

A green evolution

By Joe Maty, Editor, JAC

Development of new water-borne technologies said to hold potential for significantly expanded use of high-performance PVDF and FEVE coatings



(Above): A two-component fluorourethane coating based on a water-borne fluoropolymer emulsion was used in a field-applied restoration program on the building pictured above, in Japan. Photo courtesy of Asahi Glass Co.

(Facing page): A water-borne fluoropolymer coating based on PVDF resin chemistry was applied to the exterior of this high-rise residential building in Guam. Photo courtesy of Arkema Inc.

If the concept of “green” in the context of design, construction, and building maintenance can be defined by performance prowess as well as earth friendliness, then coatings based on fluoropolymer resins can make a claim to being a good part of the way there.

These coatings, without question, are characterized by long-term durability in the form of color and gloss retention and resistance to weathering and environmental degradation.

But the developers of fluoropolymer chemistries for coatings, certainly aware that VOCs (volatile organic compounds) and solvent content remain paramount in perceptions of green products, are laboring in the lab to devise formulas that take the technology into new, greener territories.

These efforts are well under way in the R&D programs of two major producers of fluoropolymers for coatings: AGC Chemicals, the maker of Lumiflon® resins, and Arkema Inc., the owner of the Kynar® resins brand.

Both companies in recent years have introduced water-borne fluoropolymer technologies designed to sharply reduce VOC content in field-applied, ambient-cure coatings offered by coatings manufacturers.

These technologies, and additional advances that are the subject of ongoing R&D programs, were reviewed earlier this year at the annual PACE (Paint and Coatings Expo) conference in New Orleans, in a series of presentations sponsored by the *Journal of Architectural Coatings (JAC)*.

Waterbornes enter the picture

AGC Chemicals and Arkema Inc. offer different fluoropolymer chemistries. In the case of AGC, Lumiflon resins are based on fluoroethylene vinyl ether (FEVE), while Arkema's

in fluoropolymer chemistry

Kynar resins are the product of polyvinylidene (PVDF) technology. Both chemistries yield high-performance coatings used in demanding, high-profile architectural applications, thanks to a

combination of long-term durability attributed to UV and weathering resistance and color and gloss retention.

Coatings based on PVDF resins have grown to command the dominant position

in factory applications for metal coil used in exterior building components, while coatings based on FEVE chemistry have gained favor in air-dry applications, where the technology delivers a broader range of gloss and color in field applications, with lower-VOC formulations emerging in the past 10 years.

The VOC content of conventional field-applied fluoropolymer coatings can go as high as 600 or 700 grams per liter, but more typically are closer to 300 to 400 g/L to meet VOC limits in effect in most of the U.S. Formulations with VOC content of 70 or 80 g/L have been developed for use in Southern California, where VOC limits as low as 100 g/L are the rule.

Both AGC and Arkema, however, have been at work on the development of water-borne chemistries that can take VOC levels even lower.

Fluoropolymer coatings at the corner paint store?

In a PACE conference presentation titled "New Water-Based Fluoropolymer Resins for Ultra-Weatherable Coatings," AGC's Winn Darden reviewed R&D and marketing initiatives that, theoretically, could dramatically expand the use of fluoropolymer chemistries in coatings. Darden is business manager for AGC Chemicals Americas' Lumiflon resins.

In one program, AGC is seeking to adapt existing water-borne FEVE fluoropolymer chemistry by partnering with coatings manufacturers to formulate coatings based on blends of FEVE and other types of common water-borne coatings resins, such

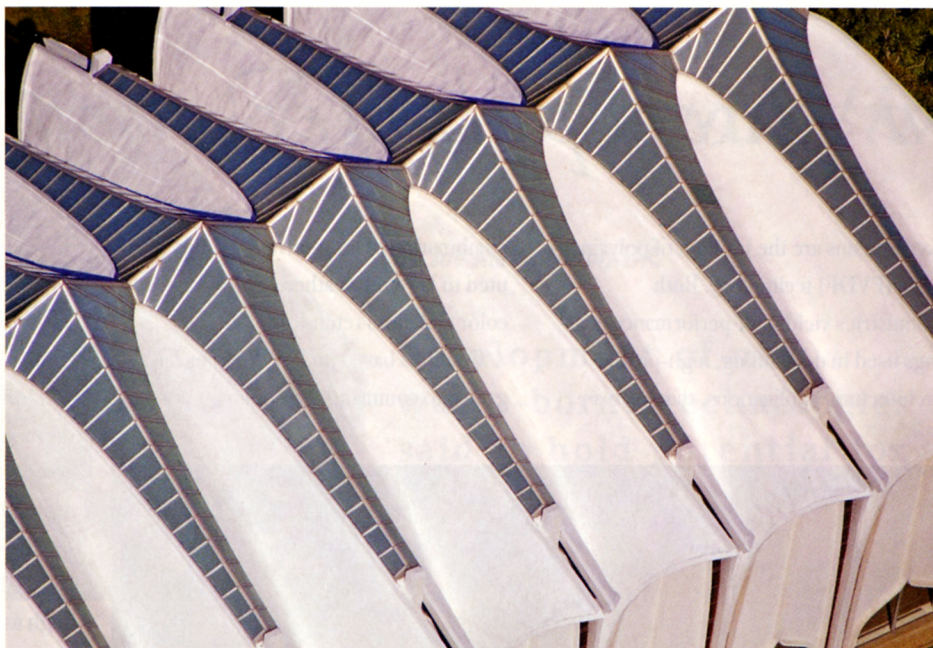


as acrylics. The objective: the development of paint and coatings products that look and apply the same as conventional latex products, but deliver an upgraded performance profile in terms of long-term durability and retention of gloss and color. Such coatings products would carry a premium price to match the performance payoff, due to the higher cost of fluoropolymer resins. But with the fluoropolymer component accounting for a maximum of, say, 20% of the total resin content, the markup would not cause serious sticker shock, Darden says.

The market potential for such products, in AGC's view, is immense, in that such do-it-yourself and professional-painter products could theoretically be packaged as premium architectural paints and coatings for the residential and the commercial painting segment, and also for certain types of industrial maintenance applications.

Darden says these water-borne paint and coatings products are already a commercial reality in Japan, AGC's home country, where they have gained a foothold in the residential and commercial paint markets. In North America, AGC is actively working with coatings manufacturers on formulations employing blends of FEVE and other coatings resins. The FEVE resins used are water-borne emulsions developed by AGC in the last several years.

In a separate program currently in an earlier phase of development, AGC is at work on FEVE resin dispersions that hold out promise of ultra-low-VOC, high-performance water-borne fluoropolymer coatings for demanding architectural



Use in reflective roof coatings is cited as a potentially significant end-use market for the water-borne PVDF resin chemistry. Photo courtesy of Arkema Inc.

applications—the kinds of high-profile settings where conventional PVDF and FEVE coatings have made their mark with extended service lives of 30 years and beyond. Typically, high-performance coatings of the FEVE type are based on two-component systems involving the fluoropolymer resin and an aliphatic isocyanate, producing a highly crosslinked coating referred to as a fluorourethane. These high-performance fluoropolymer coatings are characterized by a high degree of thermal, chemical, and weathering resistance, oil and chemical resistance, and attractive visual properties.

The water-borne dispersion technology is designed to duplicate the ultra-low-VOC content of the existing water-borne emulsion formulations, but with stronger weathering performance more comparable to conventional solvent-borne FEVE formulations, Darden says.

In his PACE presentation, Darden reviewed details of AGC's development work with the dispersion technology and

formulation of coatings based on the dispersions, and he offered test data comparing gloss and performance properties of the dispersion coatings to conventional solvent-borne FEVE and water-borne FEVE emulsion coatings. The isocyanate-crosslinked, two-component FEVE dispersion formulation delivered gloss, hardness, and adhesion, and impact and blistering resistance comparable to the two-component solvent-based formulation and superior to a two-component water-borne emulsion formulation. The water-borne dispersion formulation was far superior to a one-component (no isocyanate crosslinking) FEVE emulsion coating, with the emulsion formulation close in performance only in terms of gloss.

The results, Darden says, mean that formulations with VOC content down to zero could be produced using the water-borne FEVE resin dispersion technology. He also reviewed accelerated weathering test results showing that the dispersion-resin coating delivered similar performance

results as the solvent-based formulation.

As for market prospects, Darden says the water-borne dispersion coatings, early on at least, could find use in projects where air quality is of paramount concern—for exteriors of hospitals or high-rise residential buildings where solvent odors can be conveyed inside by means of ventilation, or in urban areas such as Southern California, where tight limits on VOC emissions are in place and are likely

ropolymer coatings resins, is receiving attention primarily in the reflective roof-coatings marketplace. But the company envisions applications in exterior wall systems as well, says Jerry Petersheim, Arkema business development engineer.

In his PACE conference review of the Kynar Aquatec™ water-borne PVDF resins technology, Petersheim said South Florida exposure testing has shown that coatings formulated with the resins exhibit

through” of asphalt and plasticizer components in roof substrates. These properties result in long-term retention of reflectivity in “cool-roof” applications, Petersheim says.

Arkema plans to introduce a new version of the Aquatec technology this year, which Petersheim says will offer enhanced elasticity, an important characteristic for roof coatings, along with a lower price tag and VOCs down to 50 g/L or less, com-

pared to approximately 120 g/L in current water-borne coatings formulations based on the resins.

Petersheim says the lower-VOC product will facilitate applications in the important Southern California market, where the water-borne PVDF-based coatings could be used as a thin-film reflective topcoat over an acrylic basecoat in programs to restore low-slope roofs with solar-reflective coatings systems. The PVDF-based topcoat provides superior dirt, stain, and mildew resistance, result-



The water-borne PVDF coatings are reported to provide a high degree of stain and dirt resistance and barrier properties that prevent “bleed-through” of asphalt and plasticizer components in roof substrates, contributing to long-term retention of solar-reflectivity levels. Photo courtesy of Arkema Inc.

to get even tighter.

Elsewhere, specifiers and users can opt for existing solvent-borne field-applied FEVE technology that in recent years has produced very low-VOC formulations of less than 100 g/L—not a great deal higher than the water-borne alternative.

Taking the plunge with PVDF in water

The water-borne PVDF technology recently introduced by Arkema Inc., owner of the well-known Kynar brand of fluo-

color and gloss retention comparable to conventional, factory-applied, PVDF-based coatings cured with a high-temperature bake. Petersheim’s PACE presentation was titled “A New Water-Based PVDF System for Weatherable Coatings.”

In the early going for the technology, the primary applications have been solar-reflective roof coatings for restoration programs, where the PVDF water-borne product is reported to provide a high degree of stain and dirt resistance and barrier properties that prevent “bleed-

ing in retention of high solar-reflectivity levels, he says.

Petersheim says extension of the technology beyond roof coatings will evolve as greater awareness of this still-novel technology occurs, and he says the company is actively pursuing opportunities in the exterior wall market. Logical candidates for these uses include the restoration or redecoration of metal building exteriors where long-term color and gloss retention are a priority.

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