Roof coatings:

With all the hype from the U.S. Department of Energy, Environmental Protection Agency, California Energy Commission and others about energy-efficient roof systems, have come a wide variety of generally acrylic-based white roof coatings out of every corner of the roofing industry and most corners of the coating and paint industries. Comparative testing indicates not all roof coatings are equal—some perform much more admirably than others. Preparing surfaces to which coatings are to be applied remains the most important step in the coating process to ensure relatively long service life. Carefully evaluating surfaces over which roof coatings are to be applied runs a close second.

Performance

Roof coatings are much like paint—the more polymer "solids" per gallon, the longer the coating's potential life. The more aluminum "metal" (not paste) in asphalt-based aluminum roof coatings, the better the potential long-term performance. Likewise, the more acrylic polymer in a water-based roof coating, the better the potential long-term performance. But the "best" roof coatings available will not live up to expectations if surfaces to which they are applied have not been evaluated for adhesion and surface preparation does not provide a suitable base for the coating. Solvent-based coatings are a little more forgiving of improperly prepared roof surfaces than are water-based coatings simply because the solvents provide a modicum of "self-priming" properties. Simply adding a "catalyst" (in two-component coatings) to the coating does not necessarily ensure better adhesion or weathering performance.

The primary qualities necessary for an acceptable roof coating are:

- Low moisture absorption
- Good flow properties at all suitable application temperatures
- Quick skinning and short-cure properties
- Good weathering properties with minimal surface chalking
- Good adhesion properties to prepared surfaces

for better or worse

by Dick Baxter

- Consistency/viscosity suitable for spray applications
- Compatibility with surfaces over which coatings are to be applied
- Acceptable heat resistance
- Algae/fungus resistance

Unfortunately, most of these properties cannot be evaluated using standard test methods, such as those developed by ASTM International. Thin-film QUV testing (testing with an artificial weathering device that uses a light source less severe than typical ultraviolet testing and operates without the humidity cycling); "peel" testing; and moisture absorption can be conducted according to ASTM International standard test methods. All other listed properties must be evaluated by other, more subjective test methods.

Given the absence of standard qualitative test methods, comparative testing is the only way to ascertain which coating formulations provide the essential qualities for suitable roof coatings and the potential for the best performance. For instance, one coating my company tested weathered suitably and had low moisture-absorption properties, good adhesion and flow properties but would not develop a skin in less than six hours. In the real world, this coating would have washed away in afternoon showers or only should be used in Arizona, southern California or Nevada where rain is not expected for the next six months.

An acrylic-based roof coating determined to have virtually all the desirable properties I listed was used as a base for comparison. Comparative testing allows us to determine how other formulations and coatings compare to an optimum formulation. Although a less expensive option may not have all the desirable properties of an optimum formulation, it may provide an acceptable, more cost-effective coating solution, especially over properly prepared substrates.

Testing and evaluation

My company typically has compared moisture-absorption properties by

placing a cured layer of coating in an autoclave for a one-hour cycle (220 F [104 C] at 18 pounds per square inch [psi] [124 kPa]). We have found moisture absorption properties vary from virtually 0 percent to 40 percent by dry weight depending on the coating formulation. Obviously, lower is better. Moisture absorption from ponded water on roof surfaces causes adhesion to the substrate to break down and the coating to separate from the substrate surface. The lower the moisture-absorption properties of the coating, the longer it will remain bonded in areas of accumulated water. But even the best coatings are not going to perform for the expected time when subjected to severe, continuous ponded water or the effects of condensate discharge from roof-mounted heating, ventilating and air-conditioning units.

Flow properties are a visual reference. When coatings are applied to smooth metal substrates with a coarse bristle brush, the better coatings flow or "wet out" to provide a uniform, relatively smooth surface. Coatings with less than desirable "wetting-out" properties will not provide a uniform film thickness on the surface to be coated (whether applied by spray, roller or brush), resulting in a less-than-aesthetically pleasing finished surface.

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Skinning properties are determined by how long it takes a coating to skin to the point where it is unaffected by sprinkling water over the fresh coating surface. This is an important property for field conditions because coatings that wash off roof surfaces create pandemonium among the environmentally conscious and a major expense for contractors who must replace the coating and clean up the mess.

A coating must set, or cure, relatively quickly to allow foot traffic for a second surface coating application within a reasonable time—at least by the next day but not so quickly as to interfere with application. Coatings we tested varied in skin time between 15 minutes (too quick) and more than 26 hours (obviously not quick enough). Thirty minutes to 45 minutes appears to be the optimum skin time to allow good flow properties during the time necessary to get the material on the substrate and not be subject to washing off in the event of sudden precipitation.

Good weathering properties are evaluated using thin film samples exposed to QUV for 90 days in a weatherometer. The beginning film thickness is known. Ideally, there will be minimal erosion of the coating from the test panel surface and minimal chalking of the coating surface following exposure. Weatherometer testing provides no valid information about the potential longevity of the coating; it only indicates one coating potentially performs better than another.

Adhesion properties subjectively are evaluated by applying a layer of coating to a section of glass and peeling the coating from the glass surface. The better coatings must be scraped off the glass surface; coatings with unacceptable adhesion properties can be smudged from the glass surface with thumb pressure. Typical acrylic-based coatings do not develop their full adhesion properties for several days under optimum ambient conditions, so peel testing is delayed for about seven days to allow for full cure of the coating. Thicker applications will require more set time than thinner applications.

Some coating projects will dictate spray application, and suitable roof coatings for sprayed applications must be of such a viscosity to allow application by airless spray. Testing for flow properties is accomplished by using airless spray equipment for the application. Coatings of the right viscosity will flow through the spray tip evenly and wet out to provide a uniform film thickness on the substrate.

Heat resistance is compared by placing samples of various coatings under infrared lamps and raising the surface temperature to about 180 F (82 C) and maintaining exposure for seven days. Heavy oxidation, discoloration and/or any indication of surface crazing is unacceptable.

Algae and fungus resistance is evaluated by subjecting samples to a warm water bath for seven days. Comparisons are by visual inspection of coating surfaces.

Compatibility with various substrates is determined by applying coatings to different surfaces and evaluating the degree of coating discoloration, adhesion to the substrate and any obvious adverse surface reactions.

Surface preparation

Properly preparing a substrate before applying any roof coating is critical to bonding of roof coatings. Surfaces contaminated with silicone (caulk, etc.) never will hold any coating until all silicone contaminants have been eliminated completely from the surface.

Pressure washing is the surface preparation method coating manufacturers generally recommend, but pressure washing can irreparably damage some roof membranes if the high-pressure water is directed into laps or flaws in the roof membrane surface. In addition, high-pressure water can be forced through some types of laps in metal roof panels. Pressure washing may not remove fungus/algae from roof and flashing surfaces. On through-fastened metal roof systems, otherwise functional fastener seals may become dislodged and nonfunctional under high-pressure spray. Seals around foam baffles at metal roof junctures may be damaged by high-pressure water spray. Most times, a stiff bristle brush and strong cleaning agent followed by a thorough "flushing" of

water will be more effective than pressure washing for surface preparation.

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To do so, prepare a sample area by applying an initial layer of the selected coating over the roof surface followed by embedding a strip of fabric (4 inches to 6 inches [102 mm to 152 mm] wide) with about 4 inches (102 mm) of tail exposed followed by another application of roof coating. Allow the test area to cure for a minimum of three days under ambient conditions, and then pull the exposed tail of the fabric straight up.

If the coating effectively bonded to the surface, it will not peel away from the surface before the fabric breaks. If the coating peels cleanly from the surface under minimal load, try various surface preparation methods, primers or different coatings until coating adhesion is positive.

TPOs

Applying acrylic-based (or most other) roof coatings to TPO roof membranes may be hazardous to your business health unless extraordinary precautions in surface preparation are taken before application. Even most adhesives do not bond well to TPO surfaces. My company's tests indicate that even roughing up a TPO surface with sandpaper does not improve adhesion of coatings tested. There are primers that will bond securely to a TPO surface over which water-based acrylic coatings can be applied with a high degree of certainty of performance, but beware of the odor released by the primer. A little experimentation may save embarrassment and money a short time after the application.

APP-modified bitumen

APP-modified bitumen membranes typically are produced with smooth surfaces or mineral-granule surfaces. Most coatings will bond to mineral-granule-surfaced APP-modified bitumen membranes but will not necessarily bond to smooth APP-modified bitumen surfaces. Solvent-based asphalt aluminum roof coatings typically will bond to either smooth- or granule-surfaced APP-modified bitumen roof and flashing membranes; acrylic-based roof coatings typically will bond to the mineral-granule surfacing but will not bond to the smooth surface of APP-modified bitumen roof and/or flashing membranes.

It is difficult to get anything to bond to polypropylene, and there is sufficient polypropylene in APP-modified bitumen sheets to inhibit bonding of anything that will not cut through to bond to the asphalt in the membrane.

Metal roof panels

Keep in mind Kynar® 500 is a Teflon®-based paint on prefinished steel and/or aluminum roof panels, and not much sticks to Teflon. Surface preparation of prefinished roof panels may require sanding of exposed surfaces to roughen the surface sufficiently to provide multiple uncontaminated surfaces to which new roof coatings can grab. There may be sufficient residual zinc in Galvalume® and galvanized finishes on metal roof panels to inhibit good coating adhesion without first pickling the surface with a mild acidic solution.

Depending on the type of protective surfacing on metal roof panels and extent of rust on steel roof panels, some major preparation may be necessary to ensure a satisfactory coating job on metal roof panels. Flaking rust almost always indicates a significant affectation of the thickness of steel roof panels, and depending on the extent of the flaked-off steel, some individual panel replacement may be in order. Temporary repairs sometimes are possible using coating and either nonwoven glass fiber or polyester reinforcement, but the area should be well-marked to prohibit foot traffic on the structurally damaged metal roof panels.

Surface rust is common at cut ends of prefinished steel roof panels or where the protective factory coating has been damaged or weathered away. Surface rust must be removed by wire brush and an impermeable rust-inhibiting primer applied to slow the oxidation process following application of the new coating. In areas of extensive surface rust, it may be more economical to apply a rust inhibitor on the existing metal panels and overlay the existing metal roof panels or replace the affected roof panels than to invest in major surface preparation and application of any coating material.

Primers

Primers for coatings may be necessary for inhibiting rust and/or adhesion of a new roof coating. Some primers are intended to inhibit the effects of rust on steel while others may be intended only to promote adhesion of the new coating. Some primers serve both functions. It is important to understand what a primer does for a new coating system before selecting a proper combination of primer and coating. Primers may not always be necessary depending on the type and properties of the coating and condition or type of substrate to which the coating is to be applied.

To be most effective, rust-inhibiting primers should be virtually impermeable to minimize further oxidation of the metal. Epoxy-type primers usually are the most effective rust inhibitors when applied following removal of all loose rust from the metal surface.

Asphalt-based aluminum

The overall quality of asphalt-based aluminum roof coatings must be judged on the total quantity of aluminum metal contained per gallon of coating. Aluminum typically is purchased as paste from major aluminum suppliers, but the total quantity of aluminum metal in a paste will vary considerably. Needless to say, the coating with the most aluminum metal per gallon will be more expensive than those with less aluminum metal, but the better grade coatings may outlast the cheaper coatings by as much as three times. It is not possible to hold much more than 2 pounds (0.9 kg) of aluminum metal in suspension in a gallon of coating, so any coating with a nominal 2 pounds (0.9 kg) of aluminum metal (not paste) will qualify as a premium-quality coating.

Labels and data sheets available from coating suppliers typically indicate only the quantity of aluminum paste per gallon but don't contain any information as to the quantity of aluminum metal in the paste. It may take some serious investigative work and interrogation of manufacturers' technical representatives to determine a coating's overall quality.

Aside from the total quantity of aluminum metal per gallon, asphalt-based aluminum roof coatings are virtually the same.

Asphalt-based aluminum roof coatings are manufactured with either solvent or water carriers. The solvent coatings essentially are self-priming, and the surface over which they are to be applied must only be cleaned of dust and debris before application. Surfaces over which water coatings are to be applied should be cleaned thoroughly and primed with asphalt primer to ensure good adhesion of the coating to the substrate surface. Caution is in order with water-carrier aluminum roof coatings because under the right conditions the water and aluminum metal may be explosive. It is not a good idea to try to save part of a pail of water-carrier aluminum roof coating; use everything in the pail and start with a new pail on the next project.

Reflectivity

Light-colored roof surfaces are hot topics. White roof coatings will provide good reflectivity for the first few months until they accumulate dirt or, depending on the quality of the coating, weather. In most cases, the long-term reflectivity will depend heavily on the substrate over which the coatings were applied; quality of the coating; suitability of the coating under given conditions; accumulation of alluvia, dirt, pollution, etc.; and drainage conditions.

Acrylic coatings may not cover black surfaces sufficiently to prevent accelerated weathering of the coating or bleed-through of the substrate material. Aluminum roof coatings will lose reflectivity as the aluminum oxidizes and the surface dulls from exposure.

Odor control

Although odors from most acrylic-based coatings are not particularly objectionable, odors from most primers and solvent-based coatings may be noxious, and some means of preventing entry of odors to the interior must be provided to minimize the effects on building inhabitants.

Controlling odors during the coating process may be as simple as masking the air intakes on roof-mounted package heating, ventilating and air-conditioning units or as complex as shutting down air intakes through penthouse walls. In most instances, sheet-metal closures can be fabricated to fit over the air intake areas fitted with flexible duct that extends to the building perimeter or upward away from the area in which coatings/primers are to be applied. In some cases, temporary sheet metal "chimneys" can be fabricated and attached to roof-mounted air intakes to draw uncontaminated air from above the working surface.

But it would be prudent to consider all options for preventing odor entry to the interior before commencing work. Lengthy explanations to all building occupants and providing factual information from material safety data sheets will help their understanding of the temporary odor problem potential.

Be cautious

Reflective roof surfaces make sense in that the lower the surface temperature of the roof membrane, the slower the aging process of the waterproofing materials. Reflective roof coatings can lower roof surface temperatures under heavy sun load and minimize cooling loads or make a more comfortable interior environment in nonconditioned—but occupied—interiors.

White roof membranes or white coating surfaces may require some proactive maintenance by building owners and facility managers to keep roof surfaces clean and restore their reflectivity. Will the additional potential maintenance costs justify the cost of providing optimum reflectivity? In areas of heavy sun load, maybe. In northern climatic areas? Probably not. But a good quality roof coating properly applied to a properly prepared substrate probably will be worth its initial cost.

It should be obvious that quality and application properties of products held out to be suitable for coating roof surfaces may not be suitable for some applications. Simple and expedient evaluation of proposed roof coatings may save much consternation, money and grief for contractors. If there ever was any credence to the old adage "you get what you pay for," it is empirically appropriate to roof coatings.

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