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.

Aroclor is used alone for a particular physical job, such as insulating, and as a sealant or expansion media. Aroclor is also used as a component or extender in elastomers, adhesives, paints, lacquers, varnishes, pigments and waxes. The properties imparted by Aroclor (and their usefulness in particular applications) vary in regular gradient over the series. Selection of the right Aroclor for a particular use can generally be made by comparison of the properties, by blending two or more, and by adjusting the percentage used in the particular mixture in which the Aroclor will be formulated.

The following table describes the properties of twelve Aroclor chlorinated compounds, each of which is representative of a series. For almost every Aroclor shown, there is a dark-colored grade of approximately the same physical and chemical characteristics. These darker products are less pure, but are lower in price.

MONS 079389

General Physical Properties of the Aroclor® Chlorinated Compounds

Form	Aroclor 1221 Colorless mobile oil	Aroclor 1232 Practically colorless mobile oil	Aroclor 1242 Practically colorless mobile oil	Aroclor 1248 Colorless to light yellow-green, clear, mobile oil	Aroclor 1254 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 210°F (98.9°C) Sec. (ASTM — D-88)	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
Flash Ignition — °C Fire Point same as Flashing Temperature — mg/kg					
Oral LD_{50}-rats (approx.)	3980*	4470*	8650*	11,000*	11,900*
Skin MLD-rabbits-mg/kg	>2000*	>1260*	> 794*	> 794*	> 1260*
administered	<3160*	<2000*	<1260 *	< 1260*	< 2000*

*undiluted ** administered as 50% soln. in corn oil # 33⅓% in corn oil

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Aroclor 1260 Light yellow soft sticky resin	Aroclor 1262 Light yellow sticky clear resin	Aroclor 1268 White to off-white powder	Aroclor 4465 Light-yellow, clear, brittle resin	Aroclor 5442 Yellow transparent sticky resin	Aroclor 5460 Clear, yellow-to-amber, brittle resin	Aroclor 2565 Black, opaque, brittle resin
50 max. (APHA)	50 Max. (APHA)	1.5 Max. NPA (molten)	2 Max. NPA (molten)	2 Max. NPA (molten)	2 Max. NPA (molten)	—
0.014	0.014	0.05	0.05	0.05	0.05	1.4
0.00057 (20°-100°C)	0.00064 (25°-65°C)	0.00067 (20°-100°C)	0.00061 (25°-65°C)	0.00123 (25°-99°C)	0.00179 (25°-124°C)	0.00056 (25°-65°C)
1.566-1.566 (99°/15.5°C) 13.90	1.572-1.583 (90°/15.5°C) 13.72	1.804-1.811 (25°/25°C) 15.09	1.670 (25°/25°C) 13.91	1.470 (25°/25°C) 12.24	1.670 (25°/25°C) 13.91	1.734 (25°/25°C) 14.44
388°-420°	395°-425°	435°-450°	230°-320° at 4 mm. Hg.	215°-300° at 4 mm. Hg.	280°-335° at 5 mm. Hg.	—
0.5 to 0.8 0.0 to 0.1	0.5 to 0.6 0.0 to 0.1	0.1 to 0.2 0.0 to 0.06	0.2 to 0.3 0.0 to 0.02	0.2 0.01	0.03 1.5 to 1.7 (at 260°—8 hrs.)	0.2 to 0.3 —
None	None	None	None	247° 477°	None	None
None	None	None	None	> 350° > 662°	None	None
31°	35°-38°	—	—	46°	—	—
88°	99°	—	—	115°	—	—
—	—	150° to 170° (hold pt.)	60° to 66°	46° to 52°	98° to 105.5°	66° to 72°
—	—	302° to 338° (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 (200°F or 130°C)	300-400	—	—
3200-4800	600-850 (160°F or 71°C)	—	—	—	—	—
—	—	—	—	—	—	—
10,000** > 1260** < 2000**	11,300** > 1260** < 3160**	10,900** > 2510### < 3160**	16,000** > 2000** < 3160**	10,600** > 1260** < 2000**	19,200# > 7940#	6,310## > 2000## < 3160

20% soln. in corn oil ### 10% soln. in corn oil

MCNS 079391

RESISTANCE TO DRYING

Aroclor is non-drying. Even when exposed to air in the form of thin films, no noticeable oxidation or hardening takes place. However, when used as a component of paints, varnishes or lacquers, it does not retard the rate of drying of the films. Quick drying varnishes and paints can be made using Aroclor in the formulation.

FIRE-RESISTANCE

Viscous, oil-like Aroclor and the Aroclor resins do not support combustion when heated alone, even at their boiling points — temperatures in excess of 350°C. Most of the Aroclor chlorinated compounds flux readily with other resinous and pitch-like materials to make mixtures that gain in fire retardance properties. Even when incorporated in nitro-cellulose films and rubber foams, Aroclor will retard the rate of burning.

ADHESIVENESS AND THERMOPLASTICITY

The Aroclor resins adhere strongly to smooth surfaces such as glass, metal, varnished or lacquered coatings.

Aroclor is permanently thermoplastic. It apparently undergoes no condensation or hardening upon repeated melting and cooling. Clear Aroclor resins can be supplied with softening points up to 105°C. Opaque, crystalline Aroclor can be supplied with initial melting points up to approximately 290°F.

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 Heat — Aroclor is a useful heat transfer media because of its stability to heat. Aroclor 1254 and particularly the less viscous Aroclor 1248 are recommended for this purpose because they may be heated at temperatures up to 315°C (600°F) in a closed system for long periods without appreciable decomposition and they are fire-resistant.

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.

The Aroclor oils and resins are readily soluble in most of the common organic solvents and drying oils. Hard crystalline Aroclor is in general less soluble than the liquid or softer Aroclor resins. Aroclor is heavier than water, a valuable property for many applications.

MONS 079392

Description

Monsanto's Aroclor plasticizers comprise a series of chlorinated biphenyls and chlorinated polyphenyls. They vary from mobile, oily liquids to white crystals and hard, transparent resins.

Twelve of the Aroclor plasticizers, each of which represents a series, are discussed in this bulletin. An understanding of the system for designation of each Aroclor should prove useful in the evaluation of the property gradations among them. The last two digits indicate the approximate weight percentage of chlorine in the product, and the first two digits indicate the type of material, as follows:

12 — chlorinated biphenyls

25 — blend of chlorinated biphenyls and chlorinated triphenyls (75:25)

44 — blend of chlorinated biphenyls and chlorinated triphenyls (60:40)

54 — chlorinated triphenyls

--Ge
Ar

Form

		mobile oil	mobile oil	mobile 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)	0.00068 (25°-65°
Typical Density Specific Gravity Pounds per gallon — 25°C(77°F)	1.182-1.192 (25°/15.5°C) 9.85	1.270-1.280 (25°/15.5°C) 10.55	1.381-1.392 (25°/15.5°C) 11.50	1.405-1.415 (65°/15.5°C) 12.04	1.495-1.5 (65°/15.5 12.82
Distillation Range — ASTM D-20 (Mod.) Corr. °C	275°-320°	290°-325°	325°-366°	340°-375°	365°-38
Evaporation Loss — % — ASTM D-6 Mod. 163°C.....5 hrs. 100°C.....6 hrs.	— 1.0 to 1.5	— 1.0 to 1.5	3.0 to 3.6 0.0 to 0.4	3.0 to 4.0 0.0 to 0.3	1.1 to 1. 0.0 to 0.
Flash Point — Cleveland Open Cup.....°C °F	141°-150° 286°-302°	152°-154° 305°-310°	176°-180° 348°-356°	193°-196° 379°-384°	None
Fire Point — Cleveland Open Cup.....°C °F	176° 349°	238° 460°	None*	None	None
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.
Viscosity — Saybolt Universal 210°F (98.9°C) Sec. (ASTM — D-88)	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	1800-25
Oral LD_{50}-rats (approx.) mg/kg	3980*	4470*	8650*	11,000*	11,9
Skin LD_{50}-rabbits-mg/	>2000*	>1260*	794*	> 794*	> 126
admin-stered	<3160*	<2000*	<1260*	<1260*	<200

*Based on tests — "No fire point up to boiling temperature of mixture"

MONS 079393

Aroclor 1260 Light yellow soft sticky resin	Aroclor 1262 Light yellow sticky clear resin	Aroclor 1268 White to off-white powder	Aroclor 4465 Light-yellow, clear, brittle resin	Aroclor 5442 Yellow transparent sticky resin	Aroclor 5460 Clear, yellow-to-amber, brittle resin	Aroclor 2565 Black, opaque, brittle resin
50 max. (APHA)	50 Max. (APHA)	1.5 Max. NPA (molten)	2 Max. NPA (molten)	2 Max. NPA (molten)	2 Max. NPA (molten)	—
0.014	0.014	0.05	0.05	0.05	0.05	1.4
0.00087 (99°-100°C)	0.00084 (25°-65°C)	0.00067 (20°-100°C)	0.00061 (25°-65°C)	0.00123 (25°-99°C)	0.00179 (25°-124°C)	0.00066 (25°-65°C)
1.565-1.566 (80°/15.5°C) 13.56	1.572-1.583 (90°/15.5°C) 13.72	1.804-1.811 (25°/25°C) 15.09	1.670 (25°/25°C) 13.91	1.470 (25°/25°C) 12.24	1.670 (25°/25°C) 13.91	1.734 (25°/25°C) 14.44
365°-420°	395°-425°	435°-450°	230°-320° at 4 mm. Hg.	215°-300° at 4 mm. Hg.	250°-335° at 5 mm. Hg.	—
0.5 to 0.8 0.0 to 0.1	0.5 to 0.6 0.0 to 0.1	0.1 to 0.2 0.0 to 0.06	0.2 to 0.3 0.0 to 0.02	0.2 0.01	0.03 1.5 to 1.7 (at 260°—5 hrs.)	0.2 to 0.3 —
None	None	None	None	247° 477°	None	None
None	None	None	None	>350° >662°	None	None
31°	35°-38°	—	—	46°	—	—
88°	99°	—	—	115°	—	—
— —	— —	150° to 170° (hold pt.) 302° to 338° (hold pt.)	60° to 66° 140° to 151°	46° to 52° 115° to 126°	98° to 105.5° 208° to 222°	66° to 72° 149° to 162°
1.647-1.649	1.6501-1.6517	—	1.661-1.667	—	1.660-1.665	—
72-78	86-100	—	90-150 (194°F or 130°C)	300-400	—	—
3260-4500	600-850 (316°F or 71°C)	—	—	—	—	—
—	—	—	—	—	—	—

MONS 079394

0,000** 11,300** 10,900** 16,000** 10,600** 19,200// 6,310///
1260** >1260** >2510/// >2000** >1260** >7910// >2000///
3200** <3160** <3160** <2000** <3160
10% soln. in corn oil /// 10% soln. in corn oil