As rules limiting solvents get tighter, painters and suppliers are adjusting to a new kind of chemistry

Paint It Green

by Ted Cushman

If you've gone to the beach on a calm day in midsummer, you've probably seen the haze: a thin, brownish gray soup in the air that's not quite smoke, not quite fog, and not quite a cloud, veiling the horizon and dimming your view of the distant hills. What you can't see — but what is often there, along with the visible haze — is ozone. In the upper atmosphere, the ozone layer is good: it shields the earth from harmful ultraviolet radiation. But at ground level, ozone is bad: it's a corrosive form of oxygen that can irritate the eyes and nose or trigger asthma symptoms. Ozone even damages plants, causing billions of dollars of crop losses every year.

House paint plays a role in both the ozone and the haze. The "volatile organic compounds," or VOCs, evaporating out of paint solvents react with powerplant and vehicle emissions to help form the harmful ozone molecules as well as the tiny, light-scattering airborne particles that we see as haze. So as federal and state governments try to get a handle on the pollution problem, they're turning their attention to paint. A cascade of regulations, moving from the U.S. Environmental Protection Agency (EPA) down through regional federal/state commissions, and finally taking effect at the state level, is putting the squeeze on suppliers to reduce the solvent content of

Three painters work together on the shady side of a house to get the paint on quickly. Modern acrylic paints and stains tend to dry quickly compared with older, higher-VOC formulas.

all paint, stain, and primer formulas, or else be forced to take the products off the market.

The gears of government grind slowly, however, so the regulations aren't ramping up overnight. Southern California imposed strict VOC rules starting in the 1960s, but the Northeast and Mid-Atlantic states are just beginning to regulate VOCs. Some coastal states have rules in place already, while others are still phasing them in. With plenty of lead time to adapt, paint makers are staying ahead of the curve, at least on the East Coast. After years of adjusting to California requirements, most suppliers can now put low-VOC products on East Coast shelves that come close to matching the performance of the old solvent-borne products they replace. But a close match isn't a perfect substitute — and therein lies the rub. For contractors in the field, the new formulas may call for some changes in the way they choose, handle, and apply their products.

WHAT'S A VOC?

The "volatile" of VOC means the material evaporates easily; "organic" means it's based on carbon; and "compound" just means that it's a molecule made up of different kinds of atoms. Alcohol and gasoline are examples of VOCs; in paint, the typical VOCs are solvents with

JEFF SCHMALTZ/NASA

Not quite a cloud nor fog, the haze of ground-level ozone is clearly visible in this image captured from NASA's *Terra* satellite on the morning of August 2, 2006, off the mid-Atlantic coast. Also known as smog, this ground-level ozone is created when VOCs react with power-plant and vehicle emissions. Paint solvents contribute a small but significant part of the VOC problem. At the time, a high heat advisory was in effect for the region. In addition to trapping particulate pollution near the earth, high heat, stagnant air, and humidity generate more ground-level ozone.

names like toluene, benzene, acetone, and ketone. Most VOC solvents come from crude oil: the most common solvent in house paint or primer is a generic mix of petroleum distillates called "Stoddard solvent," also known as "white spirits" or "mineral spirits," or simply "paint thinner."

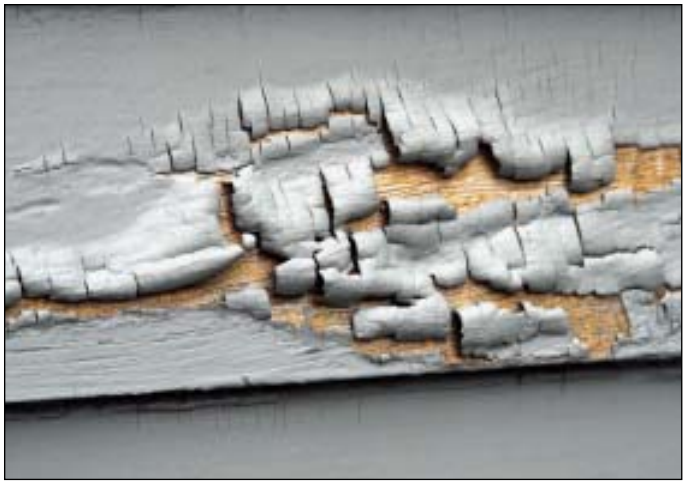
OILS VS. ACRYLICS

When you talk about solvent-borne and waterborne house paints, you're basically talking about oil (or, more precisely, "alkyd") paints versus acrylics. And as the VOC rules get tighter, oil paints are taking the brunt of the heat. That's because of the different manner in which oil and acrylic paints are formulated: as a result of their different chemistries, oil paints and stains are typically solvent-borne, while acrylic coatings are always waterborne.

Alkyd paints oxidize as they dry; oxygen reacts with the string-like alkyd molecules and helps them "cross-link" together. So an alkyd paint coating actually becomes a continuous, chemically connected film as the paint cures. That's how oil-based paints develop their particularly desirable properties, such as high gloss, hardness, abrasion resistance, water repellency, and washability. But there's a downside, too: the oxidation process continues indefinitely. Exposed to sun and air, the paint will eventually yellow, become brittle, shrink, and crack in the process known as "alligatoring."

For house paints, longer-chain alkyd molecules tend to provide a better mix of properties than shorter-chain oils, but it takes a lot of solvent to keep those bigger alkyds in solution, and multiple coats are required to achieve a really good film build. Cutting down on the solvents makes the paint thick and heavy, which means it doesn't flow or handle as well. As a result, it's hard for an alkyd paint maker to even come close to the new VOC limitts and still make a paint that will perform the way it's supposed to. As the rules get tighter, traditional alkyd paints are increasingly ruled out.

Acrylic latex paints are a very different animal. Polyacrylic is a plastic polymer derived from petroleum, rather than from plant-based oils. Polymers are long, repetitive chains built up out of short links.



Solvent-borne alkyd formulas react with oxygen, leading to eventual brittle failure over time. Shown here is an advanced case of "alligatoring" of alkyd paint over old clapboards.

Acrylic paint resins "coalesce" as they dry, creating a continuous film on top of the wood. As long as the surface is prepped well, the paint will stick. But acrylics are particularly intolerant of conditions such as mill glaze and dirt, and surfaces should be sanded to give some "tooth" to which the paint can bond.

Chemists can control the laboratory process to grow the big polyacrylic molecules to whatever size they like, out of a soup of short "acryl" pieces. And by varying the ingredients, they can modify the molecules to get special properties they desire, creating, for example, an acrylic polymer that is hard, soft, or somewhere between.

An acrylic polymer doesn't dissolve in the hydrocarbon solvents used for oil paint. In fact, acrylic won't dissolve in water, either. Instead, chemists blend the acrylic into water as an "emulsion" or "dispersion" — in simple terms, whipping the materials together with soapy surfactants and thickeners to form a smooth mixture, like making a milkshake. These surfactants and thickeners, along with flow agents, help to keep the mixture stable in the can, and help it flow and level out in use.

Compared with the small, stringlike alkyd paint molecules dissolved in a high volume of solvent, acrylic paint resins are more like large, semisoft balls suspended in a relatively small amount of water and customized additives. It's called a "high solids" formula. And as the paint dries, acrylic doesn't cross-link: instead, the bits of acrylic gradually soften and melt together, or "coalesce," to form the continuous film. Because it's not chemically active when it's dry, acrylic paint ages better than alkyd paint, especially outdoors, holding its color and gloss longer and not readily shrinking or cracking.

In addition to the acrylic binder, acrylic-based paints contain pigments and light blockers, to add color and to protect against sunlight. As the paint dries, it's tricky to keep the pigments and the binder evenly distributed, rather than clumping together and forming a faulty, inconsistent film. Because of this, waterborne paints generally have some kind of "coalescing agent" or "coalescent" additive that helps the acrylic molecules melt together around the pigment, trapping the pigment within the acrylic film. Coalescents are slow-evaporating VOC solvents — which is why even most waterborne acrylic paints contain at least 5% or 10% VOCs in the can, and it's why an acrylic paint job may take a week or more to fully harden and to stop smelling like fresh paint. As the rules get stricter, even some acrylic paint makers find it challenging to squeeze the VOCs out of their formulas to squeak in under the regulatory limit and still get the good film formation they want.

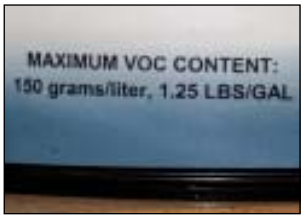
PAINT MAKERS ADAPT

Paint formulation is a game of trade-offs, explains Stewart Williams, director of the Rohm and Haas Paint Quality Institute. Even the very strict, 50 grams per liter, VOC limit enforced in smoggy Los Angeles is doable in a flat or semigloss acrylic paint, he says. "But if you go to the higher gloss, it's more challenging — because you've got to deliver those enamel-type properties that we've all grown accustomed to. I can give you a zero-VOC gloss today, but it won't have that enamel hardness or the other 20 things you may want."

Rohm and Haas and its competitors spend hundreds of millions of dollars on research each year. Advanced paints that don't exist today will be on the shelves in a few years. "There is no question that there are going to be breakthroughs," says Williams. "Whether it's on the acrylic end, or in the acrylic/alkyd hybrid end, or what have you — it's going to happen."

On the acrylic side, companies are working on natural, nonevaporative substitutes for petrochemical coalescents, hoping to get away from VOCs entirely. Acrylic polymers continue to evolve as well: Rohm and Haas' Avanse technology uses custom-brewed polymers to evenly embed pigments within the acrylic binder matrix, for better and more efficient coverage and hiding. Benjamin Moore's new Aura paint line goes a step further: the company claims its new poly-

Paint It Green



As rules tighten, 150-g/L flat acrylic paints (top left) and 350-g/L alkyd stains (above left) will be disappearing from shelves in the few coastal states where they can still be found. Taking their place may be advanced formulas such as Benjamin Moore's Aura brand (above right), a near-zero-VOC acrylic with an innovative colorfast pigment system.

merization method actually encapsulates paint pigments completely within the small spheres of acrylic polymer, achieving better gloss as well as more durable and brighter color — and with a zero-VOC formulation.

Meanwhile, oil-based alkyd suppliers are working to break away from their solvent-borne past with a new "alkyd dispersion" technology, grafting modified alkyd chains onto acrylic polymers and blending them into a mostly waterborne matrix. That technology is only a few years old and still in its early stages of development. The hybrid alkyd/acrylic chemistry is tricky — it still needs some solvents to work, and it may not yet supply all the benefits of both the alkyd and acrylic ingredients. But already, ICI (Imperial Chemical Industries) has introduced a line of "advanced alkyd technology" paints under the Dulux brand, based on the alkyd/acrylic hybrid resins, that promises the hardness and gloss of an oil paint with the convenience of soap-and-water cleanup and the advantage of lower VOCs. The raw ingredients for the new waterborne oil paints are available to any paint company from outside sources, so as the method advances, more enamel and gloss paint brands are likely to appear using water-compatible alkyds.

IN THE FIELD

What does all this mean for the professional painter? Most agree that modern paints perform as well as, or better than, traditional coatings: they stick better, last longer, and hold color better. But the new paints tend to behave differently on the brush or in the sprayer. For many painters, adjusting can be a challenge.

Nigel Costolloe runs Catchlight Inc., a custom painting company in the Boston, Mass., area. Says Costolloe, "Years of habit and practice and skills, honed in the application of one type of material, when confronted with a material that behaves markedly differently, is a challenge for anyone." If a painter is accustomed to brushing or spraying oil formulas, he'll find modern acrylics tricky at first.

To keep a house looking good, walls need to be routinely washed and repainted every few years. In coastal zones, three years between recoats is fairly good performance for paint or stain over wood siding and trim.

Oil paints dry slowly and provide lots of "open time" for painters to brush back into their work, and oil paints relax gently, allowing brush marks or lap marks to disappear more readily. Modern acrylic paints dry much faster — especially if the weather is hot, dry, or breezy — and so lap or brush marks are harder to avoid.

New England painter Charles Gilley has modified his technique to accommodate the faster-drying new acrylics. On a building exterior, for example, he has to paint fewer courses of clapboards at a time, in order to maintain a wet edge as he works. On sunny days, Gilley has to hustle to stay on the shady side of the building — once a wall is hot and sunny, the paint dries too fast. And for wood-panel doors, Gilley now follows a meticulous pattern, painting first the panels, then the rails, and then finally the stiles, so that cross brushstrokes won't create visible lap lines across the door's component parts.

A thorough and vigorous washing is the best prep for routine repainting. Don't neglect the areas under eaves — they can accumulate salt and grime deposited by moisture rising up from soil around the building.

Traditional painters particularly regret the loss of solvent-borne primers for repainting jobs on old weathered wood exteriors. The traditional method, which Gilley and other painters have practiced for years, is to start with an oil-based primer, and then apply an acrylic top coat. The solvent-borne primer wets the wood more readily and soaks in better, explains Gilley, and it can partially overcome difficult-to-remove dust and grime. "Just take some fine dust, like drywall dust, and put a drop of water on it, and you'll see what I mean," says Gilley. "Water will bead up on the dust. But if you put some paint thinner on that same dust, it will soak right in." In the same way, argues Gilley, oil paints will soak into wood through dust or dirt, where a water-based paint will get repelled and fail to form a bond.

Even Rohm and Haas, the acrylic specialist, won't argue with that tradition, says Stewart Williams. "If your substrate is sufficiently damaged and in need of repair, then yes — instead of moving large balls of acrylic through pores, you're moving string-shaped molecules with a solvent that penetrates. It's not just some belief that is out there — I think it has proven out that you get much better performance on difficult substrates by going with the old faithful alkyd primer followed by an acrylic top coat."

But Nigel Costolloe points out that a penetrating primer is no substitute for good surface preparation. Oil-based formulas may have better wetting power, he says, but years of accumulated grime and pollution can repel even an oil-based formula and prevent good adhesion. "I've seen oil-based primer flake and peel off a house prematurely when somebody didn't take the time to do the proper surface prep," he explains. "But if you do make sure that the existing paint is cleaved and the wood is sanded off to remove the deteriorated cellulose that has been damaged by ultraviolet light, and clean the surface, in my experience a waterborne primer can adhere just as well as an oil-based primer."

Even Costolloe, however, sees situations in which he prefers to use alkyd paints. "In the residential market, if you already have multiple existing coats of

Good surface prep improves the performance of any paint. Here, sun-damaged wood fibers and remnants of an old prime coat are sticking to the back side of peeling alkyd paint. A thorough sanding and washing and a high-quality prime coat would have helped this paint job hold up longer.

alkyd paint on a house, it's better to stay with an alkyd," he notes. Alkyd and acrylic paints expand and contract at different rates in response to changing weather, he explains, and where a base of alkyd paint already exists on the wall, another coat of alkyd on top of it is more compatible.

Ultimately, argues Costolloe, it's craftsmanship, not paint formula, that makes or breaks a paint job. "I think the greatest challenge for any painter is reading a label," he says — only partly in jest. "The painting business does not have a barrier to entry," he notes. "A car, a small ladder, and $65 worth of tools, and you can be up and running. And education and continuous learning and the concept of self-improvement are almost alien to our industry." But good learning resources are available, he says, including educational sessions put on by paint companies and by local chapters of the Painting and Decorating Contractors of America.

Ultimately, it's craftsmanship, not paint formula, that makes or breaks a paint job

Costolloe likes a three-hour CD-ROM training tool produced by the Quality Paint Institute: "We put all our new hires through it, and every employee retakes the program once a year." The CD is available from the Paint & Decorating Retailers Association at www.pdra.org/shop.php.

Even with the best of paints and the best of training, however, paint is temporary — especially in a coastal climate. In mild exposures, a good exterior paint job won't last a decade, admits Great Barrington, Mass., painter Paul Shepard. Some paint companies promise 12 years for a wall painted with their primer and top coat, but Shepard counters, "That's B.S. — and you can tell them I said so. I tell my customers a paint job is good for five to seven years. If I say 12, they'll come back to me after 11 years demanding satisfaction." Shepard remembers painting a house whose owner had used a paint that promised 20-year performance. "He actually waited 20 years to repaint it," says Shepard. "That wood was crying."

And Shepard works a hundred miles inland. On the coast, you're lucky to get five years from a paint job; three years is more typical. Martha's Vineyard builder John Abrams, CEO of South Mountain Company, Inc., has a simple solution: he doesn't paint exteriors. "We try to have a zero-maintenance exterior, and in our environment, paints just don't last," he says. "We've tried a lot of different kinds of paint. But in order to keep a house looking well cared for and keep the wood protected, you basically had to repaint every three to five years. And that just seemed insane."

So now, Abrams relies on aluminum-clad wood windows, white cedar shingles from the sustainable forests of Maine's Seven Islands Land Company, and recycled cypress trim. "The shingles are good for 25 to 40 years without paint," he says. "The cypress will last virtually forever."

For coastal builders who do use paint, this is a time of transition. In Virginia, Delaware, Pennsylvania, Maryland, and New York, suppliers stopped shipping high-solvent formulas at the beginning of 2006, although retailers are still allowed to "sell through" any existing inventories. Other states aren't on board yet: in Massachusetts, VOC limits may not take full effect until 2011. Will effective new formulas be available by the time existing stocks of oil-based paints run out? Only time will tell. ~

A former frame and finish carpenter, writer Ted Cushman has been covering construction business and technology since 1993. All photos by the author except as noted.