AROCLOR®

...key to lower-cost, fire-resistant, job-tailored epoxies!

Formulators and users alike have alternately sung lyrical praises and growled over the fast-setting, tight-bonding, rock-hard epoxies. Chief reasons for the praise have been the resins' fantastic impact strength, their chemical resistance, their versatility of application—from the making of plastic metal-stamping dies to tank linings and body solders. The growls stem from their cost, from 60 to 70 cents a pound, and because the resins burn lustily—a distinct drawback in certain applications, such as laminates for electrical uses. Flameproofing curing agents and resins runs the cost still higher. But now a series of property-modifying, low-cost chlorinated polyphenyls has come forward to make epoxy resin formulations both fire-resistant and significantly cheaper by the pound.



In these flame tests, one epoxy strip ignites and burns rapidly; the other, containing Aroclor, won't ignite at all.

The several hundred specialty formulators of epoxy resins (as well as the seven basic manufacturers) have uncovered a way to "job tailor" epoxies. The method is simplicity itself: just mechanical mixing into the formulation of the right amount of a selected chlorinated polyphenyl. The chlorinated polyphenyls, supplied by Monsanto under the registered trademark Aroclor, "adjust" the uncured epoxy formulations' viscosity, and the cured resins' hardness and flexibility. Most important—the addition of an Aroclor makes the epoxy formulation cheaper per pound and fire-resistant.

The Aroclor compounds, it proves out, are one of the very few materials *compatible* with epoxies. And, happily, they come as a series of some dozen liquids and solids that range from water-white mobile "oils" and clear, viscous resins to bright, pale-yellow solids resembling a good-color rosin. Chemically, the materials are progressively chlorinated di- and polyphenyls—each containing a definite percent-by-weight of inert, tightly bound chlorine.

The Aroclor compounds are some of the most *inert*, chemically stable compounds in industry. They are impervious to heat, acids, alkalis, and they are among the most ignition-resistant compounds commercially available. Most important, they are cheap—in the carload range of 16 to 19 cents per pound. When added to epoxy formulations, the liquid Aroclor compounds function as low-cost plasticizers; the solids, as reinforcing resins. Since the mobile "oil-y" forms can be mixed in any proportion with the viscous and solid resin forms, the Aroclor compounds give the epoxy formulator a perfectly gradated viscosity range of "diluent" that can plasticize or reinforce, that cuts costs, and imparts fire resistance.

With epoxy usage now in the 60-70 million pounds per year range, it is estimated that formulators supplying ready-to-use resins for about one third of the applications can significantly improve their offerings (and lower materials costs) with the use of this new technique. When used in the range of 15 to 20 parts per hundred, the Aroclor compounds greatly retard the epoxy's burning rate, and proper selection of the Aroclor compounds can impart variously: improved flow, better flexibility after curing, and better flexural and compressive yield strengths.

Since five of approximately a dozen Aroclor compounds provide a five-step variance in viscosity—ranging from almost water-like liquids to solid resins with a softening point of about 300° F.—the range of modification possible for any particular epoxy formulation is enormous. For example, solid Aroclor 5460 used in the amount of 15 PHR (plus 5 PHR of antimony oxide) acts as a reinforcing resin and produces a nonburning composition. The cured resin compares in "strengths" to an identical control without Aroclor and antimony oxide as follows:

	Control	15 PHR Aroclor 5460; 5 PHR antimony oxide
Flex Strength.....	16,900 psi	19,000 psi
Tensile.....	11,000 psi	10,200 psi
Compressive Ultimate Strength	23,400 psi	40,700 psi
Hardness (Rockwell "M")	111	111
Heat-Distortion Temp., °C.....	143	135
Burning Rate (ASTM 635-56T)....	.6 in./min.	nonburning

The low-molecular-weight liquid Aroclor compounds show a definite plasticizing effect. With liquid Aroclor additions, the heat-distortion temperature is somewhat lowered; the solids, on the other hand, show little significant effect on the heat-distortion temperature.

Depending upon the ultimate use of the epoxy formulation, producers will have to work out their own recipes. Hundreds of modifications are possible with "amine"-type cures and also with a "phthalic anhydride" cure. The nonburning benefit of adding Aroclor and antimony oxide should prove particularly valuable in laminates for printed circuits and other electrical uses. The modification of handling properties, the reinforcing effect, and the maintenance of excellent chemical resistance should have application in adhesives, surface coatings, encapsulation compounds, plastic stamping dies, and body solders. And the cost savings can hardly fail to catch the interest of all epoxy formulators.

For further information on developing lower-cost nonburning epoxy formulations, request a copy of Specialty Data Report CS-14: "AROCLOR, Fire-Retarding Plasticizers and Modifiers for Epoxy Resins." Address your request to Monsanto Chemical Company, Organic Chemicals Division, Department 4430Y, St. Louis 66, Mo.

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