From the NRCA/NBS PROCEEDINGS OF THE SYMPOSIUM ON ROOFING TECHNOLOGY, Sept 1977 PAPER NUMBER 26

CLAY TYPE ASPHALT EMULSION BASED REFLECTIVE COATINGS

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ABSTRACT

Regulations on industrial emissions to the atmosphere and increasing shortages of natural gas have accelerated a shift in the coatings industry from normal, organic solvent systems to waterborne coatings. Spurred by the increasing interest in water-based coatings for the roofing industry, studies were conducted at Imperial Coatings' research lab which developed the first emulsion-based colored aluminum roof coatings in 1975. Due to their superior sun-reflectance, color assortment and water base, the coatings save energy during their service lives, and spare the environment during their manufacture.

This paper outlines a roofing system featuring nonflammable water based products. A typical built-up roof system would consist of an 18-pound fiberglass base sheet nailed to the substrate, two layers of cementing compound, two layers of 35-pound fiberglass felt, a coat of clay type emulsified asphalt reinforced with 1½-inch fiberglass strands, and a top coat of heat-reflective emulsion based aluminum coating. Asphalt emulsions are nonflammable, nontoxic, and film curing is moderately fast, creating a reinforced ductile film, resistant to flow under heat.

The need for avoiding solvent based aluminum coatings can not be overemphasized. Local air pollution control boards, such as in Los Angeles County, impose regulations regarding solvent emission and composition which limit "exempt solvents" that can be used in formulating coatings. These solvents affect quality of the products. Tests conducted on emulsion based aluminum coatings indicated heat reflectivity up to 63%. Colored emulsion based aluminum coatings showed relectivity of the order of 42%. At present, 45,000,000 sq. ft. of roof surface have been successfully coated with these products.

"Little by little we subtract Faith and Fallacy from Fact,
The Illusory from the True, and starve upon the residue."
– Samuel Hoffenstein

INTRODUCTION

The use of solvent-based aluminum coatings in the roofing industry goes back many years. The asphalt used in these coatings is largely of relatively high softening points in the range of 170°F.to 200°F. A higher degree of glossiness is derived from the use of a proportion of gilsonite and more aromatic solvents. Leafing of aluminum pigment, i.e. concentrating at the surface of the coating and forming a continuous metallic film, have made these coatings widely accepted in the roofing industry.

Heat-reflective coatings are needed to prevent accelerated photochemical degradation of asphalt-based roofing from solar radiation. Daily cycle of heating and cooling puts thermal stress on asphalt. It loses it plasticity and leads to eventual cracking and flaking. Gravel or mineral granules can protect the roof membrane. However, they eventually wear away or are blown away by wind exposing the vulnerable asphalt surface. A reflective coating prevents oxidation of the asphalt surface and lowers heat build-up and thermal stresses.

COMPARISON – SOLVENT BASED ALUMINUM COATING VS. EMULSION BASED ALUMINUM COATING

Solvent based aluminum coatings have many drawbacks. One of the drawbacks of a fibered asphalt aluminum coating is settling. Mixing this product is a time consuming and messy job. Secondly, it can not be applied to fresh unweathered asphalt coatings or to a damp surface. Thirdly, great precautions have to be taken to prevent moisture from entering the system during manufacturing. And the use of solvent makes the product a fire hazard and expensive.

Asphalt, when dispersed in an aqueous suspension of a collodial clay mineral, forms a system commonly referred to as an asphalt clay emulsion. Emulsion-based aluminum coatings have a thixotropic body which

facilitates thick film application by brush, trowel or spray on surfaces other than horizontal. Their dried films have a static quality that will not allow them to flow even on direct exposure to blow torch. Aluminum paste readily remains in suspension and therefore provides for a nonsettling coating. They can be diluted with water. They can be applied to most clean surfaces, either wet or dry, including green or damp masonry. Hence there are no morning application delays waiting for a damp roof surface to dry out. They can be immediately applied to the roof prior to the arrival of vehicles which are often subject to overspray. While solvent-based coatings tend to dry from top down, thereby forming a skin that will slow the drying rate, clay emulsions tend to dry from the bottom up, at a faster rate. Being water-based they are economical, safe, non-polluting and non-combustible. They must, however, be protected from freezing in the containers and during the drying period.

MECHANISM OF PIGMENTING ASPHALT EMULSION WITH ALUMINUM PASTE

The art of combining two immiscible liquids has long been used by man in the preparation of small quantities of foodstuffs and ointments. These mixtures resulted when dispersed liquid was stabilized by an emulsifying agent.

Bentonite, a clay of the montmorillonite group, is most widely used for making asphalt clay emulsions. Wyoming bentonite, which has a relatively high ratio of sodium to calcium ions in its structure, has an exceptional ability to hydrate and swell. When fully hydrated it swells 15 to 25 times its dry bulk, the wet particle size being approximately 0.5 micron. Due to its unique combination of properties such as swelling, fine particle size, gelling, ion exchange, uniformity of composition and low cost, it has been the ideal clay mineral for forming stable aqueous dispersions of bituminous materials.

Dispersed clay particles carrying a negative charge stabilize asphalt droplets with a surrounding layer of strong repulsive forces to produce an oil in water emulsion. The pH of the aqueous phase is especially important in developing maximum emulsion stability. The optimum pH depends on the particular clay, asphalt source, and the presence of electrolytes and other emulsion additives. Thus optimum pH must be determined experimentally for each particular emulsion system, but generally is in the range of 5 to 7.

Water dispersible aluminum pigments (hydropaste) are used with emulsion systems. When aluminum paste is added to the emulsion it tends to aggregate and separate. Hence dispersing agents are used to suspend aluminum paste in emulsion. Dispersing agents are substances which, when added to suspensions of finely divided solids in liquids cause the disintegration of clumps or aggregates of particles into individual suspended particles, either spontaneously or with the aid of mild mechanical agitation. Such surfactants (e.g. sodium polyphosprates, disodium ethylene diamine tetracetate, sodium citrate) when added to aqueous suspensions of solids such as aluminum pigments, remove these metal ions which are absorbed on the solid surface and replace them with sodium ions. This replacement favors the development of negative surface charges on the particle surfaces, which, in turn, causes repulsion between particles and disintegration of aggregates.

EXPERIMENTS AND DISCUSSION

Typical composition of asphalt-emulsion-based aluminum coating is as follows:

Asphalt (85-100 pen)	27-29%
Clay	3-4%
Water	48-50%
Aluminum Paste	18-20%

The metal content of hydropaste is typically 69%. For comparison, composition of a typical solvent type asphalt-aluminum coating is as follows:

Asphalt (10-20 pen)	17-30%
Solvent	42-58%
Aluminum Paste (65 to 75% solids)	25-28%

Thus a smaller amount of aluminum paste is needed to achieve a higher reflectivity.

Colored reflective coatings are made by pigmenting emulsion-based aluminum coating. These coatings were applied to both granulated roofing shingles and smooth roofing panels. A thick coating can be applied without sagging. Dried and sprayed, the samples showed very little difference in total reflectivity depending upon the color. Colored emulsion based aluminum coatings showed reflectivity of the order of 35 to 40%. Aluminum coating without any color showed heat reflectivity up to 63%.

These samples were subjected to Weather-Ometer and Cleveland Humidity Cabinet tests. In Weather-Ometer, test samples were kept for 500 hours. In the Cleveland Humidity Cabinet, the coatings were applied to aluminum panels with the coatings exposed to the cabinet conditions of 100% relative humidity and 100°F.

Aluminum coating appeared to stand the test conditions and remained unaffected. Colors showed a little fading under these severe test conditions. Test panels were also prepared by applying water based aluminum coating to dry asphalt emulsion surface and dry cutback surface. They were subjected to 300 hours of

Weather-Ometer testing. Aluminum coating applied to emulsion surface showed no effect but the one applied to cutback surface showed some signs of bleed-through.

To evaluate the storage stability of these coatings, pressure studies were conducted. Pressure development from hydrogen gas can cause bulging or rupture of the sealed paint container during storage. The aluminum-water reaction can present a safety hazard and result in undesired changes in the optical properties of aluminum pigment. In the pressure test at 125°F ± 5°F, the coating developed pressures of 4 to 6 pounds in two weeks time. The samples were then placed at room temperature for one month. During this period, the amount of pressure developed at room temperature appeared to be less than ½ of a pound or negligible. A new lid was used after each determination and pressures were measured with help of a USG unit, spec. 5495 – 0, C 500, 3½ inches in diameter reading from 30 inches vacuum to 30 pounds pressure.

As these tests indicate, adequately stable asphalt-emulsion based aluminum coating can be obtained when stored under less extreme storage conditions. For commercial use, a relief valve should be provided on the container to insure a longer shelf life.

COLD-PROCESS ROOFING SYSTEM WITH REFLECTIVE COATING

The cold-process system described here is finding its greatest acceptance as an alternative to conventional hot applied roofing. The system is bituminous, and the term "cold process" refers to the fact that the adhesive is applied at ambient temperatures rather than in the molten or "hot" condition.

DESCRIPTION

The roofing system is for wood substrates. It comprises an 18-pound fiberglass base sheet nailed to the substrate, two layers of adhesive, two layers of 35-pound fiberglass felt, a coat of clay-type emulsified asphalt reinforced with special 1½-inch fiberglass strands and a heat-reflective top coat of emulsion based aluminum coating.

Interply adhesive is an air-blown asphalt cutback with small quantity of asbestos fibers. Viscosity is an important characteristic of the adhesive. The adhesive is normally spray applied, and viscosity must be high enough to permit application of adequate thickness in hot weather, and low enough to be pumpable in cold weather.

Figure 1 is a cross sectional schematic showing this built-up roof system.

INSTALLATION

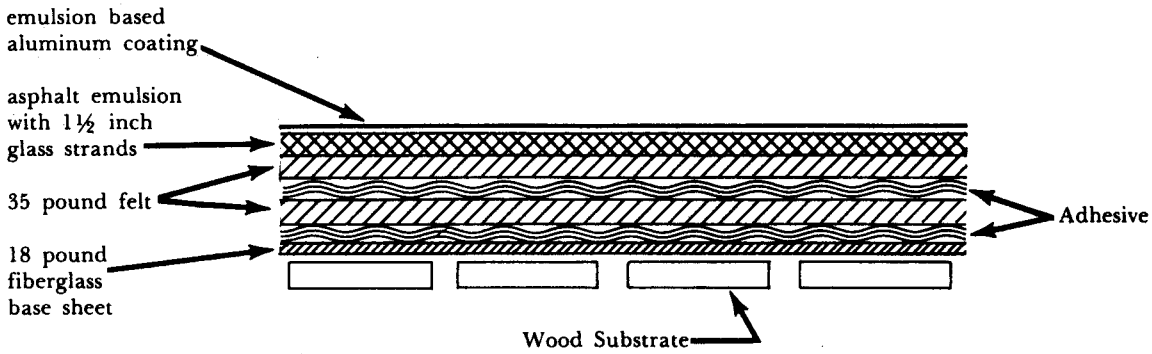
The substrate must be free of all foreign materials and consist of 1 by 8 inch lumber, spaced 1/4 inch apart, or minimum ½ inch-thick plywood. An 18-pound fiberglass base sheet is nailed to the substrate and adhesive is applied at the rate of 2 to 2-1/4 gallons per square. Into this is set a layer of the 35 pound per square fiberglass felt. A second layer of adhesive and fiberglass felt is applied in the same manner as the first layer. A coat of clay type asphalt emulsion is applied at 12 gallons per square with 3 pounds per square of 1½ inch fiberglass strands using a special three-headed gun. (See Figure 2.)

Since asphalt emulsion is water-based, temperatures must be above 35°F at time of application and it should be protected from rain for the next 24 to 48 hours. After it dries, a top coat of emulsion-based aluminum coating is applied at the rate of two-thirds to one gallon per square. Since this reflective coating is emulsion based, the same precautions are necessary as for that of emulsion.

Contractor acceptance of this overall system has been excellent, for it offers these advantages: 1) an equipment system that improves labor productivity, 2) ease of application, and 3) completion of a job in one trip instead of the two separate jobsite trips required for a solvent-based aluminum coating job. A completed job using the above roofing system is shown in Figure 3.

ACKNOWLEDGEMENT

The author acknowledges the use of Alcoa's testing lab where Weather-Ometer tests and pressure studies were conducted.



COMPONENT WEIGHTS, LBS./SQUARE				
Membrane	Adhesive	Emulsion	Glass Strands	Reflective Coating
				8
		101	3	
35				
	16			
35				
	16			
18				
88	32	101	3	8

Total - 232 lbs. per 100 square feet.

FIGURE 1

FIGURE 2 - APPLYING THE GLAS-SHIELD SYSTEM OVER THE PREPARED SURFACES.

FIGURE 3