“Cool Roof” Acrylic Coatings for Green Buildings

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Abstract:
This article discusses the value of cool roof coatings for addressing green building trends and highlights some key new developments in water-based technologies, namely acrylic copolymer emulsions and Fluoropolymer acrylic hybrids that provide additional benefits, significantly enhanced durability as well as help provide solutions to emerging needs in the restoration of aged roofs. Some myths are also dispelled – specifically about the performance attributes of styrene acrylic versus all acrylic cool roof coatings – by showing some application and performance data.

Cool Roof Coatings are an important component of Green Building Construction trends

Cool roof coatings have become popular because they increase building endurance and save energy costs for building owners. With proper coatings and application, cool roof coatings can reduce interior temperature by 6°C to 10°C and roof surface temperature by up to 60°C.

Cool roof coatings are a proven technology for achieving energy savings, especially in regions with hot climatic conditions. Concerns regarding increasing global warming and rising energy consumption have pushed a growing number of government authorities and code authorities to implement more energy-efficient building codes in construction of commercial and residential buildings. Roofing solar reflectivity requirements have been added via the ASHRAE 90.1 standard and various state and city ordinances in California, Texas, Georgia, Florida, Alabama, Hawaii, Los Angeles, Chicago, New York City, Philadelphia, Austin, Dallas, Denver, Houston and Washington, D.C.[8] This is further fueling the growth of cool roofs.

The benefits of a cool roof are manyfold and include:

- Lower Energy Usage, up to 30% savings[1]
- Lower Peak Energy Demand Charge, commonly 20 - 30%[2]
- Longer Lifespan of Roof Coating **and** Longer Lifespan of Roof Substrate
- Lower Maintenance Costs & Less Downtime
- Increased Efficiency and Longer Lifespan of HVAC Equipment
- Lower VOC Emissions, up to a 30-40% reduction[6]
- Available Tax Credits and Rebates[3, 4, 5, 8]
- Green Building Credits (LEED, others)[7]
- Cool Roof can be applied for a wide variety of roofing types.

What are Cool Roof Coatings?
Cool roof coatings are flexible, liquid applied waterproofing membranes that may contain white or special reflective pigments. The application of these coatings causes much of the sunlight hitting the roof surface to be reflected, resulting in lower energy costs and extending the life of the roof by protecting it from heat, acid rain and water damage. The coatings are custom designed to adhere to a wide variety of substrates, are flexible at low temperatures, and are commonly used for restoration of old roofs.

All Cool Roof Coatings are not the same: There are several types of cool roof coatings available, and they all provide different value based on cost and performance requirements of the projects. Majority of low slope cool roof coatings are based on elastomeric acrylic latex technology while silicone and polyurethane elastomeric coatings are also used. Arkema sells elastomeric acrylic latex products called ENCOR® Flex latexes for these applications. An emerging trend for waterborne acrylic elastomeric membrane systems for high profile structures such as stadiums, theme parks, casinos is to be thinly topcoated with Kynar Aquatec® PVDF latex, which can extend the dirt pick-up resistance, mold and mildew resistance and durability of acrylic cool roof coatings. Kynar Aquatec® PVDF latex is a polyvinylidene difluoride-acrylic hybrid emulsion with exceptional weathering resistance due to the polymer's unique chemical structure. For over a decade, some select roof-coating manufacturers have been supplying coating systems utilizing acrylic elastomeric basecoats and a Kynar Aquatec® PVDF to enhance the stay-clean properties critical to maintaining a high solar reflectance.

Figure 1 below shows some reflectivity data comparing performance of the three major polymer types, and also the improvements seen with application of a Kynar Aquatec® PVDF based topcoat. The Cool Roof Rating Council generated this for their member companies. It shows both Initial solar reflectance, emittance and an index generated from this called Solar Reflective Index.

Figure 1: Solar Reflective Index Data*

Technology	Initial Solar Reflectance	3 Year Solar Reflectance	Initial Thermal Emittance	3 Year Thermal Emittance	Initial Solar Reflective Index	3 Year Solar Reflective Index
WB Acrylic Membrane	0.85	0.72	0.89	0.90	107	89
Polyurethane Membrane	0.82	0.70	0.89	0.89	102	82
Silicone Membrane	0.87	0.69	0.89	0.89	109	84
Kynar Aquatic® Topcoat*	0.85	0.78	0.90	0.90	107	97

*Average readings for CRRC study on bright white coatings (public domain)

Generally, emittance is relatively constant and reflectance has the major impact on the solar reflective index. Waterborne acrylics have the highest three-year solar reflective index when the three elastomeric types are compared. Acrylics have become an industry standard due to their value in terms of performance, cost and user-friendliness. By adding a Kynar Aquatec® PVDF based topcoat, solar reflectance performance is enhanced significantly.

Versatile and value driven for Sustainability

In a world where sustainability is becoming increasingly important, cool roof coatings are helping lower energy needs and ultimately the carbon footprint. Consumers are becoming more educated and interested in full life cycle costs. Cool roof coatings contribute directly to UN Sustainable Development Goals.

North America accounts for the majority of the cool roof coatings market, with estimates of up to 70%, but the application is also growing in other regions. Implementation and growth vary a lot by geographic regions, and driven by locally available resources and building practices. Globally, as per various market reports, the cool roof coatings market is growing well above GDP rates, and the global growth rate is estimated at 6.5 to 7%. North American industry is still a leading innovator in this market segment and continues to influence international performance standards.

From an application standpoint, roofs have industrial, commercial and residential segments. Another way of segmentation is by type of slope: steep or low slope. About 60% of roofs in the US are low-sloped roofs. There are various types of roofing materials such as coatings, single ply membranes, asphalt-based products, and – of course – combinations of these. Cool roof coatings apply on low slope roofs with a trend toward restoration of existing roofs. As a result, the ability of cool roof coatings to perform over a wide variety of substrates is critical. Collaboration between raw material suppliers, coating manufacturers, contractors and specifiers is critical for achieving the desired goals, and flexibility to change specifications and products based on data driven product development is increasing.

Emerging needs for Cool Roof Coatings

We see an evolution of new and existing performance standards for cool roof coatings based on regional requirements, and growth in other regions outside North America. A key specification for liquid applied acrylic coatings for Roofing is ASTM D6083, which has been the performance standard for over twenty years. ASTM revised the ASTM D6083 standard in 2018 to include a Type I and Type II category. For the Type I category, the coating must pass a low temperature flex of -26°C and for the Type II category, the low temperature flexibility requirement is -10°C.

Adhesion to various roofing substrates such as asphaltic and thermoplastic olefin (TPO) based membranes is also becoming important. This is because restoration of existing roof coatings is becoming increasingly popular as a cost effective and sustainable way of extending roof life. Subsequently, improved asphalt bleed resistance and adhesion to aged TPO membranes is also an important key need.

Commonly, an industry practice is to have multiple coat system that provide synergistic performance, based on the specific needs of the projects. In many cases, a primer is applied first, followed by an acrylic elastomeric base coat in which some fabrics are impregnated to allow for further strength and waterproofing. This is followed by an acrylic, silicone or polyurethane based elastomeric membrane that provides the dirt pick up resistance, water resistance and long-term solar reflectance. Applicators generally may tend to prefer acrylics for their safety profile, ease of use and easy cleanability. As mentioned earlier, a thin film application of Kynar Aquatec® PVDF-based topcoats on the Elastomeric Acrylic coating membranes can provide significant performance enhancements.

Elastomeric acrylic emulsions to cover a spectrum of value

Acrylic copolymer emulsions are key to waterborne elastomeric acrylic coatings, and "all emulsions are not created equal." A wide variety of acrylic latex polymers are used in coatings for varying climate, roof slope and substrates. Polymer design (monomer composition, ingredients, additives, morphology) as well as the manufacturing process can have a significant performance on the application characteristics and durability.

Waterborne acrylic cool roof coatings primarily contain all acrylic or styrene acrylic emulsions as polymeric binders, have elastomeric properties and are applied at a total film build of 16-20 mils. Other hybrid acrylic waterborne coatings incorporating polyurethane linkages are also emerging for niche applications in a limited fashion. Historically, there has been a stigma attached with using styrene acrylic emulsions based coatings for exterior durability. However, due to polymer technology enhancements, it is becoming clear that styrene acrylic based coatings provide additional value in terms of early water resistance, toughness, dirt pick resistance without detracting from the long-term performance and solar reflectivity.

Arkema Coating Resins offers both all acrylic and styrene acrylic emulsions for use in elastomeric cool roof coatings, and is focused on technology agnostic solutions based on solving the market and customer needs. Typical ranges of acrylic polymer emulsions used in elastomeric acrylic roof coatings are shown in Figure 2 below. While ENCOR® Flex 187 and ENCOR® Flex 3186 latexes are examples of historically proven polymers used in the Roof Coatings industry, ENCOR® Flex 192 and ENCOR® Flex 1361 latexes are two recently introduced latex polymers offered to satisfy emerging industry needs. Innovations in the roof coatings industry will continue to be driven by higher performance and sustainability trends. Kynar Aquatec® PVDF is a fluoropolymer-acrylic hybrid that has been proven to add significant enhancements to exterior durability, dirt pick and ponding water resistance.

Figure 2: Acrylic Emulsions used for ASTM D6083 Type I & II specifications

Product	Chemistry	Total solids (%)	Tg (°C)	Features
ASTM D6083 Type I Elastomeric				
ENCOR® Flex 187 latex	Acrylic	60	-18	White elastomeric roof coatings with dirt pick-up resistance
ENCOR® Flex 192 latex	Styrene acrylic	61	-21	White elastomeric roof coatings over aged TPO; dirt pick-up resistance
ASTM D6083 Type II Elastomeric				
ENCOR® Flex 3186 latex	Styrene acrylic	50	-7	White elastomeric roof coatings with dirt pick-up resistance
ENCOR® Flex 1361 latex	Acrylic	55	-12	White elastomeric roof coatings with dirt pick-up and asphalt bleed resistance
Highly Durable Polymer for Metal Roof Coatings and Elastomeric Topcoats				
Kynar Aquatic® FMA-12PVDF latex	PVDF/Acrylic	46	12	Highly weatherable waterborne polymer dispersion with excellent dirt pick-up resistance and color retention

Innovations for Elastomeric Acrylic Roof Coatings Market

Significant technology innovations are continuing in the coatings industry driven by the interest in lowering the carbon footprint of buildings and infrastructure. Arkema has significant resources dedicated to sustainable product development, complemented by intensive exterior durability studies to engineer new solutions that are higher performing, yet cost effective!

The development of Kynar Aquatec® PVDF, an aqueous PVDF-acrylic dispersion system is one of them. It has been proven to resist degradation by ultraviolet radiation, water and atmospheric pollutants. These characteristics make topcoats based on Kynar Aquatec® PVDF a natural fit for roof restoration projects with demanding long-term color retention requirements and for cool roofing systems requiring a sustained TSR (Total Solar Reflectance) value, while still meeting VOC regulations. These topcoats are often used as topcoats over elastomeric acrylic membranes low slope roof coating systems, or as a stand-alone coating in high slope metal roof coating systems.

Innovation is also continuing in the Acrylic emulsion technology as well. Two such innovations are described below, one an all acrylic emulsion (ENCOR® Flex 1361 latex), and the other a styrene acrylic emulsion (ENCOR® Flex 192 latex)

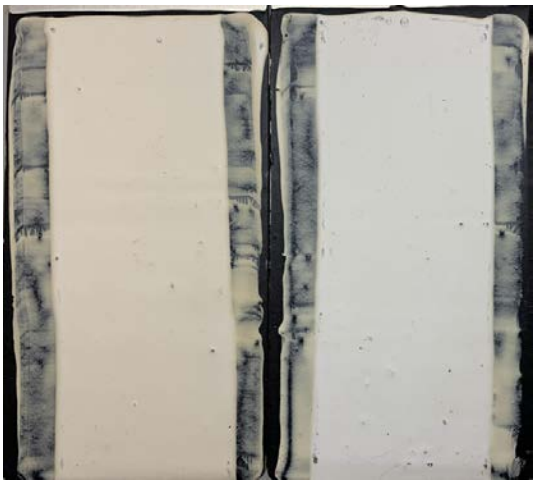
A "green" acrylic latex for improved asphalt bleed resistance and ASTM D6083 Type II standard:

Important needs for elastomeric roof coatings in the U.S. sun-belt states are UV resistance, toughness and flexibility in high heat conditions, early water resistance, dirt pick and asphalt bleed resistance. To address this need, ENCOR® Flex 1361 latex has been developed for coatings

that provides improved asphalt bleed and dirt pick up resistance (Figure 3a & 3b), meet the new ASTM D6083 Type II standard, and is APEO and formaldehyde free. Figure 4 illustrates the performance of ENCOR® Flex 1361 latex in a 40% PVC zinc oxide free formulation. Wet adhesion properties over aluminum, galvanized steel and SPUF meet the ASTM standard. This formulation at 40% PVC does not contain any co-solvent which lowers the VOC, and passes the low temperature flexibility test of -10° C.

With evolving customer needs, a higher Tg acrylic polymer meeting Type II specification is ideal for flexibility as well as enhanced dirt pick-up resistance.

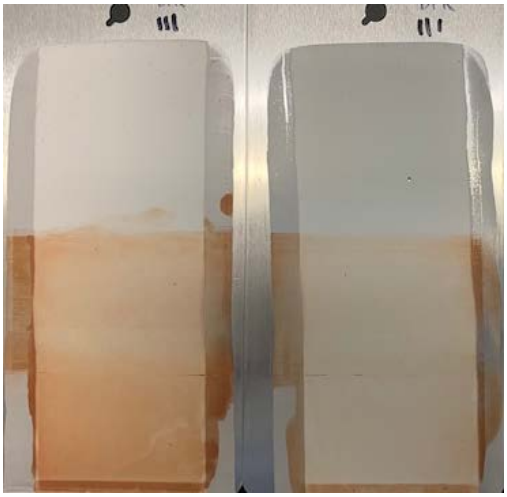
Figure 3a: Asphalt Bleed Resistance



Control Acrylic
E = 10.6

ENCOR® Flex 1361
ΔE = 3.5

Figure 3b: Dirt Pick up resistance



Control Acrylic
Reflectance Δ=24%

ENCOR® Flex 1361
Reflectance Δ=18%

Figure 4: ENCOR® Flex 1361 based Coating for ASTM D-6083 Type II Specification

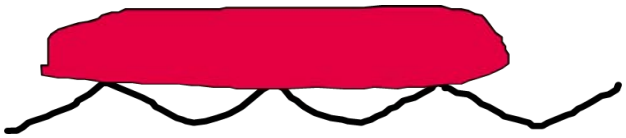
Property		Requirement	ENCOR® Flex 1361
D2370	Tensile Strength, psi	200 minimum	207
	Elongation, %	100 minimum	206
D471 Water Swell, %		20 maximum	9
C794 Wet Adhesion, pli	Aluminum	2 minimum	3.9
	Galvanized Steel	2 minimum	4.0
	SPUF	2 minimum	5.3
D522 Low Temperature Flex, -10°C		No cracking	Pass
D624 Tear Resistance, lbf/in		60 minimum	90

An "engineered, green" acrylic copolymer latex for roof restoration

ENCOR® Flex 192 emulsion is a novel acrylic-copolymer emulsion for meeting ASTM D6083 Type I performance criteria with good flexibility at -26°C, as well as other improved performance characteristics. A key feature of ENCOR® Flex 192 emulsion is its ability to stay clean for cool roof applications. The polymer has technology that allows the coating to minimize dirt adhering to the surface and which increases the toughness of the coating, resulting in higher tensile strength and elongation properties when compared to standard non-cross-linked polymers.

ENCOR® Flex 192 latex has very good adhesion to many substrates. As such, coatings based on ENCOR® Flex 192 latex are over low energy substrates such as EPDM, SPUF, and aged TPO. This allows the coating to refurbish existing membrane roofs, which is far more economical than tearing off and replacing the membrane. Figures 5a and 5b show the principle of high adhesion. The first illustration is of poor surface or substrate wetting with a polymer that has a high molecular weight. While the film itself has good toughness, its adhesion to the substrate is challenging. The bottom drawing (5b) illustrates how a polymer with low initial molecular weight can flow and obtain more contact to the substrate. As the ambient cure crosslinking occurs, the toughness of the coating develops while maintaining more surface contact with the substrate.

Figure 5a



High MW Polymer; poor flow

Figure 5b

Low to moderate MW Polymer; good flow

Figure 6 show a couple of typical failures that are suitable for rehabilitating with ENCOR® Flex 192 latex based coatings. The membrane is aged TPO and the examples illustrate crazing in Picture 1 and seam splitting in Picture 2. Also, dirt pick-up and mildew growth are evident.

Figure 6: Aged TPO Membrane Problems

Newly installed TPO membranes can be especially difficult for adhesion due to residual oils and waxes remaining from the manufacturing process. With time, these wash off from the surface making adhesion easier, but TPO remains a difficult substrate for standard elastomeric coatings.

The graph in Figure 7 illustrates the wet peel adhesions of ENCOR® Flex 192 latex compared to a standard acrylic. While the adhesion to new TPO for both polymers is low, ENCOR® Flex 192 latex has noticeably better adhesion than the standard acrylic over the aged membrane. ENCOR® Flex 192 latex can surpass the minimum requirement for D6083 wet peel adhesion. This is a relatively challenging test, with the coating submerged in water for 7 days prior to performing the test.

Figure 7: Wet Peel Adhesion over New & Aged TPO Membranes

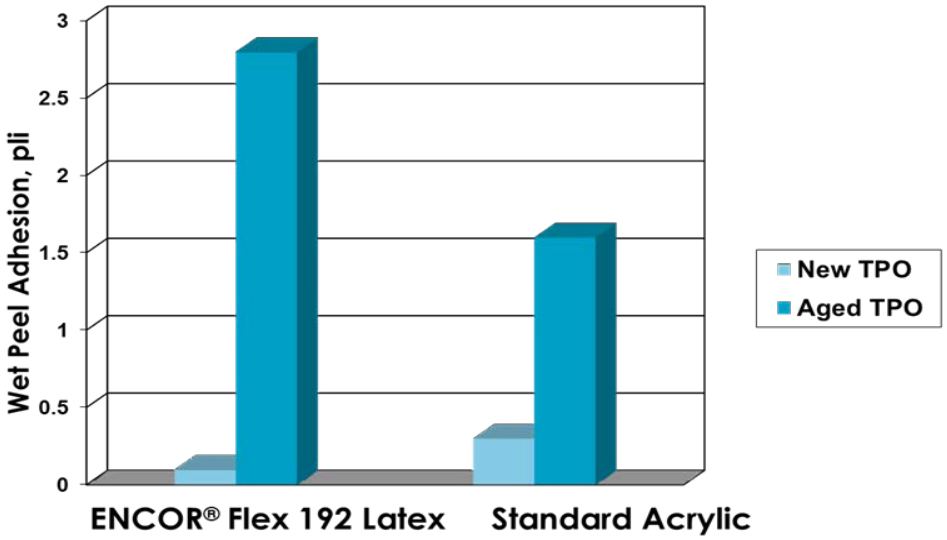
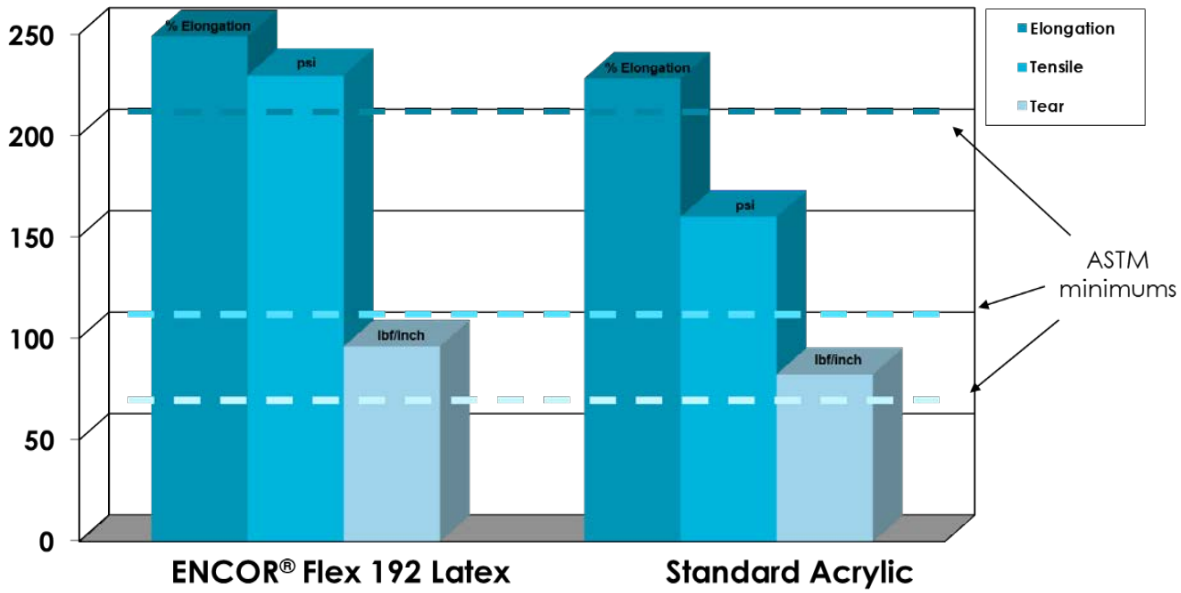


Figure 8 compares the modulus properties of the ENCOR® Flex 192 latex in a coating to a standard acrylic, and to the ASTM standard minimum requirements. The ENCOR® Flex 192 latex surpasses the minimum requirements for D6083 for each of three properties. The toughness of the ENCOR® Flex 192 latex is evident compared to the standard acrylic formulation. Even though the ENCOR® Flex 192 latex has higher elongation than the standard polymer, its tensile strength is also higher.

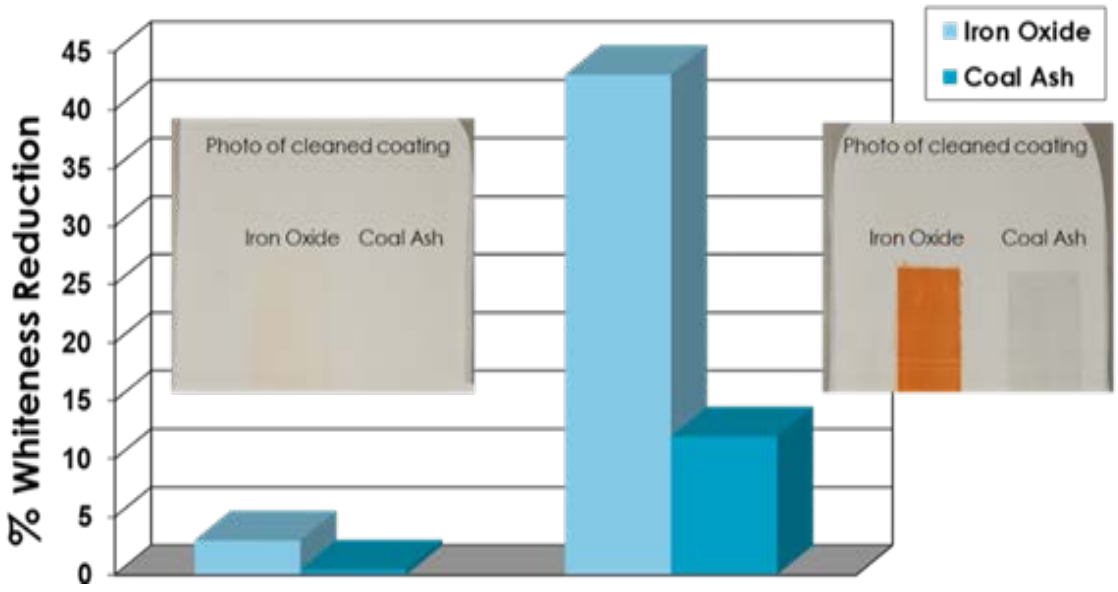
Figure 8: Tensile Properties of ENCOR® Flex 192 based Coatings



The elongation is percentage to break, tensile strength is in psi, and tear strength is lbf/in. The cured elastomeric films are approximately 20 mils thick.

ENCOR® Flex 192 latex has very good dirt pickup resistance even though it is a low Tg polymer. The lab testing protocol involves subjecting the coating to 100 hours of UV light followed by the application of either an aqueous coal ash or red iron oxide slurry. The reflectance of the stained section on the panel is compared to that of the coating prior to staining. The lower the value the better or less change due to staining has occurred. As shown in Figure 9, ENCOR® Flex 192 latex based coating has virtually no residual stain but staining remains on the coating utilizing the standard latex.

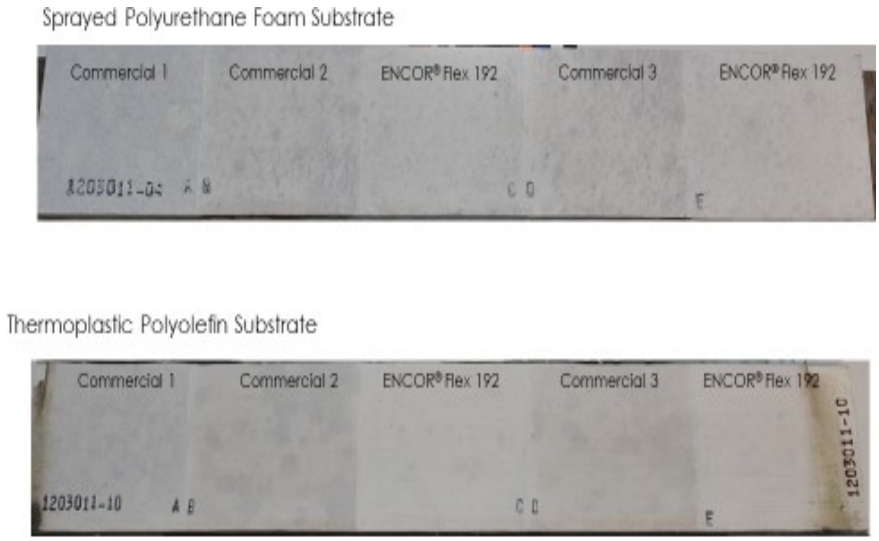
Figure 9: Dirt Pick Resistance



A Cary, North Carolina test fence site was used to evaluate a coatings performance for various weathering and durability properties. In Figure 10, the adhesion and dirt pick-up resistance for ENCOR® Flex 192 latex over SPUF and TPO substrates is shown. At the time of the rating, the panels were on exposure for 4 years at a South 5° exposure angle, which is essentially horizontal. ENCOR® Flex 192 latex has better overall dirt pick-up resistance than the various commercial coatings. The overall adhesion property of the 192 is very good with no evidence of blistering.

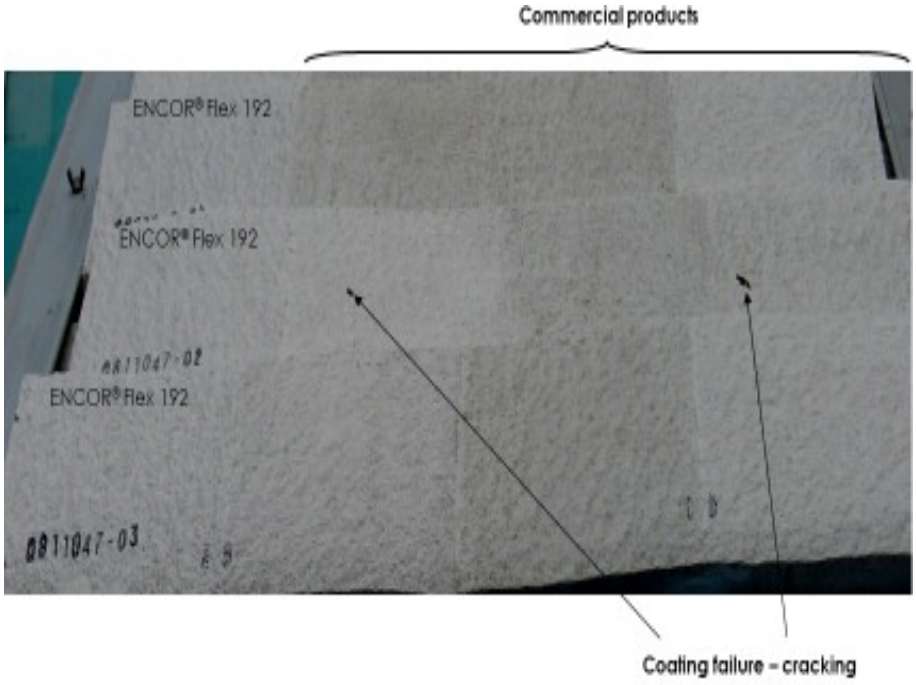
In another weathering exposure test (Figure 11), ENCOR® Flex 192 latex has been applied and being tested on spray polyurethane foam substrate versus other acrylic products. After two years exposure, it has better dirt pickup resistance than the other commercial products. The cracking in sections B and D of the middle panel is due to weathering. It is evident that these coatings lack the flexibility and durability to be used over Spray Polyurethane Foam(SPUF). This cracking will lead to water leakage and ultimately to UV degradation of the foam itself.

Figure 10: Exterior Exposure Studies of ENCOR® Flex 192 based Acrylic Roof Coatings



Cary, NC Test Fence Exposure 4 years at South 5°

Figure 11: Additional Exposure Study on ENCOR® Flex 192 latex based Cool Roof Coatings



Cary, NC Test Fence Exposure 2 years at South 5°

All acrylic versus styrene acrylic performance in roof coating applications

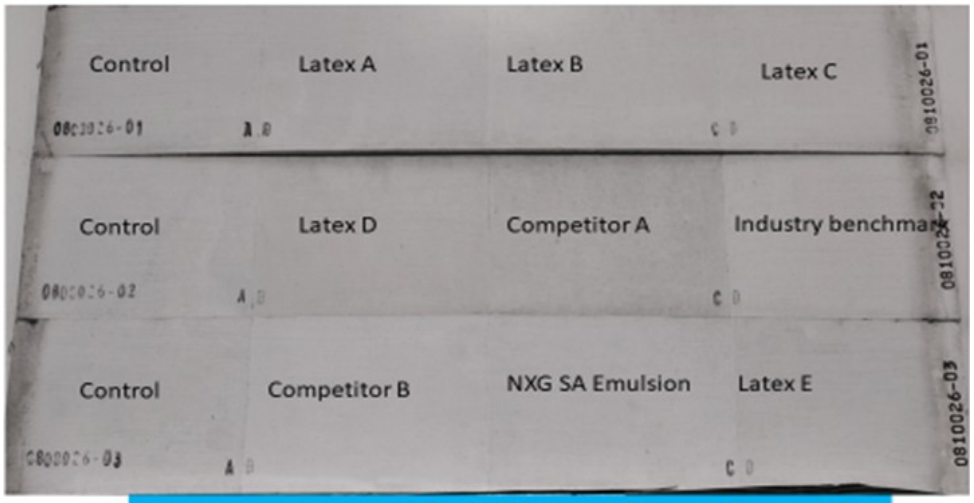
A common belief in the cool roof coatings industry is that an all-acrylic coating is necessary for the optimum performance. Extensive performance testing and exterior durability suggests that this is may no longer be the case due to advancements in polymer technology.

A long-term durability study shown below demonstrates that styrene acrylics perform equally well compared to all acrylic emulsions. With appropriate polymer design, styrene acrylic emulsions can match up to performance of all acrylic emulsions, and also offer some additional benefits such as improved hardness, hydrophobicity, asphalt bleed resistance and early water resistance.

The exterior durability study conducted was for a duration of nine years at a Cary, North Carolina US test fence site. Acrylic latex based coatings were applied to fiber-cement siding substrates at a 5 degree and 45 degree angle. A standard 40 PVC roof coating formula was used, and 10 different latex binders weretested. This includes an all acrylic acrylic emulsion, and a styrene acrylic emulsion designed for superior exterior durability. The change in reflectance values, color and other surface defects were documented per ASTM standards, and pictures of the panels taken periodically.

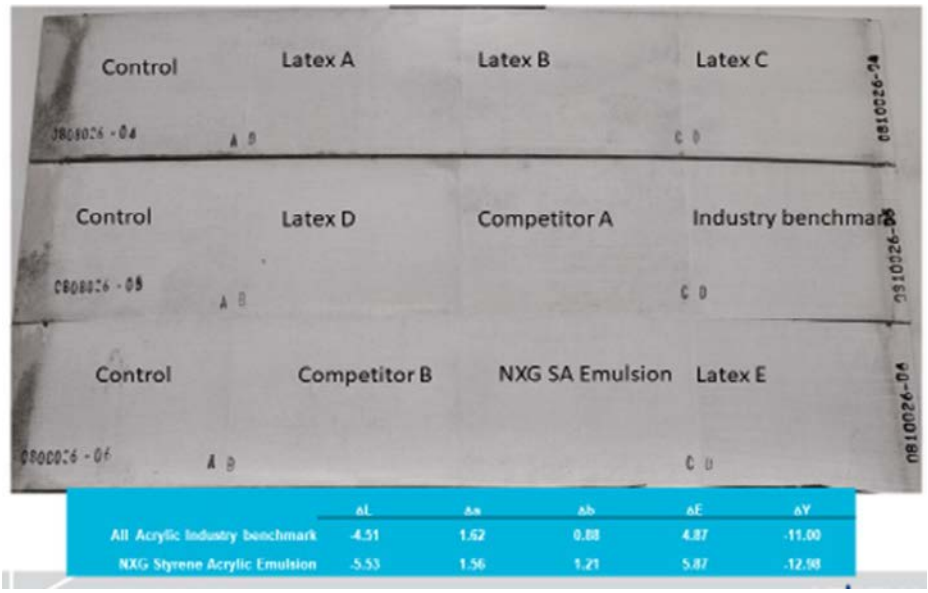
Figure 12a & 12b show the results. The styrene acrylic (commercially available ENCOR® Flex 192 latex) showed excellent color retention and dirt pick resistance compared to other coatings that meet ASTM D6083 Type 1 specification, including the coating formulated with the industry standard all acrylic latex.

Figure 12a: Nine-Year weathering of Styrene Acrylic to All Acrylic Roof Coating (Fiber Cement Siding after ~9 years @ S5 Exposure)



	ΔL	Δa	Δb	ΔE	ΔY
All Acrylic Industry benchmark	-5.70	1.45	1.48	6.06	-13.79
NXG Styrene Acrylic Emulsion	-5.68	1.53	1.43	6.05	-13.56

Figure 12b: Nine-Year weathering of Styrene Acrylic to All Acrylic Roof Coating (Fiber Cement Siding after ~ 9 years S45 Exposure)



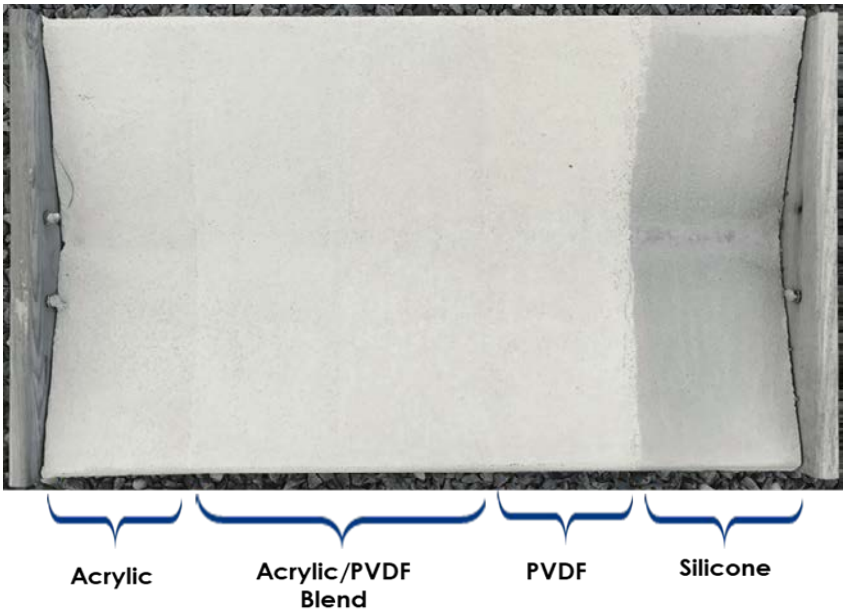
Solving reflectivity and water-ponding issues with a systems approach:

A common problem faced with roof coatings applied to low-sloped roofs is water ponding that ultimately leads to roof failure. Steps are taken to mitigate this problem such as appropriate drainage. However, the ability for the coating to sustain extended exposure to water-ponding is highly desirable.

A possible solution identified is the use of an acrylic elastomeric coating/ Kynar Aquatec® PVDF topcoat system. In an effort to simulate water-ponding, Arkema's test fence group constructed the mock-up shown below in Figure 13 to evaluate the water ponding performance of elastomeric roof coatings over an asphaltic roll. The test panel is designed with a V depression of about 3 inches deep, which allowed rainwater to pond in the center of the apparatus. With time, the water would either evaporate or slowly seep out of the end sections of the structure.

Several acrylic coatings were tested versus a commercial silicone roof coating. The A section of the exposure is an acrylic basecoat and acrylic topcoat system while the B&C sections are ENCOR® Flex based acrylic basecoat with a blend of Kynar Aquatec® PVDF and acrylic in the topcoat. The D section is an all Kynar Aquatec® PVDF topcoat formulation over the same ENCOR® Flex acrylic basecoat. Finally, the E section is the silicone coating. While silicones certainly have very good water resistance, they can have poor dirt pick-up resistance and in this case, it appears to have poor asphalt bleed resistance as well. The ENCOR® Flex acrylic, the blends, and the Kynar Aquatec® PVDF coatings are doing very well at this point.

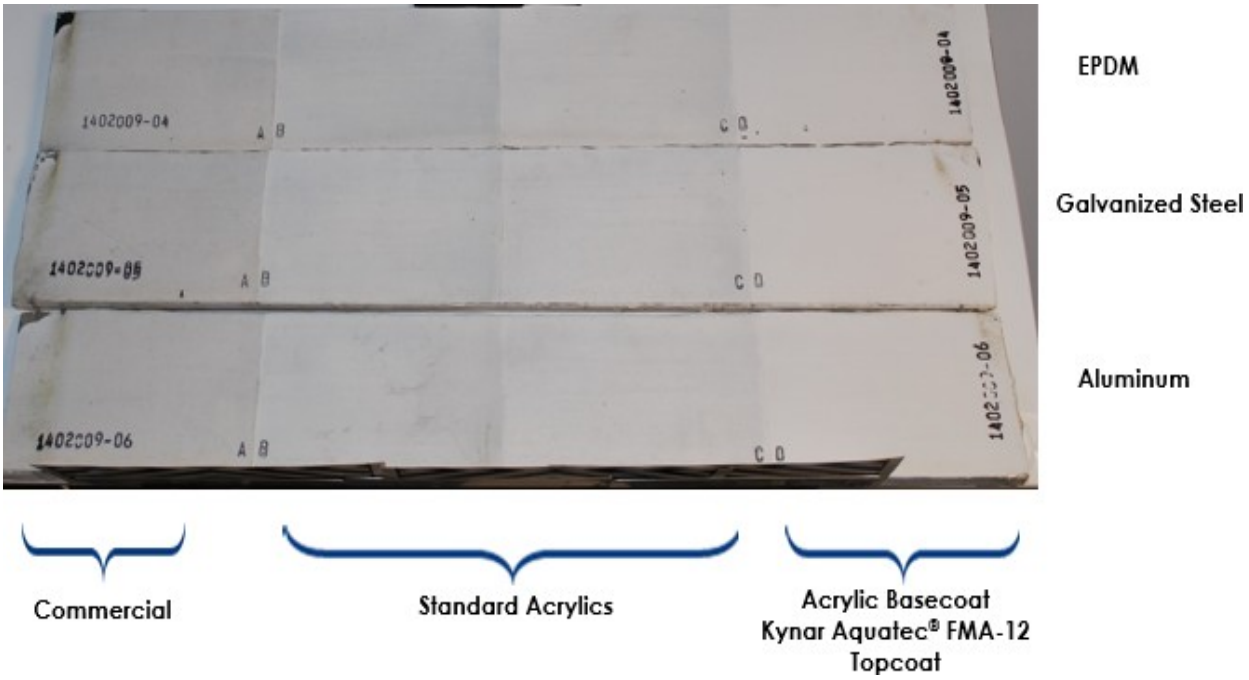
Figure 13: Water Ponding Test Results in Exterior Exposure



The system approach can also be beneficial for an ENCOR® Flex acrylic basecoat with the Kynar Aquatec® PVDF topcoat for enhancing the dirt pick up resistance of cool roof coatings as shown in Figure 14.

At the time of rating, the panels were exposed for 2 years at South 5°. The acrylic basecoat / PVDF topcoat system is on the far right D section. In the A section is a commercial elastomeric while the B&C sections contain Arkema formulations based on two different Arkema ENCOR® Flex acrylic latexes (specify which?) . As you can see, the B&C sections are performing better than the commercial coating probably due to formulation differences such as PVC. Again, the ENCOR® Flex basecoat and Kynar Aquatec® PVDF topcoat is demonstrating very good dirt resistance overall.

Figure 14: Cary, US Test Fence Exposure Studies, 2 years at South 5 Degrees



Summary

To summarize, the cool roof coatings market is growing very fast to support the global need to help reduce energy costs and urban heat island effects. Performance standards and technology is evolving to address emerging trends of construction growth in the Sunbelt states in the U.S.. Restoration of roofs is taking precedence over new roof installations. Multiple coat systems with synergistic performance of various coating technologies is a trend for the future.

Innovations in waterborne acrylic emulsions such as ENCOR® Flex are continuing to address these needs. The distinction between using all acrylic and styrene acrylic elastomeric coatings is becoming less with the industry standards and emerging performance needs, and both technology types have been proven to show value in field exposure testing, and to satisfy specific regional and national coating manufacturers. A thin film of Kynar Aquatec® PVDF based coating can significantly enhance durability as a topcoat over ENCOR® Flex based and other acrylic elastomeric coatings for low slope roofs, and as a single coating for high slope metal roofs.

CASE STUDY: Charles De Gaulle Airport

In 2018, Charles de Gaulle Airport (ADP) has taken a step forward and chose to test the concept of saving energy linked to air conditioning thanks to a passive cooling: the cool roofing. A white paint that reflects the sun light waves during sunny periods was applied on the West Pier of the Terminal 2G. Over 1,160 square meter were covered with the Cool Roof paint from the Cool

Roof France Company. The application required 10 days and two persons for the preparation of the roof/ coating application.

The coating system included:

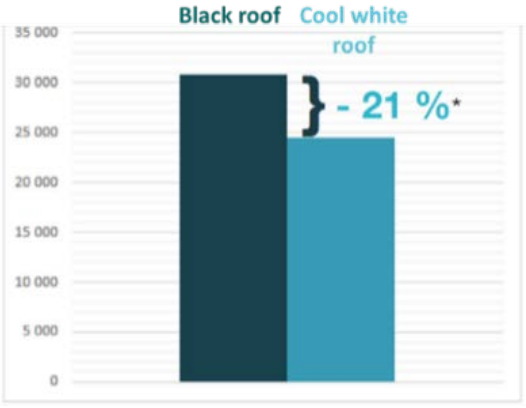
- Two layers of base coat formulated with an acrylic based paint
- A top coat based on Kynar Aquatec® latex

Some fresh air before taking off?

The West (with cool roof) and East Pier (without cool roof) of Roissy airport were monitored by Surya Consultant to estimate the efficiency of the cool roof paint system in lowering the temperature at the surface of the roof. The temperature at the surface of the roof, the temperature of the ceiling above, and the ambient temperature were monitored from June 1 to September 30. A weather station also measured outside temperature (°C) and solar radiation (W/m²). During this period, the two Piers were air-conditioned used in similar conditions (passengers, traffic...).

The recorded data displays clearly the facts: the temperature of the passive cooled roof sharply lowered by 24.2°C and the energy consumption linked to air conditioning to reach desired settings inside building has seen a drop of 21% (6374 kWh, 5.5 kWh/m²). With actual energy price, this translates over the period to a saving of 612 Euros! In addition, employees working all day long inside the Pier have reported a great improvement in thermal comfort during this period, (as well as following years).

A dark roof absorbs most of the energy received by the sun, heating the roof structure and transferring most of heat flow to the underlying building or to the surrounding air: air conditioners that suck hot air and dump it outside can further exacerbate the cooling requirement of a building. The cool roof technology not only reflect as much of the sun's energy as possible, but also affect surrounding temperatures and offset carbon emissions.



Desired long-lasting whiteness

The goal of the project was to apply the best choice of architectural coating that would provide highly efficient reflectivity and long-term durability. The durability of cool roof paints made with Kynar Aquatec® latex has many advantages: it limits dirt, mildew and soiling accumulation on the slow-sloped roof from pollution and facilitates cleaning at a lower cost. The results: a white paint that reflects 95% of the sun rays whereas traditional paint reaches only 70%, and this for many years.

References

[1] "Cool Roofs for Hot Projects", by Sherry Hao, Jessica Clark, LEED AP, Celeste Allen Novak, AIA, LEEK AP, Sara Van Mantgem. Cool Roof Rating Council.

[2] "Reducing Peak Electrical Demand with Reflective Roofs" Jim Hoff, TEGNOS Research, Inc. and Andre Desjarlais, Oak Ridge National Laboratory (ORNL), 2016.

[3] "Coatings are considered "restoration" and not a new roof system installation. Therefore they may usually be expensed in the fiscal year during which they are applied instead of amortizing the cost over the life of the roof (as in a new membrane installation). Check with your CPA or CFO to properly apply this information to your own roof situation." (https://www.roofcoatings.org/reflective-roof-coatings-institute/for-building-owners-and-facility-managers/)

[4] (https://www.irs.gov/newsroom/new-rules-and-limitations-for-depreciation-and-expensing-under-the-tax-cuts-and-jobs-act)

[5] Requires for initial solar reflectance of 0.75 and aged solar reflectance of 0.63 for many roof applications (https://ww2.energy.ca.gov/2018publications/CEC-400-2018-020/CEC-400-2018-020-CMF.pdf)

[6] Derived from a study published by Lawrence Berkeley National Laboratory on energy savings and greenhouse gas reduction. The T.S.R. value of 0.77 are three-year test data certified by the Cool Roof Rating Council. Based on a 20-year life cycle test conducted in California by Arkema Inc., roof=300 squares. TSR of Kynar Aquatec®= 0.77 and TSR of Elastomeric Acrylic = 0.55. Results will vary by location and climate type.

[7] Freedonia Report: Liquid-Applied Roof Coatings in the US by Product and Subregion 30 Nov 2017

[8] Cool Roof Rating Council (www.coolroofs.org/resources/rebates-and-codes)