AROCLOR® PLASTICIZERS

A series of inert, chemically-resistant, fire-retarding plasticizers compatible with wide variety of resins.

PLASTICIZERS Monsanto

Organic Chemicals Division / 800 N. Lindbergh Blvd. / St. Louis, Missouri 63166

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Table of Contents

Properties as Plasticizers

The Aroclor® resins/plasticizers and their blends have an unusual combination of properties which make them extremely useful products. Their most important characteristics are:

Low Cost
Highly Compatible
Chemically Stable
Fire Retardant
Excellent Adhesion

Another very useful aspect of this product line is the fact that a continuous range of properties can be achieved by using combinations of the Aroclors and their blends. Some of the physical properties which can be controlled through product selection are shown on the following pages.

Our Aroclor® product line is now made up of polychlorinated terphenyls, monochlorinated biphenyl, and blends of these products. None of these materials has been shown to create any environmental problems. On the other hand, Food and Drug Administration approval has not been obtained for any of these products. Accordingly, the Aroclor® plasticizers should not be used in connection with food or food-related products, with food wrapping or food container materials. Further, Monsanto strongly recommends that these products not be used in any other application such as non-FDA regulated food systems, in potable water systems, in any animal feeding systems, or in pharmaceuticals.

Key to Nomenclature

5400 Series

These products are chlorinated terphenyls. The last two digits indicate the chlorine content of the material, e.g., Aroclor® 5460 is a chlorinated terphenyl with 60 percent chlorine. Undistilled Aroclors® are available and are designated by a 5000 series vs. the 5400 series. They are somewhat higher in color but otherwise have product characteristics similar to the distilled products.

6000 Series

These products are blends of Aroclor® 5460 and Aroclor® 1221-B, a biodegradable monochlorinated biphenyl. The last two digits are an indication of the proportion of Aroclor® 5460 in the blend, e.g., Aroclor® 6062 has more Aroclor® 5460 in it than does Aroclor® 6050.

Miscellaneous Blends

Other product blends containing such other materials as Santicizer 140 for improved fire retardancy, or toluene/xylene for lower viscosities will also be made available as the demand for these specialty products develops.

AROCLORS

	5432	5442	5460
Adhesion/Tack	———	increasing	——→
Hardness	———	increasing	——→
Flexibility	———	decreasing	——→
Fire Retardance	———	increasing	——→
Volatility	———	decreasing	——→
Chlorine Content	———	increasing	——→
Viscosity	———	increasing	——→
Density	———	increasing	——→
Permanence	———	increasing	——→
Compatibility	———	decreasing	——→

AROCLOR BLENDS

	6040	6050	6062	6070	6090
Adhesion/Tack	←		increasing		→
Hardness	←		increasing		→
Flexibility	←		decreasing		→
Fire Retardance	←		increasing		→
Volatility	←		decreasing		→
Chlorine Content	←		increasing		→
Viscosity	←		increasing		→
Density	←		increasing		→
Permanence	←		increasing		→
Compatibility	←		decreasing		→

Applications by Product

Listed below are some of the applications where these products can be used:

Aroclor Blends

6040 Polyvinyl Acetate Emulsion Adhesives

SBR Adhesives

Miscellaneous applications where a high degree of flexibility is required.

6050 Chlorinated Rubber and other Resin systems for Coatings.

Inks

6062 Polysulfide Sealants/Adhesives

Chlorinated Rubber Coatings and Adhesives

SBR Coatings and Adhesives

Miscellaneous applications where high chlorine content, high tack, are required.

Inks

6070 Polysulfide Adhesives

Chlorinated Rubber Adhesives

Miscellaneous applications where very high chlorine content and very high tack are required.

6090 Radiation Curing Applications

Aroclors

5432	Polysulfide Sealants/Adhesives
	Chlorinated Rubber Coatings and Adhesives
	SBR Coatings and Adhesives
5442	Surface Coatings
5460	Hot Melt Adhesives, Surface Coatings

AROCLOR MARKETS

Aroclor Applications	Polymers and/or Binders	Aroclor Recommended
Adhesives		
Delayed Tack	SBR, PVAc, PS	6090, 5460
Emulsion	PVAc, SBR, Acrylic-VAc, Acrylic-ethylene	1221-B, 6040, 6050
Pressure Sensitive	Natural Rubber, SBR, Cl Rubber	1221-B, 6062, 5460
Hot Melt	EVAc, PVB, Phenoxies, Polyamides	5460, 5465, 5060, Montar 5
Sealants	Polysulfide, Nitrile Epoxy, Polyurethane	5460/S-261, HB-40, 6070, 5432
Caulking Compounds	Acrylics	5460, 6070
Surface Coatings		
Paints	PVAc, PVC, Nitriles, Styrene, Acrylics	5460, 6062, 6070
Lacquers	Alkyd, Cl Rubber	5460, 6062, 6070, 6090

AROCLOR MARKETS (Continued)

Aroclor Applications	Polymers and/or Binders	Aroclor Recommended
Surface Coatings (Continued)		
Varnish	Polysulfide	6070
Paper Coatings	Ethyl Cellulose	6040, 6050
Printing Inks	Nitrocellulose, Acrylic	5460, 6070, 6062, 6090
Miscellaneous		
Lost Wax Casting	Wax	5442, 5460, 5465
Impregnating Phenolic Resistors	Resinox, PVC	5460, 6062
Laminating Resins	Phenolic	5460, 6070
Epoxy Resins	Epoxy	6062, 6070

DELAYED TACK ADHESIVES

Total Market for Plasticizers: 3-4 Million Pounds/Year

Typical Formulations:

Component	Parts by Weight
1. Diphenyl Phthalate	60.6
Cumar W 12	15.1
Lustrex 15	24.3
2. Vinsol Resin	50.0
Santicizer 1-H	50.0
Acrysol M. R.	10.0
Thinned amine dispersant	250.0
Thinned amine dispersant	
Steric Acid	1
Poly-pale Resin	1
2-amino-2-methyl-1-propanol	1
Water	3

Properties Desired:

1. Activation at specific temperature.
2. Remains tacky for specific time period.
3. Remains bonded over wide temperature range.

Current Recommendations:

1. Dicyclohexyl Phthalate - DCHP
2. Diphenyl Phthalate
3. Santicizer 1-H
4. Aroclor 5460
5. Aroclor 6090

EMULSION ADHESIVES

Total Market for Plasticizers: 35-40 Million Pounds/Year

Typical Formulations:

Gelva S-55	90	Gelva TS-65	90
Santicizer 218-A	10	Santicizer 885	10
	100		100
Gelva S-77	90	Gelva TS-100	90
Aroclor 1221-B	10	Aroclor 6040	10
	100		100
Aircoflex 400	95	Gelva TS-100	65
Aroclor 6050	5	Aroclor 1221	10
	100	Staybelite Ester 10	15
		Butyl Acetate	10
		Santomerse SX	0.1
			100.1

Properties Desired:

1. Controlled wet tack: in most cases, the shorter the wet tack time before the adhesive grabs, the better.

2. Open time of at least one minute: open time is the time during which two adhered substrates can be adjusted after making contact.

3. Physical properties of adhesive film: the cohesive strength of the adhesive must be strong enough to hold the substrates together.

EMULSION ADHESIVES (Continued)

4. Relatively high heat delamination temperature: this depends on the film forming polymers, the type and amount of plasticizer.

5. Good resistance to water: prolonged immersion in water causes loss of adhesion by most emulsion adhesives at elevated temperatures.

PRESSURE SENSITIVE ADHESIVES

Total Market for Plasticizers: 30 Million Pounds/Year

Typical Formulations:

Component	Parts by Weight
1. Calendered into Fabric	
Cellulose Acetate	1
Santicizer 8	3
Santolite MHP	2
2. Hot Melt Type	
Crepe Rubber	15
Polyisobutylene	15
Ester Gum	20
Santolite MHP	20
Aroclor 6070	30
Wax	10

Properties Desired:

1. Low volatility
2. Good heat stability
3. High flow/spreadability at elevated temperatures
4. Good moisture resistance
5. Broad use temperature range

PRESSURE SENSITIVE ADHESIVES (Continued)

Current Recommendations:

1. Santicizer 160
2. Santicizer 148
3. Aroclor 5460, 6040, 6070
4. Santclite MHP

HOT MELT ADHESIVES

Total Market for Plastifier/Tackifier: 30-40 Million Pounds/Year

Typical Formulations:

Component	Parts by Weight
1. Basic Formula	
EVAc	30
Aroclor 5460	40
Microcrystalline Wax	30
2. Alkali Dispersable Bookbinding Adhesive	
PVAc	40
Santicizer 160	8
Aroclor 5432	26
Nevellac Hard	24
Acrowax C	1
Sodium Benzoate	0.75

Properties Desired:

1. Good heat stability
2. Sharp melting point
3. Satisfactory viscosity/temperature relationship
4. Bond flexibility
5. Adhesion

HOT MELT ADHESIVES (Continued)

Current Recommendations:

1. Aroclor 5460, 5465
2. Aroclor 5060, Montar 5
3. Santicizer 160, 141, 148
4. Santicizer 8

POLYSULFIDE SEALANTS

Typical Formulation:

Thiokol LP-2	100
Lead dioxide paste (50% PbO_2, 45% S-160, 5% St. acid)	15
Plasticizer	30
	145

Fillers such as SRF black, MT black, Lithopone, Zinc Sulfide and York Whiting may be included in the 15 to 75 phr range.

Properties Desired:

1. Adhesions
2. Specific Rate of Cure
3. Specific Creep Characteristics
4. Shelf Stability
5. Pot Life

Current Recommendations

1. Santicizer 261
2. HB-40
3. Blends of Aroclor 5460/S-261 (Santicizer 326)
4. Aroclor 5460/S-160
5. Santicizer 148

CHLORINATED RUBBER COATINGS

Typical Formulation:

Parlon S-10	35
Epon 828	1
Epichlorhydrin	0.2
Xylene	100
Plasticizer	25
TiO_2	38.4
Carbon Black	0.4
	200.0

Properties Desired:

1. Water impermeability
2. Chemical resistance
3. Adhesion to substrate
4. Flexibility

Current Recommendations:

1. Aroclor 6062
2. Aroclor 5432
3. Phthalate ester (if not chem. resistance reg.)
4. Aroclor 5460/Santicizer 711 3/1 or 4/1

ACRYLIC LACQUER

Typical Formulation:

Lucite 6011 or 6012	250 (~100 solids)
1/2 sec. cellulose acetate butyrate	0 to 40
Plasticizer	20 to 40

Properties Desired:

1. Good adhesion
2. Superior pigment wetting
3. Resistance to water and dilute alkalis
4. Excellent weatherability
5. Good abrasion resistance
6. Toughness over a broad temperature range
7. Low volatility of the plasticizer

Current Recommendations:

1. Santicizer 261
2. Aroclor 6062
3. Aroclor 5442
4. Santicizer 140
5. Santicizer 160

TYPICAL PHYSICAL PROPERTIES OF AROCLORS AND AROCLOR BLENDS

	AROCLORS				AROCLOR BLENDS				
Property	Aroclor 1221-B	Aroclor 5432	Aroclor 5442	Aroclor 5460	Aroclor 6040	Aroclor 6050	Aroclor 6062	Aroclor 6070	Aroclor 6090
Appearance	Clear, mobile oil	Clear, yellow viscous liquid	Clear, yellow sticky resin	Clear, yellow to amber brittle resin or flakes	Clear, light yellow mobile oil	Clear, light yellow mobile oil	Clear, yellow viscous liquid	Light yellow sticky resin	Light yellow resin
Color, Maximum	100 APHA*	2 NPA* (Molten)	2 NPA* (Molten)	2 NPA* (Molten)	2 NPA*	2 NPA*	2 NPA*	2 NPA*	2 NPA*
Specific Gravity	1.125 - 1.140 (25°/ 15.5° C)	1.280* - 1.300 (90°/ 15.5° C)	1.470 (25°/ 25° C)	1.670 (25°/ 25° C)	1.326* - 1.346 (25°/ 15.5° C)	1.344* - 1.357 (65°/ 15.5° C)	1.407* - 1.427 (65°/ 15.5° C)	1.425* - 1.440 (90°/ 15.5° C)	-
Acidity, Maximum (Mg KOH/Gm)	0.014*	-	.05*	.05*	0.035*	.035*	0.035*	.035*	.035*
Moisture ppm Maximum	-	-	-	-	250*	250*	250*	250*	-
Refractive Index @ 25° C	-	1.658 - 1.660	1.659 - 1.662	1.660 - 1.665	1.6334	1.6390	1.6463	1.6507	1.6580

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TYPICAL PHYSICAL PROPERTIES OF AROCLORS AND AROCLOR BLENDS

	AROCLORS				AROCLOR BLENDS				
Property	Aroclor 1221-B	Aroclor 5432	Aroclor 5442	Aroclor 5460	Aroclor 6040	Aroclor 6050	Aroclor 6062	Aroclor 6070	Aroclor 6090
Viscosity (ASTM D-88)	38 (100° F SUS)	50-60 (210° F SUS)	300-400 (210° F SUS)	-	106-146* (100° F SUS)	110-125* (130° F SUS)	54-64* (210° F SUS)	82-102* (210° F SUS)	-
Flash Point ° F Minimum (Cleveland Open Cup)	260	470° F	477	None to Boiling	260	260	260	260	340
Fire Point ° F Minimum (Cleveland Open Cup)	280	660° F	> 662	None to Boiling	300	310	320	325	550
Softening Point ° C	-	-	46-52*	98-105.5*	-	-	-	-	64-70*

*Monsanto Specification

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Toxicity and Safe Handling

Inhalation

At ordinary temperatures, the Aroclor chlorinated polyphenyls have not presented industrial toxicological problems. The hazard of potential toxic exposure varies with their volatility: the lower-chlorinated, more volatile ones present more of a potential problem from the standpoint of both inhalation and skin contact. When Aroclor plasticizers are used at elevated temperatures, engineering controls must be applied, either by the use of closed systems or by effective local-exhaust ventilation together with general workroom exhaust.

Vapor of the liquid Aroclor plasticizers at room temperature should not be breathed in a confined space, and no vapor of any Aroclor evolved at elevated temperatures should be allowed to be dispersed into the general workroom.

Skin Contact

Continuous or repeated skin contact with the Aroclor plasticizers must be avoided by the use of gloves and protective garments, because of the possible occurrence of a condition called chloracne. Although reports of this condition caused by Aroclor are rare, it can be produced by excessive skin contact. If any Aroclor is spilled on the skin, the skin should be washed in the usual manner with a soap solution.

A burn caused by contact with a hot Aroclor should be treated like any ordinary burn. Aroclor plasticizer adhering to the burned area need not be removed immediately, unless treatment of the burn demands it, in which case either soap and water or repeated washings with a vegetable oil are recommended.

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