AROCLOR® COMPOUNDS IN FORMULATING HIGH STYRENE COPOLYMER SURFACE COATINGS (PLIOLITE S-5 RESINS)

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AROCLOR COMPOUNDS

in formulating high styrene copolymer surface coatings (pliolite S-5 resins)

INTRODUCTION

This booklet has been prepared as a guide in formulating a variety of finishes using Pliolite* resins and Monsanto Aroclor** plasticizers. These finishes include exterior finishes for poured concrete, concrete blocks, cinder blocks, asbestos-cement shingles, stucco, brick, and allied masonry surfaces. High styrene copolymer resins formulated with Aroclor plasticizers make excellent paint vehicles — and are relatively easy to formulate.

Aroclor compounds are inert chlorinated bi- and polyphenyls which show excellent compatibility with high styrene copolymer resins. Compounded with Pliolite S-5 resins, the Aroclor plasticizers produce a wide variety of specialized and general purpose coatings which show excellent resistance to corrosive influences, including acids, alkalies and moisture.

The techniques presented in this booklet for preparing the protective coatings are in accordance with information prepared by the Chemical Division of Goodyear Tire and Rubber Company.

*Pliolite: T.M. Goodyear Tire & Rubber Company. Reg. U.S. Pat Off.

**Aroclor: Monsanto trademark, Reg. U.S. Pat. Off.

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Furthermore, nothing contained herein shall be construed as a recommendation to use any product in conflict with existing patents covering any material or its use.

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GENERAL PHYSICAL CHARACTERISTICS OF AROCLORS 1254 AND 5460

	AROGLOR 1254	AROCLOR 5460
Form	Light yellow viscous liquid	Yellow transparent resin
Color	150 Max. (APHA)	2.0 Max. NPA
Acidity — Maximum (Mgm. KOH per Gm.)	0.015	0.07
Average Coefficient of Expansion cc/cc/°C	0.00066 (25°-65°C)	0.00179 (25°-124°C)
Typical Density		
Specific Gravity 25/25°C (77°/77°F)	1.538	1.740
Pounds per Gallon — 25°C (77°F)	12.82	14.50
Distillation Range — ASTM D-20 (Mod.) Corr. °C	365°-390°	280°-335° at 5 mm. Hg.
Evaporation Loss-%-ASTM D-6 Mod.		
163°C..... 5 hrs.	1.1 to 1.3	0.03
100°C..... 6 hrs.	0.0 to 0.2	1.5 to 1.7 (at 260°-5 hrs.)
Flash Point-Cleveland Open Cup.....°C	None	None
°F		
Fire Point-Cleveland Open Cup.....°C	None	None
°F		
Pour Point-ASTM D-97 .....°C	-10°	——
°F	50°	——
Softening Point-ASTM E-28.....°C	——	100° to 105.5°
°F	——	212° to 222°
Refractive Index-D-line — 20°C	1.639-1.641	1.660-1.665
Viscosity-Saybolt Universal		
Sec. (ASTM-D-88) 210°F (98.9°C)	44-48	——
130°F (54.4°C)	260-340	——
100°F (37.8°C)	1800-2500	——

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SOLUBILITY OF AROCLORS IN 100 MILLILITERS OF VARIOUS SOLVENTS

Type of Solvent	1254 (@ 25°C)	1254 (@ Hot)	5460 (@ 25°C)
Ester			
Amyl Acetate	S	S	S
Butyl Acetate	S	S	S
Cellosolve Acetate	S	S	S
Dibutyl Phthalate	S	S	S
Diethyl Phthalate	S	S	S
Ethyl Acetate	S	S	S
Ether Alcohol			
Carbitol	173 (26°C)	259 (98°C)	SS
Cellosolve	S	S	S
Diethylene Glycol	I	I	I
Hydrocarbon			
Benzene	VS	VS	143
Gasoline	VS	VS	S
Kerosene	VS	VS	S
Mineral Spirits	VS	VS	S
Paraffin	SS	S	SS
Pine Oil	S	S	S
Toluene	VS	VS	142
Turpentine	VS	VS	S
Xylene	VS	VS	178
Hydroxy — derivatives			
Amyl Alcohol	S	S	S
n-Butyl Alcohol	S	S	S
Ethyl Alcohol (3-A)	10 (27°C)	28 (75°C)	2
Methyl Alcohol	15 (26°C)	22.2 (65°C)	SS
Ketone			
Acetone	S	S	260
Miscellaneous			
Water	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.

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GENERAL PHYSICAL PROPERTIES OF PLIOLITE S-5 RESINS

Pliolite resins are versatile bases for formulating a variety of paints and coatings that require good resistance to moisture, acids, alkalies and other corrosive chemicals.

The general and specific properties of Pliolite S-5 as given by Goodyear Tire and Rubber Company, Chemical Division, Akron, Ohio, are as follows:

Typical Properties of Pliolite S-5

General Properties —

Form	White resinous powder
Color of solution	Water-white
Color of film	Clear and colorless
Odor	Odorless
Toxicity	Non-toxic

Pliolite resins are available in two series distinguished primarily by the viscosity of a 33 - 1/3% solution in Xylene measured in a No. 4 Ford Cup. The viscosities obtained are as follows:

Pliolite S-5A	190-240 secs.
Pliolite S-5B	160-190 secs.

		Pliolite S-5A	Pliolite S-5B
Specific Physical Qualities	Specific gravity	1.049	1.049
	Index of refraction	1.585	1.585
	Softening range	48-55	47-53
	Acid value	Neutral	Neutral

Chemical Resistance of paint films — Non-oxidizable, non-saponifiable, highly resistant to moisture, acids, alkalies, soaps and general corrosive influences. Highly resistant to alcohol, very resistant to vegetable, animal and mineral oils and greases.

General Physical Qualities of paint films — Thermoplastic, outstanding toughness and adhesion. High degree of flexibility with a minimum amount of plasticizer. Good thermal stability; withstands baking. Highly resistant to abrasion and scrubbing. Good aging characteristics; coatings do not oxidize and become brittle.

PIGMENTED PLIOLITE S-5 PAINT BASES

Pliolite S-5 paint bases are available — with various standard pigments dispersed in Pliolite S-5 resins. These pigmented resin bases can be used where conventional grinding equipment is not available.

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For a variety of formulations, Goodyear offers pigmented resin bases given in the following table:

Pliolite S-5 Bases

Base No.	Percent Resin	Percent Pigment or Extender	Specific Gravity
1A-S5	35%	65% Titanium Dioxide, Rutile Type	2.02
2C-S5	60%	40% Carbon Black	1.27
5-S5	30%	70% Zinc Oxide	2.46
6-S5	20%	80% Red Lead	3.60
7C-S5	40%	60% Red Iron Oxide	2.06
8A-S5	40%	60% Zinc Chromate	1.84
13A-S5	40%	60% China Clay	1.66
14-S5	30%	70% Lithopone	2.25
15-S5	30%	70% Zinc Sulfide	2.20
17-S5	80%	20% Prussian Blue	1.17
38-S5	40%	60% Yellow Iron Oxide	1.92
39C-S5	40%	60% C.P. Chrome Green, Medium	1.89
41A-S5	35%	65% C.P. Chrome Yellow, Medium	2.30
46C-S5	60%	40% Lampblack	1.36
64-S5	25%	75% Molybdate Orange, Dark	2.79
65-S5	40%	60% C.P. Chrome Yellow, Extra Light	2.10
66A-S5	75%	25% Phthalocyanine Blue Lake	1.24
68A-S5	40%	60% C.P. Chrome Green, Extra Light	2.02
80-S5	35%	65% Titanium Dioxide, Rutile Type meeting Fed. Spec. TT-T-425 Type II, Class B	2.02
81-S5	35%	65% Titanium Dioxide, meeting Fed. Spec. TT-T-425 Type III, Class C	
82-S5	35%	65% C.P. Chrome Oxide	
85-S5	75%	25% Modified BON Red	

PROPERTIES OF PLIOLITE S-5 RESIN FILMS

Pliolite S-5 paint formulations containing Aroclors possess a number of advantages that make such formulations valuable for a variety of uses. Among the advantages are the following:

1. Superior resistance to acids and alkalies.
2. Excellent water resistance combined with satisfactory rate of moisture vapor transmission.
3. Tough durable films resistant to checking, peeling, pitting, flaking and cracking.
4. Excellent adhesion to masonry and allied surfaces.
5. Resistance to mildew.
6. Resistance to staining and discoloration.
7. Self-cleaning properties through controlled pigment chalking.
8. Ease of application.
9. Rapid drying.
10. Excellent can stability.

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SOLVENTS FOR AROCLORS AND PLIOLITES S-5 COMPOSITIONS

Aromatic hydrocarbons, or petroleum naphthas with high aromatic content, are the most satisfactory solvents for Aroclors and Pliolite S-5 coating compositions. Solutions in these solvents tolerate dilution with inexpensive petroleum thinners up to about 50 per cent by weight of the total solvent content.

These solutions are chemically neutral, stable and do not change in viscosity on aging nor do they react with pigments on long storage. The solution viscosity varies somewhat with the particular Pliolite resin and solvent used.

Aromatic Hydrocarbons	Pliolite S-5A Concentrations 10%	20%
Benzene	LV	LV
Toluene	LV	LV
Xylene	LV	LV
High Flash Naphtha	LV	LV
High Aromatic Content Petroleum Solvents		
*1 Apcosol 3A	LV	LV
*1 Apco Iso 12	LV	LV
*2 Solvesso No. 1	LV	MV
*2 Solvesso No. 2	LV	MV
*3 Solvent No. 2159	LV	LV
*3 Solvent No. 2161	LV	LV
Chlorinated Hydrocarbons		
Carbon tetrachloride	LV	HV
Ethylene dichloride	LV	MV
Trichloroethylene	LV	HV
Perchloroethylene	MV	HV
Monochlorobenzene	LV	MV
Orthodichlorobenzene	MV	HV
Tetrachloroethane	LV	HV
Esters		
Amyl acetate	LV	LV
Butyl acetate	LV	LV
Ethyl acetate	LV	LV
*4 Cellosolve acetate	LV	LV
Ketones		
Cyclohexanone	LV	MV
Methyl ethyl ketone	LV	LV
Methyl n-amyl ketone	LV	LV
Methyl iso-butyl ketone	LV	LV
Terpene Hydrocarbons		
Dipentene	LV	LV
Turpentine	LV	LV
Nitro Paraffins		
1-Nitropropane	LV	LV

LV — Low viscosity solution
MV — Medium viscosity solution
HV — High viscosity solution

*Suppliers
1 Anderson-Prichard Oil Corp.
2 Standard Oil Co. of N. J.
3 C. P. Hall Company
4 Carbide and Carbon Chemicals Corp.

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In addition to this general information about solvents, Goodyear in their literature (Technical Manual, Code A-9403-K) presents very comprehensive data concerning the selection of solvents and diluents for Pliolite S-5 paints. The Kauri-Butanol value has been found to be an excellent guide in choosing solvent mixtures for Pliolite S-5. In general, aromatic hydrocarbon solutions of Pliolite S-5 can be diluted with aliphatic hydrocarbons until the Kauri-Butanol value has been reduced to about 60. In the calculation of costs, this serves as a guide in computing the maximum amount of aliphatic hydrocarbon of known K-B value that can be used with a given aromatic type solvent of known K-B value. Goodyear suggests that the K-B value of the solvent mixture be kept near the 60 value but stresses the importance of the fact that during drying the solvent mixture should not become leaner in solvency than this initial value. This can be insured by choosing aliphatic and aromatic solvents possessing approximately the same boiling range. Due to their lower heat of vaporization, aliphatic hydrocarbons — when mixed with aromatic hydrocarbons of the same boiling range — always evaporate first and consequently such a solvent mixture will become progressively richer in solvent power upon drying.

Based on data taken from Circular 709 of the Scientific Section, National Paint, Varnish and Lacquer Association, Washington, D. C., and from bulletins of solvent suppliers, Goodyear has classified a large number of solvents and diluents for Pliolite S-5 (Technical Manual, Code A-9403-K) as being either very fast, medium or slow drying. This information is highly important, particularly since Pliolite S-5 paints dry almost entirely in accordance with the rate of solvent release.

GUIDE TO THE MANUFACTURE OF COATINGS WITH PLIOLITE S-5

Conventional Grinding

Pliolite S-5 resins are dissolved in a selected solvent or solvent combination to serve as the paint vehicle. A primary grinding paste is prepared, added to a secondary paste, and the mixture finally thinned to the finished product. Aroclor 1254 (liquid) serves as a plasticizer, and Aroclor 5460 (resin), both added in the final thinning, serves as a fortifying extender.

Pigments are ground into Pliolite resin pastes by the conventional methods and the coatings are formulated in the usual manner. To insure maximum durability and lasting beauty, the pigments used for masonry paints should be alkali resistant.

Using any of the general procedures listed below to facilitate solution, it is standard practice to cut the Pliolite S-5 resin in aromatic hydrocarbon solvents such as toluene, xylene or high flash naphtha for the initial vehicle preparation. After this operation the other ingredients are blended in and petroleum solvents such as mineral spirits are used to make the final dilution of the paint.

Three Methods of Solubilizing Resins (or pigmented bases)

1. Agitate the Pliolite resin and solvent by means of a stirring device, or by tumbling in a drum or pebble mill until the resin has completely dissolved.
2. A more rapid method — use simple stirring agitation until the material has softened, then pass through a pebble mill or three-roll mill to complete the solution of the resin.
3. Using an internal-type mixer such as a Banbury, mix a sufficient amount of solvent with the Pliolite pigmented base to form a heavy paste. Stir this mixture until the batch is smooth. The operation can be done in three to four hours by keeping the paste sufficiently stiff to develop a temperature of at least 150°F., from frictional heat. Following this stirring, the batch may be diluted until it can be easily transferred to a mixing tank where the balance of the ingredients are added to complete the formulation.

BALL OR PEBBLE MILLING OF PLIOLITE S-5 STUCCO PAINTS

To obtain the correct combination of impact and shearing action in the milling of Pliolite S-5A paints, Goodyear technicians undertook an exhaustive study of pebble mill grinding. As a result of this work, four factors have been shown to be of paramount importance in producing Pliolite S-5 paints in conventional ball and pebble mills and in the formulas on page 7. These are:

1. An optimum pebble charge exists for grinding stucco and masonry finishes.

   The actual (not the apparent) volume of the pebbles should be 37% of the total volume of the pebble mill.

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2. An optimum paste charge exists for grinding stucco and masonry finishes.

   This paste volume by both laboratory and plant production data indicates that an ideal grinding paste volume is 66⅔ of the interstitial volume of the pebble charge (e.g. the void volume between the pebbles, not including the free space above the pebble level).

3. An optimum paste composition yielding the most effective deflocculation of pigment agglomerates can be designed for individual stucco paint formulations.

   These optimum grinding paste compositions for the preparation of white and deep tone Pliolite S-5 stucco finishes are listed in the Table.

OPTIMUM PASTE COMPOSITIONS
RECOMMENDED PEBBLE MILL CHARGING OF PLIOLITE S-5 STUCCO PAINTS

—Pounds Per 100 Gallons—

	S-108-100 White	S-108-200 Green	S-108-300 Red	S-108-400 Brown	S-108-500 Buff	S-108-600 Gray	S-108-700 Blue	S-108-800 Yellow
Primary Grinding Paste								
Pliolite S5A	65.2	46.9	42.2	49.2	64.2	62.3	59.0	52.7
TiO_2 Rutile	177.4	.....	.....	47.4	.....	123.5	17.9	84.2
Chrome Oxide	.....	211.6	.....	.....	.....	.....	.....	.....
Red Iron Oxide	.....	.....	215.8	.....	.....	.....	.....	.....
Light Brown Oxide	.....	.....	.....	47.4	.....	.....	.....	.....
Dark Brown Oxide	.....	.....	.....	94.8	.....	.....	.....	.....
Yellow Iron Oxide	.....	.....	.....	.....	153.0	.....	.....	.....
Lamp Black	.....	.....	.....	.....	.....	18.7	.....	.....
Phthalocyanine Blue Lake	.....	.....	.....	.....	.....	.....	56.5	.....
Hansa Yellow	.....	.....	.....	.....	.....	.....	.....	28.1
Zinc Oxide	50.5	49.7	48.3	.....	45.4	47.7	.....	50.4
Asbestine	204.1	200.9	194.9	195.3	183.2	192.7	168.5	203.6
Solvesso 100	130.3	111.9	102.2	116.1	167.0	141.9	149.1	105.4
Mineral Spirits #10	130.3	111.9	102.2	116.1	167.0	141.9	149.1	105.4
	757.8	732.9	705.6	666.3	779.8	728.7	600.1	629.8
Secondary Paste Addition								
Pliolite S5A	6.3	22.6	25.2	18.3	.....	4.3	.....	18.7
Pliolite S-3 Gel*	20.0	20.0	20.0	20.0	20.0	15.0	15.0	15.0
Dicalite	75.9	74.7	72.5	72.7	68.1	71.7	62.6	75.7
Solvesso 100	42.3	48.0	46.1	48.6	21.4	44.3	49.7	50.9
Mineral Spirits #10	95.6	48.0	46.1	48.6	57.1	66.1	49.7	50.9
	240.1	213.3	209.9	208.2	166.6	201.4	177.0	211.2
Thinning Addition								
Aroclor 1254	35.3	34.7	33.7	33.7	31.6	33.3	29.1	35.2
Aroclor 5460	35.3	34.7	33.7	33.7	31.6	33.3	29.1	35.2
Solvesso 100	35.3	50.2	64.7	48.7	31.6	33.3	34.0	35.2
Mineral Spirits #10	.....	68.2	82.3	66.7	13.9	25.0	47.5	70.1
	105.9	187.8	214.4	182.8	108.7	124.9	139.7	197.1
Totals	1103.8	1134.0	1129.9	1057.3	1055.1	1055.0	916.8	1038.1

*Pliolite S-3 Gel—Ten parts by weight of Pliolite S-3 resin are added to 90 parts of Xylol. The components are mixed for a few minutes and allowed to stand for two hours. The solution is then remixed and allowed to stand for two days. The resulting product is a uniform gel, free from lumps and unswelled particles.

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4. Optimum grinding times exist for the full realization of colors in deep tone finishes.

The extensions of grinding time for fullest color development are as follows:

Paint	Prime Pigmentation	Extension*
Green S-108-200	Chrome Zinc Oxide	63.6%
Red S-108-300	Red Iron Oxide Zinc Oxide	45.5%
Brown S-108-400	Light Brown Oxide Dark Brown Oxide	3.7%
Buff S-108-500	Yellow Iron Oxide Zinc Oxide	54.5%
Gray S-108-600	Titanium Dioxide Lamp Black, Zinc Oxide	88.2%
Blue S-108-700	Titanium Dioxide Phthalocyanine Blue	140%
Yellow S-108-800	Titanium Dioxide Hansa Yellow G Zinc Oxide	38.5%

*Percent increase in grinding time beyond that required to develop maximum North fineness (approx. 4¾ North fineness)

Recommended Pebble Mill Grinding Procedures

The primary grinding pastes for Pliolites S-5 stucco paints as listed contain optimum amounts of resin, solvents and prime pigments.

To prepare the paste, dissolve Pliolite S-5A in the recommended solvent blend, either in the mill or in separate equipment. Add the other primary paste ingredients to the resin solution in the mill. Grind the paste for the time recommended.

The second addition to the mill consists of carefully balanced quantities of diatomaceous silica, bodying agent (Pliolite S-3 gel), solvent and, in some cases, additional Pliolite S-5A resin. These are added after the primary paste is properly ground. They can be added in order without preliminary mixing. After their addition, continue the grind to a North fineness value of 3 to 3½.

The third and final addition or "mix-off" contains the modifiers and the remainder of the required ingredients. This addition must be made in the form of a solution. Add the well-mixed solution to the mill and continue grinding only long enough to insure a final but thorough mixing. As an alternate procedure, this mix-off can be made in a blend tank.

ROLLER MILL GRINDING

Various investigations have shown that an efficient roller mill grinding paste must contain a high pigment concentration in combination with a high resin content. This combination is necessary to maintain sufficient paste consistency and "tack". Slippage on the rolls is eliminated and high shear forces are developed during grinding.

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"Weak" pastes (those in which pigments are improperly wetted during pre-mixing) cannot be satisfactorily processed on a roller mill. "Thin" pastes (those in which pigment and resin concentrations are too low) can be processed on the roller mill, but numerous passes are generally required. Production rates on roller mills are directly dependent on proper grinding paste compositions that have been correctly premixed.

Premixing Recommendations

Correct premixing of roller mill pastes is highly important. Premixing, in itself, can accomplish a very necessary degree of preliminary pigment dispersion. By attaining partial pigment deflocculation in the premixing operation, optimum efficiency of the roller mill is realized and maximum production rates are assured.

"Intensive" premixing produces strong pastes which process best on the mill. Such mixing is obtained by loading the mixer with the recommended amounts of vehicle and adding all the pigments before starting the stirrer. As the mixing proceeds, initial wetting of pigment mass and simultaneous release of air produces a "balling-up" condition. Because of the high viscosity of the vehicle and the high concentration of pigment employed, strong shear forces are produced. As a result of these forces, weakly held pigment agglomerates are soon broken up and the ball-like mass subsides or "breaks" into a smooth, flowing paste that has good uniformity and excellent processability on the mill.

A paste so premixed results in a high rate of production, minimum slippage on the rolls, little or no aggregate formation, and no evidences of mill abrasion. Finished paints resulting from the roller mill processing of such "intense" pastes possess superior properties.

Recommended Roller Mill Grinding Procedures

Below are listed the suggested roller mill paste formulations for Pliolite S-5 stucco and masonry paints. These contain all the required pigments, a high concentration of Pliolite S-5A resin, bodying agent (Pliolite S-3 resin) and sufficient solvent to insure optimum paste consistency for proper premixing.

In making the "pre-mix," charge the resins and solvents into the mixer and stir until solution is complete. Then, stop the stirrer. Add the required pigments and restart the stirrer. Continue stirring until the mixture "breaks" and a smooth paste is obtained.

Additional vehicle is needed for easy handling in the transfer of paste from premixer to roller mill. This addition must be made in the form of a solution. Add the required amount of solution to the initial paste and continue stirring until a homogenous mixture results.

Next, transfer the premixed paste to the roller mill. The recommended formulations listed in the Table are so designed as to require only a single pass through normal production mills.

The setting on the mill rolls varies with individual equipment. Such settings are usually governed by required degree of dispersion, production rate and possibility of mill abrasion. With Pliolite S-5 stucco finishes, mill settings can be readily found that adequately balance these various factors.

The final addition contains the modifiers and remaining formulation ingredients. This addition must be made in the form of a solution and can be carried out in any suitable mixing or blending equipment.

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RECOMMENDED ROLLER MILL CHARGING OF PLIOLITE S-5 STUCCO PAINTS

	—Pounds Per 100 Gallons—							
	S-108-100 White	S-108-300 Red	S-108-400 Brown	S-108-200 Green	S-108-500 Buff	S-108-600 Grey	S-108-700 Blue	S-108-800 Yellow
Priming Pre Mix Paste								
TiO_2 Rutile	177.4	.....	.....	.....	.....	123.5	17.9	84.2
Red Iron Oxide	.....	215.8	.....	.....	.....	.....	.....	.....
Light Brown Oxide	.....	.....	47.4	.....	.....	.....	.....	.....
Dark Brown Oxide	.....	.....	94.8	.....	.....	.....	.....	.....
Chrome Oxide	.....	.....	.....	211.6	.....	.....	.....	.....
Yellow Iron Oxide	.....	.....	.....	.....	153.0	.....	.....	.....
Lamp Black	.....	.....	.....	.....	.....	18.7	.....	.....
Phthalocyanine Blue	.....	.....	.....	.....	.....	.....	56.5	.....
Hansa G	.....	.....	.....	.....	.....	.....	.....	28.1
Zinc Oxide	50.5	48.3	.....	49.7	45.4	47.7	.....	50.4
Asbestine	204.1	194.9	195.3	200.9	183.2	192.7	168.5	203.6
Diatomaceous Silica	75.9	72.5	72.7	74.7	68.1	71.7	62.6	75.7
Pliolite S-3	2.0	2.0	2.0	2.0	2.0	1.5	1.5	1.5
Pliolite S-5 Unmilled	61.1	55.8	56.9	60.6	59.4	55.6	48.2	58.9
Solvesso 100	162.5	163.3	165.5	168.6	190.9	166.7	177.5	157.8
MS #10	38.5	38.3	54.2	43.8	71.6	44.6	31.3	36.2
	772.0	790.9	736.2	811.9	773.6	722.7	564.0	696.4
Secondary Vehicle Addition								
Pliolite S-5A	10.4	11.6	10.6	8.9	4.8	11.0	10.8	12.5
Solvesso 100	28.1	33.8	32.2	24.8	15.5	33.0	39.7	33.4
MS #10	6.5	7.9	10.5	6.4	5.8	8.8	7.0	7.7
	45.0	53.3	53.3	40.1	26.1	52.8	57.5	53.6
Final Mix-off								
Aroclor 1254	35.3	33.7	33.7	34.7	31.6	33.3	29.1	35.2
Aroclor 5460	35.3	33.7	33.7	34.7	31.6	33.3	29.1	35.2
Solvesso 100	35.3	33.7	33.7	34.7	31.6	33.3	29.1	35.2
MS #10	180.9	184.6	166.7	177.9	160.6	179.6	208.0	182.5
	286.8	285.7	267.8	282.0	255.4	279.5	295.3	288.1
Totals	1103.8	1129.9	1057.3	1134.0	1055.1	1055.0	916.8	1038.1

SUGGESTED FORMULATIONS FOR VARIOUS COATINGS

The following general formulations are suggested as starting points for a variety of vehicles which offer great latitude in the choice of solvents and will enable the paint manufacturer to formulate in accordance with his own ideas and requirements.

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WALL SEALER, FORMULATION S-103-106

(Plastic Primer-Sealer)

Pliolite S-5 is unusually resistant to alkalies and to the transmission of water vapor. The Pliolite S-5 wall sealers are easily produced, apply smoothly, cover well, dry rapidly, and hold out finish coats evenly. In addition, the sealers are inert to alkalies and quite resistant to the transmission of moisture.

Formulation

	Pounds per 100 Gallons
Pliolite S-5A	123.2
Aroclor No. 5460	41.4
TS-28 Solvent (Shell Oil)	246.4
Mineral Spirits #10	185.3
[1] Ponolith LR-142	339.3
[1] TiCal R-60	
[1] Ti Pure R-610	59.2
[2] Asbestine 3X	75.0
[3] Mineralite 3X	
Soya Lecithin	5.9
Aluminum Stearate, Tech D	5.9
Chlorinated Paraffin (40%)	41.4
	1123.0

1. Supplied by E. I. Du Pont de Nemours
2. Supplied by International Talc Co.
3. Supplied by Mineralite Sales Corp.

The specific ingredients listed were used in developing and testing the formulations. Other solvents, pigments, and extenders, equivalent to those listed, may be substituted. Either Milled or Unmilled Pliolite S-5 Resin may be used. Unmilled Resin gives slightly more body.

Preparation

To facilitate dispersion, the Pliolite S-5 is dissolved in the TS-28 Solvent to give a 33-1/3% solution, and the Aroclor No. 5460 is dissolved in an equal weight of Mineral Spirits #10 to give a 50% solution. The resins can be cut into the solvents in a churn, gum cutter, or high speed agitator.

Conventional equipment may be used for the preparation of these sealers. For a pebble mill, charge first with the following ingredients:

	Pounds
Pliolite S-5A (33-1/3% solution)	177.5
Aroclor No. 5460 (50% solution)	82.8
Mineral Spirits #10	101.6
Ponolith LR-142	339.3
TiCal R-60	
Ti Pure R-610	59.2
Asbestine 3X	75.0
Mineralite 3X	
Soya Lecithin	5.9
Aluminum Stearate, Tech. D	5.9
Chlorinated Paraffin (40%)	41.4

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The grind time for each sealer on conventional equipment is approximately 24 hours, or until a North fineness of 6½ is achieved. After grinding, the mixtures are reduced with the balance of the ingredients:

Pliolite S-5A (33 - 1/3 % solution)	192.1 lbs.
Mineral Spirits #10	42.3 lbs.

Test Methods and Data

Pliolite S-5 wall sealers, formulated with milled resin, have been comparatively evaluated with better grade commercial alkyd and oleoresinous sealers.

Gloss was tested with a Hunter Multi-purpose Reflectometer at 60° angle and using the recommended techniques for low gloss finishes. The coatings were tested on impervious surfaces.

Wet hiding was determined on Morest Charts using TT-P-141-B, method 411.2.

To determine sagging, .003" wet films were cast on glass using a blade applicator. A cut approximately ¼" wide was scratched through the wet film exposing the glass. The panels were placed in a vertical position. Sagging was measured by the movement of the bead in millimeters.

Hold-out was checked by coating 6" x 12" asbestosite panels with the various finishes after priming with the sealers. Absence of low spots indicated good hold-out. Lifting was checked at the same time and in the same manner.

Lap time was established by partially coating asbestosite panels with a freshly wetted brush, and observing the time for lapping to occur. Drying time was determined on glass with .0015" wet films, using TT-P-141-B, method 406.1.

Brushing characteristics were evaluated in practical applications and by Stormer viscosity readings.

The results of the tests are presented in the following table.

COMPARATIVE PROPERTIES OF PLIOLITE S-5 (Formulation S-103-106) WALL SEALER

	S-103-106	Commercial Oleoresinous Sealer	Commercial Alkyd Sealer
Krebs Units (at 77°F)	74	100	74
Weight/gallon, lbs.	11.23	11.3	10.7
North fineness	6½	5½	6½
Gloss (60° Spectra)	65.3	91.0	12.8
Wet Hiding, sq. ft.	160	151	139
Sagging, mm.	4	4	4
Hold Out			
Oleoresinous enamel	Good	Good	Good
Alkyd enamel	Good	Good	Good
Pliolite S-5 enamel	Good	Good	Good
Semi-gloss wall paint	Good	Good	Good
Deep tone flat wall paint	Good	Good	Good
Lap time	2 min.	3 min.	2 min.
Drying Time			
Dust free	17 min.	25 min.	17 min.
Set to touch	20 min.	25 min.	20 min.
Tack free	48 min.	3½ hrs.	5 hrs.
Dry through	3 hrs.	6½ hrs.	5½ hrs.
Lifting			
Oleoresinous enamel	None	None	None
Alkyd enamel	None	None	None
Pliolite S-5 enamel	None	None	None
Semi-gloss wall paint	None	None	None
Deep tone flat wall paint	None	None	None
Brushing	Good	Good	Good

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TRAFFIC PAINT

Paints prepared from the formulation described in the following are applied at the rate of 16-18 gallons per mile as a 4-inch strip. Outstanding properties include rapid drying, long wear, durability to sunlight and abrasion, excellent wetting and penetration through dirt or foreign matter, and resistance to alkalinity of the concrete.

The formulation suggested for the vehicle is:

Traffic Paint Vehicle

	Parts by Weight
Pliolite S-5 "B"	250
AROCLOR 5460	130
AROCLOR 1254 or 1248	120
Toluene	340
Mineral Spirits	340
	1180

Procedure: Cold-cut in agitator tank or pebble mill. Time 1 to 2 hrs.

Appearance: Cloudy liquid — clear film.

Ready-to-use White Traffic Paint

	Parts by Weight
Titanium Dioxide Anatase	200
Calcite Whiting, Low Oil, 5-15 microns	180
Diatomaceous Silica	100
Aluminum Stearate, Di-Acid	8
Lecithin	8
Vehicle (Traffic Paint Vehicle)	590
Toluene	108
	1194

Grind: 2 to 3 Pebble or Roller

Ready-to-use Yellow Traffic Paint

	Parts by Weight
Medium Chrome Yellow, C.P.	330
Titanium Dioxide, Anatase	65
Calcite Whiting, Low Oil, 5-15 microns	80
Diatomaceous Silica	140
Aluminum Stearate, Di-Acid	10
Lecithin	8
Vehicle (Traffic Paint Vehicle)	590
Toluene	133
Mineral Spirits, Regular Paint Grade	25
	1381

Grind: 2 to 3 Pebble or Roller

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CONCRETE FLOOR ENAMELS

The prime requisites for a satisfactory concrete floor enamel include alkali and water resistance, good adhesion, good resistance to abrasion and sufficient hardness to resist marring as well as grinding in of dirt and grit.

Pigmented bases of Pliolite S-5 resins are available in a variety of colors to be used where grinding equipment for making the bases is not available. The following formulations make use of a number of these bases which are initially prepared by plastic milling. The pigmented bases should be evaluated, especially for use in gloss finishes.

Although the following enamels are intended primarily for use on concrete floors, they are also suggested as formulations for general use on concrete, brick and plaster wall surfaces.

Ingredients	Yellow	Orange
	Percent by Weight	
Pliolite S-5 Base 13A	20.00	23.68
Pliolite S-5 Base 38	—	2.79
Pliolite S-5 Base 41A	25.00	16.71
Pliolite S-5 Base 64	—	4.18
Aroclor 1254	1.80	1.78
Drying Oil*	0.90	0.90
High Flash Aromatic Naphtha	26.15	25.00
Petroleum Thinner	26.15	25.00
Total	100.00	100.00

Ingredients	Chinese Red	Dark Blue
	Percent by Weight	
Pliolite S-5 Base 1A	—	3.00
Pliolite S-5 Base 13A	21.40	21.50
Pliolite S-5 Base 17	—	21.50
Pliolite S-5 Base 64	26.30	—
Aroclor 1254	1.54	2.65
Drying Oil*	0.76	1.35
High Flash Aromatic Naphtha	25.00	25.00
Petroleum Thinner	25.00	25.00
Total	100.00	100.00

Ingredients	Green	Light Gray
	Percent by Weight	
Pliolite S-5 Base 1A	1.20	22.25
Pliolite S-5 Base 13A	20.45	18.11
Pliolite S-5 Base 38	—	0.65
Pliolite S-5 Base 39C	20.21	0.28
Pliolite Base 46C	—	0.32
Pliolite Base 46C	0.12	—
Aroclor 1254	2.42	1.46
Drying Oil*	1.20	0.73
High Flash Aromatic Naphtha	27.20	28.10
Petroleum Thinner	27.20	28.10
Total	100.00	100.00

*Raw tung oil, perilla or pale grinding linseed oil.

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Ingredients	Brown	Black
	Percent by Weight	
Pliolite S-5 Base 7C	5.19	—
Pliolite S-5 Base 13A	11.83	26.28
Pliolite S-5 Base 38	29.45	—
Pliolite S-5 Base 46C	0.11	15.76
Aroclor 1254	1.89	1.84
Drying Oil*	0.95	0.92
High Flash Aromatic Naphtha	25.29	27.60
Petroleum Thinner	25.29	27.60
Total	100.00	100.00

Ingredients	Battleship Gray	Silver Gray
	Percent by Weight	
Pliolite S-5 Base 1A	22.50	23.940
Pliolite S-5 Base 7C	0.24	—
Pliolite S-5 Base 13A	20.52	21.840
Pliolite S-5 Base 38	0.85	1.191
Pliolite S-5 Base 39C	—	0.029
Pliolite S-5 Base 46C	0.96	0.153
Aroclor 1254	1.69	1.770
Drying Oil*	0.84	0.885
High Flash Aromatic Naphtha	26.20	25.096
Petroleum Thinner	26.20	25.096
Total	100.00	100.000

The above concrete enamels represent only a few of the colors attainable in Pliolite S-5 Base paints. Paint manufacturers may have their own ideas for arriving at the color desired and may wish to consult Goodyear for additional information about colors.

These paints are considered to have satisfactory ultraviolet light resistance and results of extensive durability tests indicate that they compare favorably with oleoresinous concrete enamels.

If the paint manufacturer wishes to begin formulation from the resin rather than the paint base, concrete floor enamels can be made using the normal technique for roller and pebble mills. The same formulations as given for the paint bases can be used with the exception that lower PVC is required to maintain the same level of gloss. Adequate gloss and durability characteristics can ordinarily be obtained if the PVC is maintained between 20-23%.

DRYING RATE OF AROCLOR PLASTICIZED PLIOLITE S-5 FORMULATIONS

Many of the Aroclor plasticized Pliolite S-5 enamels dry tack free in less than one hour. However, in common with other paint materials these enamels require several days to reach maximum hardness. Since drying and the development of hardness, in the case of these paints, are due only to solvent removal, force drying at elevated temperatures to accelerate the rate of solvent removal increases drying to a marked degree.

The rate of drying, especially to the tack free condition, can be varied in accordance with the evaporation rate of selected solvents. The drying rate of the enamels increases with increased pigment and filler content.

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Drying oils added to the enamels increase the time required to attain maximum hardness. The incorporation of Aroclor plasticizers tends to reduce the time required for maximum hardness to develop.

COMPATIBILITY OF VARIOUS PLASTICIZERS AND MODIFYING AGENTS IN PLIOLITE S-5 PAINTS

C — Clear film; complete compatibility
H — Hazy film
I — Cloudy film; incompatible

Material	Ratio to Pliolite S-5 Resin 5:100	10:100	25:100	50:100
Drying Oils				
[11]Drisoy "A"	sl. H	H	I	—
[11]Drisoy "B"	sl. H	H	I	—
[11]Kel X-L	sl. H	H	I	—
Linseed, high acid	C	C	H	I
Linseed, neutral	C	C	H	I
[11]Diamond K Linseed	H	I	—	—
Oiticica	C	H	H	I
Perilla	C	H	I	—
Soya, alkali refined	I	—	—	—
[7]Thermolized Tung	sl. H	H	I	—
Tung, raw	C	C	C	H
Chemical Plasticizers				
AROCLORS, chlorinated biphenyl and chlorinated polyphenyls (all grades)	C	C	C	C
Chlorinated paraffin	C	C	C	C
Diamyl naphthalene	C	C	C	C
Dibutyl phthalate	C	C	C	C
Dioctyl phthalate	C	C	C	C
[9]Hercolyn	C	C	C	C
[8]Kapsol	C	C	C	C
[8]Kronisol	C	C	C	C
[8]KP-23	C	C	C	C
[8]Methox	C	C	C	C
MONSANTO'S SANTICIZER B-16	C	C	C	C
Tricresyl phosphate	C	C	C	C
Resins				
AROCLORS, chlorinated biphenyl and chlorinated polyphenyls (all grades)	C	C	C	C
[2]Cumar (all grades)	C	C	C	C
[10]Duraplex AL-210-L	H	H	I	—
[4]Durex No. 220	C	C	C	C
Ester gum	C	C	C	C
Limed rosin	C	C	H	H
[5]Pentalyn A	C	C	C	C
[5]Pentalyn G	C	C	C	sl. H
[5]Pentalyn M	sl. H	H	I	—
[5]Pentalyn X	C	C	I	—
Polystyrene	I	—	—	—
Rosin	C	C	C	C
[8]Staybelite Ester No. 10	C	C	C	C
[6]Zinar	C	C	I	—
[6]Zirex	C	C	C	C

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Material	Ratio to Pliolite S-5 Resin 5:100	10:100	25:100	50:100
Varnishes				
Linseed-Cumar, 12½ gal	C	C	C	C
Linseed-Cumar, 25 gal	C	C	I	—
Linseed-Amberol ST-137, 12½ gal	C	C	I	—
Miscellaneous				
Acrylic resins	I	—	—	—
Alkyd resins	Alkyd resins as a class are not compatible.			
Buna-N, synthetic rubber	I	—	—	—
Cellulose Nitrate	I	—	—	—
Coumarone-indene oils and resins	C	C	C	C
Gilsonite	I	—	—	—
[6]Gloss Oil N-Glo-5y	C	C	H	I
[10]Gloss Oil	C	C	C	H
GR-S, synthetic rubber	H	H	H	H
[1]Lecithin Yelkin TTS	H	I	—	—
Maleic resins	Maleic resins as a class are not compatible.			
Phenolic resins	Phenolic resins as a class are of limited compatibility.			
[9]Piccolastic B 100	C	C	C	C
Polyvinylchloride	I	—	—	—
Rosin Oil	C	C	C	C

SUPPLIERS

[1]American Lecithin Company, Inc.
[2]Barrett Division, Allied Chemical and Dye Corporation
[4]Durez Plastics and Chemicals, Inc.
[5]Hercules Powder Company
[6]Newport Industries, Inc.
[7]O'Brien Varnish Company
[8]Ohio-Apex, Inc.
[9]Pennsylvania Industrial Chemical Corp.
[10]The Resinous Products and Chemical Company
[11]Spencer Kellogg and Sons, Inc.

USES FOR PLIOLITE-AROCLOR COATINGS

The principal applications for Pliolite S-5 paints plasticized with Aroclors are coatings for metal, concrete, brick and masonry surfaces requiring resistance to acids, alkalies, water and other corrosive influences. These coatings are suggested for use as concrete floor paints, architectural finishes, metal primers and finishes, oil and grease-resistant coatings, baking primers, corrosion-resistant industrial finishes.

Aroclors have a pronounced plasticizing action on Pliolite S-5 imparting flexibility to the paint coatings and increasing their service life.

The formulations of Aroclors and Pliolite S-5 along with their suggested uses, as given in this report, are in line with good commercial practice. Much of the information given was obtained from other firms, particularly Goodyear Tire and Rubber Company, Chemical Division, Akron, Ohio. The data given is to serve as a guide or starting point in the development of formulations to take advantage of the outstanding qualities of Aroclors as plasticizers and resins for Pliolite S-5 paints.

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