THE FUTURE OF ROOFING COATINGS

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Cold applied roof coatings, mastics and adhesives have been used in the maintenance, restoration and in the construction of new roofing membranes. Significant changes in commercial hot applied and single-ply roofing materials and application techniques took place during the period of 1970 to the mid-1980s. Evolutionary changes continue in this area as the newer systems continue to be improved based on real time performance. Technological change related to polymer modification of asphalt and solvent reduction is occurring in the cold applied roofing area as the industry moves toward the 21st century. There is also an emerging technology of liquid applied asphaltic materials that are solvent free. New technology is also being applied to the asphalt emulsion coatings and acrylic latex based white roof coatings to reduce the amount of water in these materials to enhance the speed of drying as well as improve the adhesion to common roofing materials. While the existing cold-applied roofing products will continue to have an important place in the roofing industry, the 21st century will see improvements in these products and new technologies applied to roofing materials that will provide new levels of performance in cold-applied coatings, mastics and adhesives.

KEYWORDS

Acrylic latex, adhesive, asphalt, coating, high solids, mastic, polymer modified, polyurethane.

BACKGROUND

The roofing market has been evolving since man first sought ways to protect himself from the elements. The past two decades have seen significant changes. In the 1970s, three technologies shaped the face of the industry.

The first technological change was the introduction of single-ply membranes as an alternative to conventional BUR (built-up roofing) systems. A polyvinyl chloride (PVC) membrane was introduced, which originated in Europe, and immediately following was ethylene-propylene-diene (EPDM) single-ply, which originated in the United States. Roofing membranes using these materials were extremely lightweight and could be assembled in the field using very large factory-produced sheets. Both thermoplastic and elastomeric membranes captured the attention of the roofing and architectural community using this new, non-asphalt-based technology. These products were accepted rapidly into the roofing market.

Modified bituminous membranes, already successful for more than 10 years in Europe, were imported into the North American market. Both thermoplastic atactic polypropylene (APP) and elastomeric styrene-butadiene-styrene (SBS) membranes found ready acceptance due to more consistent membrane fabrication in the factory rather than in the field and also because it was similar to BUR at least in its use of asphalt and multi-ply construction. European equipment manufacturers were quick to provide the necessary turn-key manufacturing lines and product technology necessary to meet the demand for the new products in North America.

Finally, glass fiber felts were developed in the United States as a replacement for organic felts. These glass fiber felts had superior and isotropic tensile strength along with excellent water resistance when compared to organic felt. The BUR manufacturers were somewhat slow to adopt this new technology and, therefore, set the stage for the other two previously mentioned technologies to get a head start in the roofing market.

The 1990s have brought two new initiatives forward as a result of learning from history. First, conventional built-up roofing has regained market share at the expense of other newer systems. This has been fueled by demand for a roofing system that can be restored rather than replaced. None of the new alternatives proved to be the best or the only answer to the building owners' need for a durable, problem-free roofing solution.

Second, metal roofing has been in the market for many years and has begun to increase somewhat in share as a result of two factors. Structural standing seam roofs have proven an effective solution in certain cases to reroofing over conventional built-up roofing systems. Life cycle cost analysis has been successfully used to promote this roofing system alternative.

Throughout these changes, one part of the market has been constant, but has also evolved as new technologies were utilized: cold-applied roof coatings, mastics and adhesives. As we enter the 21st century, there is increasing interest in sustainable roofing systems and the complete building envelope. A sustainable roofing system can be defined as "a low-slope roofing system that is designed, constructed, maintained, rehabilitated or demolished with an emphasis throughout its life cycle on the efficient use of natural resources and the maintenance of the global environment."[1] Roof coating systems have long been used to maintain and extend the life of existing roofs. As will be shown, there is work in progress to ensure that coatings will not only maintain their position, but will become more prominent in the roofing market both in reroofing and new roofing applications. There is also increasing demand to reduce odor on roofing projects and to remove sources of open flames such as kettles and torches in certain situations. Cold-applied roof coatings and adhesives meet this need.

Cold-applied coatings are easy to use and can be applied using a variety of methods including: trowel, brush, squeegee and spray. Coatings are easy to store and require minimal investment in application equipment. The lack of open flames from kettles or torches minimizes any risk of fire. There are minimal fumes, low odor and no visible emissions associated with cold-applied coatings. With the advent of solvent free and higher solids waterborne materials, there are even lower levels of odor.

CURRENT TECHNOLOGY

Roof coatings and adhesives encompass a wide range of materials. In the 1930s, cold-applied coatings were introduced commercially into the United States construction market. The traditional roof coatings have been produced using bitumen (asphalt or coal tar pitch) as the binder. The bitumen was compatible with most other traditional roofing materials. Since that time, asphalt coatings and mastics for roofing and waterproofing have been used successfully for many years in a wide variety of applications, including maintenance and cold-applied roof systems.

Solvent-Borne Asphalt Adhesives and Coatings

The most common type of asphalt coating is a solvent-borne material. Asphalt is mixed with a solvent to lower the viscosity and make the material a liquid at room temperature. Fillers, fibers and thixotropes are added to result in a material with the desired application consistency.

Asbestos was the fiber of choice in the past. Due to continuing concerns with the health effects of friable asbestos, the use of this material in such compounds has been declining since 1985 and will probably continue to do so. This decline is despite the fact that the asbestos fibers contained in asphalt coatings and cements are completely encapsulated and there has been a relaxation in regulations pertaining specifically to asbestos-containing bituminous cements and coatings. The fibers most often used as a partial substitute for asbestos in these materials are cellulose and other organic fibers such as polyethylene. These fibers alone do not impart the same consistency as asbestos in these solvent-borne bituminous materials, so thixotropes such as clay and other consistency modifiers such as talc are also used in conjunction with the non-asbestos fibers.

Traditional solvent-borne adhesives are products that meet American Society for Testing and Materials (ASTM) specification D 3019 for lap cement used with asphalt roll roofing. These materials can be used with glass fiber, polyester, composite or organic felt materials for both repair and new roofing membrane systems. ASTM D 2822 and D 2823 are specifications for asbestos-containing solvent-borne asphalt coatings and mastics that can also be used as interply adhesives. ASTM D 4479 and D 4586 are the corresponding asbestos-free specifications for coatings and mastics used in the same applications.

Asphalt Emulsions

As an alternative to the use of solvents, asphalt may be mixed with water using a process called emulsification. This process suspends particles of bitumen in water to form a gel-like coating or adhesive. The particles remain in suspension until the coating is applied and the water evaporates, allowing the particles to coalesce to form a protective coating or adhesive.

The first bituminous emulsions were made more than ninety years ago using anionic emulsifiers. These early clay emulsions used various types of clay. It was not until the early 1920s that bentonite clay was used as the emulsifier. This use of bentonite imparted more favorable qualities to the emulsion than some of the earlier emulsions, which needed ratios of asphalt to clay that were very low (on the order of 3 or 5 to 1). When bentonite was used, the ratio of asphalt to clay increased significantly using 15 to 30 times more asphalt than clay1 which led to the longer lasting emulsion roof coatings used today.

Colloid mills and other high-speed dispersers are often used to manufacture the emulsions for cold-applied coatings. Asphalt emulsions are typically produced using straight run asphalts, propane precipitated asphalts, or slightly oxidized asphalts. The most common type of emulsion used today for roofing and waterproofing employs bentonite clay as the emulsifier, which forms a gel-like structure with the asphalt. This improves the thixotropic properties of the low viscosity base asphalt used to produce the emulsion. The sag and flow resistance of the emulsion resembles an oxidized asphalt while the ductility of the low viscosity, un-oxidized asphalt is retained. The clay also imparts resistance to hot flow after cure and fire resistance to the coating when tested in roofing systems using ASTM E 108.[2] The solids of these emulsion products may vary from 45 to 60 percent by weight.

The only ASTM specification for asphalt emulsions are for coatings, not adhesives. Nevertheless, asphalt emulsions can be used with polyester fabrics to form a repair or a complete roofing membrane. The emulsion impregnates the fabric and the drying process results in the coalescing of the emulsion. The open polyester fabric enhances the ability of the water in the emulsion to evaporate. There are some limited cases where glass fiber felts are used with these materials as well; however, the drying process is significantly slower. Emulsion interply adhesives are described by ASTM D 1227, Standard Specification for Emulsified Asphalt Used as a Protective Coating For Roofing.

Reflective Asphalt Roof Coatings

Reflective asphalt coatings encompass several different types of materials. The most common is a solvent-borne aluminum-pigmented asphalt-based roof coating. Other types include waterborne asphalt emulsion roof coatings and grey emulsions (titanium-pigmented asphalt emulsion).

The main reason to use a reflective asphalt roof coating is to protect the roofing membrane. These coatings also reduce the heat load on the building, as well. Using an asphalt-based product to coat asphalt roofing helps to preclude any compatibility problems sometimes found in other non-asphaltic roofing products. A reflective coating is desirable because it can significantly reduce the heat load on the membrane. This reduction in temperature is one factor in slowing the rate of degradation of the roofing system as well as reducing the cooling requirements for the building. This reduction in heat load is, of course, more important in certain areas of the country than others and is also dependent on the amount of insulation used in the roofing system. Testing has shown that reflective roof coatings can decrease the temperature of the membrane from 8° to 19°C (15° to 35° F).[3] This reduction in membrane temperature slows the rate of degradation of a roofing system, thus extending its life and reducing the cooling requirements for the building. These coatings also add moisture protection to the surface of the membrane. Aluminum-pigmented asphalt roof coatings are used as part of many roofing systems that require a Factory Mutual (FM) or Underwriters Laboratories (UL) fire rating. ASTM specification D 2824 for solvent-containing aluminum-pigmented asphalt coatings describes non-fibered, asbestos fibered and asbestos-free fibrated coatings.

ASTM is currently developing a specification for a water-based aluminum-pigmented roof coating. While water-borne products have been on the market for approximately 10 years, there were, and in some cases continue to be, shelf life stability problems with this type of product. Ongoing research by the aluminum pigment manufacturers, as well as the coating manufacturers, is directed toward eliminating the stability problem. Once applied to the roofing membrane, these products perform well, exhibiting good adhesion to BUR and modified bitumen roofing membranes and good reflectivity.

In certain geographic areas, gray asphalt emulsions are used as reflective roof coatings. These emulsions are lighter in color than traditional asphalt emulsions, but not as reflective as the aluminum-pigmented asphalt roof coatings. These emulsions also add waterproofing to the roofing system and exhibit good adhesion to traditional asphalt roofing systems. These coatings, while having a slightly lower reflectance than aluminum-pigmented asphalt roof coatings, tend to reduce the heat load slightly more effectively than aluminum pigmented products due to the additional mass.[4]

Polymer Modification: Solvent-Borne Coatings, Mastics, and Adhesives

The introduction of polymer modified bituminous membranes in the 1970s[5] spurred the development of cold-applied coatings with improved properties. The polymer chosen to modify a particular asphalt depends on the properties desired. The most common modifiers for asphalt coatings and mastics are styrene-butadiene-styrene (SBS), styrene-ethylene-butylene-styrene (SEBS), styrene-isoprene-styrene (SIS) block copolymers, and styrene-butadiene rubber (SBR). Butyl, neoprene and urethane polymers are also fairly common modifiers. As with any modification of asphalt, the compatibility of the polymer and asphalt must be determined to ensure that the polymer improves the initial properties and also longer term aged properties.[6,7] Polymer/asphalt blends that are not compatible tend to exhibit a significant drop-off of properties with time.

Polymer modification of asphalt for cold-applied coatings and adhesives results in improved properties when compared to products containing asphalt that has not been polymer modified. Tensile strength and elongation of polymer modified asphalt exhibit significant improvement over asphalt. Typically, asphalt may have an elongation of 20 to 60 percent at room temperature while polymer modified asphalt exhibits 300 to 1000 percent elongation under the same conditions. The tensile strength exhibited by polymer modified asphalt is generally two to five times greater than asphalt. When elastomeric modifiers are used, they impart the property of recovery to the polymer modified asphalt on the order of 70 to 95 percent. Asphalt that has not been modified exhibits little, if any, recovery.

These polymer modified materials typically exhibit a wider service temperature range than asphalt. The low temperature properties and adhesive bond strength of polymer modified asphalts are often much improved when compared to asphalt. Two tests that show these improved low temperature properties are ductility and low-temperature flexibility. Ductility at low temperature is increased 300 to 500 percent for polymer modified asphalt. Low-temperature flexibility failure temperatures for polymer modified asphalt range from -34° to -18°C (-30° to 0° F). Asphalt that has not been modified generally exhibits a 2° to 16°C (35° to 60°F) low temperature flexibility failure temperature. The high temperature properties of polymer modified asphalt is significantly improved over asphalt, as well. These materials will not flow at elevated temperatures in the manner typical to asphalt. The wider temperature range allows polymer modified asphalt to be used in a wider range of applications than asphalt.

Polymer modification of asphalt generally involves blending a relatively low viscosity un-oxidized asphalt, ranging from roofers flux to paving AC grades, with enough polymer, generally from about 3 to 20 percent by weight, so that a continuous polymer matrix is formed with the asphalt. Using ultraviolet (UV) fluorescence microscopy, this continuous polymer matrix can be seen as the yellow to yellowish-green continuous phase with black droplets of the asphaltic phase evenly dispersed in this polymer matrix. (See Figure 1.) The addition of polymer increases the softening point from 32° to 43°C (90° to 110°F) to more than 93°C (200°F). The penetration is also lowered significantly. As mentioned previously, this polymer modification improves properties at both ends of the temperature spectrum, improving flow (sag) resistance and ductility. Oxidized asphalt is rarely used as a base asphalt for polymer modification due to its significantly lower compatibility with polymers.

Polymer modified adhesives and mastics are used in certain high-performance applications, such as high wind areas, replacing traditional coatings and hot-mopped asphalt adhesives. The use of polymer modified cold-applied adhesives with modified bitumen membranes is also a growth area. One issue related to traditional cold-applied roof systems is the time it takes for the solvent to evaporate from the system and, therefore, the time it takes for the system to develop its ultimate physical properties. In a 1975 ASTM symposium, Davis and Krenick reported that a three-ply cold-applied system reaches the National Bureau of Standards (NBS)[8] minimum tensile strength when the cold applied adhesive has reached the point that it retains only 6 percent of its solvent.[9] Polymer modified adhesives tend to reach the NBS minimum tensile strength at a higher solvent content. The loss of solvent from these systems is primarily governed by the weather conditions at the time during and after application.

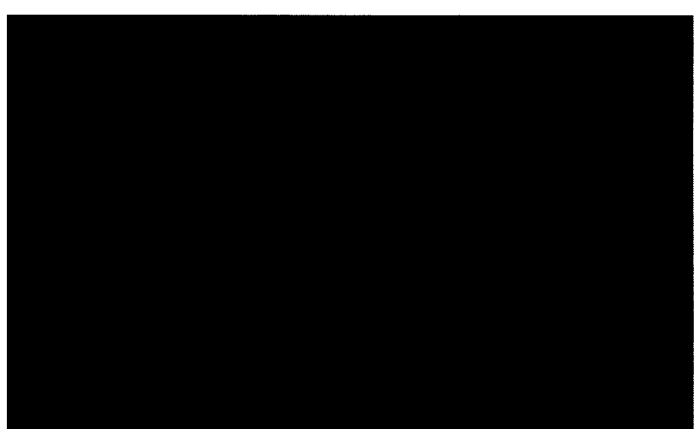

Figure 1. UV fluorescence microscope picture of asphalt dispersed in SBS polymer.

Latex Roof Coatings

As the roofing market evolved, other types of materials were employed in roofing systems. Latex coatings used in roofing application, which have been around since the 1970s, are significantly different today as compared to their predecessors. The lack of adhesion and resistance to water, both in liquid and vapor form, of these early coatings is still a recent memory. Current latex coatings have been significantly improved both in terms of adhesion and water resistance. They still do contain a significant amount of water that must evaporate during the cure process.

The performance of latex coatings used in roofing applications has met with varying results. The problems associated with these products have included: marginal adhesion to asphalt surfaces if not formulated properly or not used with a suitable primer, significant time to dry and resist rain, and less than desired resistance to ponded water in roofing systems. These coatings, however, have excellent reflectivity and the ability to significantly lower membrane surface temperatures.[4]

INTO THE 21ST CENTURY: IMPROVEMENTS AND EMERGING TECHNOLOGY FOR ROOFING SYSTEMS

Because of the excellent performance of traditional asphalt based materials throughout history dating back to the preservation of mummies with naturally occurring asphalt, these materials have and will continue to play an important role in the maintenance and construction of roofing systems. There is, at the same time, a significant amount of development directed toward using a whole new group of technologies that can be applied to roofing materials as well as improvements in existing materials.

Solvent-Containing Asphalt/Polyurethane Asphalt Coating, Mastics and Adhesives

Asphaltic polyurethane solvent-borne adhesives were first supplied to the roofing market as two component systems in the early 1980s. This type of material contains a base and catalyst that have to be mixed before application, and once mixed, have to be used in a relatively short time. These two-part systems resulted in adhesives with excellent physical properties, but it was difficult to get consistent application results due to the necessity of thorough mixing of the two components. More success was gained in industrial waterproofing applications for these materials than in roofing.

Today, there are a number of single-component, solvent-containing asphalt/polyurethane materials. These materials are based on cure technology that uses moisture in the air to cause the polymer to crosslink. Moisture-cure solvent-containing materials available today are similar in performance to the older two-part materials.

The physical properties of polyurethane systems depend on the relative amounts of polymer used to modify the asphalt portion of the adhesive. The properties range from soft and rubbery with an elongation of more than 1000 percent to a very tough and durable material with a tensile strength of more than 6895 kPa (1000 psi). These products incorporate asphalt as a material that can improve physical properties, lower permeability and reduce the material cost. Polymers tend to cost at least ten times more per pound than asphalt. Other relatively high technology materials used in the formulation of these products include thixotropes to control flow, adhesion promoters to result in exceptional adhesion to a variety of substrates, reaction catalysts to control the cure rate and ultraviolet absorbers to improve weathering characteristics of the product. These high performance materials offer combinations of high strength and elongation and exceptional adhesion to most materials found in roofing systems today and are available at solids up to 80 weight percent. Polyurethane materials also offer excellent long-term performance even in extreme environments.

100 Percent Solids Asphalt/Polyurethane Coatings, Mastics and Adhesives

Solvent reduction, to lessen VOC emissions, continues to be a goal of the industry. One approach to solvent reduction has been to reduce the quantity of solvent in traditional cold-applied coatings, adhesives and mastics to the point that they will meet and exceed mandated VOC regulation. A new more radical and significantly more costly approach involves completely removing solvent from cold-applied asphalt-based coatings and adhesives used in roofing. Since there is no solvent in these materials, they are extremely low odor.

As mentioned earlier, solvent is used in combination with asphalt and polymer modified asphalt to make the material a liquid at room temperature and, therefore, possible to apply without the heat commonly associated with hot-applied asphalt. The approach used for solvent-free materials involved the development of a base polymer that is liquid at room temperature, is a single component system and is compatible with asphalt. Asphalt in these systems offers the same advantages as in conventional systems.

Fibers and thixotropes are used to give the materials the characteristics necessary for application as either a liquid or mastic type material. After application, the materials based on this technology cure as the polymer crosslinks using moisture available in the air. A suitable catalyst system is used so that the polymer system will crosslink at relative humidity as low as 10 percent and in a temperature range of 7° to more than 49°C (20° to more than 120°F).

These materials are significantly more expensive to produce than solvent-containing materials. They exhibit high performance physical properties, such as low-temperature flexibility of -51°C (-60°F), tensile strength of 3792 kPa (550 psi), and an elongation of more than 1000 percent. These adhesives can also be specially formulated using adhesion promoters to result in excellent adhesion to most common surfaces and materials used in roofing. When high performance, cold application and low odor are required, these types of products will offer a new solution.

Latex Roof Coatings

Recent new developments in high solids acrylic and other polymer type latex materials have resulted in a family of latexes that contain more than 75 percent solids as compared to more conventional latex materials with a maximum of 60 percent solids. Reduction of the water content permits formulation of high solids coatings that dry much faster than older conventional materials.

Many latex materials do not adhere to asphalt due to lack of polarity of an asphalt surface. An asphalt surface can be likened to oil or grease both in terms of the aliphatic chemistry as well as the polarity of these materials. While certain fractions of asphalt do contain functional groups that can provide some polarity, they are sufficiently diluted in other fractions, which results in a low polarity surface. Adhesion is an important key to long-term performance of acrylic coatings.

Advances in adhesion science related to asphalt and other materials has resulted in improved adhesion of these new materials to roofing materials. This can be accomplished using adhesion promoters in the coating or using primers designed to provide an interface that adheres both to asphalt and latex.

These coatings can also be formulated with other materials that provide the ability to build high dry film thickness of the coating in a single application. Thixotrope systems and other additive materials provide the body to apply a high build of the coating without flow using airless spray, roller or brush. Control of the film forming of the coating allows the material to become resistant to wash-off rapidly while still permitting the coating to through dry. The coating system is further formulated to result in excellent resistance to standing water.

Fire resistance for these coatings is obtained by using additive fire resistant latex materials containing halogen groups, through other conventional fire resistant materials such as aluminum tri-hydrate, phosphates, ammonium molybdate or other halogen-containing compounds.

These types of coatings can then be applied at high application rates to provide long-term durability and excellent fire resistance to new roofing systems or as a restoration to the surface of in-place roofing systems. Even at high application rates of 20.3 l/m^2 (5 gallons per square), these materials are resistant to rain after two hours at 21°C (70°F) and 50 percent relative humidity.

These coatings also have good physical properties with a typical tensile of 1034 kPa (150 psi), elongation of 200 percent and low temperature flexibility of below -26°C (-15°F). The resistance to dirt pick-up of these coatings is good.

Reflective Asphalt Roof Coatings

Reflective asphalt roof coatings have good reflectivity, but with the desire to extend the life expectancy of the roofing system and knowing that increased reflectance will accomplish this, efforts aimed at increasing the reflectivity of these coatings is currently in progress. Polymer modified solvent-borne aluminum-pigmented asphalt roof coatings have been on the market for a few years. These systems have good elongation and adhesion to polymer modified materials. The polymer modification results in lower water vapor transmission rates, increasing the dampproofing capability of the coating.

Polymer Modified Asphalt Solvent-Borne Coatings

Advances are ongoing in the field of polymer research. Roof coating manufacturers are building on this research to advance the polymer modified coatings. An important part of this research is directed toward incorporating non-solvent or VOC exempt solvent extenders for polymer solvent-borne asphalt roof coatings. Non-solvent extenders, such as aliphatic oils, liquid resins and liquid polymers, will allow the coatings to cure faster in all types of weather as compared to VOC exempt solvents. The lower solvent in the polymer modified asphalt roof coatings and adhesives will also allow the products to be used with polymer modified roofing membranes and shingles without the issue of blister formation.

Polymer Modified Asphalt Emulsions

Polymer modification of asphalt emulsions also results in products with enhanced physical properties. Asphalt emulsions are known for their slow coalescence or cure as well as only fair resistance to standing water. The slow cure process is related to the solids content of the emulsion and the resistance to water is related to the particular emulsifier/stabilization system used. Polymer modification can improve both of these properties significantly. In addition, properly formulated polymer modified asphalt emulsions exhibit improved resistance to water vapor with perm ratings close to that of solvent-borne asphalt materials.

Typically, the emulsion is modified using an acrylic, neoprene or other latex emulsions. The asphalt may also be modified with SBS, SBR or butyl before emulsification and then the polymer modified asphalt is put through the emulsification process. The resulting emulsion is generally in the 50 to 60 percent solids range. Polymer modified asphalt emulsions handle similarly to the traditional emulsions and may be applied using spray, brush, squeegee or trowel. Typical physical properties of polymer modified emulsion products are found in Table 1.

In addition to clay and polymers, asphalt emulsions often contain fibers to meet certain specifications. ASTM D 1227, Standard Specification for Emulsified Asphalt Used as a Protective Coating for Roofing, requires the use of fibers for certain classes of emulsions. Other fillers such as calcium carbonate, mica or talc can also be used in addition to cellulosic

Property	Test Method ASTM	SBS Modified Emulsion	Solvent-Borne SEBS/SBS Modified	Single-Part Moisture Cure Solvent-Free Urethane	Solvent-Borne Two-Part Urethane
Tensile Strength, kPa (psi)	D 412	552 (80)	2758 (400)	3792 (550)	3585 (520)
Elongation, percent	D 412	300	650	1100	375
Water Vapor Permeability, Metric Perms	E 96	0.3	0.2	0.3	0.3
Drying Time, hours	D 2939	4	6	N/A	N/A
Cure Time, hours	N/A	N/A	2	4	
Solids, percent	D 2939	55	70	100	80
VOC, g/l	D 3960	N/A	300	<20	250

Table 1. Typical physical property comparisons of asphalt-containing materials.

and other thixotropic materials to enhance the body of the emulsion.

Recent developments have focused on solutions to the drawbacks of asphalt emulsions: the amount of water used to form the emulsion, the resultant cure time, and the freeze/thaw stability of these water borne materials. These developments have been made possible by the application of an existing emulsifier/stabilizer technology to asphalt containing products. This new class of emulsifiers are derivatives of acrylic acid polymers that have been commonly used in waterborne cosmetic products for years. These materials have resulted in stable roof coating asphalt emulsions produced at approximately 70 percent solids as compared to 55 or 60 percent for conventional emulsions. This results in an emulsion that is resistant to rain two hours after application at 21°C (70°F) and 50 percent relative humidity at application rates of 20.3 l/10 m^2 (5 gallons per square).

A second unique property of these newly developed asphalt emulsions is the ability to resist more than fifty freeze/thaw cycles in the container before application with no affect on the emulsion. These high solids emulsions can be formulated using polymers, as well, leading to all of the desirable properties imparted by polymer modification mentioned previously along with the higher solids and shorter drying time.

CONCLUSION

As we approach the 21st century, there is increased interest in sustainable roofing systems and the complete building envelope. Roof coating systems have traditionally been used to maintain and extend the useful life of existing roof systems. As this paper has shown, there is a significant amount of development being invested in these products to ensure that coatings will not only maintain their position, but will become more prominent in the roofing market. These cold-applied materials are in increasing demand for use in new roofing systems as well.

Excellent performance has always been important to roof coatings. These products can provide a monolithic surfacing over the membrane, with no exposed seams. The solvent or chemical cure results in a system that has excellent adhesion to the roofing substrate. There are many roof coating and adhesive products that are an integral part of a UL-listed or FM-approved roofing system when used in combination with other UL or FM components. Programs are underway at FM to establish further wind, hail and fire resistance ratings for cold-applied built-up roofing. These ratings will provide a foundation upon which cold-applied BUR can grow in the 21st century. While the existing cold-applied roofing products will continue to have an important place in the roofing industry, the 21st century will see improvements in these products and new technologies applied to roofing materials that will provide new levels of performance in cold applied coatings, mastics and adhesives.

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