



AROCLORS* USED IN COMBINATION WITH
SANTOPHEN* 20 (PENTACHLOROPHENOL TECHNICAL)
IN THE PREPARATION OF WOOD-TREATING
FORMULATIONS AND SOIL-POISONS

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Aroclors (chlorinated biphenyls and chlorinated polyphenyls) are used commercially as anti-blooming agents and auxiliary solvents for Santophen 20 (pentachlorophenol technical) in wood-treating formulations.

The resinous Aroclors are functional components of water repellent and wood-sealing ingredients used in preparing the preservative-water-repellent type wood-treating solutions.

Liquid Aroclors such as Aroclor 1242 are highly efficient soil-poisoning agents used to treat soil to protect wood against attack by termites.

This bulletin presents practical formulations based on the use of Aroclors and Santophen 20 for treating wood to protect it against decay, termite attack and to seal it against the influence of water and water vapor.

It also presents practical soil-poisoning formulations, including both the water emulsifiable and the oil soluble types.

*Reg.U.S.Pat.Off.

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I. INTRODUCTION

Liquid and resinous Aroclors (chlorinated biphenyls and chlorinated polyphenyls) are important companion products for use with Monsanto's Santophen 20 (pentachlorophenol technical) in wood preservative and preservative water repellent formulations and in soil-poisoning formulations used in termite control work.

It is standard practice to use 5% by weight of Santophen 20 in the wood-treating formulations, and the merits of this preservative have been established by many years of performance data obtained from the wood preserving industry (1)(2)(7)(8)(9)(12)(13). The physical, biological and physiological properties of Santophen 20 are described in Monsanto Technical Bulletin No. 0-25, "Santophen 20" (10).

Aroclors are economical for use in wood preservation. Their value in this field is based on the following properties:

1. Resinous and also liquid Aroclors prevent Santophen 20 from "blooming" on treated wood and assist in solubilizing the preservative.
2. Aroclors are commonly used in various types of wood finishes, and Aroclor-treated wood can be satisfactorily painted.
3. Aroclors are known to possess repellent action against termites and various other soil organisms.
4. Aroclors are noted for their introfying properties or their ability to facilitate the penetration of materials into wood or other cellulosic fibrous materials (6).

A detailed description of the physical and physiological properties of Aroclors is given in Monsanto Technical Bulletin No. P-115, "The Aroclors" (11).

The purpose of this bulletin is to assist formulators in preparing wood-treating solutions containing Aroclors, principally for wood that must remain clean or be paintable and free from odor. Typical formulations for treating various types of wood products are given. The formulations can be varied to meet specific or unusual requirements.

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II. AROCLOR 5460-SANTOPHEN 20 SOLUTIONS FOR TREATING FENCE POSTS

A simple formulation for a ready-to-use solution consists of:

5% by weight	Santophen 20
5% " "	Aroclor 5460
90% " "	Suitable oil solvent

A light diesel oil or one in the No. 2 fuel oil range is the type suggested for treating fence posts or wood which is not to be painted. Economical oils of this type are available from many sources and assistance in finding a supplier will be given on request. The oil should conform to the following specification:

General Specifications For A Typical Petroleum Oil Solvent For Santophen 20 For Fence Post Type Treatments

Flash, Pensky Martens Closed Cup °F.	NLT*	190
Viscosity, Say. U. at 100°F.	NMT**	45
Water and Sediment, %	NMT	0.1
Pour Point, °F.	NMT	20
Distillation	NLT	90% distilling below 650°F.
Solubility for Pentachlorophenol	NLT	10% at 75°F.

*NLT - Not less than
**NMT - Not more than

Preparation Of The Treating Solution

A mixing tank of iron, "mild" steel, alloy steel or other similar material equipped with a bottom outlet, a stirrer and with steam heating coils or electric heating elements or an external heat-exchanger is suitable for preparing the mixture.

Motors and wiring should be spark-proof, ventilation should be provided and the recommendations of the Underwriters with respect to fire safeguards should be followed.

Charge 90 parts by weight of the oil into the mixing tank, agitate, and heat to 130°-140°F. (Never heat the oil above its flash point.)

Add 5 parts by weight of Aroclor 5460 and then 5 parts by weight of Santophen 20.

Continue stirring and heating until all of the Aroclor 5460 and Santophen 20 have dissolved. Cool to approximately room temperature, filter if desirable, and package.

Application And Effectiveness
Of The Fence Post Treatments

For detailed information about the methods of application and the effectiveness of fence post type treatments, please refer to publications by Walters (13) and reports of test readings by the same author in 1946, 1947 and 1948 (12), and also publications by Blew (1), and Buchman and Para (2).

**III. AROCLOR 5460-SANTOPHEN 20 SOLUTIONS
FOR TREATING MILLWORK**

The use of Aroclor 5460 in conjunction with Santophen 20 preservative is especially important in treating solutions for window sash, doors and other millwork or any wood products that are to be painted. The following type formulation has been used successfully for this purpose:

5% by weight	Santophen 20
5-10% " "	Aroclor 5460
85-90% " "	Suitable oil solvent (Range Oil or Kerosene)
(5% " "	Pine Oil)

Selection of the oil solvent with reference to paintability of the wood is important and must conform with the following specification:

General Specifications For A Typical Petroleum Oil Solvent
For Santophen 20 For Sash, Door, And Other Millwork Treatment

Water and Sediment, %	NMT*	0.25
Pour Point, °F.	NMT	0
Viscosity, S.S.U. at 100°F.	NMT	40
Flash, Open Cup, °F.	NLT**	150
Gravity, A.P.I. at 60°F.	Range	35-40
Color, N.P.A.	NMT	1
Aniline Number, °C.	NMT	48
Sulfur, %	NMT	0.50
Distillation range, °F.	Range	385-513 (typical, not a specification)

*NMT - Not more than

**NLT - Not less than

Solvents of this type are commonly called range oil or kerosene and are readily available from many sources. Assistance in finding a supplier in a given location will be given on request.

Range oils or kerosene fractions which are relatively high in aromatic content will be sufficiently strong in solvent power to hold the 5% Santophen 20 in solution. In such cases, it is not necessary to use the pine oil auxiliary solvent. However, in cases where the range oil or kerosene solvent power for Santophen 20 is relatively low, then it is essential to incorporate 5% of pine oil in the formulation.

The procedure for preparing this formulation is essentially the same as described for preparing the solution for treating fence posts, etc., and the equipment is the same.

Application And Paintability

Many kinds of wood and different types of woodwork or wood products have been treated satisfactorily with preservative formulations of this type for industrial and domestic purposes, since their introduction over ten years ago. For information about the satisfactory paintability of the treated wood, reference is made to the publications by Gardner and Hart (3), and a subsequently published article by Klund (4). These publications about exposure studies on wood panels treated with the preservative solution and then finished with enamels and standard white lead, and mixed lead, zinc and titanium systems, indicated that the treated wood can be painted satisfactorily.

However, to eliminate any questions about paintability arising from the use of range oil or kerosene type solvents in the formulation previously described, a practical expedient is to replace the range oil with a fast-evaporating diluent such as the fractions called mineral spirits. This practice requires use of 5% of pine oil as an auxiliary solvent and also involves the use of a lower flash point thinner.

The suggested formula is:

5%	by weight	Santophen 20
5-10%	"	Aroclor 5460
5%	"	Pine Oil
80-85%	"	Mineral Spirits Solvent

The solvent for the above type formulation should conform with the following specification. Solvents of this type are available in most sections of the country and further information about suppliers will be given on request.

Typical Solvent Specification (Mineral Spirits)

1. Gravity, A.P.I. gravity of 48.9.
2. Specific gravity at 15.5/15.5°C. (60/60°F.) = 0.7844.
3. Distillation range: Initial 305°F.
5% 318
10 321
20 325
30 329
40 333
50 337
60 341
70 347
74.5 350
80 354
90 365
95 375
E.P. 390
4. Refractive index at 20°C. = 1.4336
5. Flash point (Tagliabue Closed Cup) = 101°F. Minimum
6. Kauri-Butanol Number = 35.5
7. Acidity - No acidity either when shaken with water and the water tested or when the residue from the distillation test is tested with water.
8. Corrosion - 3 hours at 212°F. = OK
3 hours at 122°F. = OK
9. Doctor test = OK
10. Water - none
11. Rate of evaporation - Rate of evaporation is determined by placing on a No. 2 Whatman filter paper 0.01 ml. of the petroleum hydrocarbon from a 1 ml. pipette calibrated in 0.01 ml. Ten such drops shall be placed on filter papers, and the papers hung vertically, protected from drafts, in an air-conditioned room at 80°F. and 55% relative humidity. The filter papers are hung so that they can be examined by transmitted light, and the average time which elapses until the oily spots are no longer perceptible is taken as the evaporation time. The average evaporation time for acceptable products shall not exceed 15 minutes by the above test.
12. Assay - The material must be 100% petroleum hydrocarbons.
A typical analysis is:
Aromatics 10.0%
Naphthenic 34.0
Paraffinic 56.0
Open chain
unsaturates None
100.0%

Methods of analysis as used for determining the data under item 12. on page 6. are described in the following two references: Thomas, Block and Hoekstra, Anal. Ed. Ind. and Eng. Chem., Vol. 10, Page 154 (1938); Grosse and Wackher, Anal. Ed. Ind. and Eng. Chem., Vol. 11, Page 615 (1939).

IV. AROCLOR 5460-SANTOPHEN 20 PRESERVATIVE-SEALER WATER REPELLENT TYPE WOOD-TREATING FORMULATIONS

The most efficient protective wood-treating formulations incorporate Santophen 20 to protect the wood against degrading organisms and insects and water-repellent materials to reduce dimensional changes.

Below its fiber saturation point (25-30% moisture) wood changes in dimensions according to variations in its moisture content, influenced by exposure to humidity of the atmosphere as well as to liquid water such as rain and condensate. For most practical purposes, such as window sash, doors or table drawers, the influence of moisture on the dimensional stability of the wood is a variable of relatively short duration. Accordingly, the function of the water-repellent materials is to retard the rate of moisture movement so as to maintain the moisture content of the wood to its average during limited periods of high variations in atmospheric moisture. As a consequence, a smaller degree of swelling and shrinking is experienced.

The following is a typical example of a preservative water-repellent formulation:

<u>Ingredient</u>	<u>Ready-To-Use Solution</u>	
	<u>Lbs./100 Lbs.</u>	<u>Lbs./100 Gals. @15.5°C.</u>
Santophen 20	5.19	37.00
Aroclor 5460	5.00	35.65
Pine Oil (Yarmor 302)	5.00	35.65
Falkovar K Extra Heavy Fish Oil	10.00	71.30
Refined Paraffin Wax	1.00	7.13
Sinclair Solvent Mineral Spirit	74.00	527.62
Cobalt Naphthenate Drier		
6% Cobalt (0.03% Cobalt Metal based on weight of Fish Oil)	22.7 ml. (not lbs.)	161.85 ml. (not lbs.)
	100.19 lbs.	714.55 lbs.

Specific Gravity 15.5°C. = 0.855
100 gallons = 714.5 lbs.; 1 gallon = 7.14 lbs.

This formulation can also be prepared as a concentrate from which a diluted ready-to-use solution can be made by adding $1\frac{1}{2}$ parts by volume of mineral spirits to 1 part of the concentrate. The formula for the concentrate is as follows:

<u>Ingredient</u>	<u>Concentrate</u>	
	<u>Lbs./100 lbs.</u>	<u>Lbs./100 gal. @ 15.5°C.</u>
Santophen 20	11.20	92.31
Aroclor 5460	10.79	88.94
Pine Oil (Yarmor 302)	10.79	88.94
Falkovar K Extra Heavy Fish Oil	21.59	177.95
Refined Paraffin Wax	2.16	17.80
Sinclair Solvent Mineral Spirits	43.46	359.70
Cobalt Naphthenate Drier 6%		
(0.03% Cobalt Metal based on weight of Fish Oil)	49.0 ml. (not lbs.)	404.0 ml. (not lbs.)
	99.99 lbs.	825.64 lbs.

Specific Gravity at 15.5°C. = 0.9883
1 Gallon = 8.25 lbs.

The solvent for the above type formulation should conform with the specification as given on page 7 of this bulletin. Solvents of this type are available in most sections of the country and further information about suppliers will be given on request.

Selection of a proper grade paraffin wax is also important and only refined paraffin wax, melting point 125-127°F. should be used. Scale wax is not recommended.

Specification For Falkovar K Extra Heavy Fish Oil (Produced
By Falk And Company, Pittsburgh, Pennsylvania)

Saybolt Viscosity at 210°	450
Gardner-Holdt Body Tube	2-1
Specific gravity at 60°F.	0.965
Acid value	3.4
Iodine No. Wtjs.	105
Refractive Index at 25°C.	1.4920
Color, Gardner Permanent Scale	8

Specifications For Pine Oil

	<u>Yarmor 302 1)</u>	<u>W.H. Barber Co. 2)</u>
Specific gravity at 15.5°C.	0.94-0.946	0.934-0.942
Ref. Index at 20°C.	1.480	1.480 min.
Color	Very pale straw	Water white
Moisture	Not over 0.5%	Not over 0.5%
Unpolymerized residue	Not over 2.5%	
Flash point (Cleveland Open Cup)	79°C. (174.2°F.)	175-195°F.
Distillation range:		
(ASTM D-268 31T)		
Initial 5%	211.0°C.	190-200°C.
50%	216.4°C.	205-210°C.
95% (end pt.)	223.0°C.	220-225°C.

- 1) Product of Hercules Powder Co., Wilmington, Delaware.
2) Product of W. H. Barber Co., Chicago, Illinois.

Equipment And Preparation

The equipment for preparing this type of formulation or its concentrate is essentially the same as described for preparing the solution for treating fence posts, etc.

The process consists of the following steps: Transfer the fish oil, pine oil and Aroclor resin to the mixing tank and heat to 110°C. from one to two hours until the solution is clear. Cool to 90°C., add the paraffin wax and Santophen 20 and agitate for one hour or until the solution is clear. Cool to 35°C. and add the Sinclair Solvent and the drier and agitate the solution for thirty minutes, and package.

Characteristics, Application And Paintability

Question may arise about the choice of the Falkovar K Extra Heavy Fish Oil selected for use in preference to other drying oils such as linseed, tung, oiticica, etc. or semi-drying oils such as soya, etc. This specific fish oil is relatively free from odor and when used with the recommended driers, it offers good drying characteristics and durability. Unlike other drying oils tested, this fish oil does not "liver" in the finished formulation when it is exposed for long periods to the atmosphere or when the solution is used continuously in open dipping vat operations.

Where the wood treating formulation is to be packaged in cans or closed containers such as used for shelf goods and where prolonged air exposure is not expected, then drying oils other than Falkovar K Extra Heavy Fish Oil may be used.

This type of water repellent preservative for wood conforms to the general specifications of the Western Pine Association's Technical Bulletin No. 6 (revised) (14).

The amount of solution to be absorbed depends upon the requirements of a given application and may vary as widely as from 10 to 15 gallons absorption per 1,000 board feet of lumber.

For sash, doors and frames, as well as for interior and exterior trim millwork, a dip of not less than three minutes made in accordance with the National Woodwork Manufacturers' Association's standard specification is usually sufficient.

Such a treatment does not adversely affect the appearance of the wood. After allowing the petroleum solvent to volatilize, the wood may be satisfactorily glazed, painted or varnished.

If the wood is to be lacquered, the paraffin wax should be eliminated from the formulation.

Oil stains may be satisfactorily applied to the treated wood, but due to the water repellent features of the treatment, the treated wood will not take water stains.

Good putty gives satisfactory adhesion and bonding to the treated wood, depending upon the time elapsed between treating and puttying. The putty may require up to twenty-four hours longer to set firmly than on untreated sash, but in no way is the bonding impaired. An overnight drying period is recommended before glazing treated sash.

Comprehensive studies were made in collaboration with the Scientific Section, National Paint, Varnish and Lacquer Association, Inc., Washington, D. C. (5) concerning the paintability of sugar pine, southern yellow pine and ponderosa pine treated with the preservative water-repellent formulations. Results of exterior paint tests conducted in Florida and Maryland and also studies on interior enamels showed that the treated wood can be painted very satisfactorily.

V. AROCLOR 5460-ALKYD RESIN-SANTOPHEN 20
PRESERVATIVE-SEALER FORMULATIONS

If it is necessary to provide faster drying or film setting times than can be accomplished when drying oils are used, it may be desirable to replace the oils with selected alkyd resins modified with oils such as linseed or cottonseed, etc.

A typical formulation is as follows:

5.0%	by weight	Santophen 20
3.0%	" "	Aroclor 5460
10.0%	" "	Oil Modified Alkyd Resin Solids
1.0%	" "	Paraffin Wax
81.0%	" "	Mineral Spirits
(0.4%	lead and 0.01% cobalt driers based on weight of alkyd resin solids)	

Formulations of this type using modified alkyds do not usually possess the good solution stability when exposed to air in an open tank for relatively long periods of time as indicated for the previous type formulations. However, this factor of stability depends almost entirely on the specific type of drying oil used in making the modified alkyd. For example, it has been our experience that a linseed oil modified alkyd will have markedly shorter solution stability than alkyds modified with semi-drying oils or cottonseed oil. With reference to the linseed oil modified alkyd, the resin was composed of 84 parts Pentek (pentaerythritol), 100 parts phthalic anhydride and 228 parts linseed fatty acids. The finished resin contained 70 parts resin solids and 30 parts mineral spirits (Varnolene).

A similar alkyd prepared using fish oil showed poor solution stability but one made with cottonseed oil indicated reasonably good solution stability. It is important to point out that these comments do not refer to the solution stability of the alkyd resins alone in mineral spirits type solvent. They refer to such solutions containing 5% of Santophen 20 which may influence this phenomena of causing solution instability.

There are many alkyd resins commercially available and in selecting an alkyd for this type of formulation, we suggest that the solution stability should be checked carefully with reference to the end use requirements. This is especially pertinent if the wood-treating solution is to be used in an open commercial dipping vat but may not be an important factor in the case of shelf goods where the consumer will use relatively small amounts of the solution without long-time exposure to the air.

The solution composed of Santophen 20, Aroclor 5460 and oil modified alkyl resins in the absence of paraffin wax are suggested for treating wood that is to be finished with lacquers. Paraffin wax has serious deleterious effects on lacquer coatings, preventing the usually strong lacquer-to-wood bonds from setting and, therefore, the wax should be eliminated when treating wood that is to be lacquered. When the wax is omitted from the formulation, the treated wood surface takes lacquer satisfactorily and with good bonding qualities.

Especially in factories where lacquer applications are on a production line schedule, the fast drying wood-treating formulations as described are desirable because they conform with the factory schedules much better than is the case with the slower drying or setting type preservative-sealers.

VI. AROCLOR 1242-SANTOPHEN 20-TRICHLOROBENZENE
WATER EMULSIFIABLE SOIL-POISON CONCENTRATE

Description And Preparation Of The Concentrate

Aroclor 1242 (chlorinated biphenyl) has been found highly efficient as a soil-poison to protect wood against termite attack. This is a new development and is based on the results of 7-year soil-poison plots installed by Monsanto in areas highly infested with termites.

Santophen 20 (pentachlorophenol technical) is a standard soil-poison regarded effective for relatively long periods of time. Monsanto's trichlorobenzene is a standard fumigant type soil-poison. To these materials we are now adding the outstanding value derived from Aroclor 1242 as a relatively permanent type soil-poison.

As described below, these materials are formulated into a water emulsifiable soil-poison concentrate carrying almost 80% by weight of active ingredients.

Aroclor 1242	34.00%
Trichlorobenzene (Mixed Isomers)	34.00
Santophen 20	10.00
Xylene	19.75
Monsanto's Emulsi- fier H	2.25
	100.00%

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To prepare the concentrate, mix the Aroclor 1242 and trichlorobenzene, heat to 55-60°C. and then add the Santophen 20 and stir until dissolved. Remove the heat, add the xylene and Monsanto's Emulsifier H. The concentrate is a sparkling clear solution and does not cloud or separate on aging.

This preferred method of preparation does not involve fire hazard since only the relatively nonflammable materials are heated.

Description And Preparation Of The Emulsion

To make the ready-to-use soil treating emulsion, add 3 parts by volume of water to one part by volume of concentrate. Place the concentrate in a container equipped with a good agitator or a circulating pump. With the agitator in operation, add the required amount of water in increments to the concentrate and agitate until a good emulsion is formed.

Where a highly stable emulsion is required, it is desirable to use a colloid mill or homogenizer. For ordinary applications this equipment is not essential.

The emulsion should be free flowing, similar to water. If it is thicker than desired, add a small amount of Monsanto's Santomerse S and agitate until the emulsion is free flowing.

Application

Use one gallon of the diluted emulsion to treat one cubic foot of soil. This will incorporate active ingredients greater in amount than the quantity usually used with reference to oil soluble soil-poison treatments. This is economically feasible because the emulsion eliminates the cost of oil and offers other attractive economies.

Pending results of field studies, it is reasonable to expect that the water emulsifiable concentrate can be used effectively at substantially greater dilutions than recommended at this time.

Advantages

1. The water emulsion soil-poison treatment eliminates the cost of using oil and the inconvenience, odor, discoloration and fire hazard prevalent when oil is used.
2. The emulsion treatment is economical, easy to prepare, free from fire hazard and is clean. Its odor is pleasant.

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3. All of the ingredients are readily available in commercial quantities.
 4. The concentrate carries a very high concentration of active soil-poison ingredients. The "old time" standards of the extermination industry are used. In addition, the outstanding value derived from Aroclor 1242 is incorporated.
 5. The water-emulsion treatment reduces the destructive action of trichlorobenzene used in oil type treatments on rubber hose and other equipment.

VII. AROCLOR 1242-SANTOPHEN 20-TRICHLOROBENZENE
OIL SOLUBLE SOIL-POISON CONCENTRATE

The water emulsifiable concentrate described in the foregoing is readily soluble in practically any petroleum oil regardless whether the oil is high in aromatic or aliphatic content. Accordingly, this product is an excellent oil soluble concentrate also. However, in the interest of added economy, the Monsanto Emulsifier H can be eliminated from the formulation when the concentrate is to be diluted with petroleum oils for soil-poison work. Thus, the suggested formula is:

Aroclor 1242	35%
Trichlorobenzene	35%
Santophen 20	10%
Xylene	20%
	100%

To prepare this concentrate, mix the Aroclor 1242 and trichlorobenzene, heat to 55-60°C. and then add the Santophen 20 and stir until dissolved. Remove the heat and add the xylene.

Application

Based on the active soil-poisoning ingredients, the concentrate is diluted with a suitable oil to a degree commensurate with the soil-poison requirements for a given application.

In calculating the active ingredient, Aroclor 1242 and Santophen 20 should be figured equivalent in effectiveness and as the long-term soil-poisoning agents; the trichlorobenzene should be calculated as the fumigant type and short-term poisoning agent.

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