# AROCLOR® PLASTICIZERS

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

MCNS 079751

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MONS 079752

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-E, 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.

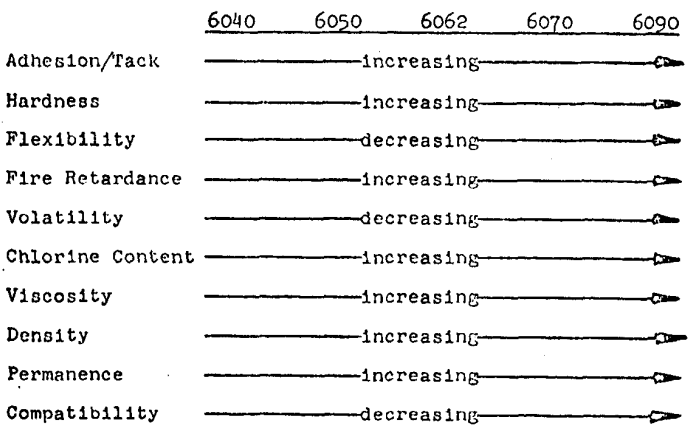
Miscellaneous Blends

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



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 |

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## 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

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## 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

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PRESSURE SENSITIVE ADHESIVES (Continued)

Current Recommendations:

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

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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 | 3[illegible] |
| Epon 828 | 1 |
| Epichlorhydrin | 0.2 |
| Xylene | 10[illegible] |
| Plasticizer | 2[illegible] |
| $TiO_2$ | 3[illegible].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 req.)
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

## 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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