T E C H N I C A L  B U L L E T I N

# THE AROCLOR® POLYCHLORINATED POLYPHENYLS

**Dielectrics for Capacitors & Transformers**

**TECHNICAL BULLETIN O-FF/1R**

Monsanto

MONS 076882

# THE AROCLOR® POLYCHLORINATED POLYPHENYLS

**Dielectrics for Capacitors & Transformers**

**TECHNICAL BULLETIN O-FF/1R**

"Nothing contained herein is to be construed as a recommendation to *use any product in conflict with any patent.* MONSANTO MAKES NO WARRANTIES AS TO THE FITNESS OR MERCHANTABILITY OF ANY PRODUCT REFERRED TO, no guarantee of satisfactory results from reliance upon contained information or recommendations, and disclaims all liability for any resulting loss or damage."

**MONSANTO INDUSTRIAL CHEMICALS CO.,**
**an operating unit of Monsanto Company**
**800 No. Lindbergh Blvd., St. Louis, Mo. 63166**

MONS 076883

## Table of Contents


GENERAL PHYSICAL PROPERTIES CHART . . 4

ELECTRICAL APPLICATION OF AROCLOR . . 7
Dielectrics for Askarel Type
Capacitors and Transformers . . . . . 7
Expansion Medium . . . . . 10


## Appendix


Solubility Table . . . . . 11
Vapor Pressure . . . . . 12
Vaporization Rates . . . . . 13
Corrosion Resistance of Structural Materials . . 14
Viscosity Table . . . . . 15
Density Table . . . . . 16
Dermatology & Toxicity . . . . . 17
Proper Handling of PCB's . . . . . 18
Safe Handling . . . . . 19
Shipping Information . . . . . 19


*Ask your Man from Monsanto for additional Aroclor literature:*

Askarel Inspection and Maintenance Guide
Aroclor® Plasticizers Technical Bulletin
Thermal® FR Fluid Heat Systems
Engineering Heat Transfer Data


Aroclor, Therminol, Sterox, Santomerse, Formvar, Lustran, and Resinox are registered trademarks of Monsanto Company.



MONS 076884

## What are the Aroclor® Polychlorinated Polyphenyls

These compounds are a series of chlorinated biphenyls and chlorinated polyphenyls. They range in form and appearance from mobile oily liquids to fine white crystals and hard transparent resins. Aroclor is non-oxidizing, permanently thermoplastic, of low volatility, and non-corrosive to metals. Aroclor is not hydrolyzed by water, alkalis, or acids. The viscous liquids and resins will not support combustion when heated alone, and they impart fire-resistance to other materials.

Crystalline Aroclor is relatively insoluble, but the liquid and resinous compounds are soluble in most of the common organic solvents, thinners and oils. All Aroclor chlorinated compounds are insoluble in water, glycerine or the glycols. Aroclor 5460 is insoluble in the lower molecular weight alcohols; 4465 is only partly soluble in the lower alcohols.

The following table describes the properties of twelve Aroclor chlorinated compounds, each of which is representative of a series.

MONS 076885

## General Physical Properties of the Aroclor® Chlorinated Compounds

| | Aroclor 1221 | Aroclor 1232 | Aroclor 1242 | Aroclor 1248 | Aroclor 1254 |
|---|---|---|---|---|---|
| Form | Colorless mobile oil | Practically colorless mobile oil | Practically colorless mobile oil | Colorless to light yellow-green, clear, mobile oil | Light yellow viscous oil |
| Color | 50 Max. (APHA) | 50 Max. (APHA) | 50 Max. (APHA) | 50 Max. (APHA) | 50 Max. (APHA) |
| Acidity — Maximum (Mgm. KOH per Gm.) | 0.014 | 0.014 | 0.010 | 0.010 | 0.010 |
| Average Coefficient of Expansion cc/cc/°C | 0.00071 (15°-40°C) | 0.00073 (25°-100°C) | 0.00068 (25°-65°C) | 0.00070 (25°-65°C) | 0.00066 (25°-65°C) |
| Typical Density | | | | | |
| Specific Gravity | 1.182-1.192 (25°/15.5°C) | 1.270-1.280 (25°/15.5°C) | 1.381-1.392 (25°/15.5°C) | 1.405-1.415 (65°/15.5°C) | 1.495-1.505 (65°/15.5°C) |
| Pounds per gallon — 25°C(77°F) | 9.85 | 10.55 | 11.50 | 12.04 | 12.82 |
| Distillation Range — ASTM D-20 (Mod.) | | | | | |
| Corr. °C | 275°-320° | 290°-325° | 325°-366° | 340°-375° | 365°-390° |
| Evaporation Loss — % — ASTM D-6 Mod. | | | | | |
| 163°C 5 hrs. | — | — | 3.0 to 3.6 | 3.0 to 4.0 | 1.1 to 1.3 |
| 100°C 6 hrs. | 1.0 to 1.5 | 1.0 to 1.5 | 0.0 to 0.4 | 0.0 to 0.3 | 0.0 to 0.2 |
| Flash Point — Cleveland Open Cup °C | 141°-150° | 152°-154° | 176°-180° | 193°-196° | None |
| °F | 286°-302° | 305°-310° | 348°-356° | 379°-384° | |
| Fire Point — Cleveland Open Cup °C | 176° | 238° | None* | None | None |
| °F | 349° | 460° | | | |
| Pour Point — ASTM D-97 °C | Crystals at 1°C | −35.5° | −19° | −7° | 10° |
| °F | Crystals at 34°F | −32° | 2° | 19.4° | 50° |
| Softening Point — ASTM E-28 °C | — | — | — | — | — |
| °F | — | — | — | — | — |
| Refractive Index — D-line — 20°C | 1.617-1.618 | 1.620-1.622 | 1.627-1.629 | 1.630-1.631 | 1.639-1.641 |
| Viscosity — Saybolt Universal Sec. (ASTM — D-88) 210°F (98.9°C) | 30-31 | 31-32 | 34-35 | 36-37 | 44-48 |
| 130°F (54.4°C) | 35-37 | 39-41 | 49-56 | 73-80 | 260-340 |
| 100°F (37.8°C) | 38-41 | 44-51 | 82-92 | 185-240 | 1800-2500 |

*[illegible] indicates -- "the fire point up to boiling temperature"

MONS 076886

| Aroclor 1260<br>Light yellow soft sticky resin | Aroclor 1262<br>Light yellow sticky clear resin | Aroclor 1268<br>White to off-white powder | Aroclor 4465<br>Light-yellow, clear, brittle resin | Aroclor 5442<br>Yellow transparent sticky resin | Aroclor 5460<br>Clear, yellow-to-amber, brittle resin | Aroclor 2565<br>Black, opaque, brittle resin |
|---|---|---|---|---|---|---|
| 50 max.<br>(APHA) | 50 Max.<br>(APHA) | 1.5 Max.<br>NPA (molten) | 2 Max.<br>NPA (molten) | 2 Max.<br>NPA (molten) | 2 Max.<br>NPA (molten) | — |
| 0.014 | 0.014 | 0.05 | 0.05 | 0.05 | 0.05 | 1.4 |
| 0.00087<br>(20°-100°C) | 0.00064<br>(25°-65°C) | 0.00067<br>(20°-100°C) | 0.00061<br>(25°-65°C) | 0.00123<br>(25°-99°C) | 0.00179<br>(25°-124°C) | 0.00066<br>(25°-65°C) |
| 1.555-1.566<br>(90°/15.5°C)<br>13.50 | 1.572-1.583<br>(90°/15.5°C)<br>13.72 | 1.804-1.811<br>(25°/25°C)<br>15.09 | 1.670<br>(25°/25°C)<br>13.91 | 1.470<br>(25°/25°C)<br>12.24 | 1.670<br>(25°/25°C)<br>13.91 | 1.734<br>(25°/25°C)<br>14.44 |
| 385°-420° | 395°-425° | 435°-450° | 230°-320°<br>at 4 mm. Hg. | 215°-300°<br>at 4 mm. Hg. | 280° 335°<br>at 5 mm. Hg. | — |
| 0.5 to 0.8<br>0.0 to 0.1 | 0.5 to 0.6<br>0.0 to 0.1 | 0.1 to 0.2<br>0.0 to 0.06 | 0.2 to 0.3<br>0.0 to 0.02 | 0.2<br>0.01 | 0.03<br>1.5 to 1.7<br>(at 260°– 5 hrs.) | 0.2 to 0.3<br>— |
| None | None | None | None | 247°<br>477° | None | None |
| None | None | None | None | > 350°<br>> 662° | None | None |
| 31° | 35°-38° | — | — | 46° | — | — |
| 88° | 99° | — | — | 115° | — | — |
| — | — | 150° to 170°<br>(hold pt.) | 60° to 66° | 46° to 52° | 98° to 105.5° | 66° to 72° |
| — | — | 302° to 338°<br>(hold pt.) | 140° to 151° | 115° to 126° | 208° to 222° | 149° to 162° |
| 1.647-1.649 | 1.6501-1.6517 | — | 1.664-1.667 | — | 1.660-1.665 | — |
| 72-78 | 86-100 | — | 90-150<br>(266°F or 130°C) | 300-400 | — | — |
| 3200-4500 | 600-850<br>(160°F or 71°C) | — | — | — | — | — |
| — | — | — | — | — | — | — |

MONS 076887

### Stability

*Toward Alkalies* — Aroclor is remarkably resistant to the action of either hydrolyzing agents or high temperature. It is not affected by boiling with sodium hydroxide solution.

*Toward Acids* — Experiments were made to determine whether hydrogen chloride is evolved during the treatment of Aroclor with sulfuric acid. Aroclor 1254 (selected as typical) was stirred with an equal volume of ten per cent sulfuric acid for a period of 150 hours. Any gases escaping from the reaction flask had to pass through a trap filled with silver nitrate solution, which would give a precipitate of silver chloride if any HCl came in contact with it. After 150 hours of treatment, neither the trap solution nor the acid layer in the treating flask showed any hydrogen chloride present.

Even prolonged treatment (255 hours) with concentrated sulfuric acid indicated negligible effect.

*Toward Oxidation* — When Aroclor is subjected to a bomb test at 140°C with 250 pounds oxygen per square inch, there is no evidence of oxidation as judged by development of acidity or formation of sludge.

### Electrical Resistivity

Aroclor has extremely interesting electrical characteristics: high resistivity and dielectric strength and low power factor. The dielectric constant ranges from 3.4 to 5.0 at 100°C and 1000 cycles, depending upon the particular Aroclor.

### Solubility

All Aroclor chlorinated compounds are insoluble in water. They are soluble, however, in most of the common solvents, plasticizers, and resins.

MONS 076888

## Electrical Applications of Aroclor

Aroclor is one of the purest commercial chemical compounds, virtually free of even traces of conducting impurities. For this reason, dielectric properties of Aroclor closely approximate the theoretical maximum for these particular organic compounds. With its stability, heat-resistance and fire-resistance — Aroclor can be used for a variety of heavy-duty dielectric applications, in hermetically sealed systems.

### Dielectrics for Askarel Type Capacitors and Transformers

Aroclor is used per se in capacitors and is formulated for the liquid coolant-insulation fluids in transformers. Such dielectrics must be highly pure with dependably minimal traces of electrolytes. They must be chemically stable and non-corrosive to a wide variety of structural materials. Most important, the dielectric fluid must be fire-resistant.

Aroclor is the only liquid in low cost commercial supply that meets these exacting requirements.

Aroclor liquids 1242, 1248, 1254, and 1260 are used directly, or are carefully formulated with chlorinated benzene and other additives to make askarel fluid for particular needs. Typical formulated askarel fluids are shown on the following pages.

Aroclor liquids 1242 and 1254, themselves or in special formulations, are used as the dielectric in fixed paper capacitors, for the power factor correction in utility transmission lines; for home appliances such as air conditioners, furnaces, washers and driers; for electric motors; and for ballast in fluorescent fixtures. There are also a number of applications in DC systems, in condensers, and the new energy storage capacitors.

### ELECTRICAL PROPERTIES

| Aroclor | Dielectric Constant at 1,000 Cycles (1) 25°C | 100°C | Volume Resistivity (2) Ohm-cm at 100°C, 500 Volts D.C. | Dielectric Strength (3) | Power Factor (4) 100°C, 1,000 Cycles |
|---|---|---|---|---|---|
| 1232 | 5.7 | 4.6 | | | |
| 1242 | 5.8 | 4.9 | Above $500 \times 10^9$ | Greater than 35KV | <0.1% |
| 1248 | 5.6 | 4.6 | Above $500 \times 10^9$ | Greater than 35KV | <0.1% |
| 1254 | 5.0 | 4.3 | Above $500 \times 10^9$ | Greater than 35KV | <0.1% |
| 1260 | 4.3 | 3.7 | Above $500 \times 10^9$ | Greater than 35KV | <0.1% |
| 1268 | 2.5 | — | | | |
| 5442 | 3.0 | 4.9 | Above $500 \times 10^9$ | | |
| 5454 | 2.7 | 4.2 | | | |
| 5460 | 2.5 | 3.7 | | | |
| 4465 | 2.7 | 3.3 | | | |

(1) ASTM D-150-47T (2) ASTM D-257-46 (3) ASTM D-149-44 (4) ASTM D-150-47T

MONS 076889

# Typical Transformer Askarel

## (MIXTURE OF AROCLOR AND CHLOROBENZENES)

| Property | Typical |
|---|---|
| Visc. @ 37.8°C. (ASTM D88) | 41-45 Sec. Saybolt Univ. |
| Spec. Gravity @ 15.5/15.5°C., (ASTM D287) | 1.563-1.571 |
| Color, APHA | 150 max. |
| Condition | Clear |
| Acidity, mg. KOH/g. | 0.01 max. |
| Pour Pt., °C., (ASTM D97) | −44°C., or lower |
| Inorganic Chlorides, ppm | 0.10 max. |
| Refractive Index @ 25°C. | 1.6075-1.6085 |
| Distillation Range (ASTM D20) Corrected for stem and barometric pressure | |
| First drop | 210°C., min. |
| 35% | 240-256°C. |
| 55% | 290-330°C. |
| 65% | 385-400°C. |
| 95% | 395-415°C. |
| Corrosion | After heating with aluminum for 6 hrs. @ 200-220°C., the aluminum must not be corroded either on visual or weight inspection. |
| | The askarel fluid meets the following specifications: |
| | Color, APHA — 200 max. |
| | Acidity, mg. KOH/g. — 0.01 max. |
| | Inorg. Chlorides, ppm — 5 max. |
| | Condition — Clear |
| Water Content, ppm. | 30 max. |
| Resistivity, 100°C., 500v., 0.1" gap | 100 x $10^9$ ohm-cm., min. |
| Dielectric Strength, 25°C. | 35 KV., min. |
| Dielectric Constant, 100°C., 1000 cycles* | 3.8-4.2 |
| Tin Tetraphenyl* | 0.125% ± 0.01% by weight |
| Burn Point, (ASTM D92)* | None up to Boiling Point |
| Fixed Chlorine* | 60.5 ± 0.5 |
| Arc Formed Gases* (Oxygen Free Liquid @ 25°C.) | Total combustible gases including carbon monoxide, hydrogen and volatile hydrocarbons. |
| Electrical Stability* | After heating for 96 hours @ 100°C in a closed container, the resistivity should not decrease more than 10%. |

*Determined by special request.

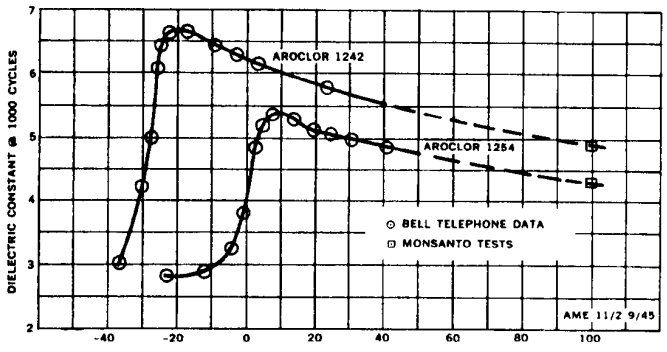
MONS 076890

## Typical Capacitor Aroclor

| Property | Typical |
|---|---|
| Visc. @ 37.8°C. (ASTM D88) | 82-92 seconds Saybolt Univ. |
| Specific Gravity @ 25/15.5°C (ASTM D287) | 1.381-1.392 |
| Color, APHA | 50 max. |
| Condition | Clear |
| Acidity, mg. KOH/g. | 0.01 max. |
| Pour Pt., °C. (ASTM D97) | −14 or lower |
| Inorganic Chlorides, ppm | 0.10 max. |
| Refractive Index @ 25°C. | 1.6240-1.6260 |
| Distillation Range (ASTM D20) Corrected for stem and barometric pressure | 10% 325°C. min.<br>90% 360°C. max. |
| Corrosion | After heating with aluminum for six hours at 210°C ± 10°C the aluminum must not be corroded either on visual or weight inspection and the Aroclor 1242 should meet the following specs.:<br>Color, APHA 60 max.<br>Acidity, mg. KOH/g. 0.01 max.<br>Inorg. Chlorides, ppm 0.10 max.<br>Condition Clear |
| Water Content, ppm | 35 max. |
| Resistivity 100°C. 500 volts DC @ 0.1" gap | 500 x $10^9$ ohm-cm., min. |
| Dielectric Constant 100°C. @ 1000 cycles (ASTM D924) | 4.7-4.9 |
| Flash Point Cleve. Open Cup* | 170°C., min. |
| Fire Point °C.* | None to boiling point |
| Sulfates (ASTM-D117-31)* | None |
| Fixed chlorine content (Carius)* | 41.5-42.5% |
| Specific Heat @ 25°C.* | 0.29 |
| Evaporation @ 100°C for 6 hrs.* | 0.4% max. |
| Dielectric Strength (KV) (ASTM D877)* | 35 Min. |

*Determined by special request

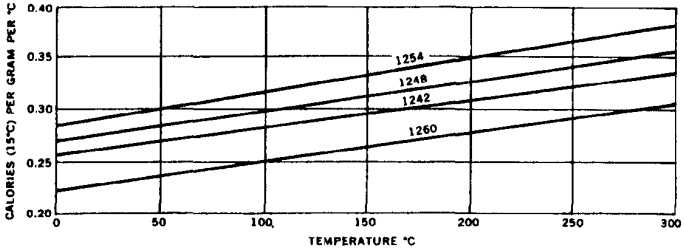
### DIELECTRIC CONSTANT VS. TEMPERATURE
### Aroclor® 1242 & Aroclor® 1254




COURTESY OF THE JOURNAL OF FRANKLIN INSTITUTE AND BELL TELEPHONE LABORATORIES

MONS 076891

## HEAT CAPACITY OF AROCLOR® LIQUIDS
### at Various Temperatures




## THERMAL CONDUCTIVITY OF AROCLOR 1248

| Temperature °C. | Temperature °F. | BTU./Hr./Sq. Ft./°F./Ft. | Calories, gram/Sec./Sq.Cm./°C./Cm. |
|---|---|---|---|
| 30 | 90 | 0.0680 | 281 x $10^{-6}$ |
| 60 | 140 | 0.0687 | 284 x $10^{-6}$ |
| 100 | 212 | 0.0697 | 288 x $10^{-6}$ |

The average coefficient of expansion of Aroclor 1248 per degree F within the various temperature ranges indicated in the table below was determined by using the simple formula $Vt = Vt^1 [1 + a (t - t_1)]$. The coefficient a, has been calculated at 100°F increments as follows:

| Temp. Range °F | Average Coefficient of Expansion cc/cc/F |
|---|---|
| 0 to 100 | 0.00037 |
| 100 to 200 | 0.00039 |
| 200 to 300 | 0.00040 |
| 300 to 400 | 0.00046 |
| 400 to 500 | 0.00048 |
| 500 to 600 | 0.00051 |

The specific volume of aroclor 1248 at different temperatures is as follows:

| Temp. °F | Specific Volume ml/gm |
|---|---|
| 0 | 0.674 |
| 100 | 0.699 |
| 200 | 0.726 |
| 300 | 0.755 |
| 400 | 0.790 |
| 500 | 0.828 |
| 600 | 0.870 |

MONS 076892

## SOLUBILITY OF AROCLOR® CHLORINATED COMPOUNDS IN 100 MILLILITERS OF VARIOUS SOLVENTS

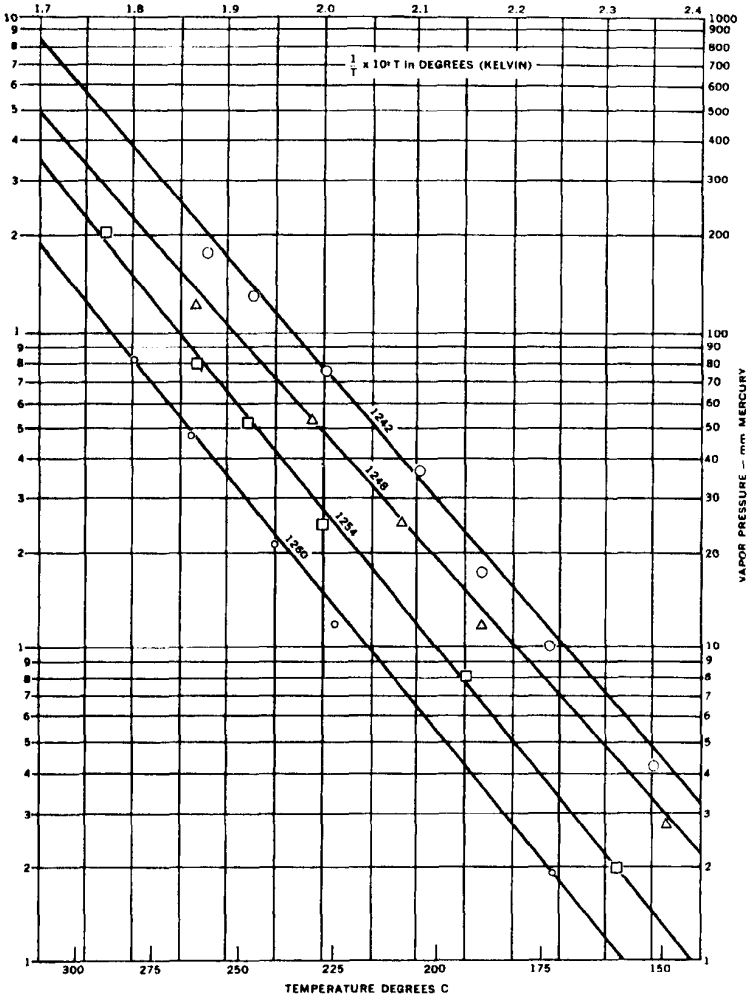
| Aroclor / Type of Solvent | 1242 25°C | 1242 Hot | 1248 25°C | 1248 Hot | 1254 25°C | 1254 Hot | 1270 Cold | 1270 Hot | 4465 Cold | 4465 Hot | 5460 25°C |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **Acid** | | | | | | | | | | | |
| Acetic Acid | S | S | — | — | S | S | — | — | SS | S | — |
| Oleic Acid | S | S | — | — | S | S | — | — | S | VS | — |
| Benzoic Acid | 10.0 31°C | — | 10.0 32°C | — | — | — | — | — | — | — | — |
| **Aldehyde** | | | | | | | | | | | |
| 40% Formaldehyde | I | I | I | I | I | I | I | I | I | I | — |
| Furfural | VS | VS | VS | VS | VS | VS | SS | SS | VS | VS | — |
| **Amine** | | | | | | | | | | | |
| Aniline | S | S | — | — | S | S | — | — | VS | VS | — |
| Pyridine | 132.5 30°C | 440 99°C | — | — | 114 31°C | 425 100°C | — | — | VS | VS | — |
| **Chloro – derivatives** | | | | | | | | | | | |
| Amyl chlorides—mixed | S | S | S | S | S | S | — | — | VS | VS | — |
| Carbon Tetrachloride | S | S | S | S | S | S | 3.7 | — | VS | VS | 156 |
| Chloroform | S | S | S | S | S | S | — | — | VS | VS | — |
| Dichlorethylene | — | — | — | — | — | — | 3.0 | — | VS | VS | — |
| Ethylene Dichloride | S | S | S | S | S | S | — | — | VS | VS | — |
| Monochlorobenzene | S | S | S | S | S | S | 2.9 | — | VS | VS | — |
| Orthodichlorobenzene | — | — | — | — | — | — | — | — | VS | VS | — |
| Tetrachlorethane | S | S | S | S | S | S | — | — | VS | VS | — |
| Trichlorethane | S | S | S | S | S | S | 3.3 | — | VS | VS | — |
| Trichlorethylene | S | S | S | S | S | S | — | — | VS | VS | — |
| **Drying Oil** | | | | | | | | | | | |
| Tung Oil | S | S | S | S | S | S | — | — | VS | VS | — |
| Linseed Oil | S | S | S | S | S | S | — | — | VS | VS | — |
| **Ester** | | | | | | | | | | | |
| Amyl Acetate | S | S | S | S | S | S | — | — | VS | VS | — |
| Butyl Acetate | S | S | S | S | S | S | — | — | VS | VS | — |
| Cellosolve Acetate | S | S | S | S | S | S | — | — | VS | VS | — |
| Cottonseed Oil | S | S | S | S | S | S | — | — | S | VS | — |
| Dibutyl Phthalate | S | S | S | S | S | S | — | — | S | VS | — |
| Diethyl Phthalate | S | S | S | S | S | S | — | — | S | VS | — |
| Ethyl Acetate | S | S | S | S | S | S | — | — | S | VS | — |
| Ethyl Lactate | S | S | S | S | S | S | — | — | VS | VS | — |
| Ethylene Glycol Diacetate | S | S | S | S | S | S | — | — | VS | VS | — |
| Methyl Acetate | S | S | S | S | S | S | — | — | S | S | — |
| Tricresyl Phosphate | S | S | S | S | S | S | — | — | SS | S | — |
| **Ether: Ethyl Ether** | S | S | S | S | S | S | S | S | S | — | — |
| **Ether Alcohol** | | | | | | | | | | | |
| Carbitol® | 224 31°C | 307 99°C | VS | VS | 173 26°C | 259 99°C | — | — | SS | — | — |
| Cellosolve | S | S | S | S | S | S | — | — | S | — | — |
| Diethylene Glycol | — | — | — | — | — | — | — | — | S | — | — |
| p-p' Dihydroxy Ethyl Ether | 16.9 23°C | 19 99°C | SS | SS | 8 30°C | 10 100°C | — | — | SS | — | — |
| **Hydrocarbon** | | | | | | | | | | | |
| Benzene | VS | VS | VS | VS | VS | VS | 3.5 | — | VS | VS | 143 |
| Gasoline | VS | VS | VS | VS | VS | VS | — | — | VS | VS | — |
| Kerosene | VS | VS | VS | VS | VS | VS | — | — | VS | VS | — |
| Mineral Spirits | VS | VS | VS | VS | VS | VS | — | — | VS | VS | — |
| Paraffin | 2.0 27.5°C | S | 2.0 28°C | S | — | S | — | — | <5.0 | S | — |
| Pine Oil | S | S | VS | VS | S | S | — | — | S | S | — |
| Toluene | VS | VS | VS | VS | VS | VS | — | — | VS | VS | 142 |
| Turpentine | VS | VS | VS | VS | VS | VS | — | — | VS | VS | — |
| Xylene | VS | VS | VS | VS | VS | VS | — | — | VS | VS | 178 |
| **Hydroxy – derivatives** | | | | | | | | | | | |
| Amyl Alcohol | S | S | — | — | S | S | — | — | S | S | — |
| n-Butyl Alcohol | S | S | — | — | S | S | — | — | SS | S | — |
| Ethyl Alcohol (3-A) | 23.3 25°C | 80.0 79°C | — | — | 10 27°C | 28 75°C | — | — | SS | — | — |
| Glycerine | I | I | I | I | I | I | I | I | I | I | — |
| Methyl Alcohol | 42.5 25°C | 88.5 60°C | — | — | 15 26°C | 22.2 65°C | — | — | SS | — | — |
| Phenol—90% | 194 30°C | S | — | — | SS | S | — | — | S | S | — |
| **Ketone** | | | | | | | | | | | |
| Acetone | S | S | — | — | S | S | — | — | S | S | 260 |
| **Miscellaneous** | | | | | | | | | | | |
| Carbon Disulfide | S | S | — | — | S | S | — | — | VS | VS | — |
| Nitrobenzene | S | S | — | — | S | S | — | — | VS | — | — |
| Water | I | I | I | I | I | I | I | I | I | I | — |

I – Insoluble S – Soluble SS – Slightly Soluble VS – Very Soluble
Figures show grams of Aroclor per 100 milliliters of solvent at 25°C unless otherwise indicated.

*Carbitol is a registered trademark of Union Carbide and Carbon Co.

MONS 076893

## VAPOR PRESSURE OF AROCLOR® CHLORINATED COMPOUNDS




MONS 076894

## VAPORIZATION RATES

| Sample | Wt. Loss Gms. | Hours Exposure | Surface Area Cm.² | Vaporization Rate gms./cm.²hr./100°C |
|---|---|---|---|---|
| Aroclor® 1221 | 0.5125 | 24 | 12.28 | 0.00174 |
| Aroclor 1232 | 0.2572 | 24 | 12.28 | 0.000874 |
| Aroclor 1242 | 0.0995 | 24 | 12.28 | 0.000338 |
| Aroclor 1248 | 0.0448 | 24 | 12.28 | 0.000152 |
| 42% chlorinated paraffin | 0.0745 | 48 | 12.28 | 0.000126 |
| dioctyl phthalate | 0.0686 | 48 | 12.28 | 0.000117 |
| Dutrex® 25 | 0.0256 | 24 | 12.28 | 0.000087 |
| Aroclor 1254 | 0.0156 | 24 | 12.28 | 0.000053 |
| Dutrex 20 | 0.0047 | 24 | 12.28 | 0.000016 |
| Aroclor 1262 | 0.0039 | 24 | 12.28 | 0.000013 |
| Aroclor 1260 | 0.0026 | 24 | 12.28 | 0.000009 |
| Aroclor 4465 | 0.0064 | 72 | 12.28 | 0.000007 |
| Aroclor 1270 | 0.0045 | 72 | 12.28 | 0.000005 |
| Aroclor 5442 | 0.0039 | 72 | 12.28 | 0.000004 |
| Aroclor 5460 | 0.0032 | 72 | 12.28 | 0.000004 |
| Tricresyl phosphate | 0.0010 | 24 | 12.28 | 0.000003 |

*Dutrex is a registered trademark of the Shell Oil Co.

## APPROXIMATE VAPOR PRESSURES CALCULATED AT 100° F (37.8° C)

| | |
|---|---|
| Aroclor® 1232 | 0.005 mm. Hg. |
| Aroclor 1242 | 0.001 mm. Hg. |
| Aroclor 1248 | 0.00037 mm. Hg. |
| Aroclor 1254 | 0.00006 mm. Hg. |

MONS 076895

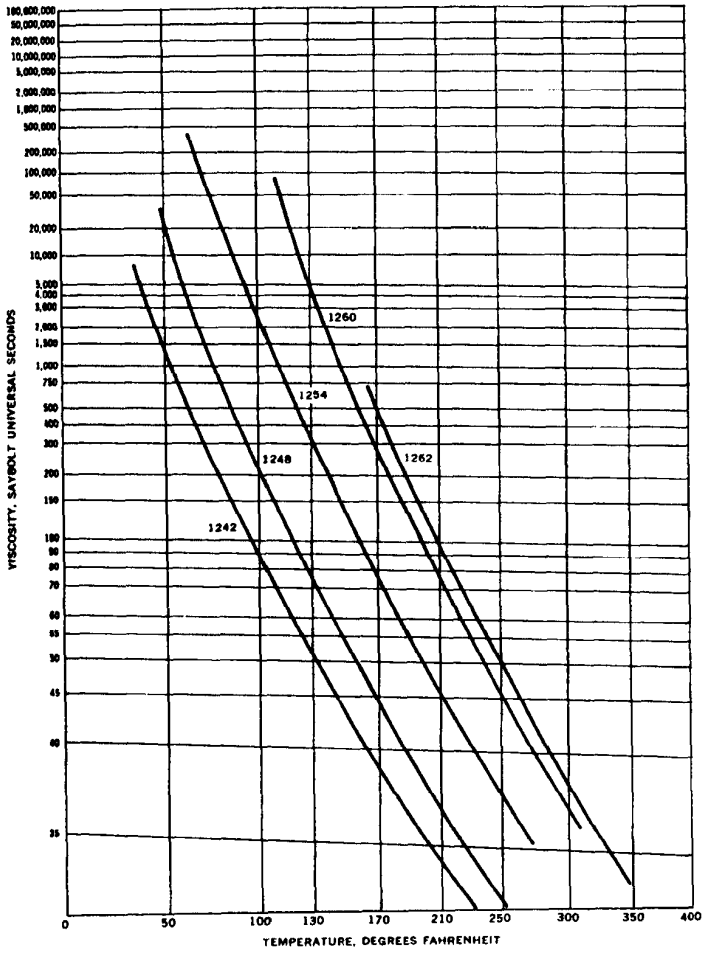
## CORROSION RESISTANCE OF STRUCTURAL MATERIALS

| Metals | Aroclor Number 1248 25°C | 1248 125°C | 1254 25°C | 1254 125°C | 4465 125°C | 5460 125°C |
|---|---|---|---|---|---|---|
| Aluminum | R | R | R | R | *RR | RR |
| Copper | R | D | R | D | D | D |
| Magnesium | RR | R | R | R | RR | *RR |
| Nickel | RR | R | R | RR | RR | R |
| Silver | R | R | R | R | R | R |
| Tin | R | R | R | R | R | R |
| Zinc | R | R | R | R | R | RR |
| Mild Steel | RR | R | RR | RR | R | RR |
| Phosphor Bronze | R | D | R | R | R | R |
| Red Brass | D | D | R | D | R | De |
| Stainless Steel (Type 316) | RR | RR | RR | RR | RR | RR |
| Yellow Brass | R | Re | R | De | Re | Re |
| **Plastics** | | | | | | |
| Alkyd Resin No. 46594-12 | *P | P | *P | P | P | P |
| Alkyd Resin No. 46594-13A | *D | P | *D | P | P | P |
| Cellulose Acetate (Fibestos) | D | P | D | P | P | P |
| Durite[1] Phenol Furfural Resin | *D | P | *R | P | D | P |
| Formvar® Highly Plasticized polyvinyl formal resins | De | T | Pe | T | T | T |
| Formvar® Low Plasticized polyvinyl formal resins | PS | T | PS | T | T | T |
| Glyptal 1276 | R | P | D | P | P | P |
| Glyptal 7136 | *D | T | *R | T | T | T |
| Maleic Resin No. 46594-13B | P | P | *P | P | P | P |
| Maleic Resin No. 46594-13C | P | P | *R | P | P | P |
| Methyl Methacrylate | *D | P | *D | P | P | P |
| Lustron® B Polystyrene | P | T | P | T | T | T |
| Resinox® Mineral Filled Melamine Resin | *D | *P | *R | R | *P | *D |
| Resinox Wood Flour Filled Melamine Resin | *D | P | *R | D | R | P |
| Resinox Mineral Filled Phenol Formaldehyde | *D | D | *D | D | R | P |
| Resinox Wood Flour Filled Phenol Formaldehyde | *D | P | *D | *R | D | P |
| Resinox Rag Filled Phenol Formaldehyde | *D | D | *D | *D | *D | P |
| Urea Formaldehyde Resin (Plaskon Co.) | *D | P | *D | *P | P | P |

Meaning of Abbreviations:
* – Based on weight gain calculated as penetration value shown.
ER – Excellent resistance – less than $1.0 \times 10^{-4}$ cm/day penetration or .0004 in/yr.
R – Good resistance – low penetration between $1.0 \times 10^{-4}$ and $10 \times 10^{-4}$ cm/day or between 0.0004 and 0.004 in/yr.
D – Doubtful resistance, penetration between $10 \times 10^{-4}$ cm/day and $100 \times 10^{-4}$ cm/day or between 0.0040 and 0.040 in/yr.
P – Poor resistance – penetration greater than $900 \times 10^{-4}$ cm/day or 0.014 in/yr.
PS – Poor resistance due to visible local action although weight change indicates greater resistance.
e – Following the letter indicating resistance signifies material may be better than indicated if totally immersed since weight loss is believed to come from oxidation of the part of test strip exposed to air
T – Material alone will not stand temperature.
(1) – Durite is a registered Trademark of Borden Chemical Co.

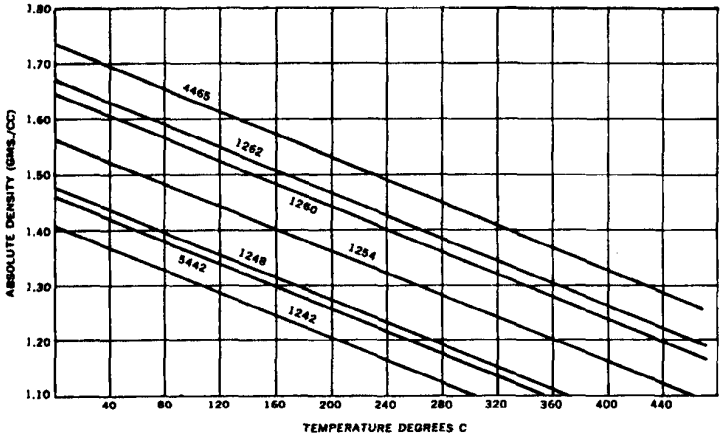
MONS 076896

## VISCOSITY RANGES OF SOME OF THE AROCLOR® CHLORINATED COMPOUNDS




MONS 076897

## DENSITIES OF AROCLOR® CHLORINATED COMPOUNDS AT VARIOUS TEMPERATURES




MONS 076898

## Dermatology and Toxicology

At ordinary temperatures the Aroclor polychlorinated polyphenyls have not presented industrial toxicological problems. The hazard of potential toxic exposure varies with their volatility: the lower-chlorinated ones, being more volatile, present more of a potential problem from the standpoint of both inhalation and skin contact. When Aroclor is 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.

Inhalation tests on animals indicate that the maximum safe concentration of vapor is in the range of 0.5 to 1.0 milligram of the lower-chlorinated Aroclor compounds per cubic meter of air. The threshold limits (maximum allowable concentration for an 8-hour working day) set by the American Conference of Government Hygienists are 1.0 milligram of the lower-chlorinated Aroclor compounds per cubic meter of air and 0.5 milligram of the more-highly-chlorinated compounds, such as Aroclor 1254, per cubic meter of air.

Schwartz patch tests on 200 volunteers showed that neither Aroclor 1254 alone when applied to gauze nor a polyvinyl chloride film containing 11.5-weight-per cent Aroclor 1254 was a primary irritant or a sensitizer. Canvas coated with an oil-modified alkyd resin (17-weight-per cent of the paint-film solids and 7-weight-per cent of the painted fabric was Aroclor 5460) did not produce primary skin irritancy or sensitization according to the same Schwartz technique. Continuous or repeated skin contact with Aroclor must be avoided because of the possible occurence of a condition called chlorance. Although reports of this condition caused by Aroclor are rare, it can be produced by excessive skin contact.

MONS 076899

## The Proper Handling of PCB'S by the Electrical Industry to Avoid Environmental Contamination

Polychlorinated biphenyls (PCB's), better known by various trade names including Aroclor (Monsanto), Pyranol (General Electric Co.), and Inerteen (Westinghouse Electric) are the most commonly used askarel class fire-resistant dielectric fluids for hermetically sealed capacitors and transformers. They have served these essential purposes in a satisfactory and irreplaceable manner for over 40 years.

PCB's are noted for their high order of stability, inertness, low volatility and very low water solubility. For these reasons PCB's will persist, if introduced into the environment. This holds true especially for the more highly chlorinated PCB's, as these members of the family have been found quite refractory to soil organisms and are considered to be essentially non-biodegradable.

Recent studies indicate that typical small amounts of PCB's found in the environment can be harmful to certain species of birds and young marine life.

Therefore it is essential to do all that is possible to avoid environmental contamination with PCB's. To establish guide lines, the FDA indicates as maximums 5 parts per million of PCB in fish and 0.2 parts per million in milk.

PCB's must not be introduced into water or marine areas. Spills or leakage must be contained.

Monsanto, and several others, provide facilities for the proper incineration and destruction of scrap PCB fluids. Such materials can be sent freight prepaid to Monsanto's attention, Supervisor Department A-246, Sauget, Illinois for incineration at 3 cents per pound.

Also, PCB fluids should be removed from solid scrap. For example, discarded transformer coils and cores, should be drained free from PCB's followed by flushing or solvent extraction, using such solvents as perchloroethylene, or trichloroethylene employed in vapor degreasing equipment. The scrap fluid mixtures should then be incinerated under the conditions, as provided by Monsanto to destroy the PCB's.

If additional assistance is required about handling PCB's, please contact Monsanto's PCB environmental coordinator, Mr. W. B. Papageorge, Monsanto Company, 800 N. Lindberg, St. Louis, Missouri 63166; phone (314) 694-4051.

MONS 076900

## Safe Handling

Vapors of the Aroclor liquids at room temperature should not be breathed in a confined space. Vapors evolved at elevated temperatures should not be allowed to be dispersed into the general workroom. Instead, engineering control must be applied to reduce vapor concentrations below the allowable concentrations mentioned above.

Continuous or repeated skin contact with Aroclor must be avoided by the use of gloves and protective garments. 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 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.

## Shipping Information

| | |
|---|---|
| **Freight Classification** | |
| AROCLOR 1221, 1243, 1242, 1248, 1254, 1260, 1262 | Synthetic Resin, Liquid, NOIBN |
| **Rail Classification** | |
| AROCLOR 1268, 2565, 4465, 5442, 5460 | Synthetic Resin, Other Than Liquid, NOIBN |
| **Truck Classification** | |
| AROCLOR 1268, 2565 | Synthetic Resin, Powder, NOI |
| AROCLOR 4465, 5442, 5460 | Synthetic Resin, Lumps or Solid Mass, NOI |
| **Shipping Regulations** | None |
| **Standard Containers** | |
| AROCLOR 1221 | Tank car, 520-lb. steel drum, 50-lb. can |
| AROCLOR 1232 | Tank car, 550-lb. steel drum, 50-lb. can |
| AROCLOR 1242, 1248, 1254, 1260, 1262 | Tank car, 600-lb. steel drum, 50-lb. can |
| AROCLOR 1268 | 200-lb. fiber drum, 50-lb. can |
| AROCLOR 2565, 4465 | 500-lb. steel drum, 50-lb. can |
| AROCLOR 5442 | 450-lb. steel drum, 50-lb. can |
| AROCLOR 5460 (flaked) | 100-lb. bag |

MONS 076901

## DISTRICT SALES OFFICES ALL DIVISIONS

*AKRON, OHIO 44313*
*260 Springside Drive*
*Montrose Development Park*
*Tel. (216) 666-4111*

*ATLANTA, GEORGIA 30339*
*320 Interstate North Parkway*
*Suite 500*
*Tel. (404) 432-7111*

*BOSTON, MASSACHUSETTS 02149*
*Everett Station*
*Tel. (617) 387-5010*

*CHICAGO, ILLINOIS*
*3158 Des Plaines Ave.*
*Des Plaines, Illinois 60018*
*Tel. (312) 296-6588*

*CINCINNATI, OHIO 45206*
*1501 Madison Road*
*Tel. (513) 751-6707*

*DETROIT, MICHIGAN*
*500 Northland Towers West*
*Southfield, Mich. 48075*
*Tel. (313) 357-0910*

*HONOLULU, HAWAII 96812*
*205 Pacific International Bldg.*
*677 Ala Moana Blvd., P. O. Box 3824*
*Tel. (808) 531-2744*

*HOUSTON, TEXAS 77027*
*1301 Post Oak Tower*
*5051 Westheimer Road*
*Tel. (713) 621-9550*

*LOS ANGELES, CALIFORNIA 90022*
*6670 E. Flotilla St.*
*Tel. (213) 723-2492*

*NEW YORK, NEW YORK 10017*
*277 Park Avenue*
*Tel. (212) 922-4111*

*ST. LOUIS, MISSOURI 63166*
*800 N. Lindbergh Blvd.*
*Tel. (314) 694-1000*

*SAN FRANCISCO BAY AREA*
*2710 Lafayette, Santa Clara, Calif. 95052*
*Tel. (408) 243-0414*

*SEATTLE, WASHINGTON 98121*
*2112 Third Avenue*
*Tel. (206) 622-4203*

*WILMINGTON, DELAWARE 19810*
*Suite 204, Bancroft Bldg.*
*3411 Silverside Road*
*Tel. (302) 478-4600*

***Additional District Offices are maintained by:***

**Agricultural Division**

DECATUR, ILLINOIS 62823
207 Decatur Professional Building
383 South Main Street
Tel. (217) 423-6031

DES MOINES, IOWA 50310
312 Merle Hay Tower
Tel. (515) 276-5503

INDIANAPOLIS INDIANA 46206
Suite 215, 4002 Meadows Drive Building
Tel. (317) 547-9148

KANSAS CITY, MISSOURI 64133
701 Blue Ridge Tower
4240 Blue Ridge Boulevard
Tel. (816) 353-6060

LULING, LOUISIANA 70070
P. O. Box 174
Tel. (504) 784-6283

MANKATO, MINNESOTA 56001
111 Madison East
Tel. (507) 387-3406

MEMPHIS, TENNESSEE 38104
203 Union Plaza Building
1836 Union Avenue
Tel. (901) 278-7911

MUSCATINE, IOWA 52761
P. O. Box 473
Tel. (319) 263-1331

**Hydrocarbons & Polymers Division**

NEW ENGLAND AREA
730 Worcester St.
Indian Orchard, Mass. 01051
Tel. (413) 788-8811

*Lion Oil*

EL DORADO, ARKANSAS 71730
Lion Oil Building
Tel. (501) 863-3111

JACKSON, MISSISSIPPI 39208
P. O. Box 10837, Westland Station
Tel. (601) 362-3649

N. LITTLE ROCK, ARKANSAS 72118
410 West 8th Street, P. O. Box 5821
Tel. (501) 376-2437

MEMPHIS, TENNESSEE 38113
1023 Riverside Drive, P. O. Box 13248
Tel. (901) 948-4451

**Plastic Products & Resins Division**

EUGENE, OREGON 97402
855 Seneca Road
Tel. (503) 342-7201

KENILWORTH, NEW JERSEY 07033
North Seventh St. & Monroe Ave.
Tel. (201) 276-2900

NEW ENGLAND AREA
190 Grochmal Avenue
Indian Orchard, Mass. 01051
Tel. (413) 788-6811

**Textiles Division**

CHARLOTTE, NORTH CAROLINA 28210
6230 Fairview Road, Suite 400
Tel. (704) 364-0110

GREENVILLE, SOUTH CAROLINA 29606
McAlister Plaza
P. O. Box 6664, Station B
Tel. (803) 242-6700

NEW YORK, NEW YORK 10001
350 Fifth Ave.
Tel. (212) 556-5100

***MONSANTO, 800 N. LINDBERGH BLVD., ST. LOUIS, MISSOURI 63166***

8/71

MONS 076902

2-3227 11-71 LITHO IN U.S.A.

MONS 076903

**Monsanto** 800 N. LINDBERGH BLVD., ST. LOUIS, MISSOURI 63166