COLD APPLIED ASPHALT COATINGS

W. J. Dickson

Cold applied asphaltic coatings should not be considered only as a convenient way of applying a coating that would otherwise have to be melted, for they often can be formulated to do a job completely impractical or even impossible with a hot-melt coating.

The two methods for modifying asphalt so that it may be applied cold are similar to those used by the paint industry to apply various resinous coatings. They may be dissolved in a solvent or made into an aqueous emulsion. A long line of useful products is produced by both methods, with each type having its own distinct characteristics and uses.

The Cutbacks

Solvent-base coatings, or "cutbacks," so-called because they are cut back or diluted with solvent, are made by the simple expedient of dissolving the asphalt base in a compatible solvent, usually of petroleum origin, until a usable consistency is obtained. The resulting solution, when applied as a coating, dries as a lacquer by loss of solvent alone. Drying rate may be controlled over a wide range by selection of solvents of varying evaporation rates. Two considerations that must always be borne in mind are that the diluting medium must have adequate solvent power and that its flash point must stay at a safe level. In the case of the former, poor viscosity stability and poor film integrity can result from an ill-chosen solvent system. As for the latter, the inherent flammability of any solvent-base coating must be kept in mind at all times, both from the point of view of safety and of shipping regulations. It must be remembered that the same volatility that speeds drying also lowers the flash point. In special instances, cutbacks can be made nonflammable in the wet state, usually by use of chlorinated solvents, but these can have their own problems. They are more expensive and must be chosen with great care owing to potential toxicity.

Because of their low surface tension, asphalt cutbacks have excellent wetting and penetrating power and, for this reason, are often used as primers for hot applied asphalts, as well as for the filled mastics of the types that will be described later. Without fillers or modifiers, cutbacks have limited use where exposed to the ravages of weather. Some of the earliest modifiers were various resins and drying oils, of which literally hundreds have been used to produce an assortment of bituminous lacquers and varnishes.

If it is desirable to obtain greater "build" of a coating, whether this be for greater weatherability, better vapor barrier characteristics, higher strength, improved abrasion resistance or for other reasons, the use of mineral fillers becomes highly important. The properties generally sought in the filled coatings are:

—resistance to flow or deformation under any temperature or climatic condition likely to be encountered
—resistance to mechanical abrasion and attrition, while maintaining strong adhesion to the substrate
—strong cohesive properties, affording internal strength
—maximum weather resistance, a property often associated with a choice of fillers having maximum opacity to actinic rays

Not all fillers can fill the above requirements. Fillers that are excessively hygroscopic, have too high oil absorption, are vulnerable to chemical vapors, or are transparent to actinic rays can cause early failure of a coating. This last property is important since all asphalts are subject to photo-oxidation. This is largely why asphalt shingle roofs are so durable, with the opaque roofing granules throwing up a protective shield for the asphalt coating beneath. A novel method, in fact, for adding to the durability of an asphalt cutback coating has been the spraying of roofing granules onto the still wet mastic so that they are permanently imbedded when the coating has dried.

Asbestos fibers are one of the many widely used fillers. Others are slate flour, rock dust, limestone, clays, ground slag, diatomaceous earth, silica, cork, vermiculite, mica, cotton and wool fibers, along with countless others. A happy aspect of the use of fillers is that while they can greatly improve the product, they often lower the cost, since they are usually less costly than the asphalt and solvent that they displace. If maximum vapor barrier characteristics are desired, a minimum of hygroscopic fillers and fibers must be used.

Applications of Cutbacks

The largest single use for asphalt cutbacks is in the construction of pavements, but this is a separate field in itself not intended for the scope of this discussion. Another high-volume use is in the waterproofing and damp-proofing of structures, the difference in the terminologies referring simply to whether the coating is applied below or above ground level. Below ground, where temperature changes are comparatively small and there is no exposure to light and air, the properly designed asphalt coating has few peers. It can normally be expected to outlive the structure it is designed to protect. Where used above ground for damp-proofing, the coating is intended to prevent the inroads of dampness and moisture on masonry surfaces.

Heavily filled asphalts of brush, spray, and trowel grades are used as industrial coatings and give many years of service. A weathered surface can be resurfaced readily with a cutback-type coating, which will form an excellent bond to the old coating. It was said earlier that asphalt is seldom decorative. One of the few exceptions is asphalt aluminum paint, in which a leafing grade of aluminum powder is added to an asphalt cutback of high fluidity. When it is applied as a paint, the aluminum leafs or floats to the surface to form a metallic coating that is not only attractive but which increases the life of the coating several-fold. By use of higher percentages of aluminum, heavy aluminized mastic coatings can be made that have exceptional resistance to weathering. A relatively recent innovation has been the introduction of asphaltic coatings incorporating high loadings of nonleafing aluminum along with colored pigments, to produce bright metallic pastel coatings of exceptional durability, that show no visual evidence of their humble parentage. These attractive colors may well be asphalt's finest hour, esthetically speaking.

Another limited, but less spectacular variation from asphalt's black color has been the incorporation of certain red oxide pigments to produce various shades of red and brown. For the best results, an asphalt should be selected that has a brown, rather than a black cast when examined in thin films by transmitted light.

Sound-deadening coatings make use of the viscoelastic properties of asphalt. These materials find volume use not only in the automotive industry, but for metal cabinets, office furniture, bathtubs, air conditioning equipment, household metal furniture, and panels where vibration and drumming must be damped. Underbody protective coatings for cars and railroad rolling stocks use not only the waterproofing and adhesive properties of asphalt, but its ability to withstand abrasion and impact as well.

All of us are familiar with the annoyance of "sweating" of cold surfaces in a damp location. A well proved cure for this expensive and annoying malady, is the application of an asphalt mastic filled with either ground cork or vermiculite or both. We are thus given insulating value plus waterproofing in a single material. Looking further into the subject of insulation, it is well known in the industry that a good vapor barrier is essential over low temperature insulation. Without it, condensation, and even ice formation, can seriously reduce the thermal efficiency of an insulation, and even destroy its mechanical integrity. In this respect, solvent-base asphalt coatings have very low moisture permeability and are well known and regarded where this requirement is paramount. This topic will be expanded later.

We have referred several times to the adhesion characteristics of asphalts, so it is only to be expected that we will see them find their way into uses where this property will be put to use. Asphalt finds many uses in hot-melt adhesives and emulsion adhesives as well as in the solvent-based asphalt field. Typical examples of the latter are the asphalt floor tile adhesives used so extensively today. Completely unaffected by dampness or even flooding, they are as durable as the flooring itself.

If coatings of the types discussed above are to protect against the inroads of water, it seems reasonable that any surface water must be removed before the coating can be properly applied. Sometimes it is impractical to produce a bone-dry substrate, so a simple way of circumventing the problem is the incorporation of various water-displacing compounds, such as oil-soluble sulfonates, phosphates, amides, amines, metallic soaps, fatty acids, and the like. The same additives can inhibit rust when the coating is applied over metal.

Asphalt coatings have been outstandingly successful in protecting numerous concrete and wood structures against the destructive action of mineral acids, acid salts, alkalies, and many corrosive chemicals. Concrete, especially, requires such protection, since portland cement is very susceptible to acid of any strength. Another large volume usage of filled asphalt mastic coatings is in protection of metal surfaces of tanks and various structures from corrosive industrial environments. The mastics are available in various grades, with choice depending on method of application and film thickness desired. Primers often are recommended as added protection against penetration of corrosion beneath the edges or at unavoidable breaks in the coating. Asphalt primers or several synthetic-base primers are compatible with most asphalt coatings.

Asphalt is, of course, a flammable hydrocarbon, and coatings deposited by any method will burn. They are difficult to kindle, however, having flash points generally in the order of 500–600° F. The incorporation of fillers appreciably decreases flammability. To carry this further, we can formulate coatings that are made highly fire retardant by several methods, such as blending with various chlorinated resins, usually in combination with antimony trioxide. It is also possible to incorporate a nonflammable solvent system in the composition.

In addition to the virtues listed above for cutback asphaltic coatings, another very significant attribute is their adaptability to application in very thick coatings.

AUTHOR *Whitman J. Dickson is on the staff of the Research Center, The Flintkote Co., Whippany, N. J.*

Where a conventional paint may be reckoned in terms of 2 or 3 mils per coat, it is not uncommon for an asphaltic coating to be applied at a rate 30 or 40 times this amount. This obviously greatly increases the protective qualities of the coatings, while expanding their utility.

Asphalt Emulsions

The other category of cold-applied asphalt coatings is that of the aqueous emulsions. Here we have the same basic situation as that existing with any other emulsion: two immiscible liquids, one dispersed into the other as very minute particles, prevented from coalescing and returning to a separate continuous phase by the presence of an emulsifying agent, sometimes referred to as a stabilizing agent, suspending agent, or dispersing agent. Asphalt emulsions may be divided into two broad categories, the chemical or soap emulsion and the clay emulsions. The former group may in turn be divided into anionic, cationic, and nonionic emulsions.

The chemical emulsions are made possible by the presence of an emulsifying agent that must be compatible with both the water and asphalt phases. Such an emulsion can be pictured as a discrete droplet of asphalt, probably about 4 microns in size, completely surrounded by the external phase, water. The molecules of the dissociated emulsifier would appear as a continuous layer around the asphalt particle, and would be so oriented that their nonpolar or organic portions would face toward the asphalt particle, while their polar portions would orient themselves outward toward the water phase. This heads-and-tails arrangement affords a basis for understanding much about both the manufacture and performance of emulsions. It has been calculated that a 65% solids emulsion of the above particle size contains approximately twenty billion asphalt particles per cubic centimeter, each entirely separate and held "at arm's length" from its neighbors by the interfacial molecular forces.

If the organic portion of the emulsifier, which governs its property as an emulsifying agent, contains a negative charge, it is called anionic. The particles of asphalt will acquire a negative charge and will be attracted toward a positively charged surface. Exactly the reverse is true in a cationic emulsion in which the positively charged asphalt particles are attracted toward a negatively charged surface. A nondissociating emulsifier imparts no particular charge to the asphalt particles, thus forming a nonionic emulsion. These properties are of great importance in the wetting of fillers and aggregates, whether this be in the manufacturing stage or in job-site applications. It is of particular concern where emulsion-type pavements are being laid.

In an asphalt clay emulsion, the same equilibrium of forces between the two immiscible liquids must be maintained, but in this instance a mineral clay acts as the primary emulsifying and stabilizing agent. In general, clay minerals which are wet readily in water, and which will disperse as colloidal particles, will act as effective emulsifiers for asphalt in water. A number of clays, such as kaolinite and attapulgite, are able to do this, but one clay, bentonite, stands alone in its efficiency as an emulsifier. It is a montmorillonite clay of unique crystalline configuration, and is as much as ten times as efficient as other clay emulsifiers.

TABLE I. UNFILLED ASPHALT COATINGS

ASPHALT PRIMER	
Asphalt (20–70 penetration)	35–55%
Solvent	45–65%
COLD-DIP PIPE COATING	
Asphalt (10–30 penetration)	30–50%
Solvent	50–70%
ASPHALT ALUMINUM PAINT	
Asphalt (10–30 penetration)	25–35%
Solvent	40–60%
Aluminum powder	15–25%
Consistency: 100–2000 cps.	
Coating thickness: 2–8 mils	

TABLE II. WEATHER-RESISTANT COATINGS

CUTBACK MASTIC, SPRAY GRADE	
Asphalt (30–50 penetration)	30–50%
Asphalt fiber (and fillers, if used)	10–20%
Solvent	30–60%
Consistency approx. 10,000–40,000 cp.	
Coating Thickness: $^1/_{32}$–$^1/_8$ inch	
CUTBACK MASTIC, TROWEL GRADE	
Asphalt (30–50 penetration)	40–55%
Asbestos fiber (and filler, if used)	15–30%
Solvent	15–45%
Consistency, approx. 50,000–100,000 cps.	
Coating thickness: $^1/_{16}$–$^3/_{16}$ inch	

TABLE III. VARIOUS CUTBACK MASTIC COATINGS

CUTBACK-BASE AUTOMOTIVE AND RAILROAD CAR PROTECTIVE COATING	
Asphalt (15–30 penetration)	30–50%
Asbestos fiber (and filler, if used)	20–30%
Solvent	30–40%
Consistency: spray	
Coating Thickness: $^1/_{16}$–$^1/_8$ inch	
CUTBACK-BASE SOUND DEADENER	
Asphalt (40–60 penetration)	15–25%
Asbestos fiber	5–10%
Fillers	40–50%
Solvent	15–30%
Consistency: spray	
Coating thickness: $^1/_{16}$–$^1/_8$ inch (approx. $^1/_2$ lb./sq. ft.)	
CUTBACK-BASE ANTISWEAT COATING	
Asphalt (10–20 penetration)	30–40%
Asbestos fiber	8–15%
Lightweight filler (cork, vermiculite, etc.)	4–8%
Solvent	35–50%
Consistency: spray	
Coating thickness $^1/_8$–$^1/_4$ inch	

Comparison—Cutbacks and Emulsions

All asphalt emulsions are made by high-shear dispersion of the asphalt in the water phase, in which the emulsifier is already present. This usually has to be at a temperature high enough to fluidize the asphalt, but not so high as to cause the water to boil. These emulsions are quite a breed apart from the solvent or cutback coatings previously discussed. They obviously involve no fire hazard. The usual rules of volatility do not apply, as water is the only volatile present. In general, they will dry faster than a solvent-applied coating of comparable thickness, since the water has no affinity or solvent effect on the asphalt, as is the case with cutbacks. While cutbacks tend to dry from the top down, thereby forming a skin that will slow the drying rate, clay emulsions tend to dry from the bottom up, and will dry to full hardness faster. Chemical emulsions may form a skin, but still will dry rapidly.

The solvent in a cutback coating gives maximum fusing of the asphalt into a dense mass on drying, whereas the disperse nature of the asphalt particles in an emulsion generally produces a coating more permeable to water vapor. Most "breather" coatings are emulsions, though incorporation of certain porous fillers can make a normally tight vapor barrier cutback coating into one that would be classed as a breather. The terms vapor barrier and breather are relative, and somewhat arbitrary, but as a rule of thumb a breather should have a minimum perm rating of approximately 1, while the vapor barrier should have a rating of 0.5 perm or less. Very low temperature applications have an allowable maximum of 0.1 perm. Both have specific uses.

The vapor barrier is designed to block the ingress of water vapor due to the vapor pressure differential that exists on the opposite sides of a coating, such as that on an insulated storage tank operated at a temperature below ambient. The breather is designed to allow the escape, as a vapor, of any moisture trapped between a coating and a surface maintained at a temperature above ambient. The penalty for choosing the wrong coating can be severe in either instance. An inadequate vapor barrier will allow insulation to become waterlogged and less efficient, and if the temperature is low enough, heavy ice buildup can result below and inside the insulation. A coating that won't breathe when it should, on

TABLE IV. TYPICAL ASPHALT EMULSIONS

ANIONIC SOAP EMULSION	
Asphalt (40–200 penetration)	58–70%
Emulsifier (e.g., vinsol or rosin)	1–3%
Water	30–40%
Viscosity range: 100–20,000 cps.	
CLAY EMULSION	
Asphalt (100–200 penetration)	50–60%
Bentonite clay	1.5–3.0%
Water	40–50%
Viscosity: 6000–20,000 cps.	

TABLE V. WATER VAPOR PERMEABILITIES

WET CUP METHOD

Product	*Typical Usage Dry Film Thickness, In.*	*Perms at 77–55° F.*
Oxidized asphalt	1/8	0.01–0.02
Mineral filled asphalt cutbacks	3/32	0.02–0.04
Cork filled asphalt cutbacks	3/16	0.04–0.09
Asphalt clay emulsion	3/32	0.2–0.6
Polyethylene film	0.004	0.16
Plasticized vinyl chloride	0.02	0.29
Polystyrene	0.005	0.7
Waterproof cellulose film	0.002	56

TABLE VI. GENERAL PROPERTIES OF ASPHALT COATINGS

	Asphalt Cutback Coatings	*Asphalt Cutback Mastics*	*Clay Emulsion Coatings*
APPLICATION PROPERTIES			
Spray	Yes	Yes	Yes
Brush	Yes	Limited	Yes
Trowel	No	Yes	Yes
Temperature range, °F.	50–110	50–110	40–110 (lower if winterized)
FIRE RESISTIVE PROPERTIES			
Wet state	Flammable, unless special solvent used	Flammable, unless special solvent used	Nonflammable
Dry coating	Flammable	Static under flame, supports combustion to limited extent	Static under flame, supports combustion to limited extent
PROPERTIES OF DRY COATING			
Oil and grease resistance	Poor	Poor	Poor
Resistance to mild acids	Excellent	Excellent	Excellent
Resistance to mild alkalies	Excellent	Excellent	Excellent
Abrasion resistance	Poor	Good to excel.	Good
Outdoor weathering	Fair	Excellent	Excellent
Flow at 300° F.	Poor	Good to excel.	Excellent

the other hand, is almost sure to blister, lose adhesion, and have its useful life shortened. A property common to both coatings is that they are equally impervious to liquid water, and are able to withstand weather.

Applications of Emulsions

Many of the uses of emulsions parallel those of the cutbacks. They accept fillers readily, but more care must be taken in choice of filler for a given type of emulsion. They have good adhesion to clean surfaces, and the chemical emulsions have wetting characteristics that can approach those of the cutbacks over dry surfaces, and readily surpass them over damp surfaces. Emulsions are used as foundation coatings, sound deadeners, underbody coatings, roof coatings, insulation coatings, masonry coatings, concrete curing agents which prevent excessive surface evaporation as the concrete cures, and they combine with portland cement to produce flooring compositions that exhibit many of the desirable features of both asphalt and concrete. The list is long.

The clay emulsions have a thixotropic body which facilitates thick application on surfaces other than horizontal, and their dried films have a static quality that will not allow them to flow even on direct exposure to flame. The bentonite clay forms a network structure in the coating which gives it outstanding durability. There are coatings of this type which are in excellent condition after over 35 years of outdoor exposure and which may well endure for another 35 years. Strangely, bentonite will not impart this exceptional durability to asphalt when it is incorporated by any other method. Asphalt emulsions are a staple item in many fields, with annual sales of approximately 600 million gallons.

A special class of asphalt protective coating is that of roofing. This may differ from other coating applications for several reasons. For one, the pitch of the roof may vary over a wide range—all the way to dead level—and there will often be layers of water in contact with the coating for prolonged periods. Another is the reversed vapor pressure differential which can exist on a roof in cold weather, causing water vapor to try to get out rather than in.

We have all seen hot-applied built-up roofs under construction, with the smoking melting kettle and the mopping of the several plies of felt in overlapping layers. The same kind of built-up roof can be constructed using only cold-applied coatings such as described above. In general, it is preferred that the two or three plies of saturated felt be laminated with cutbacks rather than emulsions because of the former's better drying and cementing characteristics under these conditions. The top, or weather, coat may be of either the cutback or emulsion type, with preference toward clay emulsions where maximum life is desired. Ten- and 15-year-old roofs bonded by this process are common, with the bond life extended to 20 years when the roof is surfaced with ground slag or gravel.

It should be noted that almost no other construction material today is covered by such a generous bond. It should also be mentioned that a properly applied built-up asphalt roof may double the service life of the bond.

A newcomer, but one which has exceptional promise, is one in which a special gun is used to spray clay emulsion and chopped glass fiber simultaneously through separate nozzles, to lay down a thick glass fiber reinforced monolithic roof in a single application.

A field that has been penetrated moderately by the cold-applied asphalts is that of underground pipe coatings designed to protect the tens of thousands of miles of large-diameter pipelines that transfer natural gas, petroleum, and other products for great distances. The hot-applied coatings still comprise the bulk of present usage, with special machines applying the hot coating and wrapping for mile after mile along the main line. But for field coating of gathering lines, valves, and fittings, cold applied asphalt forms are useful to the system. Cutback mastics are usually used for this purpose.

Both the cutbacks and the emulsions can be applied by the conventional methods of the trade, such as spray, brush, trowel, roller, and so forth, requiring no specialized equipment or training on the part of the applicator. Each type has its uses, each type has its precautions. While the cutbacks are flammable, the emulsions can freeze. The emulsion dries faster than the cutback, but is more vulnerable to unexpected rainfall, and so on. Most of these are routine considerations well known to anyone in the protective coatings trade, and not unique with asphalt. The dried coatings may be dissolved by petroleum or other solvents, but this rarely presents a problem in actual conditions of use.

This has often been called The Space Age, and it has become a symbol of prestige for an industry or a product to become associated with it. The highest distinction comes when a product or a material becomes incorporated as part of some space age flying hardware. I am happy to report that asphalt has made the ranks of this industrial elite. We have learned recently that an asphaltic deadener pad assembly has been specified for vibration damping of certain electronic components of one of our missiles. This use, however, totals only a few ounces of asphalt per missile, so it is apparent that asphalt's future will probably remain earthbound, instead of soaring into outer space. But this should be no hardship, since both past and present experience indicates that as long as Mother Nature continues to furnish this versatile material, man will use it.

REFERENCES

(1) Abraham, Herbert, "Manufactured Products," 6th ed., Vol. III, Van Nostrand New York, 1962.

(2) Barth, E. J., "Asphalt Science and Technology," Gordon and Breach, New York, 1962.

(3) Day, A. J., Herbert, E. C., Renner, Donald, "Bituminous Materials," Vol. II, Arnold J. Hoiberg, ed., Interscience, New York, 1965.

(4) Drukker, J. J., *Ibid.*

(5) The Flintkote Co., "Cold Process Built-Up Roof Specifications," 1965.

(6) Hoiberg, Arnold, ed., "Bituminous Materials," Vol. I, Interscience, New York, 1964.

(7) Mertens, E. W., Borgfeldt, M. J., *Ibid.*, Vol. II.

(8) Tarver, G. W., Alexander, S. H., *Ibid.*

(9) Traxler, R. N., "Asphalt, Its Composition, Properties and Uses," Reinhold, New York, 1961.

(10) Weeks, C. C., "Bituminous Materials," Vol. II, Arnold J. Hoiberg, ed., Interscience, New York, 1965.