RESUME OF

"CHLORINATED DIPHENYL AS A RAW MATERIAL IN THE LACQUER AND VARNISH INDUSTRY"

By: H.W.Bowron, B.Sc., A.I.C.

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Among the outstanding developments of the paint industry, and one which has occurred well within the last decade, is the manufacture of the chlorinated diphenyls. These include a series of materials ranging from colorless oils to pale amber-colored solid, and serve both as resins and plasticizers. Their properties combine the neutrality and stability of hydrocarbons with the reduced flammability of halogen compounds; they are non-drying, resistant to the action of water, chemicals, and fire, non-corrosive toward metals, and soluble in the majority of solvents and media used in lacquer and varnish manufacture.

Two series of proprietary products are commercially available: the Aroclors of Monsanto and the Clophens of I.G. Farbenindustrie A.G.

Chlorinated diphenyls were first prepared in 1917 by Meyer and Hofmann by pyrolytic condensation of chlorbenzenes and later from benzidine by chlorination of the diacetyl compound or by Sandmeyer reactions with the tetrazotized derivative. Commercial development, however, did not begin until the production of diphenyl was made an industrial process by the Federal Phosphorus Company in 1929. Within a year, this company had worked out a process for the commercial production of a wide range of the chlorinated compounds.

Diphenyl is produced by polymerizing benzene at 850°C. and fractionating from the complex diaryls also formed. This is then chlorinated with iron as iodine catalyst, regulating the temperature by heating or cooling as necessary. Since the higher chlordiphenyls tend to be crystalline, predetermined amounts of the complex diaryls are usually mixed with the diphenyl and chlorinated at the same time. These tend to prevent crystallization and stabilize the resinous form. Much of the credit for these developments is due Dr.R.L.Jenkins.

The Aroclors have found wide application in paint and varnish technology. They are compatible with a wide variety of paint components such as drying oils, cellulose esters, cellulose ethers, resins, etc.

Gardner, in 1930, proposed to fuse Aroclors containing 40 - 60% chlorine with alkyd or rosin ester resins to obtain modified resins which could be dissolved in tung oil, thinned with turpentine and

applied as quick-drying or baking varnishes. He also prepared a resin, compatible with nitrocellulose and lacquer solvents, by fusing 25 parts Aroclor, 25 parts ester gum, and 75 parts toluene sulfonamide-formaldehyde resin (Santolite). He further proposed the use of Aroclor in linoleum compositions, along with oxidized linseed oil and ground cork, to confer increased alkali-resistance and adhesiveness.

The powerful adhesion exhibited by the Aroclors makes them particularly suited for priming coats and for lacquers and varnishes intended for metal, glass and other smooth surfaces.

Aroclors have proven very satisfactory as resins and plasticizers for chlorinated rubber base paints and primers where water-resistance, corrosion-resistance and adhesion are required. They have also been used in protective coatings based on rubber itself.

By combining Aroclors containing considerable amounts of chlorinated diphenyl benzenes (boiling above 270°C.) with linseed or tung oil, adding drier and thinner and pigmenting with zinc oxide or white lead, quick-drying house paints are obtained which are hard and resistant to water, acid, alkali and other chemicals. Superior spar varnishes may be similarly produced. Fire-resistant paints may be obtained by using a relatively high proportion of these Aroclors to the oils.

Satisfactory coatings may also be prepared from Aroclors dissolved in suitable solvents along with other synthetic resins, no oils being used.

The proportions which make the Aroclors particularly valuable for cellulose lacquers and plastics are extremely slight volatility, which insures preservation of film flexibility, moisture-resistance, heat and fire-resistance, theremo-plasticity, resistance to acids and alkalies, and high dielectric strength. Benzyl cellulose is particularly improved by the inclusion of Aroclors.

Aroclors may be used in cellulose acetate compositions either alone or in combination with other plasticizers, as for example, the Santicizers.

In nitrocellulose compositions, the Aroclors may be used alone or in combination with other plasticizers or resins such as damar, shellac, copal, rosin, ester gum, vinyl acetate, glyptals, rezyls, amberols, etc.

Aroclors containing up to 10% of a wax such as paraffin, Japan wax, beeswax, montan, carnauba, ceresin, ozokerite, etc. may be used as moisture-proof coatings for cellulosic foils, wrappers, etc. and for electrical insulation. Plasticizers, as dibutyl phthalate, may be incorporated to permit an increased wax content.

Finely-divided crystals of the higher chlorinated diphenyls may be used in pigment compositions and are claimed to exhibit good opacity and hiding power.

In the electrical industry the Aroclors are employed in insulating varnishes, transformer oils, and as dielectrics for condensers of increased capacity.

On account of the unreactivity, chlorinated diphenyls have no toxic effect ordinarily, but in the vapor state they have irritant properties and may cause headache.

Aroclors may be fused with many other natural or artificial resins to obtain products with special properties.

Aroclors may be used to increase the thermoplasticity of many other resins.

For fire-proofing by impregnation, the Aroclors are said to be better than ammonium phosphate, though more expensive.

The use of Aroclors as heat transfer media has been proposed and proven on a small scale.

It is concluded that the chlorinated diphenyls deserve full consideration in every branch of the paint industry, from printing inks to water-proof and fire-proof compositions for the protection of building materials, and to ships' paint designed to withstand the rigors of high-speed ocean voyages.

Fifty-seven references to the technical and patent literature are cited.