Traffic Paints Based on Epoxy Resins

J. M. Klarquist and G. R. Somerville
Shell Chemical Corp., Union, N. J.

The characteristics of good adhesion, chemical resistance, and inherent toughness found in epoxy resin surface coatings are now well known. These same desirable properties can be incorporated readily into traffic marking paints exhibiting excellent durability.

Two general classes of epoxy resin-based traffic paints are discussed: the amine-cured type and the ester type. Field test experience with both types of paint is covered, showing relative advantages of each type.

Included is a brief discussion of solvent-free epoxy resin coatings as a new approach to traffic striping paints. Special equipment and techniques allow efficient application of thick durable marking paints.

• STEADILY mounting costs during the past few years have made the use of traffic marking stripes an increasingly expensive operation. These increased costs together with a growing traffic load on highways have motivated considerable interest in the development of new traffic paints which will provide a substantial improvement in service life. The epoxy resins, by virtue of their physical and chemical properties, are basic raw materials for extremely durable traffic paints.

The basic characteristics of epoxy resins are now well known, and because of their outstanding performance they are widely utilized throughout the paint industry. These resins have become "work horses" in the paint field because they have a remarkable combination of desirable properties. The excellent adhesion, impact and abrasion resistance, flexibility, and good over-all chemical resistance of epoxy resins are unsurpassed by any other single commercially available resin. The characteristics which have made these resins so successful in heavy duty maintenance and industrial coating applications are the same characteristics needed in a durable traffic paint. Laboratory work done by Shell Chemical Corporation and preliminary field tests indicate that these characteristics can be imparted to practical traffic striping paints.

There are actually three separate classes of epoxy paints suitable for traffic striping: polyamine-cured epoxies, epoxy esters, and solvent-free epoxy systems.

POLYAMINE-CURED EPOXY TRAFFIC PAINTS

Although this type of paint appears to dry in the same manner as conventional paints, the actual curing of the film is dependent on a chemical reaction between the curing agent or activator and the epoxy resin base. Under normal conditions, the paint film attains most of its maximum hardness in about 24 hr, but does not reach its ultimate in chemical resistance for 5 to 7 days. By way of comparison, conventional paints of similar drying characteristics require many days or even weeks to reach their maximum hardness, as well as ultimate cure, since they are dependent upon the oxygen in the air rather than a chemical curing agent.

As with all surface coatings, adequate curing and drying are not obtained under all conceivable conditions of temperature and humidity. Amine-cured epoxy resin paints, when properly formulated, can be applied at temperatures down to 40

F; however, at 40 F and below the film will cure very slowly. The cure rate at these low temperatures is, on the other hand, dependent upon the type of curing agent or activator employed. For example, an epoxy resin paint cured with a polyamine and allowed to cure at 35 F was far from being fully cured even after 35 days. The same paint cured with a proprietary curing agent based on a polyamine adduct of an epoxy resin reached its full state of cure in about 30 days.

Although a chemical reaction is involved in curing, paint of this type is manufactured using conventional paint technology and equipment. Thus, these paints are available from many paint suppliers.

Handling and application characteristics of a polyamine-cured epoxy paint are similar to those of the familiar alkyd and varnish-based traffic paints. However, the hardener and epoxy base paint are packaged separately and are mixed just before using. The usable working life of the mixed formulation is approximately one working day. As a result, no more than one day's paint requirements should be mixed at one time. The storage stability of the epoxy base paint is excellent.

TABLE 1

TYPICAL FORMULATION FOR POLYAMINE-CURED EPOXY TRAFFIC PAINT[1]

Base Component	Pounds	Gallons
Pigment		
Titanox RCHTX (or equiv)	73	2.7
Asbestine 3X (or equiv)	179	7.5
Medium chrome yellow	210	4.2
Aluminum stearate	2	0.2
Vehicle		
EPON 1001	453	45.1
Beetle 216	23	2.7
Solvent		
Acetone	143	21.7
Toluene	61	8.4
Curing agent component		
Diethylene triamine	28	3.6
Toluene	28	3.9
	1,200	100.0

Paint constants

Total non-volatile	=79.8 percent (by wt)
Viscosity (after addition of curing agent)	=108 Krebs units
Weight, per gal	=12.0 lb
Reduction	=Catalyzed material can be reduced to desired application viscosity with 70/30 blend of acetone/toluene.

[1] Yellow semigloss.

TABLE 2

TABOR ABRASION RESISTANCE OF TRAFFIC PAINT

Paint System	Loss per 100 Cycles, mg [1]
Amine-cured epoxy traffic paint	9.6
Commercial alkyd traffic paint "A"	19.9
Commercial alkyd traffic paint "B"	23.3

[1] Using CS-10 wheels and 1,000-g load. All paint films tested when 7 days old.

Table 1 gives a starting formulation for a semigloss amine-cured epoxy traffic paint which has shown considerable promise in both laboratory and field tests. The abrasion resistance of this coating versus that of two commercial alkyd-type traffic paints is given in Table 2. The abrasion resistance of the epoxy coating as measured by a Tabor Abrasor is at least twice that of the alkyd paints.

This type of epoxy coating also shows excellent resistance to many of the damaging materials encountered in road service. For example, 10-mil films of this paint were completely unaffected after four months of continuous immersion in the following materials: high detergent motor oil, premium grade gasoline, 20 percent salt brine, a saturated salt slurry, ethylene glycol antifreeze (50 percent in water), and distilled water at 100 F.

In July 1955, duplicate stripes of two polyamine-cured epoxy paints were applied on US 66 near Springfield, Ill. A commercially produced varnish-based traffic paint meeting Illinois Specification M6–54 was used as a control. Conditions and results of this field test are given in Table 3. The total life expectancy of the epoxy paints is much greater than that of the control paint. These experimental epoxy paints would significantly extend repaint intervals in actual field service. Although the price-per-gallon of the epoxy paints used in this test would be somewhat higher than that of alkyd or varnish-type paints, this additional material cost would be more than offset by

TABLE 3

FIELD PERFORMANCE OF AMINE-CURED EPOXY TRAFFIC PAINTS[1]

Stripe No.	Paint System	Time Set-to-Touch (min)	Time Open to Traffic (min)	Trackage	% Paint Remaining After 1 Yr	2 Yr	4 Yr
3	Amine-cured epoxy (flat)	18	30	None	100	75	70
4	Amine-cured epoxy (flat)	18	30	None	100	75	70
5	Amine-cured epoxy (semigloss)	20	30	None	100	85	70
6	Amine-cured epoxy (semigloss)	20	30	None	100	90	75
7	Illinois Spec. M6-54 paint	10	30	None	80	10	10

[1] Applied July 1955 on concrete pavement.
Pavement temperature = 108–117 F.
Dry film thickness = 10±2 mil.
Traffic density = 3,500 to 4,000 vehicles per day in each direction.

savings in labor by virtue of the longer paint interval.

EPOXY ESTER TRAFFIC PAINTS

Epoxy esters are simply paint vehicles produced by cooking epoxy resins with suitable fatty acids. The manufacturing procedure followed is similar to that used in cooking alkyd resins.

Unlike the polyamine-cured epoxy paints, the epoxy ester traffic paints are one-package materials and require no addition of curing agent. In contrast to the two-package activated epoxy paints, they are stable over long periods of time. They dry or harden through polymerization and oxidation of the oil component of the ester. In this respect they are identical to the materials now in common usage as traffic paint vehicles. Like other epoxy vehicles, they show the characteristics of good adhesion and flexibility.

Through proper selection of fatty acids, the paint manufacturer can produce economical epoxy ester paints with fast dry times and good durability. Since speed of dry is a requirement of traffic paints, an epoxy ester may be styrenated to further improve drying rate. Through this technique it is possible to produce paints with open-to-traffic times of 30 min or less.

In one of the western states, styrenated epoxy ester traffic paints have found considerable use over the past six years. In 1953, this state adopted a purchasing policy for traffic line paints which is based on actual field wear tests. Sample paints which qualify under the state highway laboratory tests are then placed on field test on suitable roadways and rated for relative paint life. This performance rating, together with the bid price, is then used to calculate the cost per mile per year for each paint. These paints have been based in whole or major part on styrenated epoxy esters. Table 4 gives relative performance ratings and cost per mile of these epoxy ester paints as compared with the average of all other paints submitted for testing.

TABLE 4

RELATIVE TEST PERFORMANCE AND COST PER MILE OF YELLOW TRAFFIC PAINTS

Paint System	Relative Performance Rating	Calculated Cost/Mile($)
Yellow traffic paint—epoxy ester traffic paints (avg of 9 samples)	5.250	0.477
All other paints (avg of 10 samples)	3.488	0.749
Yellow bead binder traffic paint—epoxy ester traffic paints (average of 9 samples)	4.819	1.215
All other paints (avg of 11 samples)	4.177	1.416

HIGH BUILD SOLVENTLESS EPOXY TRAFFIC PAINTS

Recently, there has been much interest in solventless traffic paints. With a paint system of this type it is possible to obtain very thick, durable films in a single application. Laboratory work indicates that films of up to 30-mil thickness are possible. Such a paint would be of interest in those areas where extremely heavy duty service is required. Since no solvents are involved, asphalt bleeding problems would be eliminated. The fire hazard associated with the storage and handling of conventional paints would also be minimized.

The most promising solvent-free traffic paints are obtained by curing liquid epoxy resins with polyamines or polyamide resins. Unfortunately, epoxy systems of this type have very short pot lives, usually less than 1 hr. Specialized spray application equipment must be used to overcome this problem. Ideally, the application equipment must accurately meter and mix proper quantities of hardener and epoxy base just before spraying. There should also be provision for automatic self-cleaning or purging after shut-down to prevent internal fouling of the equipment. Several firms are now working on the development of such application equipment. Examples of special application equipment are the Gusco Process Equipment manufactured by A. Gusmer, Incorporated, and the E–2 Applicator Machine manufactured by Hodges Chemicals Company.

A solventless epoxy striping paint was included in the Springfield, Ill., field test. Two test stripes (10 ± 2 mil) were applied and periodically rated for wear. After two years exposure, one stripe was still 100 percent intact, while the other was 95 percent intact. After four years, these stripes were 90 percent and 80 percent intact, respectively.

Although solventless epoxies show considerable promise, two basic problems must be overcome: rather long drying times and the need for rugged, fool-proof application equipment. Paints developed in the laboratory to date have open-to-traffic times in excess of two hours.

The choice of curing agent can have a profound effect on the rate of cure of an epoxy paint as well as on the performance of the paint. There is a continuous program under way in the Shell Research Laboratories in which new curing agents are being prepared and evaluated. It is hoped that a new curing agent will be forthcoming which will provide faster cures without sacrificing durability.

From the application standpoint, several equipment manufacturers are currently working on equipment which may prove suitable for handling these unique paint systems. One approach to the problem of obtaining faster cure is to heat the material briefly with a high temperature flame immediately after it is applied to the road surface. This will be a continuous process, enabling the paint to be applied at satisfactory rates, and it should provide a drying time that will allow the road to be opened to traffic in a reasonable length of time.

CONCLUSION

The steady increase in highway traffic load is putting heavy demands on the performance of highway paints and devices. The excellent durability imparted to traffic paints by epoxy resins offers a sound approach to this problem.