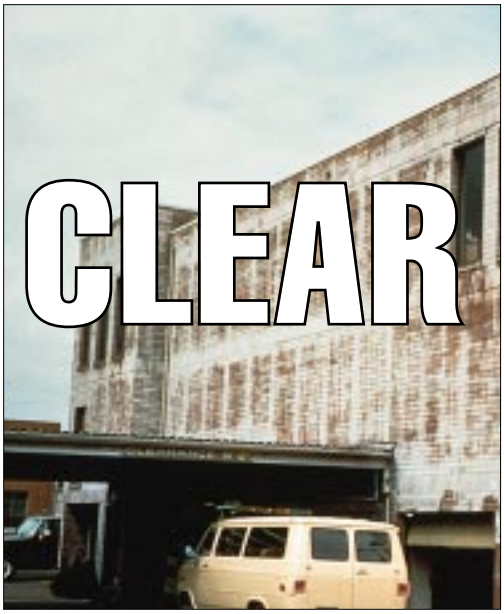
Keeping clear water repellents



Tips on selecting and field-testing water repellents to prevent them from altering masonry's color

By Mark A. Wallace

Architects and building owners select clear water repellents because they do not expect these coatings to alter masonry's natural appearance. Today, if a clear water repellent is carefully chosen, it is possible to ensure a clear finish. Pretesting on the actual masonry to be used helps in choosing the right coating. But, if specifiers and applicators don't take care, the following seven factors can discolor a wall.

Ultraviolet exposure

Water repellents containing organic resins that are unstable under ultraviolet (UV) exposure will discolor over time. Water repellents that work by forming a film on the masonry surface, especially thick, graffiti-resistant coatings made from acrylics, urethanes or polyesters, may yellow with prolonged UV exposure. Early silicone water repellents also received some bad publicity for deteriorating under UV radiation (Ref. 1).

However, UV discoloration is not a problem for today's high-end products, says Jeffrey Erdly of Masonry Preservation Services, Inc., Berwick, Pa. "The impression that water repellents change color over time under UV light still lingers, but it was only the first- and second-generation materials that yellowed or ambered," he says. Most manufacturers now use UV-stable resins.

Low water vapor transmission

The discoloration that occurs today usually occurs shortly after application. David Boyer, president of ProSoCo, Inc., a water-repellent manufacturer in Kansas City, Kan., calls it "blushing." This happens when moisture in the substrate collects under the coating and produces a milky white appearance. There are several possible causes.

Moisture may collect under the coating if the coating does not

Why water repellents are used

Applied to masonry surfaces, clear water repellents prevent absorption of liquid water not under pressure, but they generally let water vapor pass through. In the correct circumstances, water repellents protect against damage from acid rain, freeze/thaw cycling, de-icing salts, mildew and efflorescence, says the Sealant, Waterproofing & Restoration Institute (SWRI). They also help resist soiling and staining caused by atmospheric pollutants. Clear coatings can be particularly useful on light-colored masonry where soiling is noticeable and on buff brick that is vulnerable to metallic staining, says the SWRI.

But using water repellents on masonry walls, particularly brick walls, continues to be controversial. Don't use water repellents as an "insurance measure" against water penetration, advise engineers Christine A. Subasic, Brian E. Trimble and Janet Peddycord (Ref. 2).

After years of discouraging the use of water repellents, the Brick Industry Association (BIA) now suggests they may be useful in some circumstances, particularly on barrier walls that are not built to drain internal water, on chimneys and parapets, on faulty drainage walls that have been repaired and on walls of highly absorptive brick (Ref. 3).

Most sources, including BIA and SWRI, recommend repairing the causes of leaks before applying a water repellent. Replace defective sealants and spalled or cracked brick. Tuckpoint cracked or deteriorated mortar joints. Surface grout separations between brick and mortar. Clear weep holes and cavities of mortar. Replace improperly installed flashing. Others say make as many of these repairs as are affordable and practical, then apply a water repellent (Ref. 2).

"A masonry wall that leaks before the application of a water repellent will leak after the application of water repellent," says Jeffrey L. Erdly (Ref. 8). "Only sound, functioning masonry walls should be considered for water-repellent treatment."

But if the causes of leaks must be fixed before applying a water repellent and if water repellents themselves sometimes cause problems, some professionals wonder why water repellents should be applied at all (see box on page 667).

ProSoCo Inc.

A penetrating water repellent applied to a clay brick building in Kansas City, Kan., began to blush after three years. The discoloration pattern reflected the application process. Where the coat applied to one area overlapped the coat applied to an adjacent area, the coating's reduced vapor transmission developed blushed streaks.

breathe enough. Water repellents are supposed to keep water out of the wall while also letting water vapor escape from inside the wall. If they trap some water vapor inside, this moisture can create a blushing or clouding appearance. In freezing climates, trapped moisture can deposit solubilized salts behind the water repellent, and as these salt crystals grow they can exert expansive pressures that damage the brick.

An opinion: More harm than good?

Water repellents on masonry walls cause more problems than they prevent, argues consulting architectural engineer Clayford T. Grimm, Austin, Texas. In a 1993 article in *The Construction Specifier* (Ref. 6), he cited these eight shortcomings in using water repellents:

1. If the points of water entry into a wall (cracks between brick and mortar, faulty flashing, improperly installed coping, plugged or missing weep holes, or nonfunctional sealant joints) must be corrected before applying a water repellent, as most water-repellent manufacturers recommend, then why is a water repellent needed?
2. Water repellents do not stop wind-driven rain. Neither does an uncoated single 4-inch wythe of brick masonry. The solution is to drain the water out of the wall, not coat the wall with a water repellent that may retard but cannot withstand wind-driven rain.
3. Water repellents that breathe not only allow water vapor to escape, but they allow it to enter. "In hot, humid climates, they admit water vapor from the exterior into the wall where it can condense," says Grimm.
4. Even water repellents that breathe reduce water vapor transmission to some degree. Because a coated wall resists vapor transmission more than an uncoated wall, metal components stay wet longer and thus are more prone to corrosion.
5. As water in a wall evaporates, it
6. Few manufacturers have had independent tests done on water permeance, vapor permeance and durability of water repellents.
7. Since the best water repellents can be expected to last only 10 years, a brick wall expected to last 100 years or more would require at least 10 re-coatings over its lifetime, which raises concerns about compatibility between new and former coatings.
8. The cost of applying two coats* of silicone can be about $4 per square meter (37¢ per square foot) for materials and about $7 per square meter (68¢ per square foot) for cleaning. Add the financial interest that could have been earned had this money been invested and the real cost of a silicone coating is several times its initial cost.

In short, says Grimm, "clear coatings do not prevent entry of wind-driven rain into a wall, nor do they prevent entry of water vapor. Clear coatings are not durable, they retard normal drying of masonry, and they're expensive." The way to prevent water leaks, even in severe storms, is to build and maintain properly designed masonry cavity walls. Do not rely on water repellents to stop leaks.

* Costs have changed since 1993 and one coat may be sufficient.

Discoloration characteristics of the two main types of water repellents

Types	Examples	How they repel water	Vapor transmission	UV discoloration	Other discoloration
Film formers	Acrylics, stearates, silicone resins, mineral gum waxes, urethanes	By forming a continuous film that bridges cracks and fills pores	Poor to good: Low water vapor transmission can cause moisture retention and, thus, a blushing discoloration	Some products may yellow with prolonged exposure to UV light	Some products may darken the substrate or make it glossy
Penetrants	Silicates, siliconates, silanes, siloxanes	By changing the capillary forces in the pores of the masonry	Excellent: Because they coat the pores rather than bridge them, they have higher water vapor transmission than film formers	None: Because of their chemical composition and because they penetrate below the masonry's surface, penetrants are more resistant to UV degradation, and are thus also more durable	None

ture can also cause spalling. If this moisture deposits soluble salts behind the coating as the water vapor evaporates, expansive pressures created by the salt buildup can spall the masonry, too (Ref. 2).

Some film-formers are more likely than penetrating water repellents such as silanes and siloxanes to entrap water and cause a milky white appearance (Ref. 3). Silanes are more than 90% breathable, and some are near 100%, says Greg Beenen of Hydrozo Products, a unit of Harris Specialty Chemicals, Jacksonville, Fla. "You have to really work at it to make them unbreathable." Siloxanes are breathable too: Most 5%- to 15%-solids siloxanes maintain a vapor transmission rate greater than 80%, says Boyer.

"Some super high-solids water repellents reduce vapor transmission rates and cause efflorescence bloom, too," says Erdly. The high solids content can plug the pores, making them impermeable to both water and water vapor.

ProSoCo Inc.

Trapped moisture and UV deterioration caused this graffiti-resistant coating to discolor and peel away from the surface after three years. Workers removed the coating from this Lower Manhattan, N.Y., courthouse and applied a different water repellent.

Oversaturated substrate

Blushing often occurs if the wall is oversaturated when the water repellent is applied, says Boyer. The excess water gets trapped behind the coating. To avoid this, always evaluate how much moisture is in the masonry before applying a water repellent, and follow the coating manufacturer's recommendation for how much moisture is desirable (Ref. 2). Because film formers may produce a white haze when applied to an excessively damp substrate, the Sealant Waterproofing & Restoration Institute (SWRI) recommends applying acrylics and other film formers to thoroughly dry substrates (Ref. 4). You can apply penetrants, such as silanes and siloxanes, to slightly damp substrates. In fact, *some* moisture helps catalyze curing of penetrating water repellents.

If you apply a water repellent to a wet wall that is not functioning properly, don't blame discoloration on the water repellent, Erdly warns. Before coating the wall, determine why it is oversaturated. Windows may be letting water in. Flashing may not be terminated properly. Weep holes may be plugged. Don't assume a water repellent will fix water leaks; it can't. Instead it may seal liquid moisture in and trap solubilized salts behind it, producing a blushing effect. "Then people will say the water repellent is discoloring, but they are mischaracterizing what's happening," says Erdly.

"Putting a water repellent on a nonfunctioning wall is like shining the teak on the Titanic," he adds. "The ship is sinking and we're upstairs worried about what the wood looks like."

Wait at least 30 days after a new wall is constructed and at least 48 hours (some manufacturers recommend three to seven days) after a heavy rain before applying a water repellent (Ref. 5). Unless you have stopped the source of moisture, do not coat walls that have a history of efflorescence. And, if you want to rule out efflorescence in a new building, do not treat walls that are less than one year old (Ref. 2).

Hydrozo Products

Days after a water-based water repellent made from concentrate was improperly applied to on a concrete masonry building in Clackamas, Ore., dark streaks appeared where one coat overlapped and reacted with an adjacent coat.

ProSoCo Inc.

A water-based water repellent used on a church complex in Kentucky had to be chemically removed and replaced with a new material because excess surfactant in the original material left a blush appearance on the surface. Designed to meet limits on volatile organic compounds (VOCs), properly formulated and applied water-based products will not discolor.

Chemical incompatibility with the surface

If the water repellent is not compatible with highly alkaline surfaces, says Boyer, the performance of some penetrating silicone-based coatings can be short-lived. Similarly, the adhesion and appearance of many clear film formers, such as acrylics and urethanes, may be compromised when applied to high-pH surfaces.

"If the brick or mortar contains iron, as it often does, silicone can react with the iron to stain the masonry," says consulting architectural engineer Clayford T. Grimm (Ref. 6). This can occur when the iron is deposited behind the coating during evaporation.

Incompatibility with previous coatings

Sometimes, reapplying of the same coating years later may cause clouding (Ref. 2). Because new and old treatments may be incompatible, especially when waterborne water repellents are used, SWRI recommends completely removing old water repellents before applying new ones (Ref. 4).

Film formers

"Unfortunately, when applied in sufficient quantity, [most acrylics, stearates, and mineral gum waxes] tend to darken the substrate's appearance or make it glossy," says Edward McGettigan of Hüls America, Inc., Bristol, Pa. (Ref. 7). Silicones, too, can have a wetting or darkening effect, even a shine, depending on the angle of the light, says Patrick Gorman of Gorman Moisture Protection, El Paso, Texas.

Such discoloration is more likely if the product is applied at too low a temperature or in too thick a coating, says Steve Walter of Trisco Systems Inc., a waterproofing contractor in Lima, Ohio. In fact, discoloration may occur only on a building's north elevation where the sun fails to warm the surface adequately.

If the architect or building owner wants a gloss or sheen, a film former is usually selected, says SWRI (Ref. 4). But if any color change is undesirable, a penetrating water repellent is probably a better choice.

Poorly formulated water-based products

Certain water-reduced materials formulated for use where volatile organic compounds are limited (see box on page 669) also may leave a blushed appearance, says Boyer. These materials are emulsified to prevent the solids from settling out while the materials are in containers. Manufacturers use a surfactant or detergent to encapsulate the solids and keep them in solution. In some applications, the surfactant in some of these prod-

New federal regulation limits VOC content in water repellents

Respiratory infection, pulmonary inflammation and lung tissue damage all may be caused by ground-level ozone, which is formed in the atmosphere by reactions between nitrogen oxides and volatile organic compounds (VOCs). To reduce these adverse health effects, as well as damage to crops, forests and other ecosystems from ground-level ozone, the United States Environmental Protection Agency (EPA) signed a new national regulation in August limiting the VOC content in architectural coatings. When the regulation takes effect one year from the date of its publication in the Federal Register, all water repellents used in the United States will have to begin meeting new limits on VOCs.

Whereas conventional water repellents contain 700 to 800 grams of VOCs per liter, to meet the new law reformulated products will be allowed at most 600 g/l. In areas that already have stricter limits, such as California, the lower limits will continue to apply. However, some areas that have already limited VOCs, such as New Jersey, Massachusetts, Jefferson County, Ky., St. Louis, and Dallas/Fort Worth, may discontinue their own programs.

How does this change water repellents? Traditionally, the active ingredients in water repellents have been dissolved in mineral spirits. Because mineral spirits contain VOCs, many manufacturers are replacing all or part of this solvent with water. Then, to keep the solids suspended in water during storage, they are encapsulating the solid particles in a detergent or surfactant.

Another way manufacturers are reducing VOC content is by keeping the same type of solvent but increasing the percentage of solids. For example, instead of a product with 40% silane in a 60% alcohol solvent, the material can be reformulated to contain 41% to 100% silane in a 59% to 0% alcohol solvent. Pure silane penetrates three times as deep as diluted silane. While this may improve products used on parking garages and bridge decks, it is not beneficial on vertical surfaces—and the increased silane content adds considerably to the product cost. Thus, many manufacturers are increasing the solids content by only the minimum amount needed to drop the product's VOC content below the legal limits.

Several years ago, some manufacturers tried to substitute other low-VOC solvents for minerals spirits, says Greg Beenen of Hydrozo Products, Jacksonville, Fla., but "there are very few exempt solvents now and those that are exempt are very expensive."

Those products that cannot be reformulated to meet the new VOC limits can still be marketed, but a $2.80 exceedence fee eventually will have to be paid to EPA for every kilogram of VOC not in compliance. Thus, the price of any such products will probably increase considerably. Products that are made compliant by increasing solids content will also probably become more expensive, as they will contain more active ingredient than their current formulations.

On the Web

For details on the National Volatile Organic Compound Emission Standards for Architectural Coatings, consult the EPA's Web site at www.epa.gov/ttn/oarpg/. For specific documents, check these exact addresses:

The new regulation: www.epa.gov/ttn/oarpg/rule812.wpd.

Background on the standard: www.epa.gov/ttn/oarpg/aimfinf.pdf.

Preamble with significant comments: www.epa.gov/ttn/oarpg/notice1.wpd.

ucts has stayed on the wall surface, leaving a white hazy appearance.

Only one manufacturer, Hydrozo Products, has the patent to make one-component, ready-to-use water-based silanes. Some manufacturers make ready-to-use water-based siloxanes or silane-siloxane blends. But all other water-based silanes and siloxanes are sold as concentrates, which are diluted with water in the field.

These concentrate products do not discolor if properly applied. But if they start to set and "bulk up" in the bucket before application, they do not penetrate the substrate well. The reacted resin molecules become too big. If one coat overlaps a previously applied coat, you may be applying partially reactive material over already reacted material. Resin will build up on the surface. The result will be dark streaks where the coats overlap.

Passing the test

The only way to ensure that a water repellent will not leave an undesirable wet, dark, glossy or blushing appearance is to pretest it. "We always test," says Erdly. "Under no circumstance do we apply material to a whole building without testing a mockup area. Different manufacturers have different recommendations on how to do this. We pick an area of the building people cannot see and apply two of the best products in 4x4-foot areas. Then we see how they look."

"You're going to see a change in color almost immediately, perhaps within a week, if there is one," says Walter.

SWRI also recommends performing standard tests for resistance to UV radiation (ASTM G 53), resistance to efflorescence (ASTM C 67), gloss (Federal Test 141a, Method 6121), vapor transmission (ASTM E 96), and absorption (ASTM C 67 for clay brick, ASTM C 140 for concrete masonry and ASTM C 97 for natural stone). But it's critical to test the water repellent using jobsite equipment on an inconspicuous area of the actual wall. No laboratory tests can duplicate the multiple conditions unique to each jobsite.

Choose a water repellent that has good water vapor permeability, is chemically compatible with the substrate and passes a field test, and it should stay for many years in the clear.

ASTM G 53, "Standard Practice for Operating Light- and Water-Exposure Apparatus (Fluorescent UV-Condensation Type) for Exposure of Nonmetallic Materials."

ASTM C 67, "Standard Methods of Sampling and Testing Brick and Structural Clay Tile," Section 7.3, 5-hour and 24-hour immersion.

ASTM C 140, "Sampling and Testing Concrete Masonry Units, Absorption," Section II.

ASTM C 97, "Absorption and Bulk Specific Gravity of Natural Building Stone."

ASTM E 96, "Water Vapor Transmission of Materials, Water Method."

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