and 80%, says Vincent, while the number of coats has changed from three to two, still with a total thickness of 10 to 12 mil (254 to 305μm). A resulting labor savings is offset by reduced pot life and recoat times, poorer

Companies try a variety of approaches to reduce waste and pollution.

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ANL project manager Jim Frank (left) and Gene Bergemann of NTEC Versol, Inc. stand by processing equipment jointly developed by their two organizations for the improved synthesis of ethyl lactate. Photo courtesy of ANL.

tolerance to being applied in an environment hotter than 80°F (27°C), and higher cost, says Vincent.

A third tactic to decrease VOC emissions is to use coatings that are 100% solid. Vincent notes that although performance of these products, usually epoxies or polyurethanes, is excellent, application is troublesome. Most, he says, have such a short pot-life that plural component, heated, airless spray rigs are necessary. The equipment is expensive and its components must be kept scrupulously clean to avoid breakdown.

Novolac tank linings also have come on the market in both high-solids and 100%-solids formulations. They are low in VOC emissions and have a broad spectrum of chemical resistance, including mineral and organic acids, alkalis, salts, and oils.

Antifouling paints for seagoing vessels also are the subject of efforts to reduce their toxicity. In a project funded by the World Wildlife Fund and the German Federal Environmental Foundation, biocide-free paints are being tested on 25 ships operating in the field. And engineers at Jotun (Sandefjord, Norway) have developed a tin-free antifouling system for ships' surfaces. The product, developed in partnership with Nippon Oil and Fats (NOF Corp.) (Tokyo, Japan), contains copper as the active ingredient, but a Jotun spokesperson says the company expects to reduce the copper content in further development.

Cheap Production of Nontoxic Solvent

One promising formulation development being pursued by the U.S. Department of Energy's Argonne National Laboratory (ANL) (Argonne, Illinois) in collaboration with NTEC, Inc. (Mount Prospect, Illinois) is the use of ethyl lactate as a coatings solvent. Ethyl lactate, and some related lactate esters that also can be used in this development, are believed to be nontoxic. They have excellent solvent properties that allow them to replace toxic solvents for a wide range of uses, including in paints and coatings.

The solvents are not new, but ANL and its collaborators have developed a much-reduced-cost synthesis based on selective membranes to isolate the desired product after synthesis from carbohydrate feedstock. Relative to other processes, it requires little energy and produces a high-purity product without generating the large volumes of salt waste produced by currently used syntheses. The process also is cheaper—it should reduce the selling price of ethyl lactate by half, from approximately $1.60 to $2.00/lb to less than $1.00/lb., according to ANL reports. The reduced price would make these solvents economically competitive to replace approximately 80% of the 3.8 million tons of solvents now used in the U.S. each year. Solvents that ethyl lactate and other lactate esters could replace include chlorofluorocarbons (deplete atmospheric ozone), methylene chloride (carcinogenic), ethylene glycol ethers (toxic), and chloroform (carcinogenic).

Conflicting Strategies

There is some indication that reduction of coatings-carried pollution by reduction of VOCs isn't as direct and simple as it might seem. One VOC-emitting component of paints is a class of compounds known as coalescing solvents. A study led by W.R. Springle of the Paint Research Association (PRA) (Teddington, Middlesex, U.K.) has shown that some of the VOC-emitting coalescing solvents act as antimicrobials. A summary note of the report, *New Microbial Risks for Modern Waterborne Coatings*, states: "Certain cosolvents were found to contribute significantly to the microbial resistance of aqueous paints. Therefore, reducing or removing these cosolvents from a formulation may significantly increase the amount of preservative required to protect such a low-VOC paint (possibly as much as 4 to 8 times over a 'conventional' product)."

The report also notes that some latex monomers, which are chemical "leftovers" from the addition of latex polymers to paints, have a significant antimicrobial effect. Removal of the monomers could increase preservative requirements. Further, Lewis Conquer of Lewis Conquer Consultancy Services, Ltd. (Chelmsford, Essex, U.K.) has stated that treatments meant to reduce monomer content of paints can destroy the anti-

microbial agents that have been added.

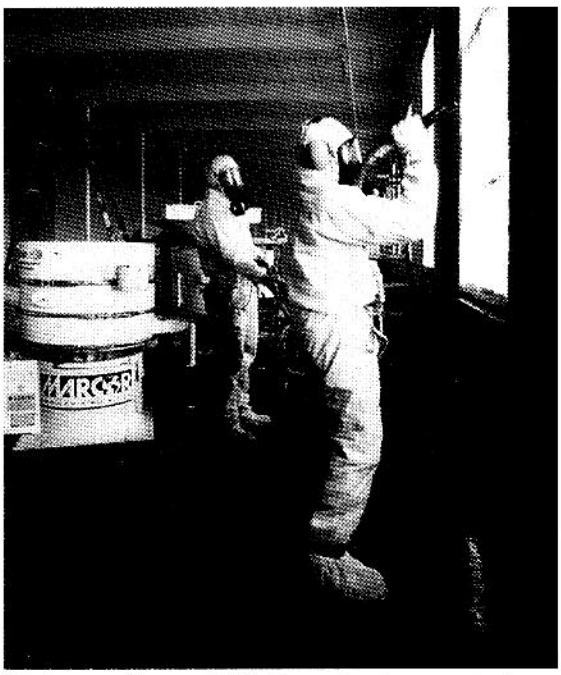
Antimicrobial additives have been found to create their own forms of pollution, and thus the effort to reduce one form of pollution could be complicated by efforts to reduce other forms of pollution.

Reduced Waste

Paint and coating waste material is another source of pollution, and industry and government agencies are developing approaches to reduce the environmental damage produced by such wastes. For example, a DaimlerChrysler plant (Düsseldorf, Germany) has developed a system to recycle and reuse vehicle paint material. Particles of oversprayed paint are reprocessed and used for painting additional vehicles. The volume of new paint used has been reduced by this methodology by 12% per year, representing 30 metric tons on the one paint line on which it has been introduced. The amount of paint sludge disposed of has been reduced by 70% (50 metric tons for the one line). The cost to install the redesigned line was $380,000. Paint and disposal savings are expected to result in amortization of this cost over 3.5 years.

Controlled Lead Paint Removal

Lead-based paint now is a known health hazard. It has been prohibited from use in housing in the U.S. since 1978, but many private and public buildings were painted before that date and still are coated with lead-containing coatings. Dust and debris created in the paint removal process creates one of the most serious hazards associated with lead paint, and many states, as well as the federal government, have instituted regulations covering the paint's removal.



Workers use Sponge-Jet blasting system to remove lead-containing paint from architectural surfaces. Photo courtesy of Sponge-Jet.

A Dodge Dakota is dipped in a lead-free electrocoat bath. Courtesy of PPG Industries, Inc.

These developments have inspired new product development such as the sponge blasting™ system manufactured by Sponge-Jet, Inc. (Eliot, Maine). The medium is particles of open-celled, water-based polyurethane impregnated with abrasives. Large volumes of it are directed at a surface analogously to other blast media. As particles impact the surface they flatten, exposing the abrasive within. After leaving the surface the medium constricts, pulling off and encapsulating coating debris that otherwise would have become airborne.

Advancing a Goal to Eliminate Lead

Other developments are eliminating lead from the remaining coatings applications (non-architectural) in which it is still used. For example, PPG Industries, Inc. (Pittsburgh, Pennsylvania) recently reformulated its automobile electrocoating process to be free of lead. A novel amine-based epoxy resin and crosslinker, with no lead content, replaces the previously used epoxy formulation that included lead pigments. The new epoxy was formulated in response to first altering a chrome phosphate surface pretreatment to eliminate chrome, another toxic element. The altered pretreatment regimen required an altered surface coating. The net result is a coating that is more water-resistant with improved corrosion resistance, and that provides the same metal passivating effect formerly provided by lead ions. "The overall cost is no more than the previous product, and perhaps less. Any increases in product cost are offset by reduction in costs for waste treatment and filter bag disposal, and lower emissions that lead to reduced oven cleaning," says John Motley, PPG business manager.

Paints and coatings are thus among the many chemical products that will change in the coming decade as increasing concern generates increasing action regarding contamination of the environment. MP