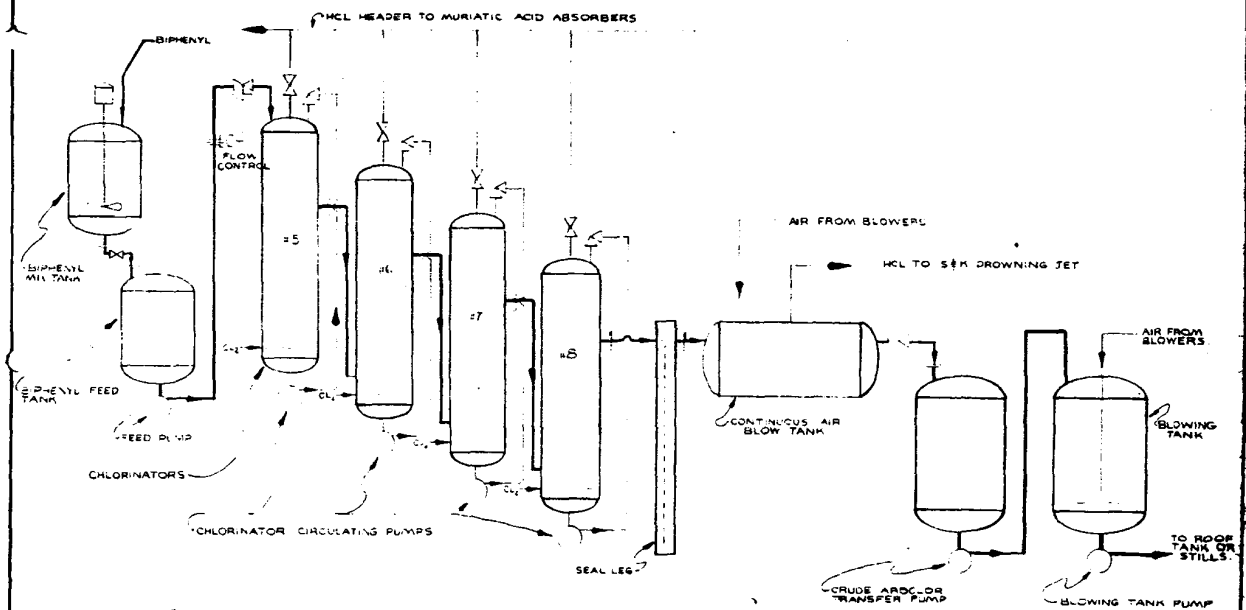
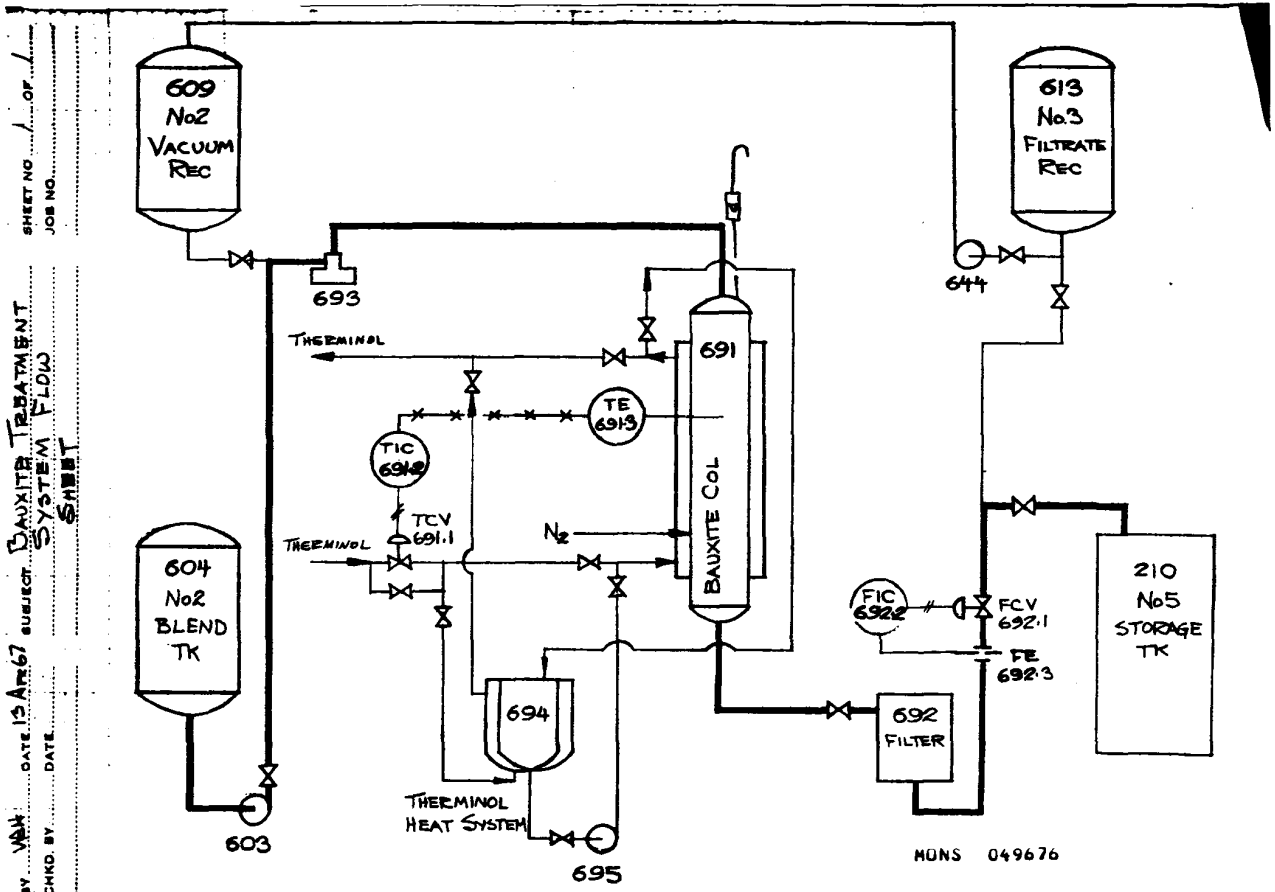


MONS 049675

ANNISTON PLANT – MONSANTO CHEMICAL COMPANY – ANNISTON, ALA.

TITLE: CONTINUOUS CHLORINATOR – FLOW SHEET				
Drawn By: EAE	Approved:	Date: 8-11-64	Scale: NONE	Dept: AROCLOR

TS-8-703



SHEET NO 1 OF 1
JOB NO.
BY VAW DATE 13 APR 67 SUBJECT BAUXITE TREATMENT SYSTEM FLOW SHEET
CHKD. BY DATE

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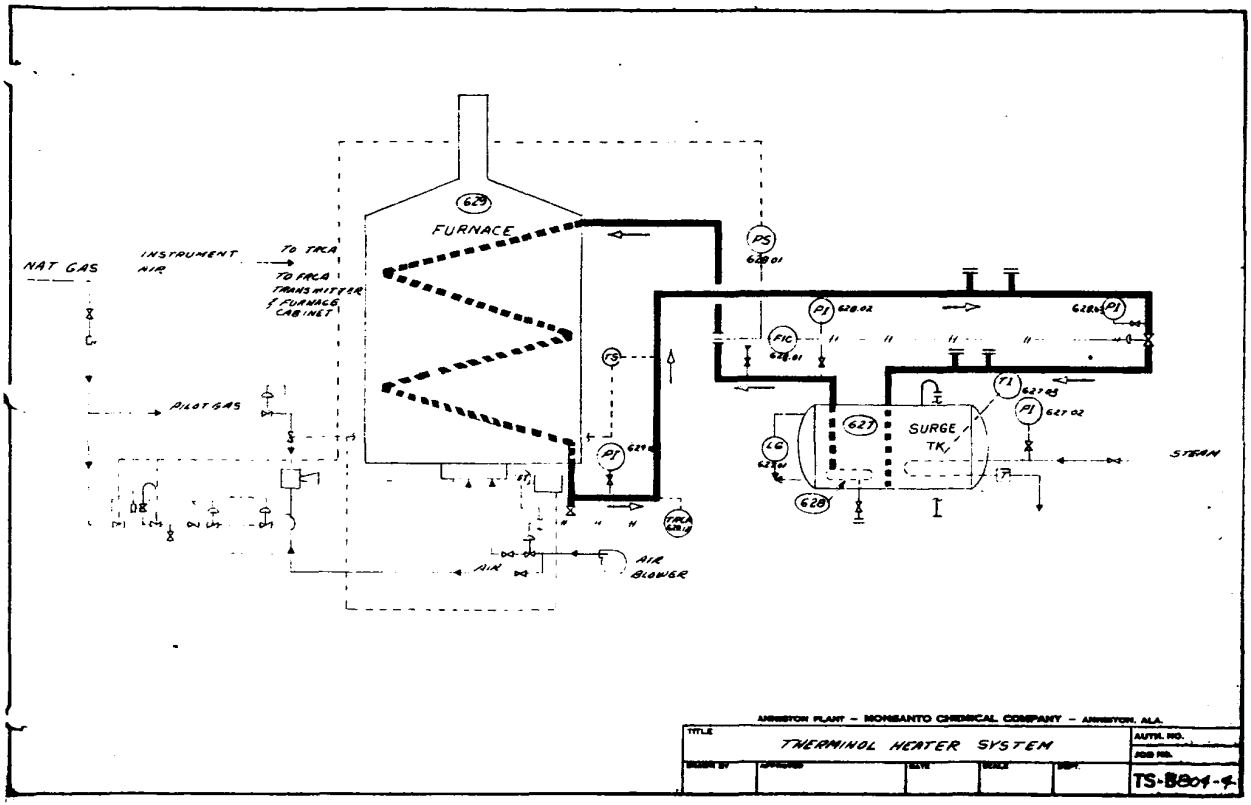

ANNISTON PLANT – MONSANTO CHEMICAL COMPANY – ANNISTON, ALA.

TITLE					AUTH. NO.
THERMINOL HEATER SYSTEM					JOB NO.
DESIGN BY	APPROVED	DATE	SCALE	DWG.	TS-8801-4

MONS 049677

MONS 049678

STANDARD MANUFACTURING PROCESS
FOR
AROCLOR

III. PROCESS IN DETAIL

A. Batch Liquid Chlorinators

Crude Liquid Aroclors are produced by batch chlorination in a vertical vessel. The reaction is cooled by external air cooled heat exchangers and agitated by a circulating pump. Biphenyl is chlorinated with chlorine gas added at the bottom of the vessel. HCl gas vented at the top of the chlorinator is a by-product which is recovered in the Muriatic Acid Department. Crude Aroclor produced in batch chlorinators is transferred to the blowing operation when the chlorination is completed. Chlorine gas is fed to the chlorinators from the Chlorine Plant and/or from tank cars.

A chlorinator charge (3,000 lbs.) of specification grade Biphenyl is pumped to the chlorinator charge tank from a Biphenyl storage tank. One and one-half (1-1/2) pounds of Ferric Chloride is slurried in Aroclor and dumped into the charge tank with each chlorinator charge. The Biphenyl and Ferric Chloride is agitated for a minimum of 15 minutes and then transferred to the chlorinator.

Aroclor 1142 can be used to charge a batch chlorinator for the production of 1148, 1154, 1160, or 1162. When 1142 is used for a chlorinator charge no Ferric Chloride is added.

After the chlorinator has been charged the circulating pump is started and then the chlorine feed is put on the chlorinator. As the chlorination progresses the specific gravity is checked at intervals until the desired gravity has been attained. When a chlorinator is finished it is transferred to a blowing tank.

B. Continuous Chlorinator Operation

The continuous chlorinator operation consists of four cascade flow chlorinators in series where specific levels of chlorination occur. Biphenyl, with Ferric Chloride added, is fed continuously into the first chlorinator where the material is chlorinated and overflows to the second chlorinator. The finished product comes off the final unit, flows into a catch tank and is pumped to a continuous blow tank. The material is pumped from this blow tank

to another blow tank for additional blowing. Chlorine is fed to each chlorinator continuously. This chlorination system can be reduced to three (3) chlorinators in series in case problems occur with one unit. Normally 1142 is the only Aroclor produced on the continuous system, however, other Liquid Aroclors can also be produced with the chlorinators set for different levels of chlorination.

C. Biphenyl Mix Tank and Feed Tank

When Biphenyl is needed for the continuous chlorinator operation a charge is pumped from a Biphenyl storage tank to the mix tank. Three and one-half (3-1/2) pounds of Ferric Chloride is added to the tank. The agitator in the tank is started and the Biphenyl and Ferric Chloride is agitated until a charge is needed for the Biphenyl feed tank. The feed tank is located under the mix tank. The feed tank low level alarm sounds the annunciator system at 25% full, at which time the mix tank batch is dropped into the feed tank. This will allow a minimum of one hour agitation in the mix tank. The agitator in the feed tank runs continuously while Biphenyl is being fed to the first stage of the continuous chlorinator operation.

D. Batch Solid Chlorinator

Crude Solid Aroclors are produced by batch chlorination when a weighed quantity of Biphenyl, Santowax, or a mixture of the two is chlorinated in a vertical reaction vessel with Ferric Chloride as a catalyst. Chlorine gas is added at the bottom of the vessel.

By-product HCl gas vented at the top of the chlorinator is recovered in the Muriatic Acid Department. Crude Solid Aroclors produced in batch chlorination are transferred to the blowing tank operation when the chlorination is completed. (The only exception being 1168 which is not air blown but pumped directly from the chlorinator to the still). Chlorine gas is fed to the chlorinator from the Chlorine Plant and/or from tank cars.

E. Blowing Tank Operation

Crude Aroclors produced in the chlorinators are air blown for a minimum of one hour, for removal of residual HCl, before the material is fed to the stills. Steam is maintained on the coils

of the Liquid blowing tanks during this operation. Therminol heat is maintained on the coil in the Solid blowing tank. Residual HCl blown out of the crude Aroclor is drowned in a water ejector which pulls a slight vacuum on the blowing tanks.

F. Liquid Stills

Aerated crude Liquid Aroclor from a blowing tank, or a roof tank containing aerated Aroclor, is fed to the still tank. Hydrated lime is added to the crude Aroclor.

Vacuum is applied to the still and the Aroclor is circulated through the furnace coil and heated to the vaporization temperature. Vapors pass up an open column to the condenser. Distilled Aroclor is collected in a receiver and then transferred into a blending tank.

Distilled Liquid Aroclors are treated with Attapulgus Earth in the blending tank, filtered, analyzed, and packaged or held in storage.

Still residue or bottoms are sold as Montars or discarded.

G. Earth Treatment and Filtration

All Liquid Aroclors are treated in the blending tank with Attapulgus Earth. This earth is dried in an oven for a minimum of four hours at a temperature of 210-250°C. The material, with the earth added, is agitated and then pumped through the filter press and back to the blend tank. When no earth is visible in the material it is then directed to a filtrate receiver. The filtered Aroclor is then ready for drumming or transfer to a storage tank.

H. Solid Still

Aerated Crude Solid Aroclor from a blowing tank is pumped to the No. 4 still pot. Hydrated lime is added to the crude Aroclor.

Vacuum is applied to the still and the Aroclor is circulated through the furnace coil and heated to the vaporization temperature.

Vapors pass up on open column to the condenser. Distilled Aroclor is collected in a receiver. Quality of the distilled Solid Aroclors is analysed by the laboratory, and if in specification, it is drawn directly from the receiver into suitable containers or transferred to the flaker operation.

Still residue or bottoms are sold as Montars or discarded.

I. Packaging

Solid Aroclors are packaged in fibre drums, galvanized drums, galvanised cans and in paper bags.

Liquid Aroclors are packaged in steel drums and cans. These drums and cans are lacquer lined. Liquid Aroclors are also loaded into tank cars and trucks.

COMMENTS
ON PROCESS

MONS 049683

STANDARD MANUFACTURING PROCESS
FOR
AROCLORS

IV. COMMENTS ON THE PROCESS

A. LIQUID AROCLORS

1. Chlorination

a. Temperature

Chlorination temperatures of 120°C or lower yield a product which will not pass the stability tests on electrical grade Aroclors. A minimum of 130°C has been set for the chlorinators. An upper temperature limit is not defined as critical to high quality Aroclor production. A practical limitation is governed by the increase of overhead product loss to the off-gas collection tank. The normal temperature range is between 140°C and 170°C.

b. Catalyst

The basket containing a bed of iron turnings in the chlorinator provides contact surface for the Chlorine and Biphenyl, and the iron reacts with the Chlorine forming Ferric Chloride which is the actual catalyst. Consumption of the turnings makes it necessary to inspect the chlorinator semi-annually and replenish the turnings if necessary. Ferric Chloride (anhydrous powder) in the amount of 0.05% is added to the chlorinator charge to provide assurance of adequate catalyst at all times during the chlorination. It is imperative that the iron turnings in each chlorinator be inspected semi-annually. Aroclor supplied to General Electric and Westinghouse must be produced in chlorinators containing the basket. (Prior to any shipment of Electrical Grade Aroclor being shipped to General Electric and Westinghouse from a process where the baskets are removed, Marketing will review the process change with both customers.)

The catalyst is added to the chlorinator charge tank or mix tank (continuous chlorinators) and agitated for at least 15 minutes but usually at least an hour before charging or feeding the chlorinators. MCL and WGK Aroclor Departments do not pre-mix the catalyst. Research has indicated the tendency to producing unstable Aroclors can be attributed to improper catalyst concentration which may be brought about by insufficient mixing prior to chlorination.

Free Chlorine in the off-gas from an individual chlorinator or from the vent at the HCl absorber sewer box indicates problem operation in the Aroclor Department. It can be caused by inadequate reaction of the Biphenyl and might indicate formation of unstable Aroclor. If this situation occurs it should be corrected immediately. Take samples from the individual chlorinator off-gas and have them analyzed for free chlorine by the laboratory. Check grab samples from each chlorinator of the crude Aroclor being produced and observe it for unusual appearances. Inadequate amounts of catalyst present as Ferric Chloride or iron turnings can cause free chlorine in the off-gas line. In case this situation occurs and cannot be resolved, remove the chlorinator from operation. Contact department supervision immediately. A badly worn chlorinator distributor can also cause from chlorine in the off-gas line.

c. Chlorine

Although the effect of air in chlorine on Aroclor quality is unknown, the amount of air in chlorine does effect the chlorination rate and therefore effects the production rate.

Problems with the chlorine vaporizer can occur which would allow liquid chlorine to be fed to the chlorinators. In case this should happen, slugs of liquid chlorine would be fed into the chlorinator possibly causing excessive reaction or excessive loss and venting of chlorine to the atmosphere. Chlorine in the HCl off-gas pipe lines could cause extreme reactions which would generate excessive heat. This reaction can cause a pipe line to become red hot and melt the pipe line in two. This would result in chlorine gas escaping to the atmosphere. Every effort possible should be made to operate the vaporizer with the control system provided.

Entrainment of Biphenyl or crude Aroclor into the HCl lines can occur from excessive chlorine rates. This same situation can occur in case the Chlorine Plant is blowing too much air. This can be checked by observing the off-gas from the chlorinators in the sight glasses on top of the Brink Demister on each chlorinator. Normal operation of the chlorinator should be to minimize this carry-over. Abnormally high or low chlorine header pressures can cause operating problems. High chlorine header pressure causes problems within the Chlorine Plant to

the department operating personnel. Chlorine fumes are forced back into the Chlorine Department and at times sulfuric acid can be blown from the Nash compressor system. Since this presents a safety hazard to the department personnel every effort should be made to eliminate high pressure problems. Low chlorine pressure can cause operating problems within the Aroclor Department. In cases of extreme low pressure, the crude Aroclor could back up in the chlorine line and begin blow-back into the chlorine header.

d. Chlorinator Off-Gas Collection

The demister on top of the liquids collection tank is used as a final knock-out for Aroclor and Biphenyl entrained droplets in the HCl gas system. Usually this system will be operating with the steam tracing around the outer shell shut off. When the steam tracing is turned on it will allow vapors to be carried through the demister to the Muristic Acid absorber. The sight glass on the discharge of the demister can be checked to determine if entrained droplets are being carried over. The steam is installed for use to unplug the demister in case this should occur. The trappings from this clean-up system are used to produce Aroclor 1148 and 1162 only. The reason for this is to be sure that we do not produce any unstable electrical grade Aroclor.

It is extremely important that the tempered water system on the liquid HCl off-gas condenser be drained during excessive cold weather if it is shut down. The bottom head on the condenser has drain valves at two locations. Both of these drain valves must be open to remove water from the off-gas condenser when the system is shut down.

2. Air Blowing of Crude Aroclors

Air blowing of crude Aroclors takes place with compressed air from air blowers. The air is not dried by any means other than that caused by compression and cooling in the air blowers. Judging by the corrosion exhibited around nozzles atop the blowing tanks a good argument can be made for thoroughly dried air. Wet air may also be the cause of poor electrical properties that occasionally occur during period of rain and high humidity. Wet air can also carry in chlorides, SO_2, and H_2S from the atmosphere. An air dryer would tend to scrub out these undesireble gases.

3. Distillation

Vacuum trouble on the stills is usually caused by flashing of product, plugged vacuum lines, or improper functioning of the vacuum jets. Flashing can usually be stopped by operating the still at a slower rate or increasing the flow of cooling water to the vapor condenser. Vacuum trouble can be traced systematically from the jets and usually isolated.

4. Earth Treatment

Exclusion of atmospheric moisture is naturally important where high electrical resistivity is required and of course the Attapulgus earth needs to be well dried. All liquid Aroclors are earth treated at the Anniston Plant to decrease the risk of contaminating electrical grade with non-electrical grade Aroclors. There are too many common lines downstream of the stills to chance non-treatment of non-electrical grade Aroclors.

5. Quality

Incomplete aeration in the blow tanks, or the addition of insufficient lime to the still pot, will cause high acidities. High inorganic chlorides either indicate contamination or the presence of attapulgus earth in the product caused by a poor filtration. Batches with high color usually indicate excessive gas heat on the heating coils or air leaks in the vacuum system. A distillation carried too far will also show a dark distillate from the distillation of colored material from the residues. Another reason for color can be the material formed when chlorinating at low temperatures or with insufficient catalyst. Batches with specific gravities, softening points and viscosities out of specifications can indicate over or under chlorinations, or incomplete draining of the process equipment when switching from one type of Aroclor to another. Iron has a deleterious affect on the electrical properties of the distilled Aroclors; therefore, tankage, process piping and pumps from the still receiver through the remainder of the process are either aluminum, tin and zinc sprayed or are constructed of monel, stainless steel or bronze.

6. Special Grades

a. Export Aroclor 1242

The export specs on 1242 call for a resistivity of 5,000 min. and a Biphenyl content of 0.05% max. Domestic specs call for 500 min. resistivity and no spec on Biphenyl content. The

Biphenyl content of 1242 made on the continuous chlorinators averages below the 0.05% max. spec and therefore causes no production problems. To meet the 5,000 min. resistivity spec the 1242 is earth treated two to five times using normal procedures until the resistivity exceeds 7,000 (dept. spec) and then drummed out from the filtrate receiver.

b. Export Aroclor 1254

The export specs on 1254 call for a resistivity of 5,000 min. and a Biphenyl content of 0.025% max. Domestic specs call for 500 min. resistivity and no spec on Biphenyl content. To meet the 5,000 min. resistivity spec the 1254 is earth treated two to five times using normal procedures until the resistivity exceed 7,000 (dept. spec) and then drummed out from the filtrate receiver. Two methods have been tried to assure low Biphenyl content.

(1) Batches three through eight in the normal ten batch distillation run have a greater tendency to meet the Biphenyl spec than the remaining four. Each batch is analysed for Biphenyl and then earth treated when in spec. This method is hit and miss and has about a 50% reliability of success and causes still downtime.

(2) Aroclor 1154 is chlorinated from low Biphenyl 1142 rather than Biphenyl. Chances of success are so great that all ten still batches have been earth treated and placed in an empty storage tank and then additional earth treatment is scheduled to avoid generating still downtime.

The second method is used whenever possible and has resulted in better inventory control of export 1254.

7. Safety

Biphenyl is flammable and burning should never be done in areas where Biphenyl or Biphenyl vapors are present.

Light Aroclors are also flammable. The viscous Aroclor oils and the resins do not support combustion when heated alone, even at their boiling points - temperatures above 350°C.

8. Dermatology and Toxicology

Aroclors do not produce primary irritancy or sensitisation of the skin. At ordinary temperatures Aroclors have not presented industrial toxicological problems. If Aroclors are used at elevated temperatures such as 200° or 300°C in open systems, methods must be designed to exhaust any vapors arising from these open systems.

B. SOLID AROCLORS

1. Chlorination

Special flexible piping joints have been made to the weigh tank since this tank is placed on scales. Actuation of the scale system will require movement of this tank approximately 1/4 inch. These flexible piping joints should be carefully inspected to be sure there are no leaks since the material contained in them is extremely hot. Steam is provided on the transfer lines and the coil to the weigh tank. From the bottom piping on the weigh tank, all the transfer lines and coils in the Solid Aroclor process vessels have Therminol heat until the end of the process at the flaker hold tank.

The No. 9, Solid Aroclor, chlorinator does not have a basket of iron turnings. Due to this, it is absolutely necessary that five pounds of Ferric Chloride be added to each chlorinator charge in the weigh tank.

Plugging of the off-gas condenser in the Solids Clean-Up System can occur. To unplug the off-gas condenser the temperature of the Therminol system is elevated as required. During this time, the off-gas condenser can be by-passed.

The Solids knock-out tank is provided with a drain system to empty the tank completely when products are to be changed on the No. 9 chlorinator. This will eliminate contamination in the weigh tank.

2. Air Blowing of Crude Aroclor

The same comments on corrosion for Liquid Aroclors hold true for the Solid Aroclor blow tanks.

Undistilled Aroclors 2565 and 5060 are lime treated in the blow tank to give a neutral acid number. Flaked 5060 on the acid side will cause the bags to fail.

3. Distillation

Vacuum problems on the Aroclor stills are usually due to flashing of product over, plugged vacuum lines, leaks in the still system, leaks at pump packing, water adjustment on inter-condenser or jets, changes in steam pressure to the jets, or problems in the jet nozzles. Flashing can be stopped by adjusting the coolant flow on the condenser or operation of the still at a slower rate. Vacuum trouble must be traced systematically from the jet, to the receiver, and then to the still.

MONS 049689

It is important to be sure the coil in the Therminol cooling system surge tank is covered when the system is in operation. This assures the circulating pump has a positive suction and prevents surging in the heater coil. This will allow more uniform control of the temperature in the Therminol cooling system.

Care must be taken not to fill the surge tank too full during normal operation. This can cause the tank to run over when the circulating pump is stopped. A normal level will be about 6" to 12" in the sight glass.

The flow measurement recording instrument for the still heater system is an extremely important portion of the controls for the No. 4 still system. A segmental orifice is used for obtaining differential pressure readings to indicate flow. This orifice system is in a specially designed Therminol jacketed pipe section. A specially designed d/p cell records the pressure readings and indicates flow. The orifice is designed to allow sucking the coil completely empty when a distillation is complete. The hole in the orifice plate is flush with the bottom of the pipe line. This flow recorder indicates low flow rates at the end of a distillation which aids the operator in completing a normal operation.

Lime addition to the Solid Aroclor still is very important. Cutting the amount of lime below 200 lbs. per batch results in occasional off-color batches.

The longer still bottoms are circulated in the heater the higher the formation of HCl and the greater the tendency to plug the heater coil. Every effort should be made to have Crude Aroclor available to charge the still at all times.

4. Solid Aroclor 1268

The bottleneck in 1268 production is the chlorinator. Increasing chlorine feed rates only increases Biphenyl and low chlorinated Aroclor carry-over to the off-gas collection system, and increases the tendency to over-chlorination and its ensuing problems with freeze-up of lines and equipment (hold points greater than 175°C).

The still has been found to run better when there is feed always available. Circulating of still bottoms while waiting on crude increases the breakdown of the Montar into more viscous material and hydrogen chloride. Draining the still between batches increases the tendency to plug the heater coil.

To move the bottleneck from the chlorinator to the still requires charging the chlorinator with 1142 and chlorinating at a rate high enough to insure finishing the batch before the still batch is completed. Other higher chlorinated crudes can be charged to the chlorinator but they will not be as readily available as 1142 from the continuous chlorinators.

A - Equipment
B - Material Specs
C - Physical Constants
D - Utilities
E - Personnel
F - Packaging & Shipping
G - Material Balance
H - Pollution
I - Process Control
J - Safety
K - Background
L - Time
M - Quality
N - Misc

A

MONS 049693

STANDARD MANUFACTURING PROCESS
FOR
AROCLOR

APPENDIX A - EQUIPMENT LIST

Area 200 - Bulk Storage

Area 500 - Chlorinator

Area 600 - Still

APPENDIX A - EQUIPMENT LIST
AREA - 200

BULK STORAGE

Item	Equipment	Equip. No.	Description
201	No. 1 Aroclor Storage Tank	22-0077	10' x 26' metal sprayed with zinc and tin. Capacity 15,000 gallons.
202	No. 3 Aroclor Storage Tank	22-0089	Horizontal, cylindrical dia. 8'-0", length 30'-0". Metal sprayed with zinc and tin. Capacity 11,000 gals.
203	No. 2 Aroclor Storage Tank	22-0076-01	10' x 26' metal sprayed with zinc and tin. Capacity 15,000 gallons.
204	No. 4 Aroclor Storage Tank		10' x 26' metal sprayed with zinc and tin. Capacity 15,000 gallons.
205	South Pyranol Mix Tank	22-0108	14'-0" I.D. x 10'-0" high. Dwg. D-6455.
206	North Pyranol Mix Tank		6'-6" I.D. x 8'-2" jacketed steel tank.
208	No. 1 Storage Tank Pump		Taber vertical submerged pump. Type CL-4. Capacity 75 GPM.
209	No. 2 Storage Tank Pump		Taber vertical submerged pump. Type CL-4. Capacity 75 GPM.
210	No. 5 Aroclor Storage Tank	22-0663	12,000 gal. vertical aluminum tank. See 22-0662, 19-0397, 19-0398, 94-0179, 94-0180, 49-0777, 28-0532.
211	No. 6 Aroclor Storage Tank	22-0662	12,000 gal. vertical aluminum tank. See 22-0662, 19-0397, 19-0398, 94-0179, 94-0180, 49-0777, 28-0532.
212	No. 6 Storage Tank Pump	19-0397	20-A-30, 3 x 2 - 13/110 Mark 11 pump w/crane seal #9 outside QP-191, Base steel plate #53 7FL Falk Spacer coupling.

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APPENDIX A - EQUIPMENT LIST
AREA 200

Item	Equipment	Equip. No.	Description
213	No. 5 Storage Tank Pump	19-0398	20-A-30, 3 x 2 - 13/110 Mark 11 Pump w/crane seal #9 outside QP-191 Base steel plate #83 7FL Falk Spacer coupling.
214	No. 3 Storage Tank Pump		Taber vertical submerged pump. Type CL-4. Capacity 75 GPM.
215	No. 4 Storage Tank Pump		Taber vertical submerged pump. Type CL-4. Capacity 75 GPM.
216	TCB UNLOADING PUMP		
700	ETHER MIXING PUMP		

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CHLORINATOR

Item	Equipment	Equip. No.	Description
505	No. 9 Chlorinator	22-0774	Vertical 4'-6" dia. x 20' straight side carbon steel vessel with dished heads (3" Sch. 80 coil 75' long). Capacity 2,390 gallons.
506	No. 9 Chlorinator Circulating Pump	19-0494	Self-priming, centrifugal pump (Pacific 2-1/2" SS type SVC, 10" impeller, 15 HP, 1750 RPM, 440 volt motor). Pump has a Crane No. 9 outside mechanical seal, Code QP-868. Capacity 250 GPM at 73' TDH.
507	Arocler Cooler No. 9 Chlorinator		1'-8" dia. x 18'-6" long, carbon steel shell heat exchanger with 304-3/4" O.D. 304 stainless steel, 14 BWG x 16" long tubes. Four passes on Therminol side (tube side). Capacity 1,400,000 BTU/hour.
508	No. 4 Chlorinator Cooler	32-0260	An air-cooled 1" BWG 16.8' long steel tube with aluminum finned cooler for removing heat from crude Arocler. 3' wide x 8' long x 6' high, equipped with an Annin pneumatic operater to adjust louvers (58 tubes). Fan has a 2 HP, 1800 RPM, 440 volt motor. Capacity 1,100,000 BTU/hour.
509	No. 3 Chlorinator Circulating Pump	19-0495	Self-priming, centrifugal pump (Pacific 1-1/2 L Type SVC, 1-7/8" impeller, 15 HP, 1800 RPM, 440 volt motor). Pump has a Crane No. 9 outside mechanical seal, code QP-868. Capacity 220 GPM at 81' TDH.
510	No. 3 Chlorinator Cooler	32-0261	Same as Item 508
511	No. 2 Chlorinator Circulating Pump	19-0496	Same as Item 509

AREA 500

Item	Equipment	Equip. No.	Description
512	No. 2 Chlorinator Cooler	32-0262	Same as Item 508.
513	No. 1 Chlorinator Circulating Pump	19-0497	Same as Item 509.
514	No. 1 Chlorinator Cooler	32-0263	Same as Item 508.
515	No. 3 Blow Tank	22-0596	7'-6" dia. x 7'-6" high Dwg. D-234-4
516	No. 3 Blow Tank Pump		Peerless Pump - Model 1-1/2 DSO.8, Sarial No. 121336.
517	No. 4 Blow Tank	22-0595	Same as Item 515.
518	No. 4 Blow Tank Pump		Peerless Pump - Model 1-1/2 DSO.8.
519	ϕ M1x Hc		
520	Biphenyl Feed Tank	22-0788	5'-6" dia. x 5'-8" long, carbon steel tank with dished heads. Tank contains a 2" Sch. 80 coil approximately 90' long. Capacity 1,000 gallons.
520-A B & C	Biphenyl Feed Tank Agitator & Drive		6-blade, turbine type, carbon steel agitator with a 4 ELEZ Faulk motor reducer driven by a 10 HP, 1800 RPM, 440 volt motor. The agitator has a 2-3/4" dia. x 8'-8" long shaft. Capacity provides medium agitation.
521	Biphenyl Feed Pump	19-0498	Self-priming, centrifugal pump (Goulds Model 3196 AVS-260, 6-5/8" open impeller, 5 HP, 1800 RPM, 440 volt motor). The pump has a Crane No. 9 outside mechanical seal, Coda QP-868. Capacity 60 GPM at 42' TDH.
522	No. 5 Chlorinator Cooler	32-0264	Same as Item 508.
523	No. 6 Chlorinator Cooler	32-0265	Same as Item 508.

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Item	Equipment	Equip. No.	Description
✓524	No. 7 Chlorinator Cooler	32-0266	Same as Item 508.
✓525	No. 8 Chlorinator Cooler	32-0267	Same as Item 508.
✓526	Crude Aroclor Catch Tank	22-0789	5'-6" x 5'-8" steel vertical tank with flanged and dished top head. Capacity 1,000 gals.
✓527	Crude Aroclor Catch Tank Pump	19-0526	100 GPM @ 75' head - vertical heavy duty centrifugal Taber pump - CV-3 #393.
✓528	Continuous Air Blow Tank	22-0682	500 gallon steel tank. Purchased from Dixie Steel & Supply Co. See MCC Dwg. D-548-3-0.
✓529	Continuous Blow Tank Transfer Pump	19-0499	Self-priming, vertical centrifugal pump (Taber vertical submerged, CL2-382, 7-1/2" open impeller, 3 HP, 1800 RPM, 440 volt motor). Capacity 15 GPM at 45' TDH.
✓530	Air Blower North	11-0338	Model 7 H - Spec. SM-488-530. Purchased from Sutorbilt Corp.
✓531	Solids Off-Gas Eductor		S&K Fig. 4010 Scrubber and S&K 4040 Separator Box Haveg & P.E. Const. 6" Suct. 6" Discharge.
✓532	Liquids Off-Gas Eductor		S&K Fig. 4010 Scrubber - 8" Suct. 8" Discharge.
✓533	Therminol Surge Tank #9 Chlor.	22-0775	4'-0" O.D. x 5'-3". Steel const. Purchased from Opelika Welding, Machine & Supply, Inc.
✓534	No. 9 Surge Tank Pump	19-0500	Spec. SM-488-534. P.O. No. OHD-7734. Purchased from Goulds Pumps, Inc.
✓535	Weigh Tank		6'-6" x 7'-9" C. steel equipped with heating coil. 5 turns 2" Sch. 80 C.S. pipe. Capacity 2,000 gallons.
✓536	Weigh Tank Pump	19-0501	Goulds Model 3196 AVS No. A 60 constructed of Ductile Iron. Capacity 125 GPM.

Item	Equipment	Equip. No.	Description
537	No. 9 Chlorinator Mist Eliminator		Monsanto Brink type demister in a 30" O.D. x 4' x 6' long carbon steel tank. Bottom nozzle 10" dia., 10" flange, with a 6" gas outlet. Designed for 30 psig at 450°F. Contains a Brink element No. 2448. Capacity 325 cfm at 8 psig and 250°C. Inlet mist loading 2,000 mg/cu.ft. Outlet mist loading 20 mg/cu.ft. Efficiency 99%.
538	No. 9 Chlorinator Cooler	32-0259	Carbon steel heat exchanger 8' long with 3/4" O.D. x 15 BWG tubes containing 184 tubes. Four pass heat exchanger on tube side. Special design Marquette expansion joint constructed of 304 SS on shell side of this heat exchanger. Capacity 1,400,000 BTU/hour.
539	No. 2 Blow Tank Pump	19-0502	Self-priming, centrifugal pump (Goulds Modal 3196 AVS-A60, 7" open impeller, with a 5 HP, 1800 RPM, 440 volt motor, and a Crane No. 9 outside mechanical seal, Code QP-868). Capacity 125 GPM at 29' TDH.
540	Biphenyl Feed Pump		Self-priming, centrifugal pump (Goulds Model 3196 AVS-A60, 6-1/16" open type impeller, 3 HP, 1800 RPM, 440 volt motor, and a Crane No. 9 outside mechanical seal. Code No. QP-868). Capacity 75 GPM at 39' TDH.
541	No. 2 Blow Tank	22-0777	7'-6" O.D. x 7'-6" straight side vertical tank, flat top with a dished bottom. Tank contains a 2" Sch. 80 pipe coil approximately 75' long. Capacity 2,500 gallons.
542	No. 1 Blow Tank	22-0266-02	Same as Item 515.
543	No. 1 Blow Tank Pump	19-0355	Vertical, centrifugal, submerged Taber pump. 2-1/2" inlet - 1-1/2" outlet. Cast iron construction. Capacity 50 GPM.

Item	Equipment	Equip.No.	Description
544	Weigh Tank Scale	24-0194	Fairbanks-Morse, Inc. overhead suspension scale, Model CA, coaxial cabinet dial, having a 22" dia. chart graduated 0-24,000 pounds with a main tare bar graduated 20,000 pounds and 5,000 pounds. The dial has one adjustable Read switch to operate at scale set point. Scale to be hung below 11' platform level built to contain the weigh tank. Capacity 0-24,000 pounds x 20 pounds increments for scale measurement. Overall capacity 0-50,000 pounds.
545	Crude Aroclor Catch Tank Transfer Pump		Self-priming, vertical centrifugal pump (Taber CV-3, #393, with a 2" suction and 1-1/2" discharge, 10" dia. x 3-1/2" I impeller, 5 HP, 1800 RPM, 440 volt motor). Capacity 80 GPM at 100' TDH.
546	Brink Demister No. 7 Chlorinator	41-0037	1'-8" dia. x 4'-2" straight side carbon steel shell with a Brink type mesh demister pad.
547	Brink Demister No. 6 Chlorinator	41-0038	Same as Item 546.
548	Brink Demister No. 5 Chlorinator	41-0039	Same as Item 546.
549	HCl Off-Gas Condenser (Liquid System)	22-0810	20' I.D. x 8' long, standard Monsanto fixed tube sheet heat exchanger with 304 3/4" O.D. x 14 BWG tubes. Exchanger has four passes. Overall area 460 sq.ft. Capacity 132,000 BTU/hour heat removal.
550	Chlorine Vaporiser	32-0185	Armstrong Chlorine Vaporizer, vertical type, complete with super heater section Monel construction - purchased from R. M. Armstrong Co. 90 tons/day capacity.
551	No. 1 Chlorinator	22-0675	3'-0" dia. x 16'-0". See Drawing E-6209.
552	No. 2 Chlorinator	22-0673	See Item 551.

APPENDIX A - EQUIPMENT LIST
AREA 500

Item	Equipment	Equip.No.	Description
553	No. 3 Chlorinator	22-0673	See Item 551.
554	No. 4 Chlorinator	22-0674	See Item 551.
555	No. 8 Chlorinator		See Item 551.
556	No. 7 Chlorinator		See Item 551.
557	No. 6 Chlorinator	22-0677	See Item 551.
558	No. 5 Chlorinator	22-0676	See Item 551.
559	No. 4 Chlorinator Circulating Pump	19-0414	Same as Item 509.
560	Brink Demister No. 1 Chlorinator	41-0040	Same as Item 546.
561	Brink Demister No.2 Chlorinator	41-0041	Same as Item 546.
562	Brink Demister No. 3 Chlorinator	41-0042	Same as Item 546.
563	Brink Demister No. 4 Chlorinator	41-0043	Same as Item 546.
564	Brink Demister No. 8 Chlorinator	41-0044	Same as Item 546.
565	Instrument Air Compressor	37-0098	Joy Manufacturing Company No. WTPOS-9, Size 8" x 5" skid-mounted air compressor unit with after-cooler and air receiver. Operated by a 25 HP, 1800 RPM, 440 volt motor. Capacity 105 cfm at 100 psig.

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Item	Equipment	Equip.No.	Description
566	Control Room Sink and Hood		Fume Hood designed by Browne-Morse Co. #73 Green unit with a gray colorlith top. Fan is an American Blower 1-1/4 HP removing 782 cfm at 1/2 S.P., 1/3 HP, 110 volt, 1725 RPM motor. Capacity fume removal 782 cfm.
567	Control Room Air Conditioner	44-0098	Carrier Model 48 DA008-601. Roof mounted cooling and heating unit; 98,000 BTU/hour nominal cooling; 240,000 BTU/hour heating nominal direct fired natural gas heater.
568	MOTOR CONTROL CENTER VENT FAN		
569	No. 6 Chlorinator Circulating Pump	19-0414	Same as Item 509.
570	No. 7 Chlorinator Circulating Pump	19-0414	Same as Item 509.
571	No. 5 Chlorinator Circulating Pump	19-0394	Same as Item 509.
572	No. 8 Chlorinator Circulating Pump	19-0405	Same as Item 509.
573	HCl Off-Gas Catch Tank (Liquid Chlorinator System)	22-0811	8'-6" dia. x 11'-3" straight side, carbon steel tank, with dished heads and a 3" Sch. 80 carbon steel pipe coil approximately 120' long. Capacity 5,000 gallons.
574	Trappings Transfer Pump (Liquid)		Self-priming, horizontal centrifugal pump (Goulds Model 3196 AVB-A60, constructed of Ductile iron with a 7" dia. open type impeller, 5 HP, 1800 RPM, 440 volt motor, with a Crane No. 9 outside mechanical seal, Code QP-868). Capacity 125 GPM at 75' TDH.
576	Brink Mist Eliminator HCl Catch Tank		Monsanto Brink type unit, 2'-6" dia. x 11' straight side, containing a Brink element designed for 5 psig at 105°F. temperature. Capacity 635 cfm at 85% HCl gas. Designed to collect 99% of entrained droplets and return to the catch tank.
575	WATER FOUNTAIN		

Item	Equipment	Equip.No.	Description
577	Therminol Surge Tank for Solid HCl Clean-Up Condenser		3'-6" dia. x 4'-3" straight side, carbon steel tank, containing a 2" Sch. 80 carbon steel coil approximately 10' long. Capacity 300 gals.
578	Therminol Pump for Solids Knock-Out Condenser		Self-priming, horizontal centrifugal pump (Goulds Model 3196 AVS-A60, constructed of Ductile iron, with an 8" open type impeller, driven by a 7-1/2 HP, 1800 RPM, 440 volt motor, pump equipped with a Crane No. 9 outside mechanical seal, Code QP-868). Capacity 150 GPM at 50' TDH.
579	Therminol Cooler for Solids Knock-Out Condenser System		Disler Model No. 2 VH air-cooled aluminum finned tube cooler, 3' x 3'-6" x 5'-9" high. Contains a fan driven by a 1 HP, 1800 RPM, 440 volt motor. Capacity 550,000 BTU/hour.
580	HCl Off-Gas Condenser (Solids System)		2' dia. x 10'-6" long, carbon steel heat exchanger, with 80 1-1/2" O.D. x 14 BWG x 8' long tubes (six tube passes). Condenser contains 250 sq.ft. surface area. Designed for 150 psig and 160°C.
581	HCl Off-Gas Catch Tank for Solid System	22-0817	4' dia. x 3'-9" straight side, carbon steel tank with dished heads. Tank is a jacketed carbon steel tank designed for 125 psig at 160°C. Jacket designed for 110 psig at 160°C. Capacity 300 gallons.
582	Water Pump for Liquid Areclor Knock-Out Condenser		Self-priming, horizontal centrifugal pump (Goulds Model 3196 AVS-A60, 2 x 3 - 10, with an 8" open type impeller constructed of Ductile iron with a Crane No. 9 outside mechanical seal, Code QP-868, driven by a 7-1/2 HP, 1800 RPM, 440 volt motor). Capacity 200 GPM at 75' TDH.
584	~~Weigh Tank~~	22-0776	~~6'-6" O.D. x 7'-0"~~ Purchased from Art Welding Co.

No 2 ϕ Feed pump S

~~Caustic~~ pump

583 Sample Bottle

Item	Equipment	Equip.No.	Description
585	Chlorinator Charge Tank	22-0787	1,000 gallon steel tank purchased from Missouri Boiler & Tank Co. P.O. NO. D-47909. Installed Nov. 1959.
586	Air Blower (South)	11-0323	Rotary positive with extended base and V-drive, intake filter muffler, exhause muffler, V-belt guard, 1" pressure relief valve. Purchased from Sutorbilt Corp.
587	Air Blower (Middle)	11-0324	Same as Item 586.
~~588~~	Biphenyl Feed Tank Agitator	18-0106	Falk 4 ELHZ, Ratio 13.9 to 1. Spec. SM-488-520C. Dwg. D-488-M116.
~~589~~	~~Duct Jet No. 2 Blow Tank~~	35-0122	Spec. SM-488-531. S&K Figure 4014, Scrubber-Separator consisting of: 1-6" Fig. 4010 Hi-Eff 61 Fume Scrubber. 1-6" Fig. 4040 Polyester Fiberglass Separator.
592	Instrument Air Compressor	37-0073	JOY WFPO8-9, Size 6½ x 4½, Capacity 50 SCFM at 100 psig output. Water cooled, single stage double acting, carbon ring, non-lubricated, with V-belt drive.
593	INST. AIR RECEIVER		
594	Instrument Air Dryer	14-0029	Electric regenerative desiccant dryer, manufactured by Trinity Equipment Corporation.
596	Cl_2 UNLOADING AIR COMPRESSOR		
597	Cl_2 UNLOADING AIR COMPRESSOR FILTER		

APPENDIX A - EQUIPMENT LIST
AREA 600

600 No 1 Still hot well

Item	Equipment	Equip.No.	Description
601	~~No. 3~~ Blend Tank Pump	19-0293	1-1/2 DSO 8 - all bronze, SAE 63 Frame 213 - Serial No. 121340 - Peerless.
602	No. 3 Blend Tank	22-0087	7'-0" O.D. x approx. 7'-0" on shell. Dwg. 9-C-8247.
603	No. 1 Blend ~~Tank Pump~~ Filt Rec pump	~~19-0269~~	1-1/2 DSO 8 - all bronze, SAE 63 Frame 213 - Serial No. 121340-Peerless.
604	No. 2 Blend Tank	22-0270	Same as Item 602.
605	No. 2 Blend ~~Tank Pump~~ Filt Rec pum	~~19-0267~~	Same as Item 603.
606	No. 1 Blend Tank		Same as Item 602.
607	No. 1 Vacuum Receiver	22-017801	Same as Item 609.
608	No. 1 Vacuum Receiver Pump	19-0272	Fig. 3202 No. 90 VPR, all bronze. Purchased from Blackmer Pump Co.
609	No. 2 Vacuum Receiver	22-0026	5'-6" I.D. x 5'-6" Monel. Dwg. C-795.
610	No. 2 Vacuum Receiver Pump	19-0271	Same as Item 608
611	No. 3 Vacuum Receiver		6'-6" dia. x 7'-9" straight side, vertical tank, lined with Monel plating. Tank equipped with a Monel coil constructed of 1-1/2" Sch. 40 Monel pipe with approx. 48 linear feet of coil. Capacity 2,000 gallons.
612	Receiver Pump (No. 3 Still)	19-0244	Model GZ-CH NEMA 213. Fig. 3202, 90 VPR bronze, Blackmer Pump.
613	No. 2 Filtrate Receiver	22-0086	7'-0" O.D. x 7'-0". Dwg. 9C-8247. Purchased from Chattanooga Boiler and Tank Co.

Item	Equipment	Equip.No.	Description
614	No. 1 Filtrate Receiver	22-0269	Same as Item 613.
615	No. 4 Still	22-0779	7'-6" dia. x 7'-0" straight side, vertical carbon steel tank with dished heads. Tank equipped with a heating coil constructed of 2" Sch. 80 carbon steel pipe with approx. 77 sq.ft. of surface area. Capacity 2,500 gallons.
616	No. 4 Still Circulating Pump	19-0505	Self-priming, centrifugal, vertical pump, (Taber vertical submerged No. 345 CC-5, 12-1/2" dia. open type impeller, 25 HP, 1800 RPM, 440 volt motor, with a jacketed stuffing box for water cooling). Pump has a special Zallea expansion joint with rods and discharge pipeline. Capacity 150 GPM at 120' TDH.
617	Freight Elevator	10-0200	1,000# all steel freight elevator with 3' x 4' platform. Purchased from Midvale Material Handling Equipment Co. Capacity 1,000#.
618	No. 4 Still Heater	32-0271	Direct fired natural gas heater with insulation and refractory lining constructed by Alcorn Combustion Company. 7'-11" dia. x 11'-8" high shell containing a 3" dia. Sch. 80 coil, 259 sq.ft. surface area in a 6' dia. circle. Heater also contains a John Zink VRM No. 10 gas burner. Capacity 355,000 BTU/hour heat absorption (heat input 550,000 BTU/hour).
619	No. 4 Still Condenser	32-0272	1'-2" dia. x 10' long, carbon steel heat exchanger with 112-3/4" x 14 BWG x 8' long tubes, designed for four passes on tube side. Designed for full vacuum. Condenser contains a special design Marquette expansion joint constructed of 304 stainless steel with Sch. 30 welding ends. Capacity 477,000 BTU/hour.

Item	Equipment	Equip.No.	Description
620	No. 4 Still Vacuum Receiver	22-0780	6'-6" dia. x 7'-9" straight side, carbon steel vertical tank with dished heads. Contains a 2" Sch. 80 carbon steel coil with approximately 52 sq.ft. of surface area. Designed for full vacuum operation at 400°C. Capacity 2,000 gallons.
621	No. 4 Still Vacuum Receiver Transfer Pump	19-0506	Self-priming, centrifugal pump (Goulds Model 3196 AVS-A60, 7-7/8" dia. open type impeller, 10 HP, 1800 RPM, 440 volt motor, jacketed stuffing box for Therminol heat, Crane No. 9 outside mechanical seal, Code QP-868, casing of pump jacketed for Therminol heat). Capacity 125 GPM at 50' TDH.
622	Therminol Surge Tank	22-0781	3'-6" dia. x 4'-3" straight side, carbon steel vessel with dished heads, contains a 2" Sch. 80 carbon steel coil with 7 sq.ft. surface area. Capacity 325 gallons.
623	Therminol Cir. Pump for No. 4 Still Coolant	19-0507	Self-priming, centrifugal pump (Goulds Model 3196 AVS-A60, 8-1/16" dia. open type impeller, 7-1/2 HP, 1800 RPM, 440 volt motor, with a Crane No. 9 outside mechanical seal, Code QP-868, constructed of Ductile iron). Capacity 100 GPM at 65' TDH.
624	Therminol Cooler No. 4 Still System		Air-cooled heat exchanger, Model No. 58E5A48, 1" O.D. BWG 16 tubes, 4' long, with aluminum fins, 60 sq.ft. surface area. Total fin surface area 1,171 sq. ft. Overall dimensions 2' x 4' x 4'-6" high. Manufactured by Disler Engineering Company. Fan for cooler 1 HP, 1800 RPM, 440 volt motor, capacity 5,500,000 BTU/hour.
625	No. 4 Still Catch Tank	22-0782	3' O.D. x 3'-9" straight side, carbon steel tank with dished heads and a 1-1/2" Sch. 80 coil 6' long. Capacity 200 gallons.

Item	Equipment	Equip.No.	Description
626	No. 4 Still Vacuum Jet	35-0123	Three-stage Worthington No. 2-1/2 JFD jet ejector. First stage special design; second stage No. 5; and third stage No. 6-A. Jet also includes a 10" I.D. porcelain barometric inter-condenser.
627	Therminol Surge Tank (No. 4 Still Cooling System)	22-0783	5'-O.D. x 12' straight side, horizontal, carbon steel tank with dished heads. Tank contains a 3" Sch. 80 coil 20' long. Capacity 1,900 gallons.
628	Therminol Heater Circulating Pump	19-0508	Self-priming, centrifugal pump (Taber vertical submerged No. 346-CC6, with a 12-1/2" open type impeller; 50 HP, 1800 RPM, 440 volt motor, jacketed stuffing box for water cooling). Capacity 350 GPM at 165' TDH.
629	Therminol Heater	32-0274	A helical tube heater with cross-flow connection of the four circulation type for heating Therminol FR-2 by direct firing with natural gas, complete with insulation and refractory lining and coil, 8'-6" dia. x 15'-6" high shell with walls lined with 5" castable refractory Lumnite-Haydite vermiculite 124 mix, suitable for 2,000°F service. 4" Sch. 80 coil 350' long with a total surface area of 950 sq.ft. Furnace fabricated by Alcorn Combustion Co. Furnace provided with a North American 6" No. 214-88 dual fuel burner. Capacity rated at 8,150,000 BTU/hour for the burner. Total heat absorbed 6,000,000 BTU/hour.
631	Flaker Tank & Agitator	22-0700	6-blade turbine type impeller, 26" dia., constructed of carbon steel with a 3-1/2" dia. x 8 ft. long shaft. Motor reducer is a Falk 4 ELHZ speed reducer with a 13.9:1 ratio. Slow speed shaft, 125 RPM, driven by a 10 HP, 1800 RPM, 440 volt motor. Capacity, provide medium agitation, in 250 gal. steel jacketed tk.
632	Barometric Sump Tank		3' dia. x 3' long vertical tank, fabricated by Fiberglass. Capacity 150 gallons.

Item	Equipment	Equip.No.	Description
634	Lime Hopper No. 4 Still		2' x 2' x 1' high hopper, fabricated of carbon steel. To fit a 6" nozzle. Capacity 50 lbs. of lime.
635	Monter Conveyor	33-0055	2'-0" x 20'-0" steel roller type conveyor. Drawing D-488-M132.
636	Still Bottoms Blower	11-0339	Centrifugal fan per spec. SM-488-636. Blower for fume removal. V-belt drive and motor assembly for above fan. 5 HP motor, 440 volt, 60/CY, 3/Phase, for chemical duty.
638	Drum Conveyor		2'-6" x 10'-0" used at Liquid Aroclor drum-out station.
639	Scale (Toledo)	24-0182	Model 2881 - Serial No. 4159, used for weighing Liquid Aroclor drums.
640	Polishing Filter		Sparkler Filter - 1'-9" x 3'-6" OAH.
641	Entrainment Separator #4 Still	41-0045	Purchased from Wright Auston. P.O.No. OKD-7952.
642	Earth Oven	14-0033	16 KW-2 door oven with controls. Standard electric oven. Purchased from Despatch Oven Company.
643	~~Dynamel~~ Filter	15-0029	Model 18-S-23 horizontal plate type 304, st. w/scavenger plate feature on pipe legs. Purchased from Sparkler Manufacturing Co.
~~644~~	~~Triplex Receiver Pump~~	19-0268	Pump 1-172 DSO 8 all bronze - SAE 63 Frame 213
645	Floor Cleaning Machine	49-0537	Model No. 204325 - Serial No. EF 17646. 5 HP, 220 volt, 3 phase motor. Purchased from G.H. Tennant.
646	Micro Pulverizer	17-0027	2 DH Micro Pulverizer with discharge chute mounted on steel base. Main motor 10 HP, 3450 RPM, fan cooled. Feed motor 1/3 HP, 1725 RPM, Serial No. 12184. Purchased from Pulverizing Machinery.

MONS 049710

Item	Equipment	Equip.No.	Description
650	No. 1 Still Pot	20-0018-01	6'-0" dia. x 5'-6" high closed steel as per drawing C-809.
651	Circulating Pump No. 1 Still	19-0230-01	No. 345 semi-stl. CC-5, centrifugal vertical motor pump. 3" inlet, 2-1/2" outlet. Purchased from Taber Pump Co.
652	No. 1 Still Heater	42-0018	3'-9" I.D. x 4'-10-1/2" steel sheet made per Dwg. E-886.
653	No. 1 Still Condenser	32-0116	12" dia., 7'-6" long, 19-1-1/2" 1 PS Sch. 40 Monel tubes. Purchased from Dowington Iron Works.
654	No. 1 Still Ejector	35-0105	#9 N9BON001 Type G Carbete Ejector.
655	No. 2 Still Pot	20-0002-01	6'-0" dia. x 5'-6" high closed steel as per drawing C-809.
656	Circulating Pump No. 2 Still	19-0240-01	Same as Item 651.
657	No. 2 Still Heater	42-0050	No Description on File.
658	No. 2 Still Condenser	32-0141	Same as Item 653.
659	No. 2 Still Ejector	35-0106	Same as Item 654.
660	No. 3 Still Pot	20-0052	Same as Item 655.
661	Circulating Pump No. 3 Still	19-0248	Same as Item 651.
662	No. 3 Still Heater	42-0052	No description on file.
663	No. 3 Still Condenser		Same as Item 653.

MONS 049711

Item	Equipment	Equip.No.	Description
✓664	No. 3 Still Ejector	35-0125	2-1/2 JPA 3rd Stage. Purchased from Worthington Corp. P.O. No. 82036. Installed January 1966.
✓669	Lime Slurry Tank	22-0790	Slurry Tank for No. 3 Still. 10" IRS steel Hyd. & flange assembly, steel internal parts.
✓670	No. 1 Roof Tank	22-0078-01	8' dia. x 30' long. Capacity 11,000 gallons.
674	Circulating Pump (Spare)	19-0238-01	Same as Item 651.
✓690	Aroclor Flaker	14-0031	Model VMS 5-56, size 24" x 48". Stainless steel drum with feed pans. Purchased from Goslin.

668 #1 Vacuum Residuals Pump for Solids

665 Spare Liq Still jet

666 Sol Avo Rework Tk

667 " " " " pump

671 #1 Roof TANK Pump

672 #2 Roof tanks

N. Madison

CONFIDENTIAL

MONS 049713

STANDARD MANUFACTURING PROCESS
FOR
AROCLOR

APPENDIX B - MATERIAL SPECIFICATIONS

I - FINISHED GOODS

a. Arocler 1221 Monsler 142
b. Arocler 1232* M 314
c. Arocler 1242 M 5,649
d. Arocler 1248 + 1254 equiv. + M 7
e. Arocler 1254
f. Arocler 1260
g. Arocler 1262
h. Arocler 1268
i. Arocler 2565 (undistilled)
j. Arocler 4465
k. Arocler 5442
l. Arocler 5460

*Arocler 1232 is a mixture of approximately 53.4% Arocler 1221 and 46.6% Arocler 1242 (by volume).

II - RAW MATERIALS

a. Biphenyl
b. Santowax C
c. Santowax R
d. Chlorine
e. Hydrated Lime
f. Attapulgus Earth
g. Ferric Chloride

Monsanto

FROM (NAME & LOCATION) Anniston, Ala.

May 2, 1969 CC

SUBJECT SPECIFICATION REMOVAL

REFERENCE

TO : [redacted]
R. A. Haydel
J. C. Landwehr
M. B. Mullally
W. B. Papageorge
H. L. Williams

Authorization has been received to cancel the following (Finished Goods) specification.

Material Name	Date Issued	Product Code
Aroclor Capacitor Fluid (Pyranol 1481)	4/18/66	1050-120-16-03/09

Please destroy your copy of this specification. Rose Higgerson, Standard Documents Department will retain one copy for reference.

G. W. Miller

/bs

MONS 049715

IN-10 REV 11-69

Monsanto
ORGANIC CHEMICALS DIVISION

FINISHED PRODUCT SPECIFICATION

PRODUCT		DEPT.
AROCLOR 1221		Anm. 608
PLANT	PRODUCT CODE	USE
Anniston	826.10	Sales
DATE EFFECTIVE	SALES CODE	
3-1-69	1040-225-04/11-009	

APPROVALS

PRODUCTION	RESEARCH
H. Williams 2/19/69	M. E. Gibbs 3/12/69
SALES	QUALITY CONTROL (Chief Chemist)
W. Ault 3/10/69	R. Blowers 3/26/69 G. W. Miller 2/15/69

GENERAL DESCRIPTION: CHEMICAL FORMULA

MIXTURE

MOL WT.

SUPERSEDES SPECS. OF	SAMPLE FOR ANALYSIS	ISSUED BY
4/25/61	2 x 1/2 gal. Amber Bottles	G. Miller

CHARACTERISTIC	LIMITS	METHOD
(R) Condition	Clear	G-1
(R) Color, APHA	100 Max.	046
(R) Specific Gravity (25/15.5°C)	1.182-1.192	052
(R) Acidity, (Mg KOH/g)	0.014 Max.	050
(R) Viscosity @ 100°F	38-41 SUS 4.0-5.5 Cp	049

MONS 049716

(R) Routine Analysis, All others Analyzed by request Only

WGH-582

Monsanto
ORGANIC CHEMICALS DIVISION

FINISHED PRODUCT SPECIFICATION

PRODUCT		DEPT. Ann. 64 WGK 246
AROCLOR 1232		
PLANT: Anniston & WGK	PRODUCT CODE: 826.11 & 81115	USE: Sales
DATE EFFECTIVE: 3-1-69	SALES CODE: 1040-230-04/11/003/009	

APPROVALS

PRODUCTION	RESEARCH
J. Molloy 3/21/69 H. Williams 2/19/69	M. E. Gibbs 3/12/69
SALES: W. Ault 3/10/69	QUALITY CONTROL (Chief Chemist): R. Blowers 3/26/69 G. W. Miller 2/15/69

GENERAL DESCRIPTION

CHEMICAL FORMULA

MIXTURE

MOL WT:

SUPERSEDES SPECS. OF	SAMPLE FOR ANALYSIS	ISSUED BY
11-17-66	2 x 1/2 gal. Amber Bottles	G. Miller

CHARACTERISTIC	LIMITS	METHOD: Anniston	METHOD: WGK
(R) Condition	Clear	G-1	10084
(R) Color, APHA	50 Max.	046	10084
(R) Specific Gravity, (25/15.5°C)	1.270-1.280	052	10114
(R) Acidity, (Mg KOH/g)	0.014 Max.	050	10087
(R) Viscosity @ 100°F	44-51 SUS 6.5-10.0 Cp	049	10086

MONS 049717

(R) Routine Analysis, All others Analyzed by request Only

WGK-866

MONSANTO CHEMICAL COMPANY
ORGANIC CHEMICALS DIVISION
ANNISTON

FINISHED PRODUCT SPECIFICATION

PRODUCT CODE: 826.11 (27-L)
METHOD IDENTITY: --
SALES CODE: 1040-230-04/11/16-09

Issued: 10/28/63
By: O. E. Dolin
O. E. Dolin
Anniston Plant
Standards Dept.

PRODUCT (Trade name): AROCLOR 1232
TYPE: Dielectric
PRODUCT (Chemical name):
TYPE:
CHEMICAL FORMULA: Mixture

SUPERSEDES SPEC'S OF: 4/25/61
SPECIAL JOB NO.: --
SAMPLE FOR ANALYSIS: 2 x 1/2 gal. amber jugs

MOL WT.: ----
USE: Sales

UNCLASSIFIED SPECIFICATIONS

Routine Tests

Property	Specification	Method No.
Color, APHA	100, Max.	14-44-54
Acidity, mg KOH/g.	0.014, Max.	14-42-54
Specific Gravity @ 25/15.5°C	1.270-1.280	14-49-54
Viscosity @ 100°F., SUS	44-51	14- 4-52

General Information

Chlorine, %	31.5-32.5	14-13-54

RESTRICTED SPECIFICATIONS

Routine Tests

Water, ppm	35 Max.	14-53-54
Refractive Index @ 25°C	1.6180-1.6200	14-34-54
Condition	Clear Liquid	10-084

General Information

Inorganic Chlorides, ppm	0.10 Max.	014
Resistivity, ohm-cm 300V DC,0.1" gap, 100°C.	500 x 10^9 Min.	14-55-54
Dielectric Constant @ 1 KC,100°C.	4.3-4.5	14-36-54
Distillation Range, °C. corrected:		
10%, by wt.	293, Min.	14-31-54
50%, by wt.	310-320	
90%, by wt.	360, Max.	

MONS 049718

RESTRICTED SPECIFICATIONS

General Information - Continued

Pour Point, °C.	Below -30	14-47-54
Corrosion Test Change in wt. aluminum, %	0.0	
Acid No. after test, mg KOH/g.	0.015, Max.	14-52-54
Inorganic Chlorides after test, ppm	0.10, Max.	014
Condition after test	Clear	C-1
Color after test, APHA	100, Max.	14-44-54

OKD/gm
10/28/63

Monsanto
ORGANIC CHEMICALS DIVISION

FINISHED PRODUCT SPECIFICATION

PRODUCT	AROCLOR 1242, ELECTRICAL GRADE		DEPT. WGK 246 Anniston 826.6
PLANT	PRODUCT CODE	USE	
Anniston - WGK	81101-82612	Sales	
DATE EFFECTIVE	SALES CODE		
10/21/69	1040-240-04/11/16-03/09		

APPROVALS

PRODUCTION	RESEARCH
H. L. Williams /s/ H. L. Williams 10/30/69	M. E. Gibbs /s/ M. E. Gibbs 1/5/70
SALES	QUALITY CONTROL (Chief Chemist) R. M. Blowers 1/7/70
W. E. Ault /s/ W. E. Ault 12/23/69	G. W. Miller /s/ G. W. Miller 10/30/69

GENERAL DESCRIPTION

Also known as Pyranol 1499

CHEMICAL FORMULA

MOL WT.

SUPERSEDES SPECS. OF	SAMPLE FOR ANALYSIS	ISSUED BY
6/17/66	3 x 5 pt. Amber Bottles	G. W. Miller

CHARACTERISTIC	LIMITS	METHOD WGK	METHOD Anniston
UNRESTRICTED INFORMATION			
(R) Color, APHA	40 Max.	10084	046
(R) Condition	Clear	10084	G-1
(R) Specific Gravity @ 25/15.5°C	1.381-1.392	10114	052
(R) Acidity, mg KOH/g	0.010, Max.	10087	050
(R) Moisture, ppm	35 Max.	10620	047
(R) Refractive Index @ 25°C	1.6240-1.6260	10125	048
(R) Inorganic (free) Chlorides	0.05 ppm, Max.	12741	014
(R) Pour Point	-14°C or lower	10115	053
(R) Dielectric Constant (1000 cycles @ 100°C)	4.70-4.90	11608	113
(R) Resistivity (500 VDC @ 100°C 0.1" Gap) as ohm-cm x 10^9	500 Min.	11607	121
(R) Hydrolysis Stability Test (as chlorides)	0.5 ppm, Max.	12672	010
(R) Monsanto Stability Test (as chlorides)	0.4 ppm, Max.	11503	133
(R) Distillation Range (ASTM D-20, Corrected)		10117	054
10% Distilled by wt.	325°C, Min.		
90% Distilled by wt.	360°C, Max.		
Sulfates	None	12169	12169-WGK
Dielectric Strength @ 25°C	35 KV, Min.	11605	043
Flash Point, °F	338-392	10123	114
Fire Point	None	10123	114
Corrosion Test (6 hrs. @ 210°C with bright aluminum foil)		10126	136
Change in wt. of Al%	0.0		
A.C. Color (APHA)	60 Max.	10084	046
A.C. Condition	Clear	10084	G-1
A.C. Acidity, mg KOH/g	0.010 Max.	10087	050
A.C. Inorganic (free) Chlorides	0.05 ppm, Max.	12741	014
Viscosity @ 100°F, SUS	82-92	10086	049

MONS 049720

(R) Routine Analysis, All others Analyzed by request Only

9M-888

GENERAL INFORMATION

		Anniston
Specific Heat @ 25°C	0.30	
Coefficient of Expansion (25-65°C)	0.00068 cc/°C	
Fixed Chlorine	42.5-43.5%	
Power Factor @ 100°C	(Typical Values)	113
60 cycles	5	
1000 cycles	0.30	

SPECIAL CUSTOMER REQUIREMENTS

General Electric		
Thermal Chemical Chlorides	0.65 ppm, Max.	039
Westinghouse		
Hydrolizable Chlorine (Westinghouse Stability Test)	1.0 ppm, Max.	092

MONS 049721

Monsanto
ORGANIC CHEMICALS DIVISION

FINISHED PRODUCT SPECIFICATION

PRODUCT		DEPT.
AROCLOR 1242, EXPORT GRADE ELECTRICAL GRADE		826.08
PLANT	PRODUCT CODE	USE
Anniston	826.12	Sales
DATE EFFECTIVE	SALES CODE	
10/21/69	1040-240-16-009	

APPROVALS

PRODUCTION	RESEARCH
H. L. Williams /s/ H. L. Williams 11/12/69	M. E. Gibbs /s/ M. E. Gibbs 1/8/70
SALES	QUALITY CONTROL (Chief Chemist)
W. E. Ault /s/ W. E. Ault 12/31/69	G. W. Miller /s/ G. W. Miller 10/30/69

GENERAL DESCRIPTION

CHEMICAL FORMULA

MOL WT.

SUPERSEDES SPECS. OF	SAMPLE FOR ANALYSIS	ISSUED BY
Tentative 6/12/67	3 x 5 pt. Amber Bottles	G. W. Miller

CHARACTERISTIC	LIMITS	METHOD
UNRESTRICTED INFORMATION		
(R) Color, APHA	40 Max.	046
(R) Condition	Clear	G-1
(R) Specific Gravity @ 25°C/15.5°C	1.381-1.392	052
(R) Acidity (mg KOH/gm)	0.010 Max.	050
(R) Moisture, ppm	35 Max.	047
(R) Refractive Index @ 25°C	1.6240-1.6260	048
(R) Inorganic (free) Chlorides, ppm	0.05 Max.	045
(R) Pour Point, °C	-14 or lower	053
(R) Dielectric Constant 1 KC @ 100°C	4.70-4.90	113
(R) Resistivity ohm-cm 500 VDC @ 100°C, 0.1" Gap	5,000 x 10^9 Min.	121
(R) Hydrolysis Stability Test (as chlorides) ppm	0.5 Max.	010
(R) Monsanto Stability Test (as chlorides) ppm	0.4 Max.	133
(R) Biphenyl, %	0.05 Max.	100
(R) Distillation Range (ASTM D-20, Corrected)		054
10% Distilled by wt.	325°C Min.	
90% Distilled by wt.	360°C Max.	
Sulfates	None	12169 (WGK)
Dielectric Strength @ 25°C	35 KV Min.	043
Flash Point (°F)	338-392	114
Fire Point	None to Boil	114
Viscosity @ 100°F (SUS)	82-92	049

RESTRICTED INFORMATION

		Typical Values	
Power Factor @ 100°C			113
60 cycles	Report	0.30 - 0.50	
1000 cycles	Report	0.08 - 0.10	

MONS 049722

(R) Routine Analysis, All others Analyzed by request Only

Monsanto
ORGANIC CHEMICALS DIVISION

FINISHED PRODUCT SPECIFICATION

PRODUCT		DEPT.
AROCLOR 1242 NON-ELECTRICAL GRADE		Ann. 606 WGK 246
PLANT	PRODUCT CODE	USE
Anniston & WGK	82612-81101	Sales
DATE EFFECTIVE	SALES CODE	
3-1-69	1040-240-04/11/009-003	

APPROVALS

PRODUCTION	RESEARCH
J. Molloy 3/21/69 H. Williams 2/19/69	M. E. Gibbs 3/12/69
SALES	QUALITY CONTROL (Chief Chemist)
W. Ault 3/10/69	R. Blowers 3/26/69 G. Miller 2/15/69

GENERAL DESCRIPTION

MIXTURE

CHEMICAL FORMULA

MOL WT.

SUPERSEDES SPECS. OF	SAMPLE FOR ANALYSIS	ISSUED BY
9/25/67	2 x 1/2 gal. Amber Bottles	G. Miller

CHARACTERISTIC	LIMITS	METHOD	
		Anniston	WGK
(R) Condition	Clear	G-1	10084
(R) Color, APHA	100 Max.	046	10084
(R) Specific Gravity (25/15.5°C)	1.381-1.392	052	10114
(R) Acidity, (mg KOH/g)	0.010 Max.	050	10087
(R) Moisture, ppm	50 Max.	047	10620
(R) Viscosity @ 100°F	82-92 SUS 22-26 Cp	049	10086
Flash Point, °F	338 Min.	114	10123
Fire Point, °F	None to Boiling	114	10123

MONS 049723

(R) Routine Analysis, All others Analysed by request Only

WGK-888

Monsanto
ORGANIC CHEMICALS DIVISION

FINISHED PRODUCT SPECIFICATION

PRODUCT		DEPT.
AROCLOR 1248 NON-ELECTRICAL GRADE		Ann. 608 WGK 246
PLANT	PRODUCT CODE	USE
Anniston & WGK	82641-81102	Sales
DATE EFFECTIVE	SALES CODE	
3-1-69	1040-260-04/11/009-003	

APPROVALS

PRODUCTION	RESEARCH
J. Molloy 3/21/69 H. Williams 2/19/69	M. E. Gibbs 3/12/69
SALES	QUALITY CONTROL (Chief Chemist)
W. Ault 3/10/69	R. Blowers 3/26/69 G. Miller 2/15/69

GENERAL DESCRIPTION

MIXTURE

CHEMICAL FORMULA

MOL WT.

SUPERSEDES SPECS. OF	SAMPLE FOR ANALYSIS	ISSUED BY
9/25/65	2 x 1/2 gal. Amber Bottles	G. Miller

CHARACTERISTIC	LIMITS	METHOD Anniston	METHOD WGK
(R) Condition	Clear	G-1	10084
(R) Color, APHA	100 Max.	046	10084
(R) Specific Gravity, (65/15.5°C)	1.405-1.415	052	10114
(R) Acidity, (mg KOH/g)	0.010 Max.	050	10087
(R) Moisture, ppm	50 Max.	047	10620
(R) Viscosity, @ 130°F	73-80 SUS 19.5-22.5 Cp	049	10086
Flash Point, °F	370 Min.	114	10123
Fire Point, °F	None to Boiling	114	10123

MONS 049724

(R) Routine Analysis, All others Analysed by request Only

WGK-998

Monsanto
ORGANIC CHEMICALS DIVISION
WGK and Anniston Plants
FINISHED PRODUCT SPECIFICATION

PRODUCT		DEPT.
Aroclor 1248 Electrical Grade(Pyranol 1498)		246 WGK 27 Ann.
PLANT	PRODUCT CODE	USE
	811.02	Sales
DATE EFFECTIVE	SALES CODE	
5/10/67	1040-260-04/11/16-03/09	

APPROVALS

PRODUCTION: P. E. Heisler	RESEARCH: N. F. Mueller
SALES: W. E. Ault	QUALITY CONTROL (Chief Chemist): G. W. Miller, W. J. Gresham

GENERAL DESCRIPTION: Mixture

CHEMICAL FORMULA:

MOL. WT.

SUPERSEDES SPECS. OF	SAMPLE FOR ANALYSIS	ISSUED BY
1/10/64 & 2/16/64	3 x 5 pt. Amber Bottles	L. E. Hornback

	CHARACTERISTIC	LIMITS	WGK METHOD	Anniston METHOD
	UNRESTRICTED INFORMATION			
(R)	Color, APHA	50, max.	10,084	14-44-54
(R)	Condition	Clear	10,084	G-1
(R)	Sp. Gr. @65.15.5°C	1.405 - 1.415	10,114	14-49-54
(R)	Acidity (mg. KOH/gm.)	0.010, max.	10,087	14-42-54
(R)	Moisture	35 ppm., max.	10,620	14-53-54
(R)	Refractive Index @25°C.	1.6285 - 1.6305	10,125	14-34-54
(R)	Inorganics (Free) Chlorides	0.05 ppm., max.	T-2092	014
(R)	Pour Point	0°C., max.	10,115	14-27-54
(R)	Dielectric Constant (1000 cycles @100°C.)	4.5 - 4.7	11,608	14-36-54
(R)	Resistivity (500 VDC @100°C. 0.1" GAP) as OHM-CM x 10^9	500, min.	11,607	14-35-57
(R)	Hydrolysis Stability Test (as Chlorides)	1.0 ppm., max.	T-2087	010
(R)	Monsanto Stability Test (as Chlorides)	0.5 ppm., max.	11,503	14-61-57
(R)	**Distillation Range** (ASTM D-20, Corrected)		10,117	14-31-54
	10% Distilled by Wt.	345°C., min.		
	90% Distilled by Wt.	385°C., max.		
	Sulfates	None	12,169	-----
	Dielectric Strength @25°C.	35 KV, min.	11,605	14-28-54
	Fire Point	None to boiling point	10,123	14-28-54
	Viscosity @54.4°C. (SUS)	73 - 80	10,086	14-4-52
	Corrosion Test (6 hrs. @210°C. with bright aluminum foil)		10,126 MONS 049725	14-55-57
	Change in wt. of Al (%)	0.0		
	A. C. Color, APHA	60, max.	10,084	14-44-54
	A. C. Condition	Clear	10,084	G-1
	A. C. Acidity (mg. KOH/g.)	0.010, max.	10,087	14-42-54
	A. C. Inorganic (Free) Chlorides	0.05 ppm., max.	10,118	010
	GENERAL INFORMATION			
	Specific Heat @25°C.	0.27		
	Fixed Chlorine	47.5 - 48.5%		

(R) Routine Analysis, All others Analyzed by request Only

Monsanto
ORGANIC CHEMICALS DIVISION

FINISHED PRODUCT SPECIFICATION

PRODUCT			DEPT.
Aroclor 1254 Electrical Grade			246 - 27
PLANT	PRODUCT CODE	USE	
WGK and Ann.	81103 82613	Sales	
DATE EFFECTIVE	SALES CODE		
11/4/68	1040-280-04/11/16-03/09		

APPROVALS

PRODUCTION	RESEARCH
J. W. Molloy	R. W. Bucknell
SALES	QUALITY CONTROL (Chief Chemist) G. W. Miller
W. E. Ault	W. J. Gresham

GENERAL DESCRIPTION

CHEMICAL FORMULA

Also called Pyranol 1476

MOL WT.

SUPERSEDES SPECS. OF	SAMPLE FOR ANALYSIS	ISSUED BY
6/28/65	3 x 5 pt. Amber Bottles	E. McEntire/G. Stites

CHARACTERISTIC	LIMITS	METHOD WGK	METHOD Ann.
UNRESTRICTED INFORMATION			
(R) Color, APHA	50, Max.	10084	14-44-54
(R) Condition	Clear	10084	G-1
(R) Sp. Gr. @ 65/15.5°C	1.495 - 1.505	10114	14-49-54
(R) Acidity (mg. KOH/gm.)	0.010, Max.	10087	14-42-54
(R) Moisture (H_2O)	35 ppm, Max.	10620	14-53-54
(R) Refractive Index @ 25°C	1.6370 - 1.6390	10125	14-34-54
(R) Inorganic (Free) Chlorides	0.05 ppm., Max.	12741	014
(R) Pour Point	7 - 12°C	10115	14-27-54
(R) Dielectric Constant (1000 cycles @ 100°C)	4.15 - 4.35	11608	14-36-54
(R) Resistivity (500 VDC @ 100°C 0.1" GAP) as OHM-CM x 10^9	500, Min.	11607	14-35-57
(R) Hydrolysis Stability Test (as Chlorides)	1.0 ppm., Max.	12672	010
(R) Monsanto Stability Test (as Chlorides)	0.5 ppm., Max.	11503	14-61-57
(R) Distillation Range (ASTM D-20, Corrected)		10117	14-31-54
10% Distilled by Wt.	366 - 378°C		
50% Distilled by Wt.	371 - 383°C		
90% Distilled by Wt.	379 - 394°C		
Sulfates	None	12169	
Dielectric Strength @ 25°C	35KV, Min.	11605	043
Flash Point	None	10123	14-28-54
Fire Point	None	10123	14-28-54
Visc. @ 210°F (SUS)	44-48	10086	14-4-52
Corrosion Test (6 hrs. @ 210°C with bright aluminum foil)		10126	14-55-57
		MONS 049726	
Change in wt. of Al (%)	0.0		
A. C. Color, APHA	60, Max.	10084	14-44-54
A. C. Condition	Clear	10084	G-1
A. C. Acidity (mg. KOH/g.)	0.010, Max.	10087	14-42-54
A. C. Inorganic (Free) Chlorides	0.05 ppm., Max.	10118	010

(R) Routine Analysis, All others Analyzed by request Only

Monsanto
ORGANIC CHEMICALS DIVISION

FINISHED PRODUCT SPECIFICATION

PRODUCT: AROCLOR 1254 NON-ELECTRICAL GRADE			DEPT. Ann. 608 WGK 247
PLANT: Anniston & WGK	PRODUCT CODE: 82613-81103	USE: Sales	
DATE EFFECTIVE: 3-1-69	SALES CODE: 1040-280-04/11/009-003		

APPROVALS

PRODUCTION: J. Molloy 3/21/69 H. Williams 2/19/69	RESEARCH: M. E. Gibbs 3/12/69
SALES: W. Ault 3/10/69	QUALITY CONTROL (Chief Chemist): R. Blowers 3/26/69 G. Miller 2/15/69

GENERAL DESCRIPTION: MIXTURE

CHEMICAL FORMULA:

MOL WT.

SUPERSEDES SPECS. OF	SAMPLE FOR ANALYSIS	ISSUED BY
9/25/67	2 x 1/2 gal. Amber Bottles	G. Miller

CHARACTERISTIC	LIMITS	METHOD: Anniston	METHOD: WGK
(R) Condition	Clear	G-1	10084
(R) Color, APHA	100 Max.	046	10084
(R) Specific Gravity (65/15.5°C)	1.495-1.505	052	10114
(R) Acidity (mg KOH/g.)	0.010 Max.	050	10087
(R) Moisture, ppm	50 Max.	047	10620
(R) Viscosity @ 210°F	44-48 SUS 7.5-10 Cp	049	10086
Flash Point	None	114	10123

MONS 049727

(R) Routine Analysis, All others Analyzed by request Only

Monsanto
ORGANIC CHEMICALS DIVISION

FINISHED PRODUCT SPECIFICATION

PRODUCT		DEPT.
Aroclor 1254 - Export Grade Electrical Grade		27-1
PLANT	PRODUCT CODE	USE
Anniston	826.13	Sales
DATE EFFECTIVE	SALES CODE	
3/23/67	1040-280-16-009	

APPROVALS

PRODUCTION	RESEARCH
R. G. Moody/s/R. G. Moody 3/23/67	L. R. Stark/s/L. R. Stark 3/21/67
SALES	QUALITY CONTROL (Chief Chemist)
W. E. Ault/s/W. E. Ault 3/17/67	G. W. Miller/s/G. W. Miller 2/23/67

GENERAL DESCRIPTION

Mixture

CHEMICAL FORMULA

MOL WT.

SUPERSEDES SPECS. OF	SAMPLE FOR ANALYSIS	ISSUED BY
Tentative 4/27/66	~~2~~ 5 pt. Amber bottles	J. A. Liddle 2/21/67

CHARACTERISTIC	LIMITS	METHOD
UNRESTRICTED INFORMATION		
(R) Color, APHA	50 Max.	046
(R) Condition	Clear	G-1
(R) Specific Gravity @ 65/15.5 °C	1.495 - 1.505	052
(R) Acidity (mg KOH/gm.)	0.010 Max.	050
(R) Moisture (H_2O), ppm	35 Max.	047
(R) Refractive Index @ 25°C	1.6370 - 1.6390	048
(R) Inorganic (free) Chlorides, ppm	0.05 Max.	045
(R) Pour Point, °C	7 - 12	053
(R) Dielectric Constant 1000 Cycles @ 100°C	4.15 - 4.35	113
(R) Resistivity ohm-cm 500 VDC @ 100°C, 0.1" Gap	$10{,}000 \times 10^9$ Min.	121
(R) Hydrolysis Stability Test as chlorides, ppm	1.0 Max.	010
(R) Monsanto Stability Test as chlorides, ppm	0.5 Max.	133
(R) Distillation Range, ASTM D-20, corrected		054
10% Distilled by wt.	366 - 378°C	
50% Distilled by wt.	371 - 383°C	
90% Distilled by wt.	379 - 394°C	
(R) Biphenyl, %	0.025 Max.	100
Sulfates	None	
Dielectric Strength @ 25°C	35 KV, Min.	043
Flash Point	None to Boil	114
Fire Point	None to Boil	114
Viscosity @ 210°F (SUS)	44 - 48	049
Corrosion Test 6 hours @ 210°C with bright aluminum foil		MONS 049728
Change in wt. of Al (%)	0.0	
A.C. Color, APHA	60 Max.	046
A.C. Condition	Clear	G-1
A.C. Acidity (mg. KOH/g.)	0.010 Max.	050
A.C. Inorganic (free) chlorides, ppm	0.05 Max.	045
RESTRICTED INFORMATION		
Power Factor @ 100°C & 60 Cycles	Report	113

(R) Routine Analysis, All others Analyzed by request Only

Monsanto
ORGANIC CHEMICALS DIVISION

FINISHED PRODUCT SPECIFICATION

PRODUCT: AROCLOR 1260 ELECTRICAL GRADE			DEPT. WGK 246 Anniston 826.6
PLANT: Anniston - WGK	PRODUCT CODE: 82614-81105	USE: Sales	
DATE EFFECTIVE: 10/21/69	SALES CODE: 1040-290-04/11/16-03-09		

APPROVALS

PRODUCTION: H. L. Williams /s/ H. L. Williams 1/12/70	RESEARCH: M. E. Gibbs /s/ M. E. Gibbs 1/14/70
SALES: W. E. Ault /s/ W. E. Ault 12/23/69	QUALITY CONTROL (Chief Chemist) R. M. Blowers 1/7/70 G. W. Miller /s/ G. W. Miller 10/30/69

GENERAL DESCRIPTION — CHEMICAL FORMULA

MOL WT.:

SUPERSEDES SPECS. OF	SAMPLE FOR ANALYSIS	ISSUED BY
5/25/66	3 x 5 pt. Amber Bottles	G. W. Miller

CHARACTERISTIC	LIMITS	METHOD	WGK	Anniston
UNRESTRICTED INFORMATION				
(R) Color, APHA	150 Max.		10084	046
(R) Condition	Clear		10084	G-1
(R) Specific Gravity @ 90/15.5°C	1.555-1.566		10114	052
(R) Acidity, mg KOH/g	0.014 Max.		10087	050
(R) Moisture, ppm	35 Max.		10620	047
(R) Viscosity @ 210°F, SUS	72-78		10086	049
(R) Refractive Index @ 25°C	1.6455-1.6470		10125	048
(R) Inorganic (free) Chlorides	0.05 ppm, Max.		10118	045
(R) Pour Point, °C	25-34		10115	053
(R) Distillation Range (ASTM D-20, Corrected)			10117	054
10% Distilled by wt.	385-398°C			
50% Distilled by wt.	390-404°C			
90% Distilled by wt.	400-420°C			
(R) Corrosion Test (6 hrs. @ 210°C with bright aluminum foil)			10126	136
(R) Change in weight of Al	0.0			
(R) A.C. Color, APHA	150 Max.		10084	046
(R) A.C. Condition	Clear		10084	G-1
(R) A.C. Acidity, mg KOH/g	0.014 Max.		10087	050
(R) A.C. Inorganic (free) Chlorides	0.05 ppm, Max.		10118	014
Flash Point	None		10123	114
Fire Point	None		10123	114
Fixed Chlorine, %	59.5-60.5		10088	
(R) Dielectric Strength @ 50°C	30 KV, Min.		11605	043
(R) Resistivity (500 VDC @ 100°C 0.1" gap as ohm-cm x 10^9)	500 Min.		11607	121
(R) Dielectric Constant 1000 cycles, 100°C	3.6-3.8		11607	113
RESTRICTED INFORMATION		MONS 049729		
(R) Monsanto Stability Test (as chlorides in ppm)	0.7 Max.		11503	133

(R) Routine Analysis, All others Analyzed by request Only

MONSANTO CHEMICAL COMPANY
ORGANIC CHEMICALS DIVISION

FINISHED PRODUCT SPECIFICATION

PRODUCT CODE: 82614 - Anniston
Department: 27 - Anniston
246 - MKK
SALES CODE: 1040-290-04/11/16/-03/09

Issued 8/1[illegible]
W. G. Krummrich Plant
By R. O. Martin

PRODUCT (Trade name)	TYPE
AROCLOR 1260	Electrical Grade
PRODUCT (Chemical name)	TYPE
	(Pyranol 1482)

CHEMICAL FORMULA: MIXTURE

MOL WT.: ---

USE: Sales

SUPERSEDES SPEC'S OF	SPECIAL JOB NO.	SAMPLE FOR ANALYSIS
3/28/58		3 x 5 pt. Amber Bottles

UNRESTRICTED INFORMATION

Routine Tests:

Property	Specification	Method No. MKK	Method No. Anniston
Color (APHA)	150, Max.	10,084	14-44-54
Condition	Clear	10,084	--------
Specific Gravity @ 90/15.5°C	1.555-1.566	10,114	14-49-54
Acidity (mg KOH/g.)	0.014, Max.	10,087	14-42-54
Moisture (H_2O) (ppm.)	35, Max.	10,620	14-53-54
Viscosity @ 210°F (SUS)	72-78	10,086	14- 4-58
Refractive Index @ 25°C	1.6455-1.6470	10,125	14-34-54
Inorganic (Free) Chlorides	No detectable amt.	10,118	14-48-57
Pour Point (°C)	25-34	10,115	14-47-54
Distillation Range (ASTM D-20, Corrected)		10,117	14-32-54
10% Distilled by wt.	385-398°C		
50% Distilled by wt.	390-404°C		
90% Distilled by wt.	400-420°C		
Corrosion Test (6 hrs. @ 210°C with bright aluminum foil)		10,126	14-55-57
Change in weight of Al (%)	0.0		
A.C. Color (APHA)	150, Max.	10,084	14-44-54
A.C. Condition	Clear	10,084	--------
A.C. Acidity (mg.KOH/g.)	0.014, Max.	10,087	14-42-54
A.C. Inorganic (Free) Chlorides	No detectable amt.	10,118	14-48-57

General Tests (made only on request)

Flash Point	None	10,123	14-28-54
Fire Point	None	10,123	14-28-54
Fixed Chlorine (%)	59.5-60.5	10,088	14-13-54
Dielectric Strength @ 50°C	30 K.V., Min.	11,605	--------
Resistivity (500 VDC @ 100°C 0.1" gap as ohm-cm. x 10^9)	500, Min.	11,607	14-35-57
Dielectric Constant 1000 cycles, 100°C	3.6-3.8	11,608	14-36-45

MONS 049730

Property	Specification	Method No. [redacted]	Method No. [redacted]
Restricted Information			
Monsanto Stability Test (As Chlorides in ppm.)	0.7, Max.	11,503	14-61-57
General Information			
Evaporation Loss after 6 hrs. @ 100°C (%)	0.2, Max.	10,116	14-32-54
Stability test - after 30 days at 100°C in glass sealed in air	No liberation of chlorine or chlorides	------	--------

Retyped:
March 7, 1963

/gm

Monsanto
ORGANIC CHEMICALS DIVISION

FINISHED PRODUCT SPECIFICATION

PRODUCT: AROCLOR 1260 NON-ELECTRICAL GRADE			DEPT. Ann. 206 WGK 246
PLANT: Anniston & WGK	PRODUCT CODE: 82614-81105	USE: Sales	
DATE EFFECTIVE: 3-1-69	SALES CODE: 1040-290-04/11/009-003		

APPROVALS

PRODUCTION: J. Molloy 3/21/69 H. Williams 2/19/69	RESEARCH: M. E. Gibbs 3/12/69
SALES: W. Ault 3/10/69	QUALITY CONTROL (Chief Chemist): R. Blowers 3/26/69 G. Miller 2/15/69

GENERAL DESCRIPTION: MIXTURE

CHEMICAL FORMULA:

MOL WT.

SUPERSEDES SPECS. OF	SAMPLE FOR ANALYSIS	ISSUED BY
9/25/67	2 x 1/2 gal. Amber Bottles	G. Miller

CHARACTERISTIC	LIMITS	METHOD: Anniston	METHOD: WGK
(R) Condition	Clear	G-1	10084
(R) Color, APHA	150 Max.	046	10084
(R) Specific Gravity (90/15.5°C)	1.555-1.566	052	10114
(R) Acidity, (mg KOH/g.)	0.014 Max.	050	10087
(R) Moisture, ppm	50 Max.	047	10620
(R) Viscosity @ 210°F	72-78 SUS 20-24 Cp	049	10086
Flash Point	None	114	10123

MONS 049732

(R) Routine Analysis, All others Analyzed by request Only

Monsanto
ORGANIC CHEMICALS DIVISION

FINISHED PRODUCT SPECIFICATION

PRODUCT		DEPT.
AROCLOR 1262 NON-ELECTRICAL GRADE		Ann. 206 WGK 244
PLANT	PRODUCT CODE	USE
Anniston & WGK	82615 & 81107	Sales
DATE EFFECTIVE	SALES CODE	
3-1-69	1040-/300/04/11/-009/003	

APPROVALS

PRODUCTION	RESEARCH
J. Molloy 3/21/69 H. Williams 2/19/69	M. E. Gibbs 3/12/69
SALES	QUALITY CONTROL (Chief Chemist)
W. Ault 3/10/69	R. Blowers 3/26/69 G. Miller 2/15/69

GENERAL DESCRIPTION

MIXTURE

CHEMICAL FORMULA

MOL WT.

SUPERSEDES SPECS. OF	SAMPLE FOR ANALYSIS	ISSUED BY
3/2/66	2 x 1/2 gal. Amber Bottles	G. Miller

CHARACTERISTIC	LIMITS	METHOD	
		Anniston	WGK
(R) Condition	Clear	G-1	10084
(R) Color, APHA	150 Max.	046	10084
(R) Specific Gravity (90/15.5°C)	1.572-1.583	052	10114
(R) Acidity (mg KOH/g)	0.014 Max.	050	10087
(R) Viscosity @ 210°F	86-100 SUS 26-33 Cp	049	10086

MONS 049733

(R) Routine Analysis, All others Analysed by request Only

Monsanto
ORGANIC CHEMICALS DIVISION

ANNISTON AND KRUMMRICH
FINISHED PRODUCT
SPECIFICATION

PRODUCT: A[illegible] DISTILLED [illegible]
PLANT: ANN. & WGK
DATE EFFECTIVE: MAR 02 1966
SALES CODE: 1040-300-04/11/1[illegible]

APPROVALS

PRODUCTION	RESEARCH
P. E. Heisler	W. D. Robinson
SALES	QUALITY CONTROL (Chief Chemist)
W. E. Ault	W. J. Gresham — O. E. Dolin

GENERAL DESCRIPTION

CHEMICAL FORMULA

MOL WT.

SUPERSEDES SPECS. OF	SAMPLE FOR ANALYSIS	ISSUED BY
1/24/62	2 x 16 oz. W.M. Bottles	J. P. Prader

CHARACTERISTIC		LIMITS	METHOD
UNRESTRICTED INFORMATION			
(R)	Appearance	Viscous liquid	10084
(R)	Color	APHA 150, max.	10084
(R)	Specific Gravity @ 90/15.5°C.	1.572 - 1.583	10114
(R)	Acid No. (mg. KOH/g.)	0.014, max.	10087
(R)	Viscosity @ 210°F.	86 - 100 SUS	10086
GENERAL INFORMATION			
Pour Point (ASTM)		35 - 38°C.	
Distilling Range		390 - 425°C.	
Total Chlorine		61.5 - 62.5%	
Specific Gravity Temperature Coefficient (85 - 130°C.)		0.001/°C.	

MONS 049734

(R) Routine Analysis, All others Analyzed by request Only

Monsanto
ORGANIC CHEMICALS DIVISION

FINISHED PRODUCT SPECIFICATION

PRODUCT		DEPT.
AROCLOR 1268		826.17
PLANT	PRODUCT CODE	USE
Anniston	826.16	Sales
DATE EFFECTIVE	SALES CODE	
10/21/69	1040-340-04-009	

APPROVALS

PRODUCTION	RESEARCH
H. L. Williams /s/ H. L. Williams 11/3/69	M. E. Gibbs /s/ M. E. Gibbs 1/15/70
SALES	QUALITY CONTROL (Chief Chemist)
W. E. Ault /s/ W. E. Ault 12/31/69	G. W. Miller /s/ G. W. Miller 10/30/69

GENERAL DESCRIPTION: MIXTURE

CHEMICAL FORMULA:

MOL WT.

SUPERSEDES SPECS. OF	SAMPLE FOR ANALYSIS	ISSUED BY
3/11/66	1 x 16 oz. Can or W.M. Bottle	G. W. Miller

CHARACTERISTIC	LIMITS	METHOD
UNRESTRICTED INFORMATION		
(R) Appearance and color	White to off-white powder	G-1
Color, Gardner	6 Max.	
(R) Hold Point, °C	150-170	119
(R) Acid No., mg KOH/g	0.05 Max.	116
RESTRICTED INFORMATION		
Screen Test, % retained on		
No. 16 mesh	0.01 Max.	120
No. 20 mesh	10 Max.	
Specific Gravity @ 25/25°C., Pycnometer	1.804-1.811	
Loss @ 163°C., %	0.15-0.24	

MONS 049735

(R) Routine Analysis, All others Analysed by request Only

WOH-308

Monsanto
ORGANIC CHEMICALS DIVISION

FINISHED PRODUCT SPECIFICATION

PRODUCT		DEPT.
AROCLOR 1148		826.08
PLANT	PRODUCT CODE	USE
Anniston		Sales
DATE EFFECTIVE	SALES CODE	
10/21/69	1040-140-04-03/09	

APPROVALS

PRODUCTION	RESEARCH
H. L. Williams /s/ H. L. Williams 11/3/69	M. E. Gibbs /s/ M. E. Gibbs 1/14/70
SALES	QUALITY CONTROL (Chief Chemist)
W. E. Ault /s/ W. E. Ault 12/31/69	G. W. Miller /s/ G. W. Miller 10/30/69

GENERAL DESCRIPTION: MIXTURE

CHEMICAL FORMULA:

MOL WT.:

SUPERSEDES SPECS. OF	SAMPLE FOR ANALYSIS	ISSUED BY
4/11/55	2 x 16 oz. W. M. Bottles	G. W. Miller

CHARACTERISTIC	LIMITS	METHOD
UNRESTRICTED INFORMATION		
(R) Appearance	Oily liquid	G-1
(R) Color	Brown to black	G-1
(R) Specific Gravity @ 65/15.5°C	1.410-1.420	052
(R) Acid Number, mg KOH/g	0.7 Max.	050

RESTRICTED INFORMATION

Acid Number of the crude which is stored in non-lacquered metal containers shall be 0.2 mg KOH/g., Max.

MONS 049736

(R) Routine Analysis, All others Analyzed by request Only

WGK-888

Monsanto
ORGANIC CHEMICALS DIVISION

FINISHED PRODUCT SPECIFICATION

PRODUCT		DEPT.
AROCLOR 1154 CRUDE		826.08
PLANT	PRODUCT CODE	USE
Anniston		Sales
DATE EFFECTIVE	SALES CODE	
10/21/69	1040-160-04-03/09	

APPROVALS

PRODUCTION	RESEARCH
H. L. Williams /s/ H. L. Williams 11/3/69	M. E. Gibbs /s/ M. E. Gibbs 1/14/70
SALES	QUALITY CONTROL (Chief Chemist)
W. E. Ault /s/ W. E. Ault 12/31/69	G. W. Miller /s/ G. W. Miller 10/30/69

GENERAL DESCRIPTION

MIXTURE

CHEMICAL FORMULA

MOL WT.

SUPERSEDES SPECS. OF	SAMPLE FOR ANALYSIS	ISSUED BY
12/21/54	1 qt. Bottle	G. W. Miller

CHARACTERISTIC	LIMITS	METHOD
UNRESTRICTED INFORMATION		
(R) Appearance and Color	Brown to black viscous liquid	G-1
(R) Specific Gravity @ 65°/15.5°C	1.500-1.510	052
(R) Acid Number, mg KOH/g	0.7 Max.	050

MONS 049737

(R) Routine Analysis, All others Analysed by request Only

Monsanto
ORGANIC CHEMICALS DIVISION

FINISHED PRODUCT SPECIFICATION

PRODUCT		DEPT.
AROCLOR 1160 CRUDE		826.08
PLANT	PRODUCT CODE	USE
Anniston	846.14	Sales
DATE EFFECTIVE	SALES CODE	
10/21/69	1040-170-04-03/09	

APPROVALS

PRODUCTION	RESEARCH
H. L. Williams /s/ H. L. Williams 11/3/69	M. E. Gibbs /s/ M. E. Gibbs 1/14/70
SALES	QUALITY CONTROL (Chief Chemist)
W. E. Ault /s/ W. E. Ault 12/31/69	G. W. Miller /s/ G. W. Miller 10/30/69
GENERAL DESCRIPTION	CHEMICAL FORMULA

MOL WT.

SUPERSEDES SPECS. OF	SAMPLE FOR ANALYSIS	ISSUED BY
3/15/65	1 pt. Can	G. W. Miller

CHARACTERISTIC	LIMITS	METHOD
UNRESTRICTED INFORMATION		
(R) Appearance and Color	Brown to black viscous sticky mass	G-1
(R) Specific Gravity @ 90°/15.5°C	1.558-1.569	052
(R) Acid Number, mg KOH/g	0.7 Max.	050

MONS 049738

(R) Routine Analysis, All others Analyzed by request Only

Monsanto
ORGANIC CHEMICALS DIVISION

FINISHED PRODUCT SPECIFICATION

PRODUCT		DEPT.
AROCLOR 1162 CRUDE		826.08
PLANT	PRODUCT CODE	USE
Anniston		Sales
DATE EFFECTIVE	SALES CODE	
10/21/69	1040-170-04-03/09	

APPROVALS

PRODUCTION	RESEARCH
H. L. Williams /s/ H. L. Williams 11/3/69	M. E. Gibbs /s/ M. E. Gibbs 1/14/70
SALES	QUALITY CONTROL (Chief Chemist)
W. E. Ault /s/ W. E. Ault 12/31/69	G. W. Miller /s/ G. W. Miller 10/30/69

GENERAL DESCRIPTION

MIXTURE

CHEMICAL FORMULA

MOL WT.

SUPERSEDES SPECS. OF	SAMPLE FOR ANALYSIS	ISSUED BY
1/24/62	1 pt. Can	G. W. Miller

CHARACTERISTIC	LIMITS	METHOD
UNRESTRICTED INFORMATION		
(R) Appearance	Viscous liquid	G-1
(R) Color	Brown to black	G-1
(R) Specific Gravity @ 90/15.5°C	1.577-1.587	052
(R) Acid No., mg KOH/g	0.7 Max.	050

MONS 049739

(R) Routine Analysis, All others Analyzed by request Only

Monsanto
ORGANIC CHEMICALS DIVISION

FINISHED PRODUCT SPECIFICATION

PRODUCT		DEPT.
AROCLOR 1168 CRUDE		826.08
PLANT	PRODUCT CODE	USE
Anniston		Sales
DATE EFFECTIVE	SALES CODE	
10/21/69	1040-210-04-09	

APPROVALS

PRODUCTION	RESEARCH
H. L. Williams /s/ H. L. Williams 11/3/69	M. E. Gibbs /s/ M. E. Gibbs 1/14/70
SALES	QUALITY CONTROL (Chief Chemist)
W. E. Ault /s/ W. E. Ault 12/31/69	G. W. Miller /s/ G. W. Miller 10/30/69

GENERAL DESCRIPTION

MIXTURE

CHEMICAL FORMULA

MOL WT.

SUPERSEDES SPECS. OF	SAMPLE FOR ANALYSIS	ISSUED BY
4/25/61	1 x 16 oz. can or W.M. Bottle	G. W. Miller

CHARACTERISTIC	LIMITS	METHOD
UNRESTRICTED INFORMATION		
(R) Hold Point, °C	155-175	119
(R) Appearance and color	Black solid	G-1

MONS 049740

(R) Routine Analysis, All others Analyzed by request Only

WBN-396

Monsanto
ORGANIC CHEMICALS DIVISION

FINISHED PRODUCT SPECIFICATION

PRODUCT		DEPT.
Aroclor 2565		27-S
PLANT	PRODUCT CODE	USE
Anniston	826.18	Sales
DATE EFFECTIVE	SALES CODE	
3-11-66	1040-390-04-009	

APPROVALS

PRODUCTION	RESEARCH
R. G. Moody /s/ 12-29-65	L. R. Stark /s/ 3-8-66
SALES	QUALITY CONTROL (Chief Chemist)
W. E. Ault /s/ 3-2-66	O. E. Dolin /s/ 12-29-65

GENERAL DESCRIPTION: Mixture

CHEMICAL FORMULA:

MOL WT.

SUPERSEDES SPECS. OF	SAMPLE FOR ANALYSIS	ISSUED BY
4-25-61	1 x 16 oz. Can or W.M. Bottle	J. A. Liddle 11-30-65

CHARACTERISTIC	LIMITS	METHOD
UNRESTRICTED INFORMATION		
(R) Appearance and Color	Black, brittle resin	G-1
(R) Softening Point, °C	66 - 72	115
(R) Acid No., mg KOH/g	1.4 Max.	116

MONS 049741

(R) Routine Analysis, All others Analyzed by request Only

Monsanto
ORGANIC CHEMICALS DIVISION

FINISHED PRODUCT SPECIFICATION

PRODUCT		DEPT.
AROCLOR 4065		826.17
PLANT	PRODUCT CODE	USE
Anniston	826.19	Sales
DATE EFFECTIVE	SALES CODE	
10/21/69	1040-410-04-009	

APPROVALS

PRODUCTION	RESEARCH
H. L. Williams /s/ H. L. Williams 11/3/69	M. E. Gibbs /s/ M. E. Gibbs 1/15/70
SALES	QUALITY CONTROL (Chief Chemist)
W. E. Ault /s/ W. E. Ault 12/31/69	G. W. Miller /s/ G. W. Miller 10/30/69

GENERAL DESCRIPTION: MIXTURE

CHEMICAL FORMULA:

MOL WT.

SUPERSEDES SPECS. OF	SAMPLE FOR ANALYSIS	ISSUED BY
3/15/66	1 x 16 oz. Can or W.M. Bottle	G. W. Miller

CHARACTERISTIC	LIMITS	METHOD
UNRESTRICTED INFORMATION		
(R) Appearance and Color	Black, brittle resin	G-1
(R) Softening Point, °C	66 - 72	115
(R) Acid No., mg KOH/g	1.4 Max.	116

MONS 049742

(R) Routine Analysis, All others Analyzed by request Only

Monsanto
ORGANIC CHEMICALS DIVISION

FINISHED PRODUCT SPECIFICATION

PRODUCT		DEPT.
AROCLOR 4465		826.17
PLANT	PRODUCT CODE	USE
Anniston	826.19	Sales
DATE EFFECTIVE	SALES CODE	
10/21/69	1040-430-04-009	

APPROVALS

PRODUCTION	RESEARCH
H. L. Williams /s/ H. L. Williams 11/3/69	M. E. Gibbs /s/ M. E. Gibbs 1/15/70
SALES	QUALITY CONTROL (Chief Chemist)
W. E. Ault /s/ W. E. Ault 12/31/69	G. W. Miller /s/ G. W. Miller 10/30/69

GENERAL DESCRIPTION

MIXTURE

CHEMICAL FORMULA

MOL WT.

SUPERSEDES SPECS. OF	SAMPLE FOR ANALYSIS	ISSUED BY
3/11/66	1 x 16 oz. Can or W.M. Bottle	G. W. Miller

CHARACTERISTIC	LIMITS	METHOD
UNRESTRICTED INFORMATION		
(R) Appearance and Color	Clear, light yellow resin	G-1
(R) Color, NPA, Molten	2 Max.	G-4
(R) Softening Point, °C	60-66	115
Acid No., mg KOH/g	0.05 Max.	116

MONS 049743

(R) Routine Analysis, All others Analyzed by request Only

Monsanto
ORGANIC CHEMICALS DIVISION

FINISHED PRODUCT SPECIFICATION

PRODUCT		DEPT.
AROCLOR 5042		826.17
PLANT	PRODUCT CODE	USE
Anniston	826.21	Sales
DATE EFFECTIVE	SALES CODE	
10/21/69	1040-440-04-009	

APPROVALS

PRODUCTION	RESEARCH
H. L. Williams /s/ H. L. Williams 11/3/69	M. E. Gibbs /s/ M. E. Gibbs 1/15/70
SALES	QUALITY CONTROL *(Chief Chemist)*
W. E. Ault /s/ W. E. Ault 12/31/69	G. W. Miller /s/ G. W. Miller 10/30/69

GENERAL DESCRIPTION

MIXTURE

CHEMICAL FORMULA

MOL WT.

SUPERSEDES SPECS. OF	SAMPLE FOR ANALYSIS	ISSUED BY
3/15/66	1 x 16 oz. Can or W.M. Bottle	G. W. Miller

CHARACTERISTIC	LIMITS	METHOD
UNRESTRICTED INFORMATION		
(R) Appearance and Color	Black, sticky resin	G-1
(R) Softening Point, °C	50 - 56	115
(R) Acid No., mg KOH/g	1.4 Max.	116

MONS 049744

(R) Routine Analysis, All others Analyzed by request Only

Monsanto
ORGANIC CHEMICALS DIVISION

FINISHED PRODUCT SPECIFICATION

PRODUCT		DEPT.
AROCLOR 5442		826.17
PLANT	PRODUCT CODE	USE
Anniston	826.21	Sales
DATE EFFECTIVE	SALES CODE	
10/21/69	1040-470-04-009	

APPROVALS

PRODUCTION	RESEARCH
H. L. Williams /s/ H. L. Williams 11/3/69	M. E. Gibbs /s/ M. E. Gibbs 1/15/70
SALES	QUALITY CONTROL (Chief Chemist)
W. E. Ault /s/ W. E. Ault 12/31/69	G. W. Miller /s/ G. W. Miller 10/30/69

GENERAL DESCRIPTION

MIXTURE

CHEMICAL FORMULA

MOL WT.

SUPERSEDES SPECS. OF	SAMPLE FOR ANALYSIS	ISSUED BY
3/15/66	1 x 16 oz. Can or W.M. Bottle	G. W. Miller

CHARACTERISTIC	LIMITS	METHOD
UNRESTRICTED INFORMATION		
(R) Appearance and Color	Clear, yellow sticky resin	G-1
(R) Color, NPA, Molten	2 Max.	G-4
(R) Softening Point, °C	46-52	115
Acid No., mg KOH/g	0.05 Max.	116

MONS 049745

(R) Routine Analysis, All others Analyzed by request Only

Monsanto
ORGANIC CHEMICALS DIVISION

FINISHED PRODUCT SPECIFICATION

PRODUCT		DEPT.
AROCLOR 5060		826.17
PLANT	PRODUCT CODE	USE
Anniston	826.20	Sales
DATE EFFECTIVE	SALES CODE	
10/21/69	1040-450-04-009	

APPROVALS

PRODUCTION	RESEARCH
H. L. Williams /s/ H. L. Williams 11/3/69	M. E. Gibbs /s/ M. E. Gibbs 1/15/70
SALES	QUALITY CONTROL (Chief Chemist)
W. E. Ault /s/ W. E. Ault 12/31/69	G. W. Miller /s/ G. W. Miller 10/30/69

GENERAL DESCRIPTION

MIXTURE

CHEMICAL FORMULA

MOL WT.

SUPERSEDES SPECS. OF	SAMPLE FOR ANALYSIS	ISSUED BY
3/11/66	1 x 16 oz. Can or W.M. Bottle	G. W. Miller

CHARACTERISTIC	LIMITS	METHOD
UNRESTRICTED INFORMATION		
(R) Appearance and Color	Black, brittle resin	G-1
(R) Softening Point, °C	105-115	115
(R) Acid No. mg KOH/g	0.5 Max.	116

MONS 049746

(R) Routine Analysis, All others Analyzed by request Only

WGH-898

Monsanto
ORGANIC CHEMICALS DIVISION

FINISHED PRODUCT SPECIFICATION

PRODUCT		DEPT.
AROCLOR 5460 (HIGH SOLUBLE GRADE)		826.17
PLANT	PRODUCT CODE	USE
Anniston	826.22	Sales
DATE EFFECTIVE	SALES CODE	
5-20-69	1040-480-04-009	

APPROVALS

PRODUCTION	RESEARCH
H. L. Williams 5/20/69	M. E. Gibbs 6/13/69
SALES	QUALITY CONTROL (Chief Chemist)
W. E. Ault 6/10/69	G. W. Miller 5/20/69

GENERAL DESCRIPTION

MIXTURE

CHEMICAL FORMULA

MOL WT.

SUPERSEDES SPECS. OF	SAMPLE FOR ANALYSIS	ISSUED BY
3-11-66	1 x 16 oz. Can or W. M. Bottle	G. W. Miller

CHARACTERISTIC	LIMITS	METHOD
UNRESTRICTED INFORMATION		
(R) Appearance and Color	Clear, yellow to amber brittle resin or flaker	G-1
(R) Color, NPA, Molten	2 Max.	G-4
(R) Softening Point, °C	98 - 105.5	115
(R) Solubility (25g in 25g Acetone @ 25°C)	3 hour, Min.	117
Acid No., mg KOH/g	0.05 Max.	116
Chlorine, %	58.5 - 60.6	093
RESTRICTED INFORMATION		
Hydrolysis Stability, ppm Cl	300 Max.	092

MONS 049747

(R) Routine Analysis, All others Analyzed by request Only

WDH-996

Monsanto

FROM (NAME & LOCATION): P. D. Fowlkes - Research Center

DATE: July 15, 1970

SUBJECT: AROCLOR 5432 SPECIFICATIONS

REFERENCE:

TO: G. L. Arnett - ANNISTON

cc: W. R. Richard
R. W. Weiss
L. R. Stark
J. R. Savage JSAVA
Q. E. Thompson
H. L. Williams ANNISTON
G. W. Miller ANNISTON
J. T. Bell ANNISTON

This is to confirm our phone conversations regarding the following Aroclor 5432 tentative specifications.

Specific gravity: 1.263 - 1.290

which corresponds to a chlorine level of 30.5% - 33.0%

Color $\leq$ 2 NPA

These specs will be evaluated and possibly modified with the eventual goal of producing a material with just enough chlorine to prevent the formation of insolubles.

Dwaine
P. D. Fowlkes

ms

MONS 049748

IN 10 REV 11 65

Monsanto
ORGANIC CHEMICALS DIVISION

FINISHED PRODUCT SPECIFICATION

PRODUCT: MONTAR 1			DEPT. 246 WG. 826.47 Annis.
PLANT: Anniston	PRODUCT CODE: 82868-82683	USE: Sales	
DATE EFFECTIVE: 9-1-69	SALES CODE: 6405-001-04-03/09-02-01		

APPROVALS

PRODUCTION: H. L. Williams 8/12/69 J. W. Molloy 9/29/69	RESEARCH: M. E. Gibbs 9/19/69
SALES: W. E. Ault 9/17/69	QUALITY CONTROL (Chief Chemist): R. M. Blowers 9/30/69 G. W. Miller 8/8/69

GENERAL DESCRIPTION: MIXTURE

CHEMICAL FORMULA:

MOL WT.

SUPERSEDES SPECS. OF	SAMPLE FOR ANALYSIS	ISSUED BY
9/25/67	2 x 16 oz W.M. Bottles	G. W. Miller

CHARACTERISTIC	LIMITS	METHOD: Anniston	METHOD: WGK
UNRESTRICTED INFORMATION			
(R) Appearance	Black Viscous Liquid - Semisolid	G-1	11321
(R) Acidity, mg KOH/gm	Basic	050	10087
Typical Physical Properties			
Chlorine Content, %	36-42	093	
Calcium Oxide, %	5-15	---	
Flash Point, °F COC	500-620	114	10123

MONS 049749

(R) Routine Analysis, All others Analysed by request Only

MONSANTO CHEMICAL COMPANY
ORGANIC CHEMICALS DIVISION
Krummrich and Anniston
FINISHED PRODUCT
SPECIFICATION

PRODUCT CODE	DEPT. OR JOB
82868	WGK 246 Ann. 27

USE: Sales

SALES CODE: *See Below

Issued JUL 15 1964
W. G. Krummrich Plant
By M D Dial

PRODUCT (Trade Name) TYPE
Montars 1 and 2

PRODUCT (Chemical Name) TYPE
Polychlorinated Polyphenyls

CHEMICAL FORMULA

Mixture

MOL WT.

SUPERSEDES SPECS OF	SAMPLE FOR ANALYSIS
6-15-61	2 x 16 oz. W. M. Bottles

UNRESTRICTED INFORMATION

Routine Tests	Specification	Anniston WGK Method No.
Appearance	Black Solid	14-17-52 11321

General Information

Physical Properties (Typical Values)	Montar 1	Montar 2
ftening Point (ASTM E-28-51T)	54-160°C	70-170°C
Acidity	Slightly Basic	Slightly Basi
Chlorine Content	36-42%	44-48%
CaO	5-15%	5-15%
Fe	0.5-1.0%	0.5-1.0%
Benzene Insoluble	- - - -	12.5%
Flash Point	500-620°F	- - - -

RESTRICTED INFORMATION

Montars 1 and 2 are the still residues from distillation of Aroclors 1242 and 1248 respectively. Composition of these Montars is not controlled, being entirely dependent on conditions required to make acceptable distilled product.

Sales Code Nos.

Montar 1 6405 - 001 - 04 - 03/09
Montar 2 6405 - 002 - 04 - 03/09

MONS 049750

MONSANTO CHEMICAL COMPANY
ORGANIC CHEMICALS DIVISION
Krummrich and Anniston
FINISHED PRODUCT SPECIFICATION

PRODUCT CODE	DEPT. OR JOB
82868	WGK 246 Ann.27

USE: Sales

SALES CODE: *See Below

Issued JUL 15 1964
W. G. Krummrich Plant
By M D Dietz

PRODUCT (Trade Name) TYPE: Montars 3 and 4

PRODUCT (Chemical Name) TYPE: Polychlorinated Polyphenyls

CHEMICAL FORMULA: Mixture

MOL WT.

SUPERSEDES SPECS OF	SAMPLE FOR ANALYSIS
6-15-61	2 x 16 oz. W. M. Bottles

UNRESTRICTED INFORMATION

Routine Tests	Specification	Anniston Method No.	WG No.
Appearance	Black Solid	14-17-52	113

General Information

Physical Properties (Typical Values)	Montar 3	Montar 4
Softening Point (Method ASTM E28-51T)	86-168°C	92-206°C
Acidity	Slightly Basic	Slightly Bas
Chlorine Content	50-52%	54-56%
CaO	5-10%	5-10%
Fe	0.3-0.6%	0.5-1.0%

RESTRICTED INFORMATION

Montars 3 and 4 are the still residues from distillation of Aroclors 1254 and 1260 respectively. Composition of these Montars is not controlled, being entirely dependent on conditions required to make acceptable distilled product.

*Sales Code Nos.

Montar 3 6405 - 003 - 04 - 03/09
Montar 4 6405 - 004 - 04 - 03/09

MONS 049751

Monsanto
ORGANIC CHEMICALS DIVISION

FINISHED PRODUCT SPECIFICATION

PRODUCT		DEPT.
Monter 5		28
PLANT	PRODUCT CODE	USE
Anniston	828.68	Sales
DATE EFFECTIVE	SALES CODE	
7-5-67	6405-005-04-009	

APPROVALS

PRODUCTION	RESEARCH
R. G. Moody /s/ R. G. Moody 4/6/67	L. R. Stark /s/ L. R. Stark 7/5/67
SALES	QUALITY CONTROL (Chief Chemist)
W. E. Ault /s/ W. E. Ault 6/30/67	G. W. Miller /s/ G. W. Miller 3/28/67

GENERAL DESCRIPTION: Mixture

CHEMICAL FORMULA:

MOL WT.

SUPERSEDES SPECS. OF	SAMPLE FOR ANALYSIS	ISSUED BY
5/5/61	1 pint can	John A. Liddle 3/22/67

CHARACTERISTIC	LIMITS	METHOD
UNRESTRICTED INFORMATION		
(R) Appearance	Dark brown or black solid	G-1
(R) Softening Point °C	155 - 230	115
RESTRICTED INFORMATION		
Acid No. (mg KOH/g)	Slightly basic	116
Cl, %	53 - 55	093
CaO, %	1 - 3	
Fe, %	0.1 - 0.2	
Flash Point °F	None	114
Fire Point °F	None	114

Monter 5 is the still residue from distillation of Aroclor 5460

MONS 049752

(R) Routine Analysis. All others Analyzed by request Only

Monsanto
ORGANIC CHEMICALS DIVISION

FINISHED PRODUCT SPECIFICATION

PRODUCT		DEPT.
Montar 6		28
PLANT	PRODUCT CODE	USE
Anniston	828,68	Sales
DATE EFFECTIVE	SALES CODE	
7-5-67	6405-006-04-009	

APPROVALS

PRODUCTION	RESEARCH
R. G. Moody /s/ R. G. Moody 4/6/67	L. R. Stark /s/ L. R. Stark 7/5/67
SALES	QUALITY CONTROL (Chief Chemist)
W. E. Ault /s/ W. E. Ault 6/30/67	G. W. Miller /s/ G. W. Miller 3/28/67

GENERAL DESCRIPTION: Mixture

CHEMICAL FORMULA:

MOL WT.

SUPERSEDES SPECS. OF	SAMPLE FOR ANALYSIS	ISSUED BY
5/5/61	1 pint can	John A. Liddle 3/22/67

CHARACTERISTIC	LIMITS	METHOD
UNRESTRICTED INFORMATION		
(R) Appearance	Dark brown or black liquid	G-1
(R) Softening Point °C	135 - 190	115
RESTRICTED INFORMATION		
Acid No. (mg KOH/g)	Slightly basic	116
Cl, %	59 - 61	093
CaO, %	2 - 5	
Fe, %	0.2 - 0.4	
Flash Point °F	None	114
Fire Point °F	None	114

Montar 6 is the still residue for distillation of Aroclor 4465

MONS 049753

(R) Routine Analysis. All others Analyzed by request Only

Monsanto
ORGANIC CHEMICALS DIVISION

FINISHED PRODUCT SPECIFICATION

PRODUCT		DEPT.
Montar 7		28
PLANT	PRODUCT CODE	USE
Anniston	828.68	Sales
DATE EFFECTIVE	SALES CODE	
7-5-67	6405-008-04-009	

APPROVALS

PRODUCTION	RESEARCH
R. G. Moody /s/ R. G. Moody 4/6/67	L. R. Stark /s/ L. R. Stark 7/5/67
SALES	QUALITY CONTROL (Chief Chemist)
W. E. Ault /s/ W. E. Ault 6/30/67	G. W. Miller /s/ G. W. Miller 3/28/67

GENERAL DESCRIPTION: Mixture

CHEMICAL FORMULA:

MOL WT.:

SUPERSEDES SPECS. OF	SAMPLE FOR ANALYSIS	ISSUED BY
Tentative 5/5/61	1 pint can	John A. Liddle 3/22/67

CHARACTERISTIC	LIMITS	METHOD
UNRESTRICTED INFORMATION		
(R) Appearance	Black solid	G-1
(R) Softening Point °C	200 Min.	115

RESTRICTED INFORMATION

Montar 7 is Aroclor 1268 still residue

MONS 049754

(R) Routine Analysis. All others Analyzed by request Only

IN 84 **MONSANTO CHEMICAL COMPANY**
ORGANIC CHEMICALS DIVISION
ANNISTON, ALABAMA

FINISHED PRODUCT SPECIFICATION

PRODUCT CODE	828.68
METHOD IDENTITY	--
SALES CODE	See below

Issued 5/5/61
By W. W. Klemme
Anniston Plant
Standards Dept.

PRODUCT (Trade name) MONTAR 5, MONTAR 6, MONTAR 9 TYPE

PRODUCT (Chemical name) TYPE

CHEMICAL FORMULA

MIXTURES

MOL WT. --

USE Sales

SUPERSEDES SPECS OF	SPECIAL JOB NO.	SAMPLE FOR ANALYSIS
7/29/55	--	1 Pt. Tinned Can

UNCLASSIFIED SPECIFICATIONS

Routine Tests

Property	Specification
Appearance	Dark brown or black solid

GENERAL INFORMATION

Properties	Typical Values		
	Montar 5	Montar 6	Montar 9
Softening Point, °C. (ASTM E28-51T)	155-195	135-190	130-175
Acidity (mg KOH/g)	slightly basic	slightly basic	0.1 - 0.3
Cl (%)	53-55	59-61	-
CaO (%)	1-3	2-5	-
Fe (%)	0.1 - 0.2	0.2 - 0.4	0.2 - 0.4
Flash Point (°F.)	-	-	450-550
Fire Point (°F.)	-	-	530-630

Sales Codes: Montar 5 - 6405-005-04-09
Montar 6 - 6405-006-04-09
Montar 9 - 6405-009-04-09

RESTRICTED INFORMATION

Montar 5 is the still residue from distillation of Aroclor 5460
Montar 6 is the still residue from distillation of Aroclor 4465
Montar 9 is the still residue from distillation of Santowax R.

Composition of these Montars is not controlled, being totally dependent on conditions required to make acceptable distilled product.

Monsanto
ORGANIC CHEMICALS DIVISION

FINISHED PRODUCT SPECIFICATION

PRODUCT		DEPT.
Biphenyl Technical		20
PLANT	PRODUCT CODE	USE
Anniston	826.01	Sales
DATE EFFECTIVE	SALES CODE	
5-7-68	1315-000-03-09	

APPROVALS

PRODUCTION	RESEARCH
H. L. Williams /s/H. L. Williams 5/2/68	L. R. Stark /s/John F. Herber
SALES	QUALITY CONTROL (Chief Chemist)
W. E. Ault /s/W. E. Ault 5/7/68	G. W. Miller /s/G. W. Miller 4/29/68

GENERAL DESCRIPTION: White, crystalline solid

CHEMICAL FORMULA: $C_{12}H_{10}$

MOL WT.

SUPERSEDES SPECS. OF	SAMPLE FOR ANALYSIS	ISSUED BY
5-5-61	1 x 16 oz. can	J. L. Brown

CHARACTERISTIC	LIMITS	Typical	METHOD
(R) Appearance	White to pale yellow crystals		
(R) Crystallizing Point, °C	68.7 Min.		018
(R) Color, Gardner	6 Max.		019
General Tests (determined only on request)			
Biphenyl, %		99.9	165
Distillation Range	(Must include		
1st Drop - Dry point, 2.5°C	255°C)		

MONS 049756

(R) Routine Analysis, All others Analyzed by request Only

WQN-300

IN 84

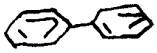
MONSANTO CHEMICAL COMPANY
ORGANIC CHEMICALS DIVISION

FINISHED PRODUCT SPECIFICATION

PRODUCT CODE: 826.01 F 6
METHOD IDENTITY:
SALES CODE: 135-000-03-09

Issued 5/5/61
Anniston Plant
By W. W. Klemmer
Revised to add typ values 11-18-65

PRODUCT (Trade name): Biphenyl — TYPE: Technical
PRODUCT (Chemical name): Biphenyl — TYPE: Technical
CHEMICAL FORMULA:



$C_{12}H_{10}$

MOL WT.: 154.20
USE: Sales

SUPERSEDES SPECS OF	SPECIAL JOB NO.	SAMPLE FOR ANALYSIS
7/8/65		1 x 16 oz. can

Characteristics	Limits	Typical Values
Routine tests		
Appearance	White to pale yellow crystals	White crystals
Crystallizing Point, °C	68.7 Min.	68.8
Color, Gardner	6 Max.	1.5
General Test (determined only on request)		
Biphenyl, %		99.9
Napthalene, %		0.001
3 - Methylbiphenyl, %		0.05
4 - Methylbiphenyl, %		0.02
Unknown, %		<0.03
Distillation Range, °C 1st drop - Dry Point	Must include 255°C	

MONS 049757

This specification for internal use only

Monsanto
ORGANIC CHEMICALS DIVISION

FINISHED PRODUCT SPECIFICATION

PRODUCT		DEPT.
SANTOWAX C		826.02
PLANT	PRODUCT CODE	USE
Anniston	829.10	Internal
DATE EFFECTIVE	SALES CODE	
10/21/69	7795-050-11-009	

APPROVALS

PRODUCTION	RESEARCH
H. L. Williams /s/ H. L. Williams 11/3/69	M. E. Gibbs /s/ M. E. Gibbs 1/8/70
SALES	QUALITY CONTROL (Chief Chemist)
W. E. Ault /s/ W. E. Ault 12/31/69	G. W. Miller /s/ G. W. Miller 10/30/69

GENERAL DESCRIPTION

MIXTURE

CHEMICAL FORMULA

MOL WT.

SUPERSEDES SPECS. OF	SAMPLE FOR ANALYSIS	ISSUED BY
3-9-66	2 - 1 pt. Cans	G. W. Miller

CHARACTERISTIC	LIMITS	METHOD
RESTRICTED INFORMATION		
Appearance	Brown, waxy solid	G-1
Boiling Point, °C	350 Min.	
*Ortho Terphenyl, %	**10	064
*Meta Terphenyl, %	**50	064
*Para Terphenyl, %	**26	064
*Quaterphenyl, %	**14	072
*Biphenyl, %	**0.1	064
Flash Point, °C	**375	114
Chlorine, ppm	2.0 (Typical)	
Sulfur, ppm	2.0 (Typical)	

*Distribution of isomers and quaterphenyls very with operating condition.

**Only limited data is available; therefore, the limits given are typical values of these characteristics.

This product is mainly used as a raw material for other finished products produced at Anniston.

This specification is for internal use only.

MONS 049758

(R) Routine Analysis, All others Analyzed by request Only

WGN-898

Monsanto
ORGANIC CHEMICALS DIVISION

FINISHED PRODUCT SPECIFICATION

PRODUCT		DEPT.
SANTOWAX M		826.04
PLANT	PRODUCT CODE	USE
Anniston	826.05	Sales
DATE EFFECTIVE	SALES CODE	
10/21/69	7795-200-11-009	

APPROVALS

PRODUCTION	RESEARCH
H. L. Williams /s/ H. L. Williams 11/3/69	M. E. Gibbs /s/ M. E. Gibbs 1/8/70
SALES	QUALITY CONTROL (Chief Chemist)
W. E. Ault /s/ W. E. Ault 12/31/69	G. W. Miller /s/ G. W. Miller 10/30/69

GENERAL DESCRIPTION

TERPHENYL MIXTURE

CHEMICAL FORMULA

MOL WT.

SUPERSEDES SPECS. OF	SAMPLE FOR ANALYSIS	ISSUED BY
3-4-66	2 - 1 pt. Cans	G. W. Miller

CHARACTERISTIC	LIMITS	METHOD
UNRESTRICTED INFORMATION		
(R) Color, Gardner	6.0 Max.	035
(R) 1st Crystals, °C	93 Max.	032
(R) Hold Point, °C	80 Min.	119
RESTRICTED INFORMATION		
M-Terphenyl, %	95 (Typical Value)	064

MONS 049759

(R) Routine Analysis, All others Analyzed by request Only

WGH-594

Monsanto
ORGANIC CHEMICALS DIVISION

FINISHED PRODUCT SPECIFICATION

PRODUCT		DEPT.
SANTOWAX O		826.02
PLANT	PRODUCT CODE	USE
Anniston	826.06	Sales
DATE EFFECTIVE	SALES CODE	
10/21/69	7795-300-11-009	

APPROVALS

PRODUCTION	RESEARCH
H. L. Williams /s/ H. L. Williams 11/3/69	M. E. Gibbs /s/ M. E. Gibbs 1/8/70
SALES	QUALITY CONTROL (Chief Chemist)
W. E. Ault /s/ W. E. Ault 12/31/69	G. W. Miller /s/ G. W. Miller 10/30/69

GENERAL DESCRIPTION — CHEMICAL FORMULA

TERPHENYL MIXTURE

MOL WT.

SUPERSEDES SPECS. OF	SAMPLE FOR ANALYSIS	ISSUED BY
3-2-66	2 - 1 pt. Cans	G. W. Miller

CHARACTERISTIC	LIMITS	METHOD
UNRESTRICTED INFORMATION		
(R) Color, Gardner	5.0 Max.	035
(R) Hold Point, °C	49.0 - 54.5	119
(R) Distillation Range, °C		
1st Drop	333 Min.	130
96% by wt.	350 Max.	
RESTRICTED INFORMATION		
O-Terphenyl, %	95 (Typical Value)	072

MONS 049760

(R) Routine Analysis, All others Analyzed by request Only

WBK-888

Monsanto
ORGANIC CHEMICALS DIVISION

FINISHED PRODUCT SPECIFICATION

PRODUCT		DEPT.
SANTOWAX P		826.04
PLANT	PRODUCT CODE	USE
Anniston	826.07	Sales
DATE EFFECTIVE	SALES CODE	
10/21/69	7795-100-11-009	

APPROVALS

PRODUCTION	RESEARCH
H. L. Williams /s/ H. L. Williams 11/3/69	M. E. Gibbs /s/ M. E. Gibbs 1/8/70
SALES	QUALITY CONTROL (Chief Chemist)
W. E. Ault /s/ W. E. Ault 12/31/69	G. W. Miller /s/ G. W. Miller 10/30/69

GENERAL DESCRIPTION — CHEMICAL FORMULA

TERPHENYL MIXTURE

MOL WT.

SUPERSEDES SPECS. OF	SAMPLE FOR ANALYSIS	ISSUED BY
6-9-68	2 - 16 oz. W.M. Bottles	G. W. Miller

CHARACTERISTIC	LIMITS	METHOD
UNRESTRICTED INFORMATION		
(R) Color, Gardner	4 Max.	035
(R) 1st Crystals, °C	207 Min.	032
RESTRICTED INFORMATION		
P-Terphenyl, %	98 - 99.5	064

MONS 049761

(R) Routine Analysis, All others Analyzed by request Only

WORK-888

Monsanto
ORGANIC CHEMICALS DIVISION

FINISHED PRODUCT SPECIFICATION

PRODUCT		DEPT.
SANTOWAX R		826.02
PLANT	PRODUCT CODE	USE
Anniston	826.02	Sales
DATE EFFECTIVE	SALES CODE	
10/21/69	7795-000-11-009	

APPROVALS

PRODUCTION	RESEARCH
H. L. Williams /s/ H. L. Williams 11/3/69	M. E. Gibbs /s/ M. E. Gibbs 1/8/70
SALES	QUALITY CONTROL (Chief Chemist)
W. E. Ault /s/ W. E. Ault 12/31/69	G. W. Miller /s/ G. W. Miller 10/30/69

GENERAL DESCRIPTION — CHEMICAL FORMULA

MIXED TERPHENYLS

MOL WT.

SUPERSEDES SPECS. OF	SAMPLE FOR ANALYSIS	ISSUED BY
3-2-66	2 x 1 pt. Cans	G. W. Miller

CHARACTERISTIC	LIMITS	METHOD
UNRESTRICTED INFORMATION		
(R) Appearance	Yellow white noncrystalline flaked solid	G-1
(R) Color (liquid), NPA	4.0 Max.	128
(R) Upper Hold Point, °C	136 - 145	129
(R) Lower Hold, °C	48 - 63	129
RESTRICTED INFORMATION		
Distillation Range, °C, 80% (Uncorrected)	350 - 400	
Ortho terphenyl, %	10.0 - Typical Value	
Meta tarphenyl, %	54.0 - Typical Value	
Para terphenyl, %	27.0 - Typical Value	
Quaterphenyls, %	9.0 - Typical Value	

MONS 049762

(R) Routine Analysis, All others Analyzed by request Only

WSK-692

Monsanto
ORGANIC CHEMICALS DIVISION

FINISHED PRODUCT SPECIFICATION

PRODUCT		DEPT.
SANTOWAX OM (Reactor Grade)		826.76
PLANT	PRODUCT CODE	USE
Anniston	829.52	Sales
DATE EFFECTIVE	SALES CODE	
10/21/69	7795-500-11-009	

APPROVALS

PRODUCTION	RESEARCH
H. L. Williams /s/ H. L. Williams 11/3/69	M. E. Gibbs /s/ M. E. Gibbs 1/8/70
SALES	QUALITY CONTROL (Chief Chemist)
W. E. Ault /s/ W. E. Ault 12/31/69	G. W. Miller /s/ G. W. Miller 10/30/69

GENERAL DESCRIPTION

CHEMICAL FORMULA

MIXED TERPHENYLS

MOL WT.

SUPERSEDES SPECS. OF	SAMPLE FOR ANALYSIS	ISSUED BY
3-2-66	5 x 16 oz. Wide Mouth Bottle	G. W. Miller

CHARACTERISTIC	LIMITS	METHOD
UNRESTRICTED INFORMATION		
(R) Ortho/Meta Ratio	1.5/1 to 3.0/1	064
(R) Solution Point, °C	85 Max.	096
(R) P-Terphenyl, %	5 Max.	064
(R) Biphenyl, %	3 Max.	064
Hi-Boiler (Quaterphenyls), %	1 Max.	072
(R) Ash, ppm	5 Max.	065
(R) Moisture, ppm	200 Max.	034
(R) Elemental Impurities, ppm		
Boron	0.5	Determined by Research by Emission Spectroscopy
Cobalt	0.1	" "
Iron	2.0	093
Magnesium	0.1	127
Chlorine	2.0	070
Sulfur	10.0	088
Sodium	0.2	Determined by Research by Emission Spectroscopy
Phosphorus	8.0	" "
*Aluminum		" "
*Manganese		" "
*Copper		" "
*Barium		" "
*Calcium		" "
*Lead		" "
*Molybdenum		

*Report the value obtained.

MONS 049763

(R) Routine Analysis, All others Analyzed by request Only

WGH-300

Monsanto
ORGANIC CHEMICALS DIVISION

FINISHED PRODUCT SPECIFICATION

PRODUCT		DEPT.
SANTOWAX OMP (Reactor Grade)		826.32
PLANT	PRODUCT CODE	USE
Anniston	826.32	Sales
DATE EFFECTIVE	SALES CODE	
10/21/69	7795-800-11-009	

APPROVALS

PRODUCTION	RESEARCH
H. L. Williams /s/ H. L. Williams 11/3/69	M. E. Gibbs /s/ M. E. Gibbs 1/8/70
SALES	QUALITY CONTROL (Chief Chemist)
W. E. Ault /s/ W. E. Ault 12/31/69	G. W. Miller /s/ G. W. Miller 10/30/69

GENERAL DESCRIPTION — CHEMICAL FORMULA

TERPHENYL MIXTURE

MOL WT.

SUPERSEDES SPECS. OF	SAMPLE FOR ANALYSIS	ISSUED BY
3-4-66	3 x 16 oz. Wide Mouth Bottle	G. W. Miller

CHARACTERISTIC	LIMITS	METHOD
UNRESTRICTED INFORMATION		
(R) Appearance	Light yellow to yellow waxy solid	G-1
*(R) Terphenyl, %	98%	--
(R) Biphenyl, %	1.0 Max.	036
(R) High Boiler, %	1.0 Max.	033
(R) Solution Point, °C	157 Max.	032
(R) 1st Crystals, °C	156 Max.	032
(R) Water, ppm	500 Max.	034
(R) Chlorine, ppm	2 Max.	093
(R) Trace elements, ppm		Determined by Research emission spectroscopy
Al	1.0	
B	0.5	
Co	0.1	
Mn	0.1	
Cu	2.0	
As	0.5	
Ba	2.0	
Ca	10.0	
Cr	1.0	
Fe	10.0	
Pb	4.0	
Mg	1.0	
Mo	1.0	
Ni	3.0	
Si	3.0	
Ag	0.1	
Sn	1.0	
Ti	5.0	

MONS 049764

(R) Routine Analysis, All others Analyzed by request Only

(R) Trace elements (continued		Determined by Research by emission spectroscopy
Zn	1.0	
Zr	1.0	
Se	0.5	
Hg	0.1	
S	60.0	127
P	8.0	088
Na	0.2	070

RESTRICTED INFORMATION

Color, Gardner	11	035
Terphenyl, %		
Ortho	11.8 (Typical Value)	064
Meta	55.0 " "	
Para	31.2 " "	
Quaterphenyl	2.0	064

*Determined by difference: 100% - (% Biphenyl + % High Boiler) = % Terphenyl

Monsanto
ORGANIC CHEMICALS DIVISION

FINISHED PRODUCT SPECIFICATION

PRODUCT		DEPT.
Santowax R		32
PLANT	PRODUCT CODE	USE
Anniston	826.02	Sales
DATE EFFECTIVE	SALES CODE	
3-2-66	7795-000-11-009	

APPROVALS

PRODUCTION	RESEARCH
R. G. Moody /s/ 1-31-66	L. R. Stark /s/ 2-3-66 - M. McEwen /s/ 2-22-66
SALES	QUALITY CONTROL (Chief Chemist)
W. E. Ault /s/ 2-22-66	O. E. Dolin /s/ 1-25-66

GENERAL DESCRIPTION — CHEMICAL FORMULA

Mixed Terphenyls

MOL WT.

SUPERSEDES SPEC. OF	SAMPLE FOR ANALYSIS	ISSUED BY
2-12-62	2 x 1 pint cans	J. A. Liddle 1-11-66

CHARACTERISTIC	LIMITS	METHOD
UNRESTRICTED INFORMATION		
(R) Appearance	Yellow white noncrystalline flaked solid	G-1
(R) Color (liquid), NPA	4.0 Max.	128
(R) Upper Hold Point, °C	136 - 145	129
(R) Lower Hold, °C	48 - 63	129
RESTRICTED INFORMATION		
Distillation Range, °C, 80% (Uncorrected)	350 - 400	
Ortho terphenyl, %	10.0 - Typical Value	
Meta terphenyl, %	54.0 - " "	
Para terphenyl, %	27.0 - " "	
Quaterphenyls, %	9.0 - " "	

MONS 049766

(R) Routine Analysis, All others Analyzed by request Only

WGK-500

Monsanto
ORGANIC CHEMICALS DIVISION

RAW MATERIAL SPECIFICATION

MATERIAL CODE	MATERIAL
826.38	CHLORINE GAS
PLANT	**USING DEPTS.**
Anniston	826.08 and 826.17
DATE EFFECTIVE	**SUPPLIER**
12/17/69	Diamond Shamrock Corp.

APPROVALS

PRODUCTION	RESEARCH
H. L. Williams /s/ H. L. Williams 12/17/69	M. E. Gibbs /s/ M. A. Terpstra 12/22/69
PROCUREMENT	**QUALITY CONTROL** (Chief Chemist)
H. L. Phillips /s/ H. L. Phillips 12/18/69	G. W. Miller /s/ G. W. Miller 12/17/69

GENERAL DESCRIPTION — **CHEMICAL FORMULA**

GREENISH YELLOW GAS

SUPERSEDES SPECS OF	SAMPLE FOR ANALYSIS	ISSUED BY
New	GLC sampling container	G. W. Miller

CHARACTERISTIC	LIMITS	METHOD
(R) Assay, (Vol. %)	99.4 Min.	113
(R) Residual Gases (Vol. %)	0.5 Max.	113
(R) Moisture, ppm	40 Max.	
(R) Non-volatile Matter, ppm	40 Max.	

MONS 049767

(R) Routine Analysis, All others Analyzed by request only.

WGK-814

Monsanto
ORGANIC CHEMICALS DIVISION

RAW MATERIAL SPECIFICATION

MATERIAL CODE	MATERIAL
17860	CARBON DIOXIDE
PLANT	USING DEPTS.
Anniston	Niran & Biphenyl
DATE EFFECTIVE	SUPPLIER
12/18/69	Pure Carbonic

APPROVALS

PRODUCTION	RESEARCH
H. L. Williams /s/ H. L. Williams 12/19/69	M. E. Gibbs /s/ M. E. Gibbs 1/5/70
PROCUREMENT	QUALITY CONTROL (Chief Chemist)
H. L. Phillips /s/ H. L. Phillips 12/19/69	G. W. Miller /s/ G. W. Miller 12/18/69

GENERAL DESCRIPTION

COLORLESS, ODORLESS GAS OR
COLORLESS LIQUID

CHEMICAL FORMULA

CO_2
Mol. Wt. = 44.01

SUPERSEDES SPECS OF	SAMPLE FOR ANALYSIS	ISSUED BY
10/21/69	Standard gas sampling bottle	G. W. Miller

CHARACTERISTIC	LIMITS	METHOD
UNRESTRICTED INFORMATION		
Carbon Dioxide, %	99.87 Min.	
Nitrogen, %	0.05 Max.	
Oxygen, %	0.01 Max.	
Moisture, %	0.07 Max.	
Total Sulfur, ppm	1.0 Max.	

These specifications are those set by the supplier for finished goods.

MONS 049768

(R) Routine Analysis. All others Analyzed by request only.

Monsanto
ORGANIC CHEMICALS DIVISION

RAW MATERIAL SPECIFICATION

MATERIAL CODE	MATERIAL
38800	LIME HYDRATE (VERTICAL HYDRATE ONLY)
PLANT: Anniston	USING DEPTS.: Aroclor -- 826.08 & 826.17
DATE EFFECTIVE: 6-22-70	SUPPLIER: Alabaster Lime Co.

APPROVALS

PRODUCTION	RESEARCH
H. L. Williams /s/ H. L. Williams 6/24/70	W. R. Richard /s/ W. R. Richard 7/9/70
PROCUREMENT	QUALITY CONTROL (Chief Chemist)
H. L. Phillips /s/ H. L. Phillips 6/25/70	J. T. Bell /s/ J. T. Bell 6/22/70

GENERAL DESCRIPTION: WHITE FINE POWDER

CHEMICAL FORMULA: $Ca(OH)_2$
Mol. wt. = 74.10

SUPERSEDES SPECS OF	SAMPLE FOR ANALYSIS	ISSUED BY
10-21-69		J. T. Bell

CHARACTERISTIC	Typical Analysis	METHOD

UNRESTRICTED INFORMATION

CaO, %	73.00	
MgO, %	1.20	
SiO_2, %	0.36	
Al_2O_3, %	0.60	
Fe_2O_3, %	0.30	
Ignition Loss, %	24.04	
$Ca(OH)_2$, % (Calculated)	97.50[1]	

Screen Analysis

Through 200 mesh, %	99.8	120
Through 325 mesh, %	94.5	

Basis of Specifications: Supplier's typical analysis of product (5/23/66)

[1] $Ca(OH)_2$ % = 100% - [MgO (%) + SiO_2 (%) + Al_2O_3 (%) + Fe_2O_3 (%)]

MONS 049769

(R) Routine Analysis, All others Analyzed by request only.

Monsanto
ORGANIC CHEMICALS DIVISION

RAW MATERIAL SPECIFICATION

MATERIAL CODE	MATERIAL
48289	REGULAR POROCEL
PLANT: Anniston	USING DEPTS.: 826.08
DATE EFFECTIVE: 12/18/69	SUPPLIER: Porocel Corp. (A Subsid. of Mineral & Chemicals Phillip Corp.)

APPROVALS

PRODUCTION	RESEARCH
H. L. Williams /s/ H. L. Williams 12/19/69	M. E. Gibbs /s/ M. E. Gibbs 1/5/70
PROCUREMENT	QUALITY CONTROL (Chief Chemist)
H. L. Phillips /s/ H. L. Phillips 12/19/69	G. W. Miller /s/ G. W. Miller 12/18/69

GENERAL DESCRIPTION: ACTIVATED BAUXITE

CHEMICAL FORMULA:

SUPERSEDES SPEC'S OF	SAMPLE FOR ANALYSIS	ISSUED BY
New	2 x 16 oz. W. M. Bottles	G. W. Miller

CHARACTERISTIC	LIMITS	METHOD
UNRESTRICTED INFORMATION		
(R) Appearance	Free from lumps and foreign material	
(R) Mesh Test:		
Less than 60 mesh:	3%, Max.	
20 to 60 mesh inclusive:	67%, Min.	
Greater than 20 mesh:	30%, Max.	
(R) Water	1%, Max.	
Volatile Matter (at 1000°C to constant weight)	2%, Max.	

MONS 049770

(R) Routine Analysis. All others Analyzed by request only.

W8K-814

Monsanto
ORGANIC CHEMICALS DIVISION

RAW MATERIAL SPECIFICATION

MATERIAL CODE	MATERIAL
19400	Attapulgus Earth - RVM Grade
PLANT	USING DEPTS.
Anniston	27-L
DATE EFFECTIVE	SUPPLIER
7-20-66	~~Minerals & Chemicals Phillip Corp.~~ Southern Clay Products

APPROVALS — same people

PRODUCTION	RESEARCH
R. G. Moody /s/R. G. Moody 6/9/66	N. F. Mueller /s/N. F. Mueller 7/13/66
PROCUREMENT	QUALITY CONTROL (Chief Chemist)
H. L. Phillips /s/H. L. Phillips 6/10/66	O. E. Dolin /s/O. E. Dolin 6/8/66

GENERAL DESCRIPTION — CHEMICAL FORMULA

Impure Hydrous Magnesium Aluminus Silicate

SUPERSEDES SPECS OF	SAMPLE FOR ANALYSIS	ISSUED BY
Sept. 9, 1957	1 lb. can	T. A. Liddle - 5/25/66

CHARACTERISTIC	LIMITS	METHOD
UNRESTRICTED INFORMATION		
Screen Analysis Through 200 Mesh (%)	95 Min.	
Loss on Ignition (% @ 950°C)	15 Max.	
Typical Analysis from Supplier (May 23, 1966)		
SiO_2 (%)	67.5	
Al_2O_3 (%)	12.8	
Fe_2O_3 (%)	4.5	
MgO (%)	11.1	
CaO (%)	1.6	
K_2O (%)	0.8	
Na_2O (%)	0.1	
TiO_2 (%)	0.6	
Other (%)	1.0	

MONS 049771

(R) Routine Analysis, All others Analyzed by request only.

WGK-814

Vince Haupt

Monsanto
ORGANIC CHEMICALS DIVISION

RAW MATERIAL SPECIFICATION

MATERIAL CODE	MATERIAL
11751	Aluminum Powder MD-101
PLANT	USING DEPTS.
Anniston	826,17
DATE EFFECTIVE	SUPPLIER
12/28/70	Alcan Metal Powders

APPROVALS

PRODUCTION	RESEARCH
J. L. Condra	W. R. Richard/S/W. R. Richard 2/71
PURCHASEMENT	QUALITY CONTROL (Chief Chemist)
H. L. Phillips	J. T. Bell

GENERAL DESCRIPTION — CHEMICAL FORMULA

ATOMIZED Aluminum Powder

SUPERSEDES SPECS OF	SAMPLE FOR ANALYSIS	ISSUED BY
		J. T. Bell

CHARACTERISTIC	LIMITS	METHOD

UNRESTRICTED INFORMATION

Apparent Density (g/cc)	1.1
Free Metallic Al (%)	99.3
Average Particle Size (Microns)	16
Sieve Analysis (%)	
+ 100	Trace
+ 200	10
+ 325	10
- 325	80

These specifications are those set by the supplier for finished goods.

MONS 049772

(R) Routine Analysis. All others Analyzed by request only.

24. W. J. Davey, *J. Inst. Petrol.* **31**, 73–88 (1945).
25. F. M. Rowe, ed., *Colour Index* (CI), 1st ed., Society of Dyers and Colourists, Bradford, Yorkshire, 1924; Supplement, 1928.
26. Brit. Pat. 310,910 (June 26, 1929), N. Bennett and W. C. Sprent (to Imperial Chemical Industries Ltd.).
27. U.S. Pat. 1,557,153 (Oct. 13, 1925), A. George (to Mathieson Alkali Works).
28. U.S. Pat. 1,591,545 (July 6, 1926), F. E. Stockelback (to Mathieson Alkali Works).
29. Ger. Pat. 234,200 (1909) (to Badische Anilin- und Soda-Fabrik A.G.).

H. Sidi
Heyden Newport Chemical Corporation

CHLORINATED BIPHENYL AND RELATED COMPOUNDS

Biphenyl (diphenyl), terphenyls, higher polyphenyls, or mixtures of these compounds can be chlorinated to give products which have outstanding chemical and thermal stabilities. Individual isomers, which range from liquids to high-melting crystalline solids, are of little commercial importance whereas the mixed chlorinated components have considerable commercial significance.

Registered trademarks for some commercial brands of chlorinated biphenyls in the United States are the following: Aroclor (Monsanto Company), Chlorextol (Allis-Chalmers Manufacturing Company), Dykanol (Cornell-Dubilier Division, Federal Pacific Electric Company), Inerteen (Westinghouse Electric Corporation), Noflamol (Wagner Electric Corporation), Pyranol (General Electric Company), and Therminol (Monsanto Company). Some other registered trademarks or trade names for commercial chlorinated biphenyls found throughout the world are the following: Clophen (I. G. Farbenindustrie A.G., Germany), Fenclor (Caffaro, Italy), Kannechlor (Kanegafuchi Chemical Co., Japan), Pyralene (Prodelec, France), and Sovol (Russia).

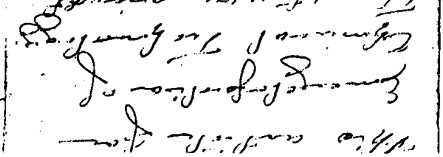
Commercial manufacture of the Aroclor brand of chlorinated biphenyls was started in 1929. These products vary from mobile oily liquids to white crystalline solids and hard noncrystalline resins. Because of the many forms and properties, they have found applications in many diverse fields—in electrical insulation, fire-resistant heat-transfer and hydraulic fluids, lubricants for use at high temperatures and pressures, sealant and expansion media, and as constituents in elastomers, adhesives, paints, lacquers, varnishes, pigments, and waxes.

Physical and Chemical Properties

The physical properties of individual chlorobiphenyl isomers vary widely as may be seen in Table 1. Mixed isomers as produced in a commercial product have physical properties which are quite different from those of the individual isomers. This is particularly true for the solidification point.

Chlorinated biphenyls, in general, are considered to be inert materials. However, they will react with certain reagents when treated under rather rigorous conditions. For example, chlorobiphenyls will react with sodium hydroxide at elevated temperatures to yield phenolic materials (28).

Mixtures of chlorinated biphenyls, such as those found in commercial products, will not react with acids, alkalies, or water under normal to moderately rigorous conditions (29). They are insoluble in water, glycerol, and the glycols. The oils and



MONS 049871

resins are readily soluble in most of the common organic solvents, but most of the hard crystalline members are less soluble than the liquids or softer resins. The chlorinated biphenyl mixtures are nondrying even when exposed to air in thin films. They are permanently thermoplastic and except for the lower chlorinated members are nonflammable. The resins will adhere strongly to smooth surfaces such as glass, metal, varnished or lacquered surfaces. Most of the common metals and alloys

Table 1. Physical Properties of Chlorobiphenyls

Compound	Melting point, °C	Boiling point, °C (mm Hg)	Bibliography references
2-chlorobiphenyl	34	267–268; 154 (12)	(1–3)
3-chlorobiphenyl	89	284–285	(4,5)
4-chlorobiphenyl	75.5; 76; 74	125 (14)	(2,6,7)
2,2′-dichlorobiphenyl	59; 61–62		(8,9)
3,3′-dichlorobiphenyl	23; 29	322–324; 320–326	(9–12)
4,4′-dichlorobiphenyl	148	315–319	(2,9,12)
3,5-dichlorobiphenyl	36	166 (10)	(13,14)
2,5-dichlorobiphenyl		171 (15); 182 (30)	(14,15)
3,4-dichlorobiphenyl	46; 49–50	195–200 (15)	(16,17)
2,3-dichlorobiphenyl		172 (30)	(15)
2,4′-dichlorobiphenyl	44		(15,18)
2,4,5-trichlorobiphenyl	78–79		(19)
2,3,5-trichlorobiphenyl	41		(13)
2,4,4′-trichlorobiphenyl	55–56		(9,20)
2,5,4′-trichlorobiphenyl	67		(21)
3,5,4′-trichlorobiphenyl	88		(13)
3,4,2′-trichlorobiphenyl	65–66		(22)
3,5,2′-trichlorobiphenyl	58		(13)
3,4,3′,4′-tetrachlorobiphenyl	172	230 (50)	(11,23)
3,4,2′,5′-tetrachlorobiphenyl	103		(21)
2,6,2′,6′-tetrachlorobiphenyl	198		(23)
2,5,3′,5′-tetrachlorobiphenyl	162		(23)
2,4,2′,4′-tetrachlorobiphenyl	83		(12,24)
2,5,2′,5′-tetrachlorobiphenyl	84–85		(25)
2,4,5,3′,4′-pentachlorobiphenyl	179	195–220 (10)	(19,26)
3,4,5,3′,4′,5′-hexachlorobiphenyl	198		(23)
2,4,6,2′,4′,6′-hexachlorobiphenyl	111.5–112		(12,27)
2,3,4,5,2′,4′,5′-heptachlorobiphenyl		240–280 (20)	(19)
2,3,5,6,2′,3′,5′,6′-octachlorobiphenyl	161		(23)
2,3,4,5,6,2′,3′,4′,5′,6′-decachlorobiphenyl	310		(23)

have excellent resistance to the chlorinated biphenyls even at elevated temperatures. However, copper and some copper alloys are affected to a limited extent and show penetration rates between 0.0014 and 0.014 in./yr. Many plastic materials of construction are attacked by chlorinated biphenyls. In addition to high resistance to thermal degradation, they also have many interesting electrical properties.

The general properties of the more important members of the Aroclor brand of chlorinated biphenyl products are shown in Table 2 and the electrical properties are shown in Table 3.

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Table 2. General Properties of Some Aroclors

Material	Form and color	Specific gravity	Distillation range,[a] °C (corr)	Flash point,[b] °C	Fire point,[c] °C	Pour point,[d] °C	Softening point,[e] °C	n_D^{20}	Viscosity,[f] sec 37.8°C	Viscosity,[f] sec 98.9°C
Aroclor 1221[g]	colorless, mobile oil	1.182–1.192 (25/15.5°C)	275–320	141–150	176	crystals at 1°C		1.617–1.618	38–41	30–31
Aroclor 1232	almost colorless, mobile oil	1.270–1.280 (25/15.5°C)	290–325	152–154	238	−35.5		1.620–1.622	44–51	31–32
Aroclor 1242	almost colorless, mobile oil	1.381–1.392 (25/15.5°C)	325–366	176–180	none	−19		1.627–1.629	82–92	34–35
Aroclor 1248	yellow-green tinted, mobile oil	1.405–1.415 (65/15.5°C)	340–375	193–196	none	−7		1.630–1.631	185–240	36–37
Aroclor 1254	light yellow, viscous oil	1.495–1.505 (65/15.5°C)	365–390	none	none	10		1.639–1.641	1800–2500	44–48
Aroclor 1260	light yellow, soft, sticky, resin	1.555–1.566 (90/15.5°C)	385–420	none	none	31		1.647–1.649		72–78
Aroclor 1262	light yellow, sticky, clear resin	1.572–1.583 (90/15.5°C)	395–425	none	none	35–38		1.6501–1.6517		86–100
Aroclor 1268	white to off-white powder	1.804–1.811 (25/25°C)	435–450	none	none		150–170[h]			
Aroclor 1270	white crystalline powder	1.944–1.960 (25/25°C)	450–460	none	none		249–300[h]			
Aroclor 4465	transparent, yellow, brittle resin	1.670 (25/25°C)	230–320 (4 mm Hg)	none	none		60–66	1.664–1.667		90–150 (130°C)
Aroclor 5442	yellow, transparent, sticky resin	1.470 (25/25°C)	215–300 (4 mm Hg)	247	>350	46	46–52			300–400
Aroclor 5460	clear, yellow-to-amber, brittle resin	1.670 (25/25°C)	280–335 (5 mm Hg)	none	none		98–105.5	1.660–1.665		
Aroclor 2565	black, opaque, brittle resin	1.734 (25/25°C)		none	none		66–72			

[a] ASTM D-20 (modified). [b] Cleveland open cup. [c] Cleveland open cup; none indicates no fire point up to boiling temperature. [d] ASTM D-97. [e] ASTM E-28. [f] Saybolt Universal, ASTM D-88. [g] Last two digits indicate approximate chlorine content, ie, Aroclor 1221 contains about 21% chlorine. [h] Hold point on solidification.

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Table 8. Electrical Properties of Some Aroclors

Aroclor	Dielectric constant at 1000 cycles[a] 25°C	100°C	Volume resistivity,[b] Ω-cm at 100°C, 500 V, dc	Dielectric strength,[c] kV	Power factor,[a] 100°C, 1000 cycles, %
1232	5.7	4.6			
1242	5.8	4.0	above 500×10^9	>35	<0.1
1248	5.6	4.6	above 500×10^9	>35	<0.1
1254	5.0	4.3	above 500×10^9	>35	<0.1
1260	4.3	3.7	above 500×10^9	>35	<0.1
1268	2.5				
5442	3.0	4.9	above 500×10^9		
5454	2.7	4.2			
5460	2.5	3.7			
4465	2.7	3.3			

[a] ASTM D-150-47T.
[b] ASTM D-257-46.
[c] ASTM D-149-44.

Manufacture

A number of the pure compounds formed by the chlorination of biphenyl, terphenyl, or more complex polyphenyls are crystalline solids, some of which have very high melting points (30). However, mixtures containing a number of such compounds may be either liquids or noncrystalline resins. Chlorination of aromatic hydrocarbons to various levels not only gives several isomers of the same chlorine content but also gives appreciable portions of the isomers of compounds of higher and lower chlorine contents (31,32). At any level of chlorine content, batch chlorination gives the highest proportion of compounds corresponding in composition to the average chlorine content, whereas single-stage continuous chlorination gives the lowest proportion of such compounds. As the number of stages is increased, multistage continuous chlorination gives compositions approaching those obtained by batch chlorination. The proportion of the various isomers and of compounds of higher and lower chlorine contents than the average is also influenced by factors such as temperature, quantity and kind of catalyst employed, degree and type of agitation, and rate of admission of the chlorine.

A procedure for carrying out a single-stage fluid-bed chlorination is described in the patent literature for polychlorination of biphenyl (33). Continuous liquid chlorination in a multiple-stage unit can also be used. Batch chlorination has been found to be particularly well suited for the manufacture of the various products (32,34).

The chlorinators may be cylindrical steel towers, 3 ft in diameter and 18 ft high, which are equipped with chlorine distributors at the bottom and with coils for heating and cooling the material undergoing reaction. Pumps provide agitation by circulating the liquid charge. The lower half of the chlorinators is filled with iron turnings, which have been burned free of oil and moisture. In German practice, the chlorinators are agitated 10,000-liter lead-lined vessels, and ferric chloride is used as the catalyst instead of iron turnings. Fifteen kg of ferric chloride is used for each charge of 6000 kg (35) of biphenyl.

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Raw Materials. The raw material used depends on the type of chlorinated material to be produced; anhydrous chlorine is used as the chlorinating agent in all cases. In general, it can be said that biphenyl alone gives liquid or soft, sticky noncrystalline products up to a chlorine content of 60%, low-melting resinous products between 60 and 65% chlorine content, and partly crystalline or crystalline products of much higher melting points at chlorine contents above 65% (32). In the case of products that are solid at ordinary temperatures, the higher the proportion of terphenyls or more complex polyphenyls in the mixture before chlorination, the higher the softening point and the less the crystallizing tendency of the chlorinated product after distillation. For those products that are solid or partly crystalline at room temperature, the higher the chlorine content, the higher the softening point, and the greater the tendency of the material to crystallize (34).

Preparation of Crude Chlorinated Biphenyl. For the manufacture of any given grade of chlorinated biphenyl, the chlorinator is charged with the proper raw material or mixture of raw materials to give the desired product in an amount sufficient to cover the catalyst bed and to permit circulation. Then the flow of vaporized chlorine is started and the charge is circulated with the pump. Throughout the chlorination, the temperature is kept well above the melting point of the mixture, but below 150°C, to avoid excessive sublimation and plugging of the line discharging the hydrogen chloride produced by the chlorination. Samples are withdrawn for examination from time to time until the desired chlorine content has been reached. At the lower chlorine contents, specific gravity measurements are taken using a hydrometer to determine the composition. After the product has become too viscous or has reached too high a melting point for convenient determination of the specific gravity at temperatures below 100°C, the degree of chlorination is determined by measuring the hold point as the material crystallizes, or by the ball-and-ring softening-point test (36). The time required for chlorination is 12 to 36 hr, depending upon the chlorine content of the product. The anhydrous hydrogen chloride, which is evolved during the chlorinations, is absorbed in water in equipment of conventional design.

Distillation of Crude Products. Although the crude products find some applications, for most purposes further purification is necessary to remove the color, and the traces of hydrogen chloride and ferric chloride (32,34,35). The methods of purification are somewhat different for the different types of end products. The high-melting solid products are difficult to distill. Distillation under reduced pressure is particularly difficult as it is desirable to keep the boiling point above the solidification point. Generally, these products are distilled in gas-fired retorts at atmospheric pressure. The distillate is flaked on chilled rolls. From practical considerations of quality and better overall processing efficiency, the liquid and resinous products are distilled at lower temperatures in more conventional equipment under reduced pressure. The crude liquid and resinous products are held at an elevated temperature and blown with dry air for several hours, after which a few tenths of 1% of lime or sodium hydroxide is stirred with the material to react with any remaining hydrogen chloride or ferric chloride. This is followed by batch distillation under reduced pressure. Complete distillation and mixing of the distillate is necessary in order to obtain uniform material of the desired composition.

If increased electrical resistivity is desired, the material is stirred at an elevated temperature with a few tenths of 1% of well-dried fuller's earth and then filtered through paper (35,37).

MONS 049875

Containers and Shipping

The liquid chlorinated biphenyls are packed and shipped in galvanized-steel drums or in tank cars constructed of nonrusting metals such as aluminum or tin-coated metal. The resinous products are packed and shipped in open-top galvanized-steel drums, and the high-melting solid products are packed and shipped in bags. The railroad shipping classification is Resin Synthetic NOIBN.

Health and Safety Factors

Prolonged exposure to chlorinated biphenyl vapor evolved at high temperature can lead to systemic toxic effects. Inhalation tests on animals indicate that the maximum safe concentration of vapor is in the range of 0.5 to 1.0 mg of the lower chlorinated biphenyl mixtures per cubic meter of air. The threshold limits (maximum allowable concentration for an eight-hour working day) set by the American Conference of Governmental Industrial Hygienists are 1.0 mg of the lower chlorinated biphenyl compounds (42% chlorine) per cubic meter of air and 0.5 mg of the more highly chlorinated biphenyl compounds (54% chlorine) per cubic meter of air. When chlorinated biphenyl compounds are used at elevated temperatures, engineering controls must be applied, either by the use of closed systems or by effective local mechanical exhaust ventilation together with general workroom exhaust. Although the chlorinated biphenyls are not normally skin irritants, their solvent action can remove natural protective oils and fats, and lead to drying and cracking of the skin. Also, continuous or repeated skin contact with chlorinated biphenyls should be avoided because of the possible occurrence of a condition called "chloracne" (38).

Uses

Electrical Applications. All of the uses of the chlorinated biphenyls depend on their chemical stability and their physical properties, which may be varied to suit the specific application. One very important use is as dielectric mediums in such applications as fluids for transformers and as impregnants for capacitors and condensers (29, 30,39–44). Chlorinated biphenyls, used either alone or in blends with other materials such as trichlorobenzene, meet the need for a fire-resistant dielectric fluid with a high resistivity, a high dielectric strength, a relatively high dielectric constant, and a very low power factor. By replacing hydrocarbon oil with chlorinated biphenyls or mixtures of chlorinated biphenyls with trichlorobenzene, it has been possible to redesign equipment with a great reduction in size for the same capacity and voltage. At the same time, the fire hazards have been eliminated. See also Dielectrics and piezoelectrics; Insulation, electrical.

The maximum dielectric constant of commercial chlorinated biphenyl mixtures at 1000 cycles and 25°C is approximately 6.0. In recent years, considerable attention has been given to upgrading this property (45–48). Combinations of fractional distillation, chlorination, and isomerization can be used to obtain dielectric constants of 7.0 or slightly above. Direct synthesis of specific trichlorobiphenyl isomers can be utilized to obtain dielectric constants in the order of 10 (49). Improved analytical techniques, primarily capillary gas chromatography (50), have been of great aid in studying the complex chlorobiphenyl mixtures.

MONS 049876

Other important electrical applications for the chlorinated biphenyls are as impregnants for cotton or asbestos-fiber insulation (51), as constituents of asphalt-base wire-impregnating compounds, and as plasticizers in wire-coating compounds, particularly those containing neoprene, rubber, or combinations of polyvinyl chloride, ethylcellulose, and polyvinyl butyral (52–55). Also, chlorinated biphenyls are employed as sealing mediums for electrical insulators and as impregnants for carbon resistors to reduce the influence of moisture.

Plastics, Lacquers, Paints, and Varnishes. Chlorinated biphenyls are compatible with most of the common plastic materials and resins, and are soluble in paint and varnish oils (29). In combination with asphalt, ethylcellulose, chlorinated rubber, Pliolite (styrene–butadiene copolymer), or other plastic materials, they are used extensively in protective coatings for wood, metal, and concrete (38,56,57). In combination with dioctyl phthalate, they are coplasticizers for polyvinyl chloride compositions (29,38). See also Coatings, industrial; Paint.

In paints and varnishes the hard resinous chlorinated biphenyls are used to impart increased hardness to the films, and the softer resins are used to give flexibility. The role of these materials is similar to that of the oil, except that they do not oxidize and lose flexibility on ageing. In nitrocellulose lacquers, chlorinated biphenyls are employed either alone or in combination with other plasticizers and resins to impart increased weather resistance, luster, adhesion, and decreased burning rate (57–60). The hard, white, crystalline chlorinated biphenyls of high melting point are useful as pigments with various plastics (61).

Adhesives (qv). The resinous products are used in synthetic adhesive compositions in combination with such base materials as polyvinyl acetate, ethylcellulose, chlorinated rubber, polyvinyl butyral, isoprene–styrene copolymer, and polyisobutylene. Chlorinated biphenyls are used in the preparation of coatings of pressure-rupturable capsules for adhesive tape (62).

Lubricants (qv). Chlorinated biphenyls find application as lubricants under extreme conditions such as highly oxidising conditions, high temperatures, extreme pressures, or submerged locations. Mixtures with other oils to form heavier-than-water lubricants are used in submerged locations, such as bridge rollers. Lubricants for extreme pressures are made by adding up to 15% of the chlorinated biphenyls to petroleum hydrocarbon oils.

Heat-Transfer Media (qv). Chlorinated biphenyls have been used for some time in indirect heating applications (63). Recently, products of this type sold by Monsanto Company under the registered trademark Therminol have been introduced, which are specifically directed to use as heat-transfer media (64). These fluids are particularly well suited for efficient and safe operation in applications involving flammable materials where uniform temperatures are required and for high-temperature (bulk temperatures of 600°F) indirect heating. Specifically designed units for such applications are required to prevent local overheating.

Miscellaneous Applications. Carnauba wax may be extended by blending with chlorinated biphenyl in combination with ceresin and paraffin (29,65). Satisfactory waxes and polishes are prepared without the use of carnauba wax by blending ouricury (licuri) wax with chlorinated biphenyl, ceresin, and paraffin. Chlorinated biphenyls are ingredients of many fire-resistant compositions. Fire-retarding paints usually contain antimony oxide or barium sulfate in addition to the chlorinated biphenyl. In making fireproof fiberboard, emulsified chlorinated biphenyl is added to the fiber

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stock (66). Modifying waxes are added to chlorinated biphenyl in the preparation of textile-coating materials.

In addition to the uses listed above, chlorinated biphenyls are ingredients of some sealing compounds for use with wood or canvas to give protection against moisture, mildew, or attacks of organisms. They are also used in formulating calking compounds, powdered metal pastes, some soil-poison and wood-preserving compositions, paper transparentizers, and printing inks. Carbonless reproducing paper is made by an encapsulation procedure which uses chlorinated biphenyl as part of the formulation (67) (see Encapsulation).

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CHLORINATED NAPHTHALENES

Laurent, in 1833, observed that waxlike materials resulted from reaction of chlorine with naphthalene in the presence of certain catalysts. These chlorination products were further studied by Fischer in 1878. It was more than twenty years later, however, that Aylsworth discerned their technological potentialities (1).

Chemically and physically, the chlorine derivatives of naphthalene presented investigators with a much more complex problem than the chlorobenzenes. Following Erlenmeyer's establishment of the fused-ring structure of naphthalene in 1866, many years elapsed before many of the theoretically possible chlorination derivatives of the compound were isolated and identified; even today the positions of the substituent chlorine atoms in all isolated tetrachloro- and pentachloronaphthalenes have not been allocated with certainty (see Table 1). Physically, the difficulty of isolating isomers from the mixtures produced by chlorination of naphthalene is such that indirect

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STANDARD MANUFACTURING PROCESS
FOR
AROCLORS

APPENDIX K - BACKGROUND INFORMATION

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MONS 049888

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MONS 049895

W. Kay

CONFIDENTIAL

MONS 049896

STANDARD MANUFACTURING PROCESS
FOR
AROCLOR

APPENDIX L - TIME CYCLES

The continuous chlorinator operation, used for production of Crude Liquid Aroclors, consists of four cascade flow chlorinators in series. The maximum daily production from the continuous system is 90,000 pounds.

There are four batch operated liquid chlorinators and one batch operated solid chlorinator. See following table for time cycles and batch weights.

The bottleneck in the production of Aroclors is the still system.

AROCLOR TIME CYCLES AND BATCH WEIGHTS

AROCLORS	1121	1142	1148	1154	1160	1162	1168*	2565*	4065*	5042*	5060*
Chlorinator Charge: Lbs. Biphenyl	3,000	3,000	3,000	3,000	3,000	3,000	9,500	7,550	5,850		
Santowax C								2,560			
Santowax R									3,920	9,800	9,500
Approximate Lbs. Chlorine Required to Produce Batch	1,600	4,330	5,560	7,040	9,030	9,600	40,375	37,750	34,620	14,875	28,500
Approximate Weight of Crude Batch	3,750	5,080	5,660	6,350	7,160	7,500	22,420	27,000	25,000	16,000	22,900
Approximate Time Required to Produce Batch	6 hrs.	9 hrs.	10 hrs.	13 hrs.	17 hrs.	18 hrs.	20 hrs.	17 hrs.	16 hrs.	9 hrs.	13 hrs.

*Solid Aroclors

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MONS 049899

STANDARD MANUFACTURING PROCESS
FOR
AROCLORS

APPENDIX M - QUALITY CONSIDERATIONS

Aroclors for electrical equipment uses must be highly pure with only slight traces of contaminants. Two to three drops of sweat contain enough salt to reject a drum of Aroclor on chlorides. They must be chemically stable and non-corrosive to a side variety of structural materials.

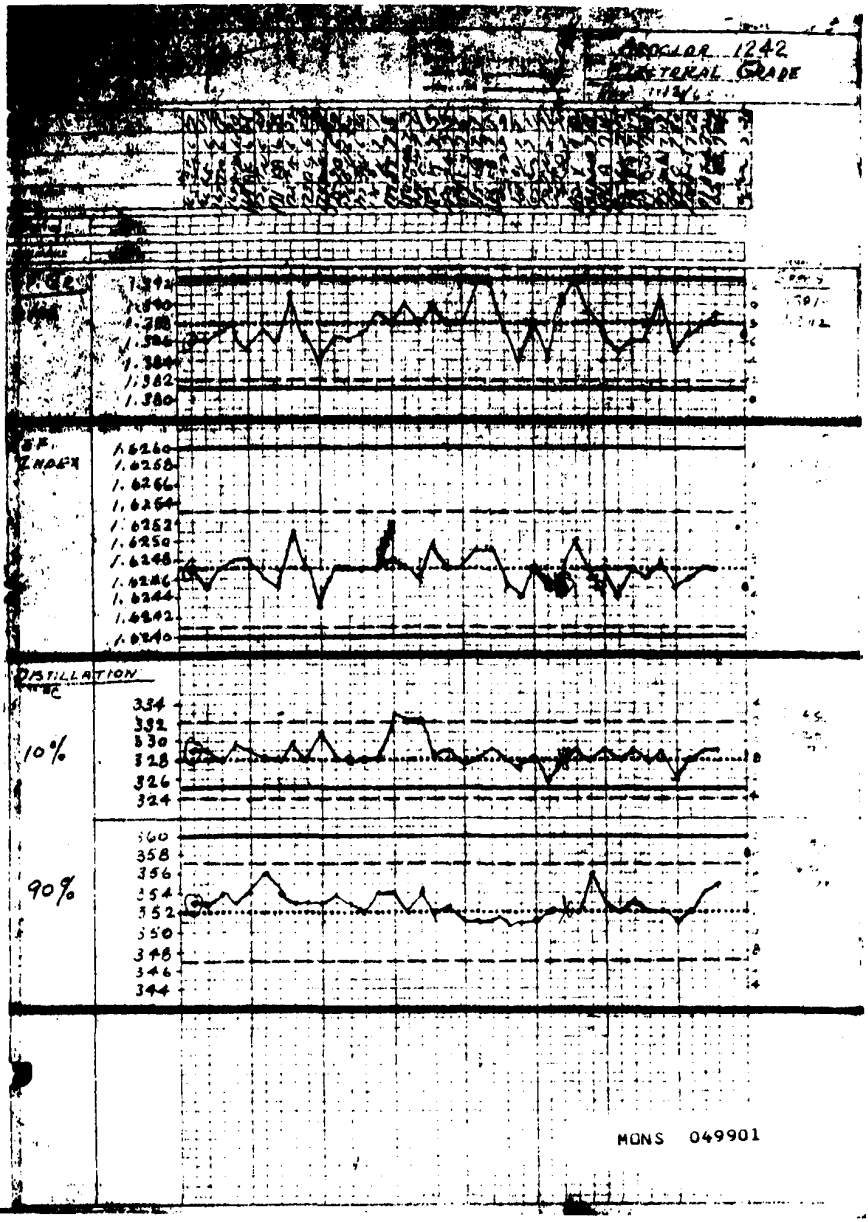
Obviously, continuous quality control must be maintained during manufacture, packaging, and shipping to assure that the customer is always satisfied with the performance of our Aroclors.

Normal power factor correcting capacitors used in air conditioners contain about ten cents worth of Aroclor. If the capacitor should explode and cause a fire, damage as high as $20,000 could result. These capacitors are designed for 12 to 20 year's life. Quality ingredients, such as Anniston Aroclor, must be used to guarantee this life as there is no non-destructive procedure for pre-determining this life. This vividly illustrates the "mushrooming" damage and the major reason for such intense desire for quality products by our customers.

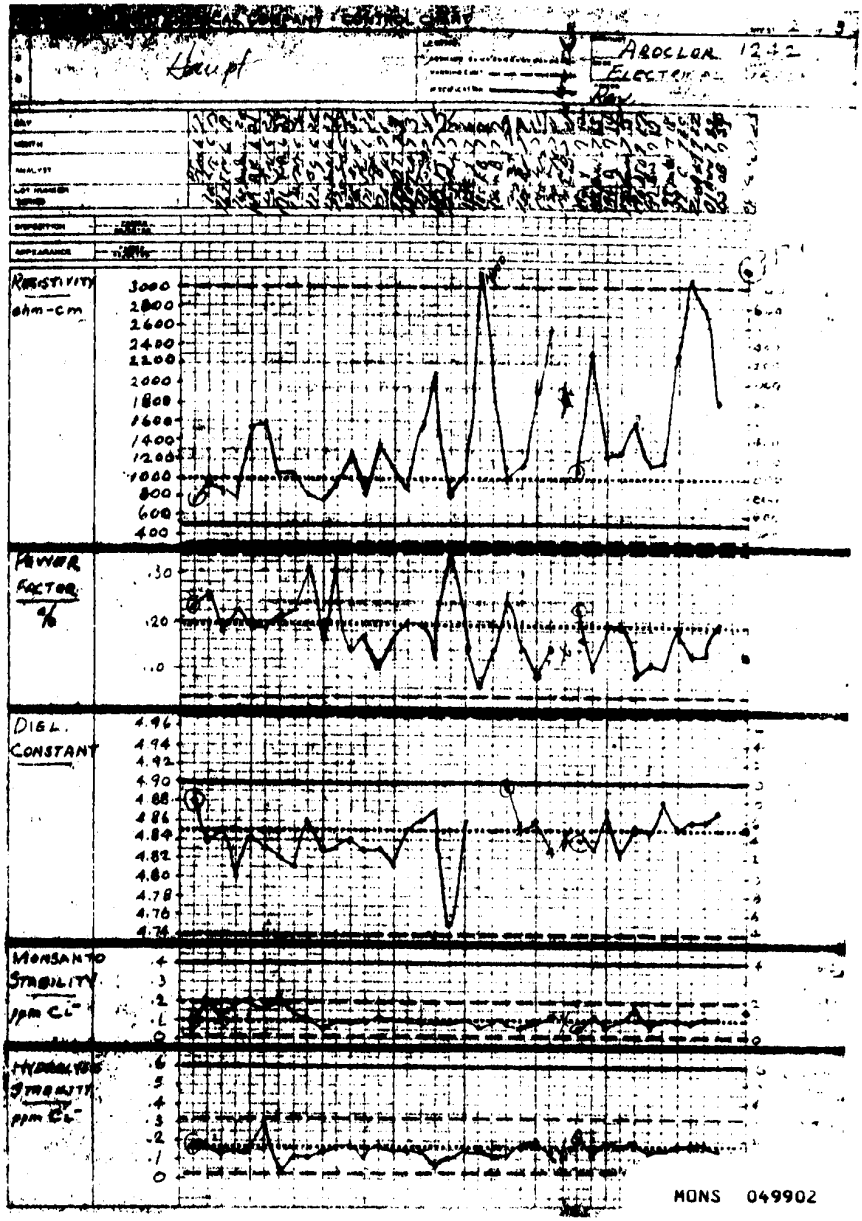
Each sales lot of Aroclor is analyzed prior to shipment. Preliminary samples are analyzed prior to loading in cars, trucks, and/or drums. The specs to be met are given in greater detail in Appendix B.

Each Aroclor tank car is thoroughly cleaned before filling to prevent contamination by material left in the car by the customer. Examples of the quality control charts kept by the Laboratory are included in this appendix. The charts are for Aroclors 1242 and 5460 (our heaviest demand products). All electric grade Aroclors have control charts that are monitored by the Laboratory, Quality Control Board, and Production. These charts are used to spot trends which would eventually lead to poor quality Aroclor. Besides showing maximum and/or minimum specs on each property, the averages and two sigma values are shown which make it relatively easy to spot both good and bad trends. Production is responsible for knowing the cause and corrective measures to be taken for any trends toward poorer quality Aroclors. Export lots of Aroclors 1242 and 1254 must meet additional specs of higher resistivities and lower biphenyl content.

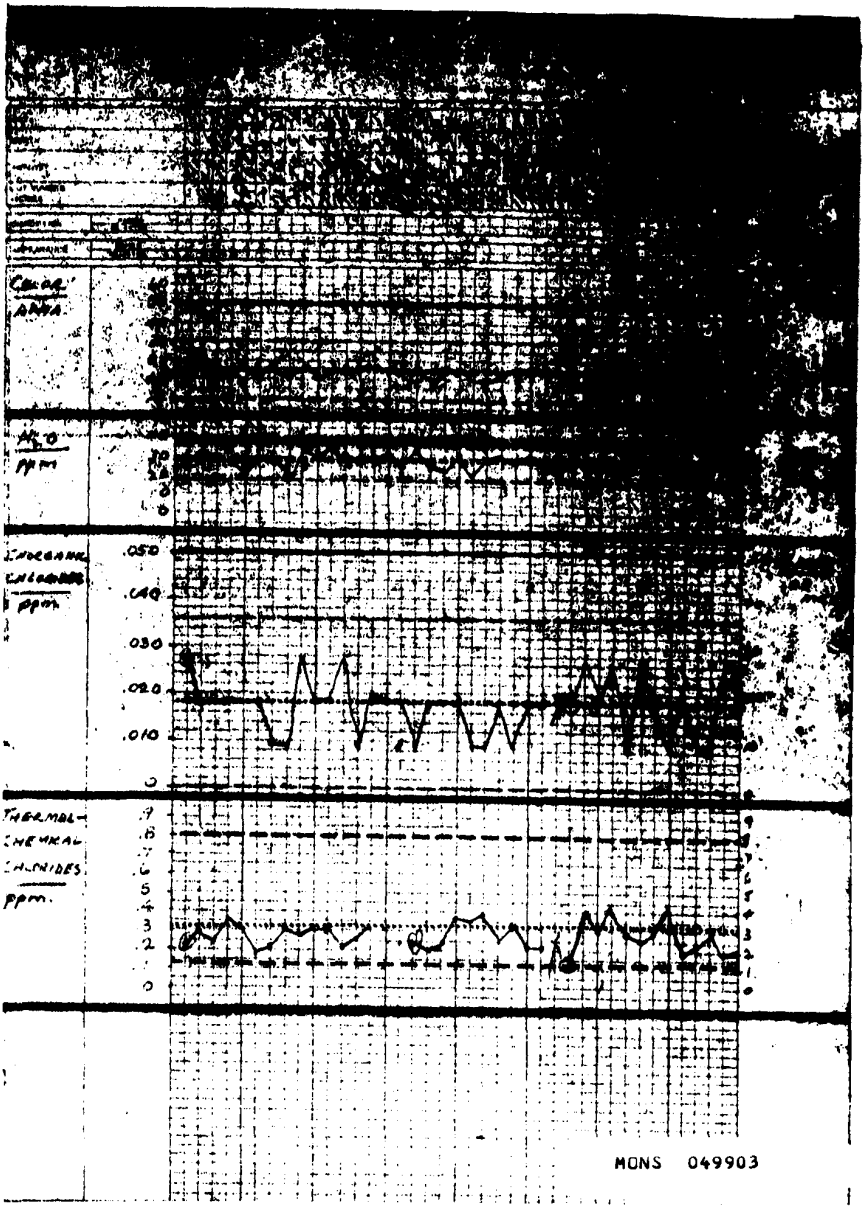
Aroclor	Property	Spec.
1242	Biphenyl	0.05 % max.
	Resistivity	5,000 giga ohm cm min.
1254	Biphenyl	0.025% max.
	Resistivity	5,000 giga ohm cm min.


AROCLOR 1242
ELECTRICAL GRADE
1.392
1.390
1.388
1.386
1.384
1.382
1.380
SP. GR.
1.6260
1.6258
1.6256
1.6254
1.6252
1.6250
1.6248
1.6246
1.6244
1.6242
1.6240
DISTILLATION
°C
10%
334
332
330
328
326
324
90%
360
358
356
354
352
350
348
346
344

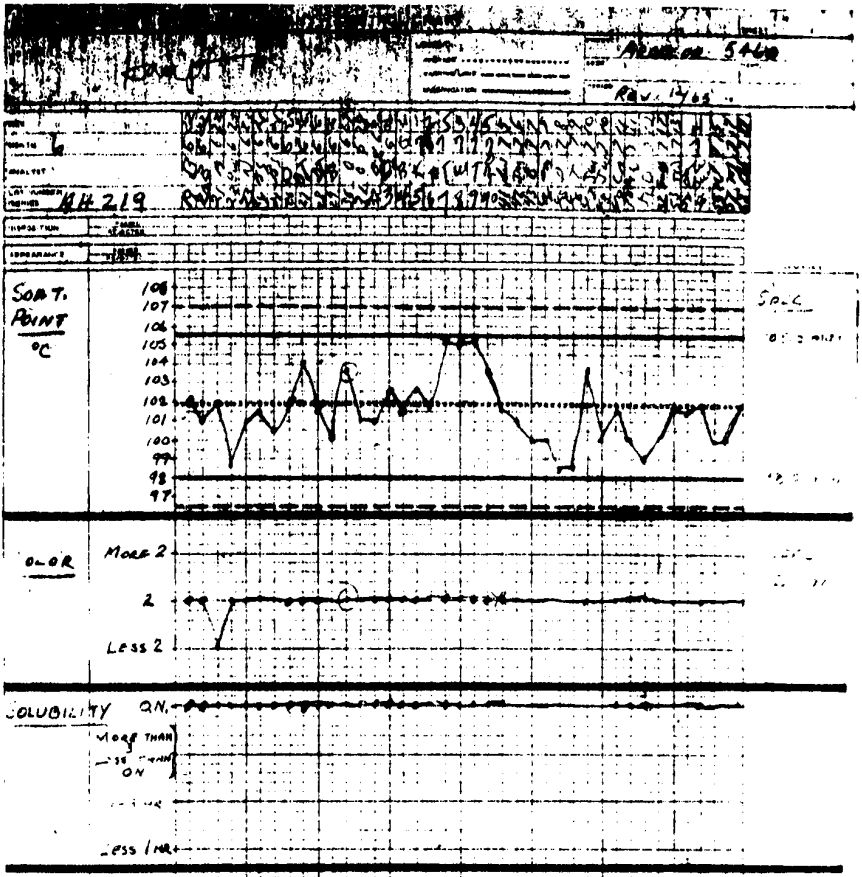
MONS 049901


ARoclor 1242
Hercupt
RESISTIVITY
ohm-cm
3000
2800
2600
2400
2200
2000
1800
1600
1400
1200
1000
800
600
400
POWER FACTOR %
.30
.20
.10
DIEL. CONSTANT
4.96
4.94
4.92
4.90
4.88
4.86
4.84
4.82
4.80
4.78
4.76
4.74
MONSANTO STABILITY ppm Cl⁻
.4
.3
.2
.1
0
HYDROLYSIS STABILITY ppm Cl⁻
.6
.5
.4
.3
.2
.1
0

MONS 049902



MONS 049903


Arrow 5440
Rev. 14/65
SOLC
SOLT. POINT °C
108
107
106
105
104
103
102
101
100
99
98
97
COLOR
More 2
2
Less 2
SOLUBILITY
Q.N.
More than
Less than
Q.N.
Less 1 hr.

MONS 049904

MONS 049905

STANDARD MANUFACTURING PROCESS
FOR
AROCLORS

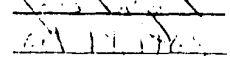
APPENDIX N - MISCELLANEOUS

MONSANTO POWER FACTOR SYSTEM

OPERATING PROCEDURE

Written By: J. G. Bryant
Date: October 19, 1968

Approved for Field: 

Date: 

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INTRODUCTION:

Increasing quality demands on liquid askarels have necessitated improved refinement techniques and better methods of electrical property measurement. Recently, more accurate, namely; three terminal electrical measurements with improved measuring sensitivity have been developed for laboratory measurements. Factory needs went even further. Here, the desire was to have a quick reproducible and reasonably accurate method of quality measurement. The equipment needed to be rugged and either mount on the process or analyze a small side stream, thereby eliminating the intricate sampling and sample handling methods normally employed for laboratory analysis. Another feature desired was a simple direct read out which could easily be adapted to a recorder. The Monsanto Power Factor System answers all these needs.

The system takes a small side stream of askarel (Aroclor) from the process into the instrument, automatically heats the fluid to the measurement temperature of 100°C, measures the power factor and returns the sample to the process in three minutes on a continuous basis. The measurements are in picofarads (10^{-12}) and phase angle (power factor) differences as low as 0.00005. Needless to say, precision is mandatory. It is very important that the system be precisely connected and properly grounded to obtain an accurate measurement. This compact system was designed to replace the troublesome laboratory power factor measurement used in the past for routine quality control. This

system requires no exterior sampling and is a quick responding to quality changes.

The basic measurement system consists of a precision capacitor, a bridge, and a liquid sample holder. The bridge reads the difference between the reference (precision) capacitor and the unknown (liquid sample). Since these units are set up to read low power factors (good quality), the material supplied to the unit must be of reasonable quality to even make a measurement.

INITIAL ASSEMBLY:

The Monsanto Power Factor System is made up of standard components where possible. All the parts are listed on the attached Bill of Material with their appropriate identification. The cell, a Monsanto patented design, is manufactured by Balsbaugh Laboratories and installed in the cabinet by Custom Engineering. All the piping, thermocouple and electrical connections are installed in the cabinet by Custom Engineering. The electronic detector (General Radio Impedance Comparator 1605 AH), the Precision Capacitor (General Radio Type 1422 CB) and the auxiliary cables (Item 18 on the bill of material) are shipped directly from General Radio to avoid excessive handling and possible damage to the equipment. Initial assembly requires only the installation of the electronics in the cabinet and connection to the appropriate terminals.

Note: This is precision equipment so process fluid leaks, dust, and dirt in the system cannot be tolerated.

INSTRUMENT MODIFICATIONS:

The co-axial cables, tees and ells should come from the factory equipped with teflon spacers. If not, the normal plexiglass spacers should be replaced with teflon so the cables can withstand the heat. A GR874 90° ell with teflon insulators should be installed on top the cell.

If the comparator is to be used on 220 V/50 HZ power, the connections shown on page 43 for Operating Instructions Type 1605A-AH Impedance Comparator must be made.

If a recorder is used to log the power factor a precision 50 ohm resistor should be installed across the phase angle difference meter. (See circuit for correction for Recorder GR 1605AH.) The same is recommended for capacitance balance recording.

The cell and any insulation surrounding it should be removed from the housing to facilitate the check out.

CHECK OUT:

Temperature Indicator

The temperature indicator is a small API MOD503 unit for direct indication of temperature. Connected to the instrument may be a "shorting" metal clip to prevent damage to the instrument during transit. If installed, this must be removed. A stainless steel sheath thermocouple is connected to this pyrometer to complete the measuring circuit. To achieve proper operation, a resistor is attached to one side of the pyrometer. The total resistance (in series) of the thermocouple and the resistor should be 10 ohms. The resistor must be cut until

the combination of the thermocouple and the resistor is 10 ohms. If the indication is erroneous, the unit must be replaced. For more detailed procedures, see the API Instruction Manual 955-31, Rev. A.

Heat Exchanger (See"Bill of Material")

The heat exchanger is a 110 VAC/60 HZ (or 220 VAC/50 HZ if so equipped) electric heater parallel ten feet of $\frac{1}{4}$ inch OD stainless steel tubing. The control is a silicone control recifier (SCR). The sensing unit is a 500K ohm thermister. It is very important that the thermister wires be twisted together. The wires should not be run parallel to any circuits carrying large currents or near transformers. The thermister should read around 500K (thousand) ohms at room temperature. Of course, temperature variations give varying resistance. The calibrated knob is for setting the operating temperature of the heat exchanger. The calibration is as follows:

Scale Setting	Temperature (°C)
65	53
39	100
35	110
32	120

The other non-calibrated knob is the maximum voltage setting. To check the heat exchanger:

(1) Check the resistance on the thermister. This should be approximately 500 K(1000) ohms.

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(2) Plug in the power supply.

(3) Set the calibrated knob at 35.

(4) Check the output voltage from the SCR (70 volt maximum). Adjust the maximum voltage to read around 70 volts. This adjustment is made by turning the slotted shaft control in the appropriate direction. Note as the control approaches the set point, the power is proportioned so maximum voltage adjustments must be made with the temperature 10°C or less than the set point.

(5) Check the amperage on the heater at full load. The amperage should be about 13 amps. Maximum heat input should be 12 watts/in.^{2} Adjust the set point around the temperature and check the proporting action. If the amperage check fails, disconnect the heater and check the resistance for an open circuit or short. If either occurs, the heater must be replaced.

(6) Once the heater functioning is checked satisfactory, proceed with an electronics check.

(7) Unplug the power to the heat exchanger to avoid difficulty in the pressure test.

Components

Unpack the General Radio 1605AH Impedance Comparator and the General Radio Type 1422 Precision Capacitor and inspect for physical damage.

Open the front and rear doors of the Monsanto Power Factor System case, remove the capacitor retaining case install the

capacitor in the case and lock the capacitor in position. Secure the capacitor case to lock the capacitor in place. Next install the General Radio 1605AH comparator through the front of the cabinet and plug it into the power source.

Remove the GR 874 plug from the Impedance Comparator (uppermost jack between the "Standard" and "Unknown" terminals) and insert into the right side of the GR1422CB capacitor. Install a GR874 co-axial tee in the position where the GR874 plug was removed from the comparator. Install a 90°ell on the other connection of the GR1422 capacitor. Connect the left side of the co-axial tee "Standard" to the 90° ell on the Precision capacitor with one GR874 Patch Cord. Connect the right side of the comparator and the cell with a GR874 Patch Cord and 90°ell. Cut two equal lengths of rubber covered stranded copper wire (18 or 16 gauge). Install a 90° jack on each end of one wire and install one 90° jack and one small lug on the other wire. Connect the lower left terminal "Standard" to the other jack plug on the Standard capacitor by the wire with the two jacks. With the other wire connect the jack plug to the right plug "Unknown" on the comparator and connect the lug to the outside electrode on the cell. Cut two short ground wires and connect them from the ground terminal (lower) on the comparator to the case of the capacitor with one and to the piping with the other. It may be necessary to remove the standard capacitor from its case to secure the ground wire. This should be done with utmost care to avoid damaging the

capacitor. (See the top of the Bill of Materials for a schematic of the electronics.)

Reinstall the cell back into the cabinet and replace all connections to the instrument frame.

Connect the cell to the instrument (Use a GR 90° ell for the top connection), otherwise, the cell must be removed to make the electrical connections.

Lock the thermocouple in place by inserting it into the cell until the sheath touches the center electrode. Then back off about 3/16 inch and tighten the lock nut. When the thermocouple is removed, it must never be tightened more than the initial assembly otherwise, the sheath may touch causing a shorting in the measurement.

Connect all piping connections.

Piping System (Leak Test)

Connect dry air or N_2 to the inlet on the process line and connect a pressure gauge on the outlet. Open the flow control valve and the two shut off valves.

Pressurize the system and test for leaks. A leak of more than 2 psig per 15 min. must be located and stopped. Note: The heat exchanger must not be powered during this test.

Once the system checks satisfactory on pressure test, continue with installing the system on the process.

INSTALLATION ON PROCESS

(1) Connect the power cord to a power source with a positive ground.

(2) Connect the "process in" to a supply source with 30 to 50 psig driving force to force the sample through the instrument.

(3) Connect the "process out" to the system to return the material to the process. (For example, across a valve or orifice plate.)

(4) Connect the purge line to dry air or N_2.

(5) Connect the cooling water jacket on the top of the instrument to a water source. (Note: Except under extreme heat conditions, the cooling water and cooling blower are probably not necessary.)

(6) Plug the bridge into the power inside the cabinet. The blower and heat exchanger are connected on the terminal block.

(7) Set the control on the SCR at 35 and adjust as necessary for adequate control. See Check Out Procedure under "Heat Exchanger" for calibration. The heat exchanger has a built in maximum temperature override so the unit can not overheat.

INITIAL PROCESS START UP

(1) Turn on the power to the bridge and adjust the bridge according to normal operating procedure (See Normal Operation). There is no process flow, so omit flow instructions.

(2) Read and record the capacitance read on the cell. (This is the air capacitance.)

(3) Start the process flow through the cell and let the flow level off at 5 gph. Observe the temperature of the fluid on the temperature indicator and as it approaches 100°C, the measurement is made. (Note: When the unit is started, the off scale lights will come on and the instrument will not read. This is normal and is a built in feature to prevent damaging the unit. Once the proper temperature is reached, proceed according to normal procedures. The normal capacitance balance for Aroclor should be 4.7 times that of air (empty cell).

NORMAL OPERATION:

With the flow set on 5 gph and the temperature of 100°C, a reading is ready to be taken. Normally, taking a reading will consist of no more than just reading the indicators. To set the instrument up to read or to check the system, the following is done:

(1) Set the frequency on 100C. The "Power" light should be on and the instrument given 15 minutes to warm up.

(2) Set the Impedance Difference Percent on 1. (Note: Any difference from one (lower) makes the instrument too sensitive and (higher) it is relatively insensitive.)

(3) Check the zeroes of the meters by (a) turning the function switch (top center) to either of the zero positions; (b) adjust the thumb-set zero controls on either side until the meters are zeroed.

(4) Check the calibration by:

(a) Set the function switch on calibrate (the Impedance Difference Percent must remain on 1).

(b) Adjust the Cal switch by turning until the "Impedance Difference" reads full scale 10.

Note: To avoid confusion in reading the instrument scales, we need to consider the instrument design. Each meter has two scales which are plus (+) and minus (-). On the inside, each meter has range selector with four positions (two with 3's and two with 10's). The top scale on the meters go to 3 which is used to make the reading any time the selector switch is on a 3 position (3, .3, .03, or .003). The selector switch on the inside of the instrument face sets the maximum and the divisions are the indicated portion of that maximum. (Example: The range switch (Phase Angle Difference Radians) is 0.03 and the meter reads 1.4, then the actual reading is 0.014. The ten scale (lower) is used only for the ranges having a 1 and indicates in the same manner and the upper scale except in divisions of 10.) The "Impedance Difference" can read plus or minus depending on whether the unknown is greater or smaller than the standard.

(5) Adjust the "Phase Angle Difference" to the maximum setting (0.03).

(6) Set the function switch on "Operate Guarded".

(7) Turn the standard capacitor until the "off scale" lights go off and the "Impedance Difference" meter balances at

zero. This is the total capacitance. The reading for Aroclor 1242 should be about 4.7 (dielectric constant) times the capacitance of the cell empty (clean). Record the capacitance on the standard capacitor drum when the zero is obtained on the "Impedance Difference" meter. This can be used to determine any dielectric constant change by merely dividing by the air capacitance. Also a balance value on any other Aroclor or mix can be calculated by multiplying the dielectric constance by the air capacitance of the cell.

(Note: If everything else has checked out satisfactorily up to this point and the "off scale" lights do not go off, the power factor is greater than 3% for GR 1605 AH and greater than 10% for the GR 1605A of which are the maximum scale for the respective units. To extend the range use the equation shown under "Off Scale lights will not go off" and add to the left side of the instrument instead of the right.

(8) If the reading on the "Phase Angle Difference" is low enough to read on the next scale lower, then switch to the lower scale for improved sensitivity. (Example: If the range selector switch is on 0.03 and the needle reads 0.008, then this would be below 0.01 which is the lower third of the scale. To read more accurately, we adjust the range selector to 0.01 and then the reading is 80 percent of full scale.

(3a) If the bridge fails to check out, see the Comparator Manual starting with Page 24 for servicing or else replace the bridge and return the other unit for repair. Before removing a bridge from service, the cable connections must be eliminated as a source of trouble. These can be visually inspected for broken connectors etc. and checked with an ohm meter to make sure they are tight.

(3b) If the bridge and cables check, then the problem is in the cell. See "Cell Cleaning Procedure".

(3c) Make sure the thermocouple sheath is not touching the center electrode.

"Off Scale" lights "chatter"(off and on):

The trouble may be loose terminals in the cable. Check and tighten as necessary. If polystyrene is used, then replace it with teflon insulators. Make sure the thermocouple is at least 0.15 inch away from the center electrode.

Capacitance reading is different on the same fluid:

(1) Check the cell for O ring failure (See Cell Cleaning procedure.). Although the cell contains two sets of rings, it is possible to experience a failure.

Power factor continues to be too high and quality is known to be good:

(1) Check Cell for O ring failure. (See Cell Cleaning Procedure.)

Cell Cleaning Procedure (See the reference drawing "Monsanto In Line Cell")

(1) Remove the cell carefully from the system.

(a) Close off the flow control valve and the shut off valve in the line;

(b) Drain the cell into a beaker (cell volume 130 cc);

(c) Disconnect the wiring and remove the cell from the system;

(d) Wash and clean up any spilled material.

(2) Cleaning the Cell

Take the cell to some clean room (safely ventilated for use of acetone) and disassemble:

(a) Disassemble the cell by removing nuts 22 or 23 from bolts 21;

(b) Lift the cell apart. The assembly should disassemble into three parts (1) top flange and center electrode (2) outside shell and (3) the lower flange. Rinse all parts thoroughly with cp acetone.

(c) Disassemble the top of the cell

(1) Remove the outside shield on the GR 874 connector(30) and unscrew the center connection.(28).

(2) With the proper size screw driver, remove the holding screw(16). Hold the center electrode in a soft clean paper towel to disassemble.

(3) Inspect the assembly parts and replace as necessary

a. Kel F washer (29)

b. Teflon spacer (17)

c. Outer O rings (18)

d. Inner O rings (19)

(4) If the fluid is between the inner O ring and the center electrode, this will cause erroneous readings and the cause should be eliminated. Fluid between the outer O rings does not present any problem since the outer O ring is a safety feature.

(5) Rinse the entire system with cp acetone, being careful to hold the electrodes with clean, soft paper.

(6) Dry the parts in a clean, dry place, preferably heat the electrode to drive off any solvent left on the surface. The electrode surfaces are polished and should be free of any deposition.

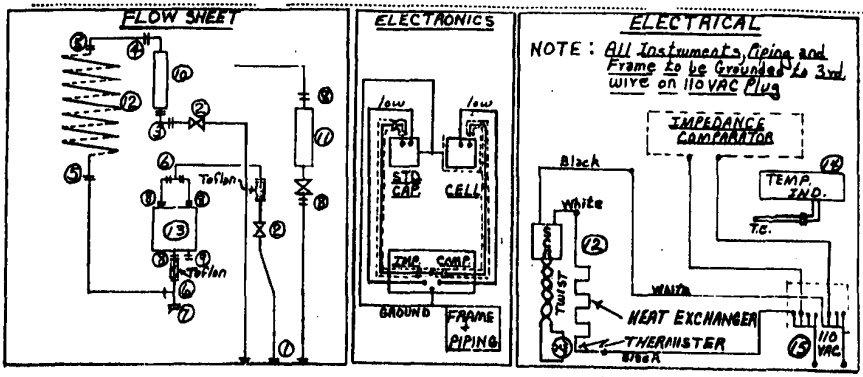
(7) Reassemble the cell in reverse order while hot (100°C) being extremely careful not to touch the electrodes. Also, be especially careful to make sure the O rings fit and are carefully in place before tightening the top flange to the center electrode. New O rings should be used. However, if the O rings swell slightly and must be reused, they can be shrunk by using dry ice. If they are shrunk by this method, the unit must be assembled quickly.

(8) Keep the cell clean and dry until reassembly.

(3) Reassemble the cell in reverse order except read the capacitance balance before the process fluid is started and check with previous readings. Resume according to normal operating procedures.

BY J.G.B. DATE 4-10-68 SUBJECT Monsanto Power Factor System SHEET NO 17 OF

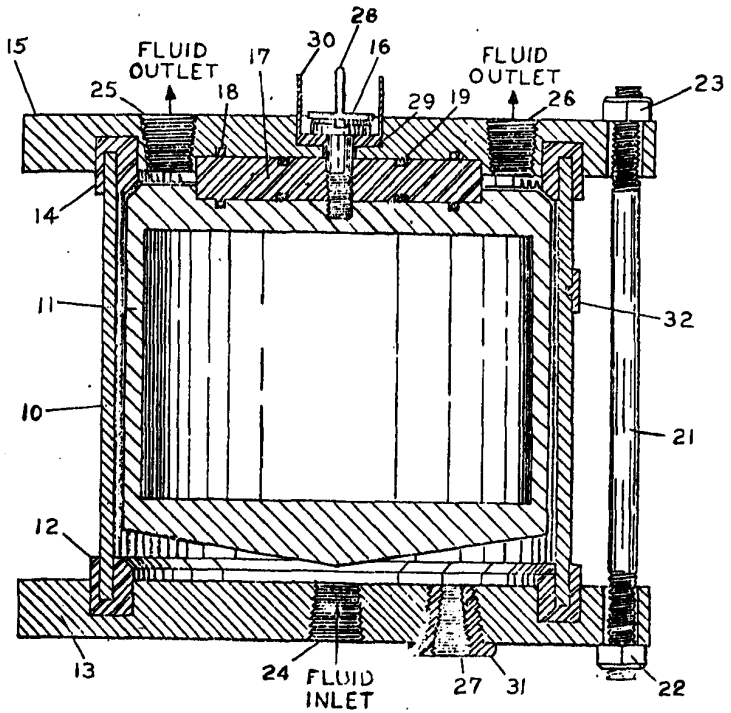
CHKD. BY DATE Diagrams - Bill of Material JOB NO.



Bill of Material

Item	No. Used	Manufacturer	Description	Identification
1	3	Swagelok	Bulk Head Union	400-61-316
2	2	Whitey	#1 Series Valve	1-VS-4-316
3	1	Swagelok	Male Elbow	400-2-4-316
4	1	Swagelok	Male Connector	400-1-4-316
5	2	Swagelok	Union	400-6-316
6	2	Swagelok	Union Tee	400-3-316
7	1	Swagelok	Plug	400-P-316
8	5	Swagelok	Male Connector	400-1-2-316
9	1	Swagelok	*Male Connector *Drill for 1/8" thermocouple	200-1-2-316
10	1	Brooks	Rotameter	6-1114-6 Tube 6-15-2-SS-Ball
11	1	Brooks	Purge Meter	1350V-316 SS-1/8" NPT (1-10) Panel Mount (CfM)
12	1	Thermon	Special Heat Exchanger	Bryant - 500K-SCR
13	1	Balsbaugh Labs	MONS Cell	Bryant
14	1	API (Allied)	Pyrometer	Mod. 503 - #51E5345
	1	Leeds & Northrup	I.C. Thermocouple 1/8" x 4" 316 SS	Cat. No. 8795-4
	1	Allied	I.C. Jack Plug	
15	1		4 Outlet Plug	Metal Box & 3 Wire Cord 10'
16	15'		Stainless Steel Tubing	316 SS 1/4" O.D.
17	4"		Teflon Tubing	1/4" O.D.
18	Electronics			
	1	General Radio	Impedance Comparator Type 1605AH, Rack Model	1605-9961
	1	General Radio	Precision Capacitor Type 1422CB	1422-9916
	2	General Radio	Patch Cord	0874-9680
	1	General Radio	874T-Tee	0874-9910
	2	General Radio	874 EL 90° ELL	0874-9526-Teflon
	4	Electronic Supply House	90° Jacks	
	10'	Electronic Supply House	Rubber Coated Wire	18 gauge
19	1	Custom Engineering Corp.	Cabinet	M-678
			Labels	(1) Monsanto Power Factor System (2) Nitrogen (3) Flow (4) Flow Control (5) Cell Temp.
		Additional 1 x 1/8" L (aluminum) & 5 1/2 x 6" dia. pipe, and two teflon support rings are provided with the cabinet		

MONSANTO IN-LINE CELL



MONS 049926

Nomenclature

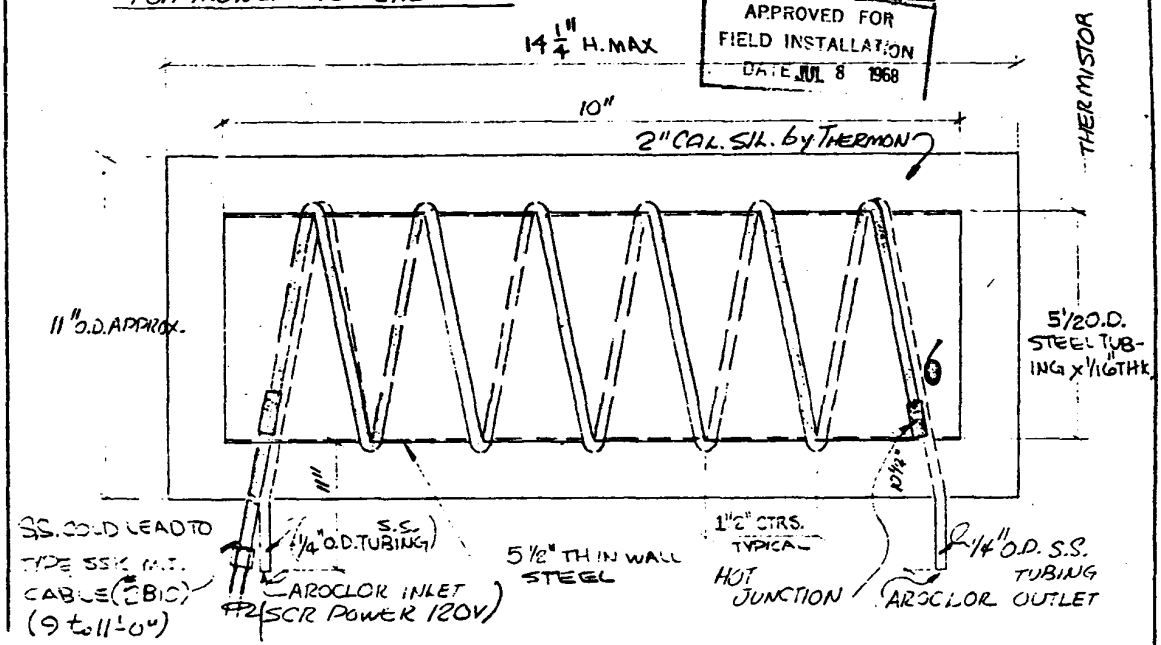
10. Outside electrode (low)
11. Inner electrode (high)
12. Teflon insulator
13. Lower guard and bottom
14. Teflon insulator
15. Upper guard and top
16. Electrode screw and center contact
17. Teflon spacer
18. Outer Silicone O ring seal
19. Inner Silicone O ring seal
21. Support bolts and guard connection
22. Lower lock nut
23. Upper lock nut
24. Fluid inlet
25. Fluid outlet
26. Fluid outlet
27. Insert hole for thermocouple
28. Inner electrode terminal on GR 874 plug
29. Kel F insulator washer
30. Guard connector to GR874 plug
31. Connector for 1/8"tube x 1/8" NPT pipe
32. Outside electrode terminal

Form 4824

CUST. CUSTOM ENGINEERING CO. LOCATION TUCKER, GEORGIA

FOR MONSANTO CHEM. CO.

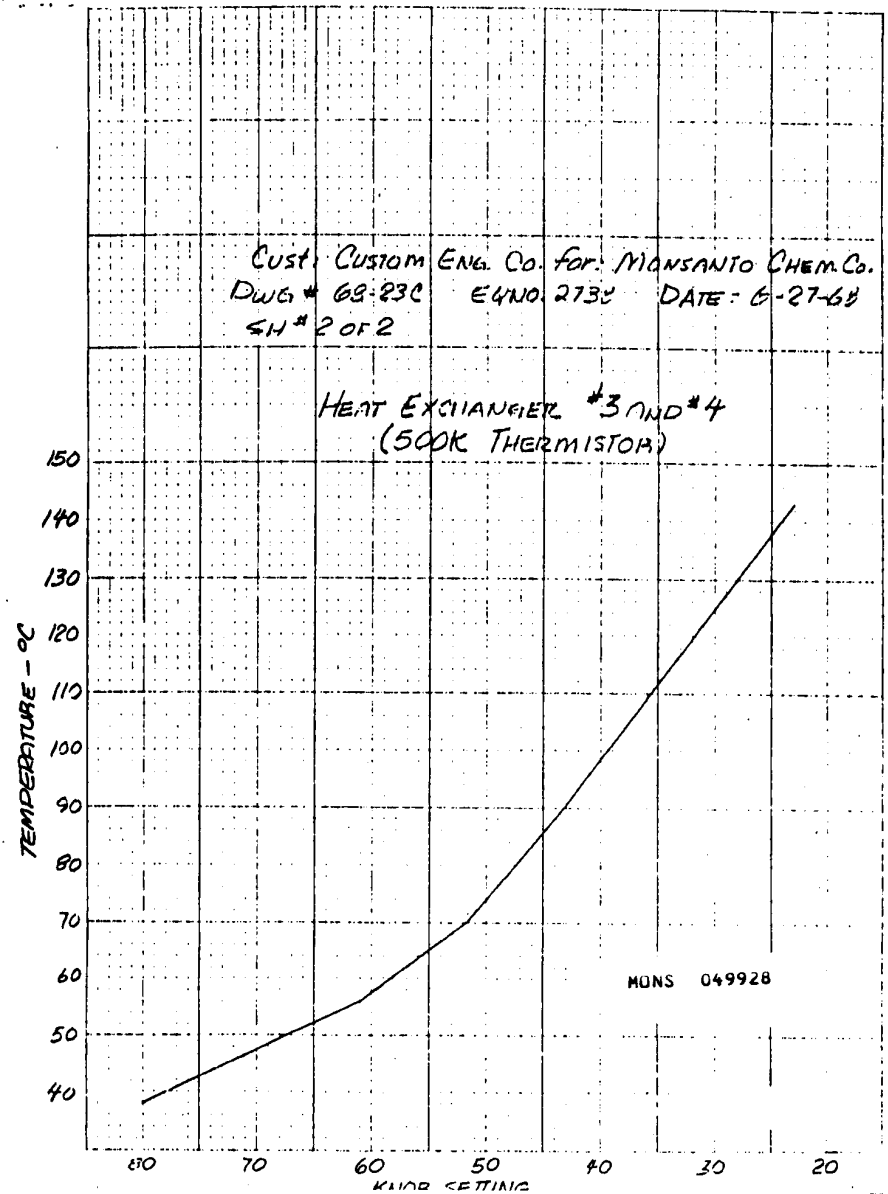
APPROVED FOR FIELD INSTALLATION
DATE JUL 8 1968



THERMON MANUFACTURING COMPANY 9941 ROWLETT RD. HOUSTON TEXAS	DRAWN BY D.E.D. DESIGNED BY D.E.D. APPROVED BY	DATE 6-27-68 EQ. NO. 2738 DWG. NO. 68-236 SH 1 OF 2

19

MONS 049927


Cust: Custom Eng. Co. for: Monsanto Chem. Co.
Dwg # 69-23C Eng No. 2736 Date: 6-27-69
Sh # 2 of 2
Heat Exchanger #3 and #4
(500K Thermistor)
Temperature - °C
150
140
130
120
110
100
90
80
70
60
50
40
80
70
60
50
40
30
20
Knob Setting
MONS 049928

Insulation Colors								
	Thermocouple Wire				Extension Wire			
Thermocouple Material	ISA Type	Outside Sheath	Positive Wire	Negative Wire	ISA Type	Outside Sheath	Positive Wire	Negative Wire
Iron-Constantan	J	Brown	White	Red	JX	Black	White	Red
Copper-Constantan	T	Brown	Blue	Red	TX	Blue	Blue	Red
Chromel-Alumel	K	Brown	Yellow	Red	KX	Yellow	Yellow	Red
Pt 10% or 13% Rh-Pt		---	---	---	SX	Green	Black	Red

ZERO SETTING

Pyrometers with automatic cold junction compensation have a small coiled bimetallic spring which moves the zero setting of the pointer to agree with the internal temperature of the meter. It may need adjustment from time to time. This is done by turning the zero adjustment screw on the front of the pyrometer. Make this adjustment only after the pyrometer has been in a room with even temperature for several hours. Disconnect the thermocouple leads and adjust the pointer to read actual room temperature. Reconnect the thermocouple leads.

ALL THERMOCOUPLE CONNECTIONS MUST BE TIGHT. A LOOSE CONNECTION OR BAD THERMOCOUPLE JUNCTION WILL CAUSE ERRATIC READINGS.

API INSTRUMENTS CO.
CHESTERLAND, OHIO 44026 • (CLEVELAND 216) 729-1091 • TWX (810-427-9229 • TELEX 000-0000
In Canada: Oakville, Ontario • (416) 876-1541

MDNS 049929

API INSTRUMENTS CO.

INSTRUCTION MANUAL
INDICATING PYROMETERS

MOUNTING

API pyrometers are balanced for accurate reading in a normal vertical position unless specified otherwise.

All pyrometers labeled "shielded meter" may be used in any type of panel with little or no effect on calibration. Those labeled "non-magnetic" must be used only on aluminum, plastic, wood or other non-magnetic panels. They will read low if mounted in a steel panel. Pyrometers which are labeled "magnetic" are intended for installation on steel panels. A steel compensating ring is normally supplied where panel material is not specified. Discard the ring when mounting on a steel panel. If the pyrometer is used on a non-magnetic panel, the steel ring must be used. Be sure that the slit in the ring is at the top of the meter barrel and the ring is pushed as far forward as it will go.

THERMOCOUPLE SELECTION AND CALIBRATION

Each pyrometer is marked on the dial with the type of thermocouple and the total external resistance for which it is calibrated. Use of any other type of thermocouple or one with a higher resistance than marked will result in incorrect readings. (Standard thermocouples and thermocouple wire are available from API.)

All standard pyrometers are calibrated for 10 ohms external thermocouple resistance and are provided with a 10 ohm calibrating resistor bobbin. (Non-standard pyrometers are usually calibrated for the specific external resistance ordered and no resistor bobbin is supplied.) This resistor bobbin must be adjusted so that the total resistance of the thermocouple and the bobbin add up to 10 ohms in order to maintain calibration accuracy. Therefore, for a 5 foot, 20 gauge, iron-constantan thermocouple, the resistance of the thermocouple would be approximately 1.75 ohms and this resistance must be subtracted from the calibrating bobbin. Each turn of the wire on the resistor bobbin represents 0.5 ohms and for this example, 3½ turns would be removed. The total resistance of the thermocouple plus the resistor bobbin would then add up to 10 ohms. For other values of thermocouple resistance, simply remove more or less turns to adjust for the total value of external resistance marked on the pyrometer dial. Extra 10 ohm resistor bobbins may be ordered by part number 251-34.

It is very important that the resistor wire be properly soldered after adjusting.

-NOTE-

WHEN THERMOCOUPLES WITH EXTERNAL RESISTANCE HIGHER THAN 10 OHMS WILL BE USED, A SPECIAL PYROMETER WILL BE REQUIRED. THE USE OF OTHER THAN THERMOCOUPLE WIRE FOR LEADS OR EXTENSIONS MAY RESULT IN IMPROPER AMBIENT COMPENSATION.

ABBREVIATED TABLE OF THERMOCOUPLE RESISTANCE*

The table below lists the resistance in ohms per pair-foot for various types of commonly used thermocouples for a number of different gauges of wire. By using this table, it is necessary only to measure the length of the thermocouple, knowing the type and gauge, to determine its approximate resistance. (Actual measurement of the thermocouple resistance is preferred to using the table.)

	OHMS PER PAIR-FOOT		
Gauge B&S	Iron/Constantan (Type J)	Copper/Constantan (Type T)	Chromel/Alumel (Type K)
8	.0215	.0184	.0365
10	.0341	.0293	.0580
12	.0542	.0466	.0922
14	.0863	.0741	.1470
16	.1370	.1180	.2330
18	.2180	.1870	.3710
20	.3570	.2980	.5900
22	.5510	.4690	.9370
24	.8770	.7530	1.490
26	1.390	1.200	2.370
28	2.220	1.910	3.770
30	3.520	3.030	5.980

*A complete table of resistance for various wire gauges will be sent on request.

MDNS 049930

CONNECTION OF THERMOCOUPLE

Pyrometers are polarity sensitive and must have the thermocouple connected to the proper terminals to indicate properly. On all API pyrometers, the left terminal (from the rear) is positive. See Figure 1 for further clarification.

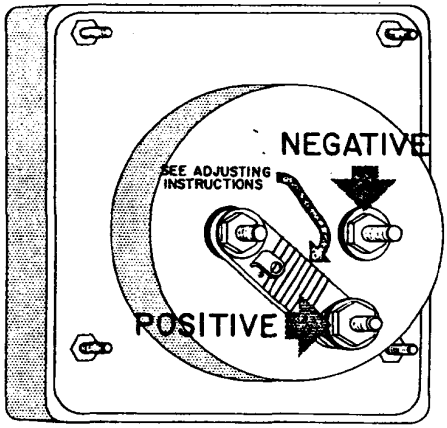
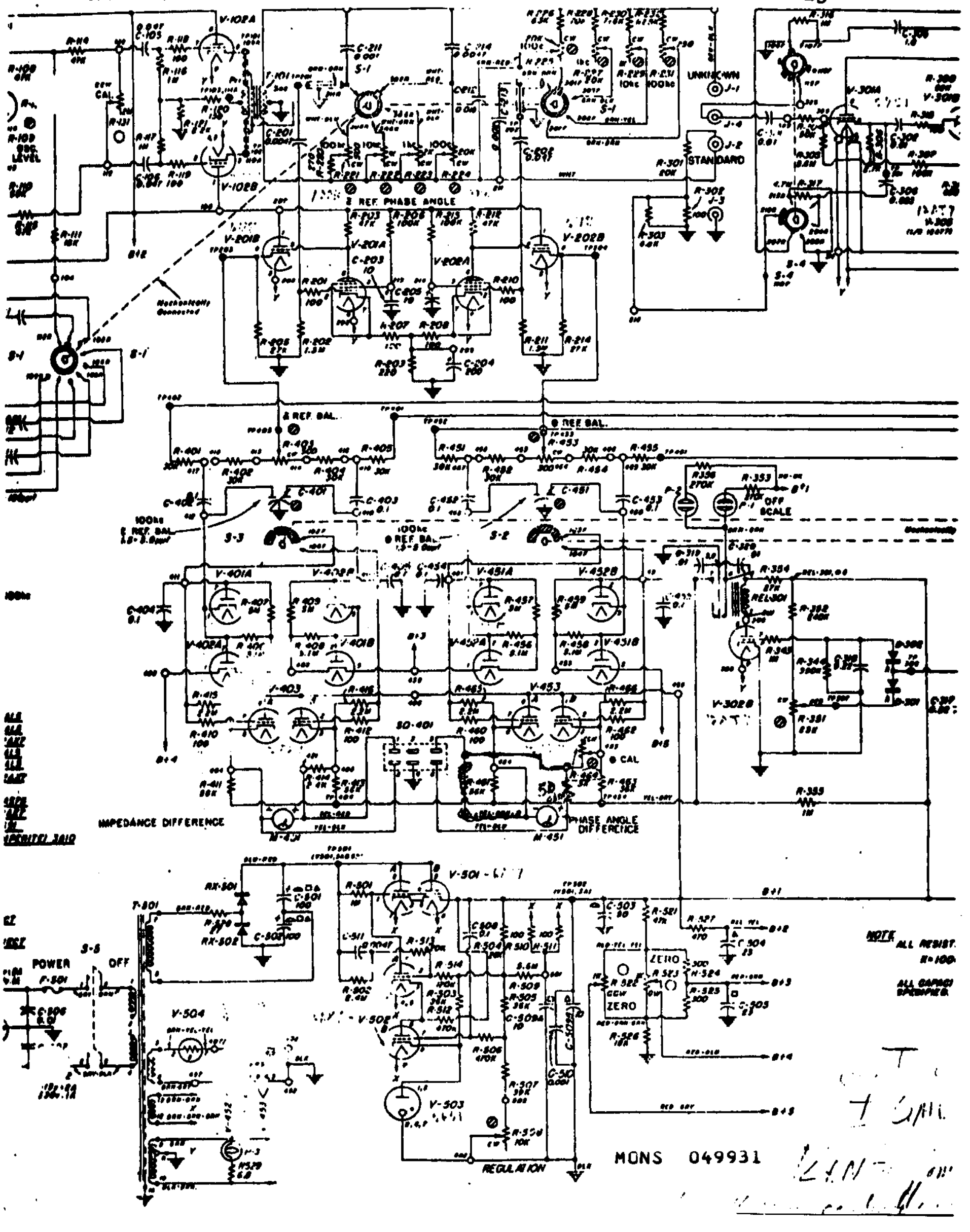


FIGURE 1

TABLE OF THERMOCOUPLE COLOR CODES

The following table lists polarities and color codes for the commonly used thermocouples and extension wires. If the thermocouple is not coded or if there is doubt on the proper connection, the polarity may be verified by passing the thermocouple junction tip through a match flame momentarily until the meter indicates an increase in temperature. For best accuracy, the external thermocouple resistance should be adjusted as outlined to within one percent of the resistance of the measuring circuit (internal resistance plus external resistance). For scale spans of 500 degrees or more, adjustment accuracy should be better than ±0.5 ohms. For scale spans of 300 degrees, adjustment accuracy should be better than ±0.25 ohms.

22


V-102A
V-102B
C-105
C-106
R-116
R-118
R-119
R-111
R-131
CAL
OSC. LEVEL
T-101
S-1
C-211
C-214
C-201
C-202
R-221
R-222
R-223
R-224
10kc
100kc
UNKNOWN
STANDARD
J-1
J-2
J-3
J-4
R-301
R-302
R-303
V-301A
S-4
REF. PHASE ANGLE
V-201A
V-201B
V-202A
V-202B
C-203
C-204
C-205
R-201
R-202
R-203
R-205
R-207
R-208
R-210
R-211
R-214
REF. BAL.
R-401
R-402
R-403
R-404
R-405
R-451
R-452
R-453
R-454
R-455
C-401
C-403
C-404
C-451
C-453
S-2
S-3
100kc
V-401A
V-401B
V-402A
V-403
V-451A
V-451B
V-452B
V-453
SO-401
CAL
M-451
IMPEDANCE DIFFERENCE
PHASE ANGLE DIFFERENCE
R-353
R-354
R-355
OFF SCALE
REL-301
V-302B
R-351
B+1
B+2
B+3
B+4
B+5
V-501
V-502
V-503
V-504
RX-501
RX-502
C-501
C-502
C-503
C-504
C-505
T-501
POWER
OFF
S-5
F-501
ZERO
REGULATION
NOTE ALL RESIST.
ALL CAPACI SPECIFIED.

MONS 049931

SPARE PARTS LIST:

The best source of spare parts is a complete spare cell. Presuming this isn't practical, the next best approach is to maintain spares on certain critical items. These items can be obtained directly from:

Balsbaugh Laboratories
25 Industrial Park Road
South Hingham, Massachusetts 02043

They are:

Item	Part No.	Description
1	12 or 14	Teflon insulator
2	28	Inner electrode terminal on GR 874 plug
3	16	Electrode screw and center contact
4	29	Kel F insulator washer
5	30	Guard connector to GR 874 plug
6	19	Inner Silicon O ring seal (2 pair)
7	18	Outer Silicon O ring seal (2 pair)
8	17	Teflon spacer

The other components of the system should operate essentially trouble free. No spare parts are maintained for these.

MONS 049932

AROCLOR MFG PROCESS

MONS 049605

OPERATIONS MANUAL

ANNISTON, ALABAMA PLANT

MONSANTO CHEMICAL COMPANY

MONS 049606

Vince Haupt

A/VA787/536/AU05/1124/1/FI/QZQ

M B DUNLAP
ANNISTON

RE YOUR TELETYPE APPROVALS REQUIRED FOR MANUFACTURING PROCESSES
EB 40 TPM J SMITH RES MGR J R DARBY
CHLORINE/CAUSTIC TPM H CARDER RES MGR O DEGARMO

A YUHN MONSANTO CO ST LOUIS DC

536/A /1124

MONS 049607

APPENDIX IV

METHOD OF RUNNING HOLDING POINTS

1. Obtain representative sample of material from sample line at pump discharge line. Catch sample in a pint can.

2. The receptacle for running the sample is 1" x 4-1/2" Pyrex tube, sealed at one end. The tube is inserted in a square 8-oz. bottle which is insulated in the bottom by a layer of 1" asbestos fibre. The tube is held in place by a large cork. Insulation is used in an effort to keep the Aroclor from cooling too rapidly.

3. Pour the material into the tube until it is filled within 1-1/2" of the top.

4. Material will probably crystallize in the cold tube and will have to be melted again.

5. When the material is melted, insert a suitable thermometer (0-360°C.) which is fitted with a cork to hold it in place. The bulb of the thermometer should be fitted in the center of the sample, care being taken that it is not too close to the side of the tube.

6. Heat the tube to 200°C., place it in the asbestos jacket, then put it in the bottle.

7. Take readings on the thermometer every 30 seconds. At first the temperature will drop rapidly (4-6°C. between readings). This drop will decrease and finally come to a stop and stay constant for several readings, or will start to go back up several degrees.

8. Record the point at which the temperature remains constant, or in case of a rise, the highest point of the rise is the hold point of the material.

APPENDIX V

METHOD OF RUNNING SOFTENING POINTS

1. Obtain representative sample of material from sample line at discharge of circulating pump. Catch the sample in can lid or Pyrex beaker.

2. Heat ring and sample.

3. Place ring on can lid or metal plate and fill with sample until material stands slightly higher than edge of ring. Fill the ring from the large diameter side.

4. Cool the ring and lid from bottom of the side until sample sets up, being careful not to get any water on top of the sample.

5. Finish cooling by running water on top of the sample after it sets up.

6. Remove filled ring from lid and trim off any material that is on the outside.

7. Make slight indentation on top of the sample in the center of the ring with a heated wire to hold the ball in place.

8. Fill beaker with water or glycerin.

   a. Use water when expected softening point is under 80°C.

   b. Use glycerin when expected softening point is over 80°C.

9. Place the ring in the sample holder, place ball on sample, and put holder in the beaker.

10. Adjust the thermometer in the holder so that the tip of bulb protrudes 1/4" through the hole in the crossbar that holds sample.

11. Place the beaker on a stand with screen under it and set burner under the stand.

MONS 049609

12. Light burner and adjust to give a temperature rise as shown on the thermometer of 5°C. per minute.

13. Bring temperature up 5°C. per minute until ball falls through the sample.

14. Record temperature at time ball falls to lower crossbar as the softening point.

CONFIDENTIAL

MONSANTO COMPANY
Sauget, Illinois

November 16, 1970

Messrs: J R. Savage - G.O.
W. R. Richard - G.O.
B. W. Corlew
D. W. Jackson
W. C. Engman
R. M. McCutchan
Technical Information Center (2)
Vital Record Center - G.O.
W.G.K. Plant Records
Process Holders

Tentative Amendment "K"

TITLE

Tentative Amendment "K" to the Standard Manufacturing Process for the Manufacture of Aroclors, Department 246, dated October, 1966.

SUB-TITLE

Demonstrate a modified chlorination procedure to determine the effect on the Monsanto and after corrosion stability of Aroclor 1260.

PRESENT PRACTICE

Chlorination of Biphenyl to Aroclor 1260 is presently done in the five batch chlorinators. Ferric Chloride (concentration 0.05%) is used as the catalyst. Chlorination is begun at the temperature of the incoming Biphenyl which is about 115°C. (± 5°C.). The batch is allowed to heat up to about 140°C. from the heat of reaction before cooling is begun. This takes about 30 minutes or less. As cooling is started, the batch temperature gradually rises to 150°C. over another 30 minutes. The batch is finished at 150 C. and when finished, pumped to the blow tanks. Total batch time is about ten hours.

PROPOSED CHANGES

A designed experiment will be run on the batch chlorinators in Aroclor 1260 production. The variables to be modified are catalyst charge, temperature at the start of chlorination and chlorination finishing temperature. The variables with the present and proposed settings are listed on page 2.

PROPOSED CHANGES (Cont'd)

Variable	(-) Level Present Level	(+) Level Proposed Level
Ferric Chloride Catalyst	0.05% (2 pounds/batch)	0.10% (4 pounds/batch)
Temperature At Start Of Chlorination	110°C.	125°C.
Chlorination Temperature	150°C.	190°C.

Other controllable variables will remain normal. Individual chlorinator batches will be sampled and laboratory distilled to be analyzed for Monsanto stability and after corrosion chlorides.

JUSTIFICATION

Aroclor 1260 being produced at W.G.K. is presently failing the after corrosion chloride and Monsanto stability tests. This experiment is designed to determine whether the three variables being changed affect the stability mentioned above.

SOURCE OF DATA

Past research projects have indicated that catalyst concentration, starting temperature and finishing temperature affect Aroclor 1242 stabilities. W.G.K. P.R.&D. reports on project 91370:3794 are examples. Aroclor 1260 is expected to respond in a like manner.

SAFETY

These conditions have been run in this equipment as recently as three years ago with no safety problems. None are anticipated at this time.

QUALITY

The quality of this material will be monitored closely to determine the effect of the changes. Normal analytical tests will be made of the finished goods and disposition will depend on the outcome of these tests. If the material is within specifications, it will be used as normal Aroclor. If not, a decision will be made by production with Marketing approval as to disposition.

DEMONSTRATION CRITERIA

The particular tests to be watched are Monsanto stability and after corrosion chlorides. Analysis of the data will be made to determine whether changing the three operating variables had an effect on the stabilities. A decision on permanent changes will depend on how much improvement is made by this test and whether or not an underlying cause is found and can be corrected.

Written By: Wayne A. Krull

sms

Approved By:

M C Richard 11/30/70
Mgr., R&D Business Group

Olive DeGarmo 12/2/70
Mgr., R&D Process Technology

PROCESS TECHNOLOGY SAFETY REVIEW COMMITTEE

John A Greene 12/3/70

Mike Sapateka 12/4/70

J [illegible] 12/7/70

Approved By:

R M McCutchen 11/18/70
Production Supervisor Date

B W Cordell 11/23/70
Production Gen. Superintendent Date

W C Engman 11/19/70
TSD Process Gp. Superintendent Date

D W Johnson 11/20/70
Gen. Supt. Tech. Services Date

S A Seveso 12/1/70
Manufacturing Manager Date

MONSANTO COMPANY
Sauget, Illinois

August 26, 1970

Messrs: J. R. Savage - G.O.
W. R. Richard - G.O.
N. W. Corlew
D. W. Jackson
W. C. Engman
R. M. McCutchan
Technical Information Center (2)
Record Center - G.O.
W. G. K. Plant Records
Process Holders

VRH
Do we agree?

Tentative Amendment "J"

TITLE

Tentative Amendment "J" to the Standard Manufacturing Process for the Manufacture of Aroclors, Department 246, dated October, 1966.

SUB-TITLE

Demonstration of a modified aeration procedure.

CHANGES

The present blow tanks and the piping to the drowning jet will be modified to reduce stream pollution due to entrained Aroclor from the blow tanks. The air flow from the two batch blow tanks and the continuous blow tank will be combined. This combined flow will be piped to a condensate tank which has a Brink Mist Eliminator on top of it. The Mist Eliminator should remove 99% or more of the mist which will be collected in the condensate tank.

The air stream will be piped to the drowning jet to remove HCl. As an aftermath to the equipment addition, a small pressure (about 10 inches W.C.) will be put on the blow tanks where there is presently a slight vacuum. This necessitates closing the batch blow tanks which are open to the atmosphere.

JUSTIFICATION

This equipment addition will reduce Aroclor stream pollution by as much as 250 pounds per day.

Let's get it!!!

SOURCE OF DATA

A simple trap in the blow tank line has been catching about 250 pounds of Aroclor per day that formerly went to the sewer. Also, a Brink Mist Sampler was used to sample the line and indicated an additional 35 pounds per day of mist.

SAFETY

Rupture discs will be installed on the old batch blow tanks. The burst pressure will be 5 psig. A new vent line will be run to the drowning jet to maintain the chlorinators at atmospheric pressure for catalyst charging. The present vent is to the blow tank and would have resulted in pressure on the chlorinators and a safety hazard to the operator during catalyst charging.

QUALITY

No change in quality should result from these changes. Condensate from this operation will be used to produce non-electrical grade Aroclors by combining it with present off gas condensate or by separate reworking similar to the present procedures for off-gas condensate. Normal testing will be done on both the normal run Aroclors and the rework from the condensate.

DEMONSTRATION CRITERIA

Operation with the new Mist Eliminator will continue unless operational or quality difficulties result that can be attributed to the Mist Eliminator.

Written By: Wayne A. Krull

Approved By:

M R Richard 9/3/70
Research And Development Manager Date

Research Safety Review Committee

M A Tesoriero 9/15/70 Date

[illegible] 9/16/70 Date

W J Knapp 9-16-70 Date

Approved By:

R M McCutchan 8/27/70
Production Supervisor Date

Bill Conlew 9/28/70
Product Group Superintendent Date

N. C. Engman 8/28/70
T.S.D. Group Superintendent Date

D. W. Jackson 9/31/70
T.S.D. General Superintendent Date

J R Tavares 9/3/70
Manufacturing Manager Date

MONS 049615

sms

VRH

MONSANTO COMPANY
Sauget, Illinois

August 26, 1970

Messrs: J. R. Savage - G.O.
W. R. Richard - G.O.
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D. W. Jackson
W. C. Engman
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Record Center - G.O.
W. G. K. Plant Records
Process Holders

Tentative Amendment "I"

TITLE

Tentative Amendment "I" to the Standard Manufacturing Process for the Manufacture of Aroclors, Department 246, dated October, 1966.

SUB-TITLE

Demonstrate that scrap Aroclors returned from customers can be reworked to produce salable product.

CHANGES

The existing #1 still will be used to distill Aroclors returned from customers. A storage tank will be installed to hold the returned Aroclors and feed the #1 still. The #1 receiver will catch distilled rework. Finished rework will be transferred to either the #7 storage tank (boildown storage) or to the #1 mix tank which will be unused with the absence of Pydraul business.

If filtering is necessary, the existing 36" sparkler filter or the Alsop filters to be installed will be used. In no event will the rework material be allowed to contact normal run product.

JUSTIFICATION

A savings of $16,000 per year can be realized by reworking an anticipated 2M pounds per year of returned scrap. Also, the pollution problem can be reduced by removing the 2M pounds per year of scrap from the environment.

SOURCE OF DATA

MONS 049616

Functional fluids research is repsonsible for providing the data for the type of reworking necessary to produce salable material. Material found unsuitable for rework will be incinerated.

SAFETY

This amendment should not create any safety hazards. Operations will be similar to normal Aroclor production.

QUALITY

The material produced by reworking the returned Aroclor is expected to meet the specifications for Pydraul formulations and will be used as such.

DEMONSTRATION CRITERIA

Scrap Aroclor will be reworked if Research indicates it is possible to produce salable goods by a method within production capabilities. Costs should be held at or below current Aroclor production costs. If attempts at reworking fail, the material will be incinerated.

Written By: Wayne H. Krull

Approved By:

M R Richard 9/3/70
Research & Development Manager Date

Research Safety Review Committee

M A Terpstra 9/15/70
Date

E Fawcett 9/16/70
Date

W Knapp 9-16-70
Date

Approved By:

R M McCutchan 8/27/70
Production Supervisor Date

Bill Carlew 8/28/70
Product Group Superintendent Date

W. C. Engman 8/29/70
TSD Group Superintendent Date

D W Jackson 8/31/70
TSD General Superintendent Date

J R George 9/2/70
Manufacturing Manager Date

MONS 049617

ams

MONSANTO COMPANY
ORGANIC CHEMICALS DIVISION
ANNISTON, ALABAMA

STANDARD MANUFACTURING PROCESS
FOR
AROCLOR

Departments 826.08
826.17

Supersedes: Standard Manufacturing Process
For
Aroclor
Issued: 10/22/57

Prepared by: M. J. Williams
Prod. Foreman

Supervisor: V. R. Haupt

Production Supt.: R. G. Moody

Issued: September, 1966

COPY NO. 7

MONS 049618

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STANDARD MANUFACTURING PROCESS
FOR
AROCLOR

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MONS 049619

STANDARD MANUFACTURING PROCESS
FOR
AROCLOR

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MONS 049620

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T. W. Lawrence

J. C. Landwehr

MONSANTO COMPANY
ANNISTON PLANT

13 JAN 71

TENTATIVE AMENDMENT "F"

TO

AROCLOR STANDARD MANUFACTURING PROCESS

Dated Jul 69

TITLE: PRODUCE AROCLOR 5068

OBJECTIVE: To produce Aroclor 5068 in the existing solid Aroclor system.

PRESENT PROCEDURE: Aroclor 5068 has not been produced in plant equipment before and there has been no previously established procedure to follow.

PROPOSED AMENDMENT: Make a test batch of Aroclor 5068 in existing solid Aroclor equipment.

The process changes will be conducted as follows:

a. Approximately 8500 pounds Santowax R will be chlorinated to 60% by weight chlorine by standard operating procedures.

b. At approximately 60% chlorine, 5 pounds more catalyst will be added to the chlorinator to increase chlorine efficiency. As the batch proceeds, this procedure may be repeated to keep chlorine efficiency at an acceptable level.

PROPOSED AMENDMENT: continued

c. Chlorine feed rates will be controlled so that the temperature of the batch remains approximately 260°C. to 280°C. and free chlorine in the off-gas is kept at a minimum.

d. At approximately 65% chlorine by weight and a softening point of 130°C., three or four 50-gallon drums of material will be removed from the chlorinator to be used in producing 5465.

e. Throughout the batch from 60% chlorine to 68% chlorine, hourly samples of off-gas and product will be taken to assist in design of a full production system.

f. When the softening point of the batch reaches 150°C. to 160°C., the chlorine feed will be stopped.

g. The batch will be transferred to the blow tank and air blown before being drummed out of the blow tank.

h. The product will be allowed to solidify and then will be ground to a powder for shipment to potential customers.

SOURCE OF DATA:

Anniston PR&D work (letter from G. L. Arnett to Aroclor 5068 file dated 1/11/71).

SAFETY:

There is one main potential safety problem created by this test. As the weight per cent chlorine increases, the rate of reaction will decrease and free chlorine will be released in the off gas. This free chlorine poses two potential problems:

1. The possibility of chlorine and steel combustion at temperatures above 250°C. in the off gas lines. To cope with this problem, temperatures will be watched closely and water will be sprayed on the lines to cool the steel if needed.

2. The possibility of too much free chlorine being released to the atmosphere. All process variables will be closely watched and controlled to keep the free chlorine released to the atmosphere at a minimum. However, if the free chlorine released to the atmosphere reaches an intolerable amount, the test will be discontinued.

QUALITY: MONS 049622

This material is requested by the Textiles Division and they require a softening point of $\geq$ 150°C. and that no lime be added to neutralize any entrained HCl.

EXTENT OF TRIAL:

A plant test batch will be made the week of January 25, 1971 and the data from this test will be evaluated before any further tests are made.

Originated by: Gary L. Moore
Gary L. Moore

:kd

APPROVALS:

Department Supervisor: G. W. Miller — Date: 1-14-71

Production Superintendent: J. L. Corder — Date: 1-15-71

Plant Manager: G. L. Jessee — Date: 1-18-71

PR&D Group Leader: J. L. Brown — Date: 1-14-71

Research Group Leader: Master copy signed by J. W. Baker — Date: 1-20-71
J. W. Baker

Mgr. of Research & Dev.: Master copy signed by W. R. Richard — Date: 1-20-71
W. R. Richard

Manufacturing Manager: Master copy signed by J. R. Savage — Date: 1-18-71
J. R. Savage

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Master signed by H. E. Schulte
H. E. Schulte

Master signed by T. W. Lawrence, Jr.
T. W. Lawrence

Master signed by J. C. Landwehr
J. C. Landwehr

MONSANTO COMPANY
ANNISTON PLANT

13 OCT 70

TENTATIVE AMENDMENT "E"

TO

AROCLOR STANDARD MANUFACTURING PROCESS

Dated Jul 69

TITLE: INCREASE CHLORINATION EFFICIENCY IN THE PRODUCTION OF SOLID AROCLOR 5060 BY USING ALUMINUM CHLORIDE AND/OR POWDERED ALUMINUM METAL AS THE CATALYST.

OBJECTIVE: To increase the efficiency of the Aroclor 5060 chlorination to alleviate free chlorine in the by-product hydrogen chloride gas.

PRESENT PROCEDURE: Santowax R is preheated to 150°C., mixed with 0.05% ferric chloride, and charged to a batch chlorinator from a weigh tank. Chlorine gas is added until the desired softening point is attained. Both chlorine flow and reaction mass temperature are closely controlled at 3000 #/hr. max. and 250°C. max. respectively.

It is then transferred to an air blowing tank to remove the hydrogen chloride gas before charging to the still.

Vacuum distillation is carried out in the presence of 0.5% lime and then the product is flaked, bagged and drummed for storage before sales.

PROPOSED AMENDMENT:

Santowax R will be chlorinated using 0.05% aluminum chloride and/or powdered aluminum as the catalyst. The test will be carried out on normal plant batch chlorinations.

The process changes will be conducted as follows:

a) 0.05% (approximately 5.5 pounds) of aluminum chloride and/or powdered aluminum will be added to the Santowax R in the charge tank.

b) After proceeding with the batch as a normal chlorination batch, immediate improvement in the amount of free chlorine in the product hydrogen chloride off gas should be noted.

SOURCE OF DATA:

Anniston PR&D Report No. 1 of Job No. 446-507, 1-22-69.

SAFETY:

Aluminum chloride must be handled so as not to contaminate it with water, because HCl will be liberated.

Powdered aluminum does burn, but under plant conditions will not cause any new safety problems.

QUALITY:

Chlorinations using aluminum chloride and/or aluminum metal does slightly change the isomer content of the product. This does not change the final material specifications of the product. However, this slight change in isomer content makes Aroclor 5460 more closely resemble the isomer content of our foreign competitors, Bayer and Kanegafuchi, and therefore doesn't change any desired properties of our Aroclor 5460.

EXTENT OF TRIAL:

A drop in the free chlorine should be immediately noticeable; however, the normal six month trial period is requested to assure sufficient time to run further tests after evaluating the first.

Originated by: Gary L. Moore
Gary L. Moore

:kd

APPROVALS:

Department Supervisor:	Master signed by G. W. Miller G. W. Miller	10/14/70 Date
Production Superintendent:	Master signed by J. L. Corder J. L. Corder	10/14/70 Date
Plant Manager:	Master signed by G. L. Jessee G. L. Jessee	10/14/70 Date
PR&D Group Leader:	Master signed by J. L. Brown J. L. Brown	10/14/70 Date
Research Group Leader:	Master signed by J. W. Baker J. W. Baker	10/27/70 Date
Mgr. of Research & Dev.:	Master signed by M. W. Farrar M. W. Farrar	10/28/70 Date
Manufacturing Manager:	Master signed by J. R. Savage J. R. Savage	10/29/70 Date

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APPROVAL OF SAFETY REVIEW COMMITTEE

Master copy signed by H. E. Schulte
H. E. Schulte

Master copy signed by P. K. Ward
P. K. Ward

Master copy signed for J.C.Landwehr
J. C. Landwehr by V.R.H.

MONSANTO COMPANY
ANNISTON PLANT

17 Jul 70

TENTATIVE AMENDMENT "D"

TO

AROCLOR STANDARD MANUFACTURING PROCESS

Dated Jul 69

TITLE: PRODUCTION OF AROCLOR 5432

OBJECTIVE: To produce Aroclor 5432 in the existing Solid Aroclor system

PRESENT PROCEDURE: Aroclor 5432 has not been produced in plant equipment before and there has been no previously established procedure to follow.

PROPOSED AMENDMENT: Follow the standard operating instructions for producing Aroclor 5442 with the following exceptions. Chlorination level can be monitored by checking product specific gravity at 90°C. To produce a final distilled product within the specified 1.263-1.290 gravity range (30.5-33% chlorine), the chlorinators should be finished between 1.273-1.300 gravity units.

Tentative Amendment "D"
Aroclor Standard Mfg. Process
Dated Jul 69

SOURCE OF DATE:

a) Anniston PR&D Report No. 1 of Job No. 446-515, 5-26-70

b) Letter P. D. Fowlkes to G. L. Arnett on Aroclor 5432 specs 7-15-70

SAFETY: The amended process has no effect on safety of operation. Normal department safety practices will be followed.

QUALITY: The following properties will be monitored during chlorination and distillation:

a) Crude Aroclor specific gravity, 1.273-1.300 gravity units at 90°C.

b) Distilled Aroclor specific gravity, 1.263-1.290 gravity units at 90°C.

c) Distilled Aroclor color, $\leq$2 NPA

EXTENT OF TRIAL:

An initial plant demonstration run will be made the last week of Jul '70. The normal six month trial period is needed to make any minor spec. changes to assure compatibility of Aroclor 5432 with the components of the various Aroclor blends Aroclor 5432 will be used to make.

Originated by: C R McIlwain
C. R. McIlwain and V. R. Haupt

:kd

MONS 049629

APPROVALS:

Department Supervisor Master copy signed by G. W. Miller 7/20/70
G. W. Miller Date

Production Superintendent Master copy signed by H. L. Williams 7/20/70
H. L. Williams Date

Plant Manager Master copy signed for G.L. Jessee by L.C.L. 7/20/70
G. L. Jessee Date

PR&D Group Leader Master copy signed by J. L. Brown 7/20/70
J. L. Brown Date

Research Group Leader: Master copy signed by J. W. Baker 7/29/70
J. W. Baker Date

Mgr. of Research & Dev.: Master copy signed by M. W. Farrar 7/30/70
M. W. Farrar Date

Manufacturing Manager: Master copy signed by J. E. Smith 7/22/70
J. E. Smith Date

COMPANY CONFIDENTIAL

Hougen

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Plant Standards Dept. (Extras)

Master copy signed by H. E. Schulte
H. E. Schulte

Master copy signed by P. K. Ward
P. K. Ward

Master copy signed by V.R.H. for Landwehr
J. C. Landwehr

MONSANTO COMPANY
ANNISTON PLANT

14 Jul 70

TENTATIVE AMENDMENT "C"

TO

AROCLOR STANDARD MANUFACTURING PROCESS

Dated Jul 69

TITLE: USE SODIUM HYDROXIDE TO PRODUCE LOW COLOR SOLID AROCLOR 5460

OBJECTIVE: To produce Aroclor 5460 with a color less than 1.25 NPA

PRESENT PROCEDURE:

Santowax R is preheated to 150°C., mixed with 0.05% ferric chloride, and charged to a batch chlorinator from a weigh tank. Chlorine gas is added until the desired softening point is attained. Both chlorine flow and reaction mass temperature are closely controlled at 3000 #/hr. max. and 250°C. max. respectively.

It is then transferred to an air blowing tank to remove the hydrogen chloride gas before charging to the still.

Vacuum distillation is carried out in the presence of 0.5% lime and then the product is flaked, bagged and drummed for storage before sales.

PROPOSED AMENDMENT:

Aroclor 5460 will be vacuum distilled in the presence of 0.5% lime and up to 2.5% sodium hydroxide.

The test will be carried out on the smaller still (No. 4) to minimize the pounds of intermediate color Aroclor 5460 and to minimize the risk (loss of production) of corrosion of caustic on the steel equipment.

The distillation step will be modified as follows:

a) Air blow 5060 for a minimum of 1 hour

b) Charge still and pull vacuum before adding lime and sodium hydroxide

c) Vent still and add 250 lbs. of lime and 250 lbs. of flaked sodium hydroxide

d) Begin heatup. When temperature reaches 318°C. (melting point of sodium hydroxide) in the still, hold temperature for 10 minutes

e) After 10 minute hold period, follow normal operating procedure until distillation is complete

f) Draw bottoms immediately after every batch. Solidification of sodium hydroxide begins at 318°C.

g) Repeat steps a-f using 2.5% (625 lbs.) sodium hydroxide. The system should now be flushed out

h) Intermediate color 5460 produced during flushing operation will be segregated from normal and low color 5460. It will be blended with darker 5460 to prevent regular customers from receiving this improved color product

i) Run up to 10 batches using 625 lbs. of sodium hydroxide.

SOURCE OF DATA:

a) Anniston PR&D Report No. 2 of Job No. 446-507, 9-30-69.

b) Teletype from O. Siebert indicates no corrosion problems encountered using sodium hydroxide; dated 5 Dec '69.

MONS 049632

SAFETY:

Bottoms will contain hot caustic. Faceshield must be worn when drawing bottoms. Discard drums at plant dump. Standard safety procedures will be used in handling the anhydrous sodium hydroxide. Caustic left in an opened drum after a still has been charged will not be used in the next charge. Wet caustic will not be used at any time during the test to prevent the instantaneous formation of steam upon addition to the still batch (240°C.).

QUALITY:

The color and other properties of Aroclor 5460 will be monitored closely during the test. All intermediate color 5460 will be segregated. Montar 5 (bottoms) produced will be checked for alkalinity.

Samples of the Santowax R and resultant Aroclor 5460 will be analyzed for effect on caustic treatment on the biphenyl, PCB contents.

EXTENT OF TRIAL:

Color improvement should be noticeable almost immediately. A one to two week trial should be sufficient to determine whether any further work is required. However, the normal six month trial period is needed to assure sufficient time to run further tests depending on the results of the first test.

Originated by: Master copy signed by C. R. McIlwain V. R. Haupt
C. R. McIlwain and V. R. Haupt

APPROVALS:

Department Supervisor	Master copy signed by: G. W. Miller G. W. Miller	7/23/70 Date
Production Superintendent	J. L. Corder J. L. Corder	7/29/70 Date
Plant Manager	G. L. Jessee by L.C.L. G. L. Jessee	7/23/70 Date
PR&D Group Leader	J. L. Brown J. L. Brown	7/23/70 Date
Research Group Leader	J. W. Baker J. W. Baker	8/24/70 Date
Mgr. of Research & Dev.	M. W. Farrar M. W. Farrar	8/24/70 Date
Manufacturing Manager	J. E. Smith J. E. Smith	8/26/70 Date

Monsanto

FROM (NAME & LOCATION): P. D. Kinnear - Anniston, Alabama

DATE: July 2, 1969

SUBJECT: Aroclor Process Tentative Amendment "B"

REFERENCE:

cc: H. L. Williams
J. C. Landwehr
V. R. Haupt
G. W. Miller
G. L. Arnett

TO: R. A. Haydel

What do we do with off-spec batch?
Off spec material will be reworked if it is still bad after proper column treating

The Aroclor process tentative amendment to reduce lime content and increase yields in the still has been approved. A field test of the amendment should now be scheduled.

The following are the recommended procedures for running the test:

1. Install the plant's portable recording ammeter to No. 3 still pump to record pump current during test. Get MRO

2. Segregate No. 3 still system from the rest of the system. All product should go to a separate storage tank for laboratory checking before it is added to the other finished product.

3. Normal start-up procedures are to be followed with the following exceptions:

   a) 150 lbs. of lime are to be added to the still at start-up.

   b) The still will then be operated continously until a degradation of color, thermal chlorides, or electrical properties develops. The coil inlet and outlet temperatures and the still pump ammeter should be watched for a possible plug in the coil throughout the test.

   c) Sample the forward flow from the still every eight (8) hours after the still has run five (5) batches. Have the laboratory test for color and HST. A sample of the product which has been stored in the separate tank should also be sent to the laboratory for color, HST and resistivity before it is pumped to the main storage area.

   d) Notation of the batch number at which product is off specifications must be recorded.

MONS 049634

IN-10 REV. 11-69

e) Then add 150 lbs. of additional lime to still when product goes off specifications.

f) Continue feed to still repeating the above procedures. If the still bottoms become too vicious as indicated by an increase in still pump current or coil inlet and outlet temperatures, feed should be discontinued and the procedure for boiling down the still should be started.

g) When the product goes off specification again, stop the feed to the still.

h) Boil down still level to 20% if possible before discarding the bottoms.

i) Repeat the entire test procedure three times.

j) This terminates the complete test and normal operating procedures should be resumed.

P. D. Kinnear

jw

P. D. Kinnear

MONS 049635

Monsanto

COMPANY CONFIDENTIAL

FROM (NAME & LOCATION) K. G. Hale - Anniston Plant

BY February 9, 1971

SUBJECT EXTENSION TO TENTATIVE AMENDMENT "C" TO AROCLOR STD. MFG. PROCESS (USE NaOH TO PRODUCE LOW COLOR AROCLOR 5460)

REFERENCE

TO : See attached Amendment

cc Technical Information Center (2)-St.L.
Security File - St. L.
D. Danna (3) - General Offices
V. R. Haupt
G. L. Arnett
Technical Services (3)
Plant Standards - Extras

G. W. Miller (Dept. Supervisor)
J. L. Corder (Production Supt.)
G. L. Jessee (Plant Manager)
J. L. Brown (PR&D Group Leader)
J. W. Baker (Res. Group Leader) - So. 2nd
Q. E. Thompson (Res. Group Leader) - G. O.
M. W. Farrar (Mgr. of Research & Dev.) - G.O.
W. R. Richard (Mgr. of Research & Dev.) - G.O.
J. R. Savage (Mfg. Manager) - G.O.
H. E. Schulte)
T. W. Lawrence) Safety Review Committee
J. C. Landwehr)

Three plant batches of Low Color 5460 have been completed (one - 9/70, two - 1/71). Operational problems occurred on two of the three batches in the plant while using the previously proposed recommendations for NaOH addition. Problems were related to degasing (dewatering) of the caustic, and an apparent short period of a caustic reaction with evolution of heat. Additional lab studies were completed and another plant run will be necessary to determine the scope for caustic addition equipment and optimum caustic charges.

The following operating procedures are proposed for future plant runs:

1. Add lime in blow tank.
2. Check for acid in blow tank.
3. Add additional lime and NaOH mixed in blow tank at 250°C.
4. Blow and circulate for mixing.
5. Transfer to still.
6. Pull vacuum down on still.
7. Raise temperature slowly holding vacuum.
8. Distill as normal after reaching 320°C.

MONS 049636

NOTE: Plant batches indicate that lower NaOH concentration may be used to meet color specs. Future plant tests will use reduced NaOH charges in an attempt to optimize concentrations in the plant.

The tentative amendment attached is requested to be extended by six (6) months with the above operating changes.

Tentative Amendment "C"
Aroclor Std. Mfg. Process
changes

We will start the plant tests during the Aroclor run beginning 2/17/71 unless we receive adverse comments on the tentative amendment extension by 2/15/71.

K G Hale

K. G. Hale
Process Engineer
Technical Services Dept.

:kd
Attachment

MONS 049637

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APPROVAL OF SAFETY REVIEW COMMITTEE

H. E. Schulte

P. K. Ward

J. C. Landwehr

MONSANTO COMPANY
ANNISTON PLANT

14 Jul 70

TENTATIVE AMENDMENT "C"

TO

AROCLOR STANDARD MANUFACTURING PROCESS

Dated Jul 69

TITLE: USE SODIUM HYDROXIDE TO PRODUCE LOW COLOR SOLID AROCLOR 5460

OBJECTIVE: To produce Aroclor 5460 with a color less than 1.25 NPA

PRESENT PROCEDURE:

Santowax R is preheated to 150°C., mixed with 0.05% ferric chloride, and chargod to a batch chlorinator from a weigh tank. Chlorine gas is added until the desired softening point is attained. Both chlorine flow and reaction mass temperature are closely controlled at 3000 #/hr. max. and 250°C. max. respectively.

It is then transferred to an air blowing tank to remove the hydrogen chloride gas before charging to the still.

Vacuum distillation is carried out in the presence of 0.5% lime and then the product is flaked, bagged and drummed for storage before sales.

PROPOSED AMENDMENT:

Aroclor 5460 will be vacuum distilled in the presence of 0.5% lime and up to 2.5% sodium hydroxide.

The test will be carried out on the smaller still (No. 4) to minimize the pounds of intermediate color Aroclor 5460 and to minimize the risk (loss of production) of corrosion of caustic on the steel equipment.

The distillation step will be modified as follows:

a) Air blow 5060 for a minimum of 1 hour

b) Charge still and pull vacuum before adding lime and sodium hydroxide

c) Vent still and add 250 lbs. of lime and 250 lbs. of flaked sodium hydroxide

d) Begin heatup. When temperature reaches 318°C. (melting point of sodium hydroxide) in the still, hold temperature for 10 minutes

e) After 10 minute hold period, follow normal operating procedure until distillation is complete

f) Draw bottoms immediately after every batch. Solidification of sodium hydroxide begins at 318°C.

g) Repeat steps a-f using 2.5% (625 lbs.) sodium hydroxide. The system should now be flushed out

h) Intermediate color 5460 produced during flushing operation will be segregated from normal and low color 5460. It will be blended with darker 5460 to prevent regular customers from receiving this improved color product

i) Run up to 10 batches using 625 lbs. of sodium hydroxide.

SOURCE OF DATA:

a) Anniston PR&D Report No. 2 of Job No. 446-507, 9-30-69.

b) Teletype from O. Siebert indicates no corrosion problems encountered using sodium hydroxide; dated 5 Dec '69.

MONS 049639

SAFETY:

Bottoms will contain hot caustic. Faceshield must be worn when drawing bottoms. Discard drums at plant dump. Standard safety procedures will be used in handling the anhydrous sodium hydroxide. Caustic left in an opened drum after a still has been charged will not be used in the next charge. Wet caustic will not be used at any time during the test to prevent the instantaneous formation of steam upon addition to the still batch (240°C.).

QUALITY:

The color and other properties of Aroclor 5460 will be monitored closely during the test. All intermediate color 5460 will be segregated. Montar 5 (bottoms) produced will be checked for alkalinity.

Samples of the Santowax R and resultant Aroclor 5460 will be analyzed for effect on caustic treatment on the biphenyl, PCB contents.

EXTENT OF TRIAL:

Color improvement should be noticeable almost immediately. A one to two week trial should be sufficient to determine whether any further work is required. However, the normal six month trial period is needed to assure sufficient time to run further tests depending on the results of the first test.

Originated by: C. R. McIlwain and V. R. Haupt

APPROVALS:

Department Supervisor	G. W. Miller	7/23/70 Date
Production Superintendent	J. L. Corder	7/23/70 Date
Plant Manager	G. L. Jessee	7/23/70 Date
PR&D Group Leader	J. L. Brown	7/23/70 Date
Research Group Leader	J. W. Baker	8/24/70 Date
Mfg. of Research & Development	M. W. Farrar	8/24/70 Date
Manufacturing Manager	J. E. Smith	8/26/70 Date

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Approval Of Safety Review Committee

C. K. Eastman

R. M. Ward

J. C. Landwehr

MONSANTO COMPANY
ANNISTON PLANT

April 29, 1969

TENTATIVE AMENDMENT "B"

TO

AROCLOR STANDARD MANUFACTURING PROCESS

Dated: October, 1968

TITLE: Reduce lime concentration in Liquid Aroclor stills to increase yields

OBJECTIVE:

To increase the Liquid Aroclor yield to 98% by changing the distillation procedure.

PRESENT PROCEDURE:

Liquid Aroclors are produced by semi-continuous distillation of the crude material. A batch is considered to be 1,000 gallons of distilled product.

The present procedure is to add 250 lbs. of lime to the first batch of each run. The still is then operated with continuous feed for five batches. At this point 250 lbs. of lime is again added to the still. The distillation run is then continued until the tenth batch. Then the feed is discontinued and the level in the still is boiled down to a 20% still laval before the bottoms are discarded.

PROPOSED AMENDMENT:

The W. G. Krummrich Plant presently adds 150 lbs. for each 15 batches and runs for 30 batches before dropping bottoms. Anniston Plant PR&D work indicates that it is possible to reduce the lime addition even further than this.

It is proposed that a plant test be conducted to determine how many batches can be distilled before lack of lime effects the product. In this test 150 lbs. of lime will be added to the still and product distilled until a degradation of color, thermal chlorides, or electrical properties develops. Then 150 lbs. of additional lime will be added and the test continued until product quality begins to deteriorate or until the still bottoms become too viscous as noted by increased still pump current.

SOURCE OF DATA:

Anniston PR&D Report No. 1 of Job No. 913.70: 446506; 3/17/69.

SAFETY:

The amended process has no effect on safety of operation.

QUALITY:

The quality of Aroclor produced will be monitored closely.

No off-grade material will be allowed in the storage tanks.

EXTENT OF TRIAL:

The proposed lime concentration will be maintained until the effects are noted. Two or three runs should be sufficient to determine the maximum number of batches possible without additional lime. The test will run for the normal 6 month trial period, however, to determine long range effects.

Originated by: Edward E. Bowles
E. E. Bowles

jw

APPROVAL

Department Supervisor	R. A. Haydel R. A. Haydel	5/5/69 Date
Production Superintendent	H. L. Williams H. L. Williams	5/5/69 Date
Plant Manager	W B Papageorge W. B. Papageorge	5-6-69 Date
Research Group Leader	M. E. Gibbs/JW M. E. Gibbs	5/26/69 Date
Research Manager	W. R. Richardson W. R. Richards	5/22/69 Date
Technical Production Manager	W. A. Kuhn/JW W. A. Kuhn	5/27/69 Date

This Copy for → XC: VRH GWM

Hi Arclor Hi Elec. Gulf 1969.

WGK

MONSANTO COMPANY
Sauget, Illinois

May 13, 1969

Messrs: W. A. Kuhn
H. C. Carder
J. W. Molloy
M. E. Gibbs
D. C. Armstrong
Technical Information Center (2)
Process Holders

Tentative Amendment "G"

TITLE

Tentative Amendment "G" to the Standard Manufacturing Process for the manufacture of Aroclors, Department 246, dated October, 1966.

SUB-TITLE

Demonstrate quality improvement of Aroclor 1254, as measured by stability tests, by use of modified plant conditions.

PRESENT PRACTICE

Biphenyl is preheated to 120°C, charged to the batch chlorinator, 0.05% ferric chloride is added, and a controlled flow of chlorine is turned on. The reaction mass temperature increases to 150°C where it is controlled. When the proper specific gravity of the reaction mass is attained the chlorine flow is stopped.

The batch is pumped to an air blown tank where the residual hydrogen chloride is removed. It is then distilled from lime, earth treated and stored for sales.

CHANGES

It is the intent of this amendment to permit the demonstration of the effect of iodine as a co-catalyst in the chlorination of biphenyl. It is proposed that 0.05% iodine be added with the ferric chloride. All other conditions would remain the same.

JUSTIFICATION

It is the objective of the Functional Fluids Business Group to produce Aroclor 1242 with a thermal chemical chloride (TCC) test limit of less than 0.1 ppm. The use of the iodine-ferric chloride catalyst system is the only action which has consistantly achieved this goal in the laboratory.

No improvement in the stability of plant produced Aroclor 1242 was experienced when iodine co-catalyst was used during four plant tests. It is thought that these failures were due to a masking effect by organic impurities in the chlorine from the Hooker chlorine facilities. These impurities have been reduced since the Hooker shutdown.

Aroclor 1254 was chosen because improvements similar to those of Aroclor 1242 have been seen in the lab work. Since plant produced Aroclor 1254 exhibits a higher TCC average compared to Aroclor 1242 (0.64 vs. 0.14 for first quarter 1969), the effect of iodine in the plant should be easy to document. If there is an improvement in Aroclor 1254 stability, a plant test in the continuous Aroclor 1242 line will be requested. If there is no improvement found in the Aroclor 1254 plant test, no further plant tests or laboratory work will be conducted until it is deemed necessary by the Business Group.

SOURCE OF DATA

The Process Research group at WGK has extensively investigated iodine as a co-catalyst in the Aroclor chlorination step. Variables investigated have included chlorination temperature, $FeCl_3$ content, iodine content and biphenyl variability. All the data indicates iodine improves the thermal chemical stability. The electrical properties are not affected.

SAFETY

Iodine is a severe irritant to the skin and lungs. Care should be taken to avoid skin contact or inhalation of the vapors.

The effect of iodine vapor upon the body is similar to that of chlorine or bromine, but it is more irritating to the lungs.

QUALITY

The batches made during the plant test will be processed as non-electrical grade Aroclor 1254. Laboratory chlorinated material using iodine as co-catalyst meets all specification properties and exhibited excellent stability.

QUALITY (Cont'd.)

Based on off-gas analyses during past iodine tests, the off-gas could contain as much as an average of 1-2 parts per million of iodine. This could result in approximately 1 ppm in the muriatic acid produced in Dept. 218. The acid will be analyzed for iodine and will be sewered if it contains more than 5 ppm; it will be sold as industrial grade if it contains from 1 to 5 ppm and food grade if it contains less than 1 ppm. The test batches will be scheduled with Dept. 236 batches so that no Dept. 246 gas is transferred to Dept. 217.

EXTENT OF DEMONSTRATION

The demonstration will consist of three consecutive batches from the same chlorinator, each utilizing 0.05% iodine and 0.05% ferric chloride based on biphenyl. At least six normal batches will be taken as baseline. The batches will be sampled at the 1242 and 1254 stage and processed in the laboratory. All four stability tests will be measured for each sample in the analytical section.

CRITERIA FOR ACCEPTANCE

This amendment is to allow temporary demonstration of modified plant conditions and further demonstration would be necessary before adoption.

Written by: C. W. Hamlet, Jr.

Approved by:

Div. Resch. Group Leader — 6/4/69 Date

Manager of Research — Date

Research Safety Review Committee

6/20/69

6-20-69

6/2/69

Approved by:

Prod. Supervisor — 5/29/69 Date

Prod. Gen. Supt. — 6/2/69 Date

PR&D Group Leader — 5/29/69 Date

MONS 049646

Gen. Supt. Technical Services — 6/2/69 Date

Technical Prod. Manager — 6/24/69 Date

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C. K. Eastman
TSD File (3)
Plant Standards Department (Extres)

SAFETY REVIEW COMMITTEE

This Copy For

MONSANTO COMPANY
ANNISTON, ALABAMA

December 27, 1967

TENTATIVE AMENDMENT B

To

AROCLOR STANDARD MANUFACTURING PROCESS

Dated

September 1966

TITLE: High Temperature Chlorination

OBJECTIVE: To propose a change in the chlorination stage of the Liquid Aroclor Process.

PRESENT PRACTICE:

Crude liquid Aroclors are produced by batch chlorination and by a continuous chlorinator operation. This latter operation consists of four cascade flow chlorinators in series where specific levels of chlorination occur. Three factors are considered critical for the production of Aroclor 1142 (crude form of electrical grade 1242) in the continuous unit:

1. The catalyst baskets provide adequate contact surface
2. The temperature of the chlorinators is held to between 140°C. and 170°C.
3. Ferric chloride in the amount of .05% (weight) be present in the feed to the system.

PROPOSED AMENDMENT:

Laboratory investigations at the W. G. Krummrich Plant have shown substantial quality improvement (primarily lower thermal chemical chlorides) by the use of higher chlorination temperatures (190°C.) and up to .20% catalyst. W.G.K. TSD reports No. 1 and No. 2 of job No. 91370:3794 present the laboratory background.

It is proposed to chlorinate in the continuous system with the chlorination temperature at 190°C. in the last two chlorinators of the cascade and with various catalyst concentrations up to .10%.

SOURCE OF DATA:

W. G. Krummrich TSD Reports 1 and 2 of Job No. 91370:3794.

SAFETY:

The amended process has no effect on the safety of operation, although overhead product loss to the off-gas collection tank may become severe.

QUALITY:

Quality of the Aroclor produced will be monitored closely. This product will be segregated and sold to previously committed customers only.

EXTENT OF TRIAL:

The proposed temperature and catalyst levels will be maintained until discernible effects are noted. Length of run will also be dependent upon sales commitment. A period of six months should be adequate for the catalyst/temperature evaluation.

Originated by: John MacPherson

Tentative Amendment B
Aroclor Manufacturing Process

December 27, 1967

APPROVAL:

Department Supervisor	V. R. Haupt	2 Jan 68 Date
TSD Superintendent:	D Cowan	1/5/68 Date
Production Superintendent:	H. L. Williams	1/3/68 Date
Plant Manager:	W B Papageorge	1-4-68 Date
Research Group Leader:	/S/ M. E. Gibbs	1/12/68 Date
Research Manager:	/S/ W. R. Richard	1/22/68 Date
Technical Production Manager:	H. C. Carder	1/15/68 Date

Monsanto

FROM ANNISTON, ALABAMA

DATE September 19, 1967

SUBJECT POROCEL COLUMN TREATMENT FOR AROCLOR 1242

REFERENCE Tentative Amendment A to Aroclor Standard Manufacturing Process

TO H. L. Williams

cc: H. C. Carder - G.O.
H. L. Hubbard - So. 2nd
N. F. Mueller - So. 2nd
W. B. Papageorge
H. L. Williams
L. C. Fuhrmeister
J. MacPherson
C. K. Eastman
T.S.D. File (3)
Technical Info. Center-St. Louis (2)

The Porocel Column has been used intermittently since May 27, 1967 to treat Aroclor 1242. Results to date show no decrease in bed activity (20 M giga ohms resistivity) after treating 428 M gals. of 1242. Problems have shown up in trying to maintain this high quality in storage tanks and then in drums. One storage tank has been segregated to accept column treated 1242 only and is presently being upgraded. Use of the column has shown the necessity to improve sampling techniques and devices along with standardizing analytical equipment and techniques.

The success of the Porocel Column is such that acceptance of this amendment is recommended now instead of when the six months test period is up in November 1967.

Unless there are any objections by October 1, 1967, the Porocel Column operating instructions will be incorporated into the Aroclor operating instructions which are presently being up-dated and will be added to the next revision of the Standard Manufacturing Process for Aroclor in 1968.

V. R. Haupt

:md

MONS 049650

IN-10 REV. 6-64

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SAFETY REVIEW COMMITTEE

Originally signed by E. M. Emery

Originally signed by J. F. Quinn

Originally signed by C. W. Roos

MONSANTO COMPANY
ANNISTON, ALABAMA

18 May 67

TENTATIVE AMENDMENT A

To

AROCLOR STANDARD MANUFACTURING PROCESS

Dated

Sept. 1966

TITLE: Packed Bed Treatment of Electrical Grade Aroclors.

OBJECTIVE: To propose a change in the refining of liquid electrical grade Aroclors.

PRESENT PRACTICE

Two still batches (20,000 lbs.) of Aroclor 1242 are accumulated in the blending tank and 40 pounds (0.2% by weight) of Attapulgus Earth (Attaclay) which has been dried for a period varying from one to twelve hours at a temperature in the range of 100-300°C is added to the blend tank. The material is agitated for 3 hours and then filtered.

PROPOSED AMENDMENT:

MONS 049651

Laboratory investigations at Anniston have shown substantial quality improvements can be achieved by the use of activated bauxite (Porocel) for earth treatment of liquid Aroclors. Anniston R&D Report No. 9, Job No. 370-322 presents laboratory background. Additional laboratory work demonstrated considerable advantage to a treatment technique using a packed bed of Porocel. Anniston R&D Reports 13 through 15 of Job No. 370-322 and Report No. 4 of Job No. 370-340 present the laboratory background.

It is proposed to treat electrical grade Aroclors 1242 and 1254 by passing still batches through a packed bed of 30-60 mesh Porocel.

SOURCE OF DATA:

Anniston R&D Reports No. 13 through 15 of Job No. 370-322 and Report No. 4 of Job No. 370-340 present laboratory background.

SAFETY:

The amended process has no effect on the safety of operation.

QUALITY:

Quality of the Aroclor produced will be improved significantly, and will be monitored closely. The higher quality product will be segregated for export sales only.

EXTENT OF TRIAL:

Still batches will be processed utilizing the activated bauxite to evaluate this process change. The data, and results of the test, will be completely analyzed. A period of six months should be required to evaluate the electrical grades.

Originated by: John MacPherson

MONS 049652

Tentative Amendment A
Aroclor Manufacturing Process

18 May 67

APPROVAL:

Department Supervisor:	V. R. Haupt	19 May 67 Date
TSD Superintendent:	L C Fuhrmeister by WJ L. C. Fuhrmeister	5/19/67 Date
Production Superintendent:	H. L. Williams H. L. Williams	5/19/67 Date
Plant Manager:	Originally signed by W. B. Papageorge W. B. Papageorge	5-31-67 Date
Research Group Leader:	Originally signed by M. E. Gibbs N. F. Mueller	5-25-67 Date
Research Manager:	Originally signed by H. L. Hubbard (by J. F. Quinn) H. L. Hubbard	5-22-67 Date
Technical Production Manager:	Originally signed by H. C. Carder H. C. Carder	5-26-67 Date

STANDARD MANUFACTURING PROCESS
FOR
AROCLOR

AMENDING RECORD SHEET

The disposition of the Amendments to the Standard Manufacturing Process dated October 22, 1957 are as follows:

Amendment No.	Title or Description	Date	Disposition
A	Reclaim Pyranol made with TTCB with high hydrolysable chlorides	12/21/60	Accepted
B	Circulate chlorinator material during entire chlorination period	10/22/57	Accepted
C-Rev.#1	Use of LVM Attasorb	5/15/59	Rejected
D	Optimum Lime Concentration	12/31/58	Rejected
E	Use of Undried Earth	1959	Rejected
F	Recycle Boildown to Still	5/15/59	Rejected
G	Number of Runs before Boildown	6/16/59	Rejected
H	Earth Treat (0.2%) Aroclor 1242 at 70-80°C. Dry earth at 100-300°C or use as received	9/22/61	Accepted in part
I	Earth Treat (0.1-0.4%) Aroclor 1242 at 50-100°C	11/15/61	Never Tried (Re-submit)
J	N_2 Blanket Bleed Tanks, Filtrate Receivers and Storage Tanks	8/29/63	Rejected due to large losses of N_2
K-Rev.#1	Remove Catalyst Basket from Chlorinator to make Aroclor 5060	7/29/64	Accepted
L	Optimize Earth Treatment Time	8/18/64	Accepted
M	Eliminate Earth Drying	1/20/65	Rejected
N	Increase Mesh Size of Earth	2/5/65	Rejected
O	Start-Up of No. 9 Solid Aroclor Chlorinator	5/3/65	Accepted
P	Earth Treatment of Aroclor 1242 (Porocel Batch)	9/8/66	Accepted 12/16/66

MONS 049654

SYNOPSIS
OF PROCESS

MONS 049655

Burn File – Chlorination

TENTATIVE MANUAL OF OPERATIONS

CONTINUOUS AROCLOR CHLORINATION

1142 CHLORINATION

SECTION I

Biphenyl with one-half pound of dissolved ferric chloride for every 1,000 pounds of Biphenyl is pumped at a steady rate from a Biphenyl feed tank through a 4-stage cascade chlorination to a crude 1142 Aroclor hold tank. A constant rate of Chlorine is fed to all chlorinators and each chlorinator is held in progressively higher temperature ranges.

SECTION II - CONTINUOUS CHLORINATION START-UP

1. Chlorinators ~~6, 7, 8~~ 5 8 7 6 and ~~5~~ are each charged with 3,000 pounds of Biphenyl with one and one-half pounds of ferric chloride from the Biphenyl charge tank (melting pot).
2. They are chlorinated to the following level:

Chlorinator	Temperature	Final Gravity
5	120-130	1.086-1.098 (90°C)
8	130-140	1.178-1.190 (90°C)
7	140-150	1.262-1.274 (90°C)
6	150-160	1.344-1.357 (65°C)

3. The mix tank charge is prepared and dropped to the feed tank.
4. The mix tank is reloaded with Charge No. 2.
5. When the chlorinator charges are at the right temperature and gravity the system is switched to continuous as follows:

MONS 049656

6. The valves in the Biphenyl feed line from the feed are set for circulation and for flow thru the control valve. The by-pass around the control valve is kept closed.

The control valve is kept closed until needed by setting the controller

at zero flow. The feed pump is turned on and the charge is started circulating.

The Biphenyl feed line is opened to No. 5 chlorinator. The valve on No. 8 should be closed.

7. Each chlorinator is set for flow into the bottom of the chlorinator. All by-pass valves on the chlorinators are closed.

   CAUTION: Check that all sample valves are closed.

8. The valve in the over flow line to the crude Aroclor catch tank is opened.
9. The bottom valve is checked closed.
10. Check that the crude Aroclor catch tank pump is not operating.
11. The Chlorine Plant is notified 30 minutes prior to changing to continuous operation. The Chlorine Plant will set their controls to produce 15-25 pound line pressure.
12. Start the chlorine flow to Chlorinators 5, 8, 7 and 6 at the specified pounds per hour feed. (See table under normal operations)
13. The excess chlorine to be given to Chlorinators 1, 2, 3 and 4.
14. Start the Biphenyl feed forward by setting the flow controller at the valve corresponding to the chlorine rate. (See table in normal operations)
15. Open the valve in the feed line to No. 5 chlorinator, check that the alternate feed line to No. 8 is valved off.
16. The crude 1142 is pumped as needed to the blowing tanks. The inches and gallons pumped are recorded on the pump-out sheet. MONS 049657
17. When excess 1142 is available it is used to charge chlorinators 1, 2, 3, or 4 for processing to 1248, 1254, 1260, 1262, or 1268. No additional catalyst is added when the material is pumped directly to another chlorinator. The normal charge will be _____ gallons of 1142.

SECTION III - LOADING OF MIX TANK AND FEED TANK

1. Check that bottom valve is closed.
2. Check that temperature controller is set at 100°C.
3. Charge Biphenyl as follows:
   a. Notify Biphenyl still operator when ready for charge.
   b. Still man to measure Biphenyl taken from catch tank and have recorded on data sheet.
   c. Chlorinator operator on mix tank platform opens Biphenyl charge line and with agitator off fills tanks to 50" (800 gals.) of Biphenyl.
4. Start agitator.
5. Add ferric chloride as follows:
   a. Remove cap from spare 4" nozzle.
   b. Insert catalyst funnel.
   c. Pour 3.3 (3 lbs. 3 oz.) of $FeCl_3$ thru funnel.
   d. Replace cap.
6. Agitate for two hours, or more, at 100°C.
7. The tank has a Hi Alarm at 64 inches (980 gals.) and a low alarm at 5 inches (200 gals.).
8. When the feed tank level has fed down to 200 gallons which is 4½ inches on the level gauge, the LOW level alarm will flash on the control board and the alarm will sound at the inside and outside alarm horn. 200 gallons will allow the feed to continue for about one hour. The full charge from the mix tank is now dropped to the feed tank as follows:
   a. Stop agitator in the mix tank.
   b. Check tank level gauge - it should read 4½ inches or less.
   c. Open 3" plug cock on bottom of mix tank and allow tank to drain empty to the feed tank.

MONS 049658

d. Observe Feed Tank level gauge to determine when the mix tank is empty. It should gain 46 inches when the regular charge has been added.

e. The feed tank is provided with a high level alarm which will alarm thru the control panel when the tank has reached 59 inches.

f. The temperature controller on the feed tank is set to control at 100°C.

SECTION IV - NORMAL OPERATION WITH FOUR CHLORINATORS

1. Set Biphenyl feed at level specified. (See Table No. I)
2. Adjust all chlorine feed to the same pounds per hour rate.
3. Feed all excess chlorine to Nos. 1, 2, 3, and 4 chlorinators.
4. Always notify the Chlorine Department of any new change in chlorine demand. Give them 30 minutes notice when a scheduled change in chlorine load is to be made.
5. Check gravity of each chlorinator at _____ minute intervals.
6. Adjust to proper gravity as follows:
   a. With all chlorinators at same chlorine feed, adjust Biphenyl feed rate up or down as needed to produce No. 6 over-flow in proper range. (See Table No. 2)
      Make small adjustments of 0.1 gals. per min. Allow 20 minutes to observe charge before making another adjustment.
   b. When one chlorinator produces above or below the other three, make gradual adjustments in chlorine feed to bring it in gravity range.
      CAUTION: Do not adjust Biphenyl feed and Chlorine feed at the same time.
   c. Adjust the chlorinator to the middle of the temperature range.
7. When the feed tank level reaches 4½ inches on the gauge, the alarm will sound in the control room and the panel alarm will show LOW feed level. Then:
   a. Drop full charge from the mix tank.
   b. Recharge the mix tank.

MONS 049659

TABLE NO, I - FOUR CHLORINATORS ONLY

BIPHENYL FEED RATES FOR DIFFERENT CHLORINE FEED RATES

CHLORINATOR RATES LBS. PER HOUR	BIPHENYL FEED RATES GALS. PER MIN.
350	2.1
400	2.4
450	2.7
500	3.0
550	3.3
600	3.6
650	3.9
700	4.2
750	4.5
800	4.8
850	5.1
900	5.4
950	5.7
1000	6.0

TABLE NO, II - FOUR CHLORINATORS ONLY

TEMPERATURE AND GRAVITY RANGE

CHLORINATOR NO,	TEMPERATURE RANGE	OVERFLOW SP.GR.
5	120 - 130	1.086-1.098 (90°C)
8	130 - 140	1.178-1.190 (90°C)
7	140 - 150	1.262-1.274 (90°C)
6	150 - 160	1.344-1.357 (65°C)

MONS 049660

8. The crude product is pumped to the blowing tank or other chlorinators as needed. Record amount pumped in inches and gallons.

9. Record the following data at _____ minute intervals on the data sheet or whenever any change is made in conditions of Biphenyl feed or Chlorine rate.

   a. Record each Mix Tank dropped in inches and gallons.

   b. Record each pumping from the Crude Aroclor Catch Tank in inches and gallons.

   c. Record all data shown on the data sheet.

SECTION V - SAFETY

The following items are some of the hazards that we must be aware of and have control of when we are operating the chlorinators.

Thermal Burns

1. Sampling - Wear goggles and gloves when taking a hot Aroclor sample.

Burns - Lung Irritation

2. High pressure in the chlorinator resulting in release of HCl, and sometimes liquid, into the chlorinator area.

   a. May be caused by water getting into the chlorinators from Biphenyl or a leak in the coil.

   b. From a plugged HCl line.

Burns - Fire

3. Fire

   a. Fire can result if Biphenyl is blown or leaks into a gas tank.

   b. Fire could result from a spark in a hot Biphenyl - air mixture. Well lines are installed in the mix and catch tank.

   c. Fires can result from Biphenyl or Aroclor pulling back into the Chlorine header.

MONS 049661

4. Biphenyl line rupture

   The Biphenyl line can rupture if it is allowed to set up and then remelted in a closed line without room for expansion.

5. Sprains - Breaks

   Careful footing must always be obtained before operating the hard to reach valves on the chlorinators.

6. A safety belt is required prior to inspecting the flame arrestors on the mix tank or the feed tank.

M. J. Williams

February 13, 1961

/ml

APPROVED:

B. O. Severson

February 13, 1961

STANDARD MANUFACTURING PROCESS
FOR
AROCLOR

I. SYNOPSIS OF PROCESS

Aroclors are the reaction products formed by chlorination of Biphenyl and/or Terphenyls using Ferric Chloride Catalyst. The by-product HCl gas produced is absorbed in water to produce Muriatic Acid. Crude Aroclors are produced in the chlorinators, air blown, distilled, earth treated, filtered, and loaded for shipment.

Aroclor is a trade name used to disignate chlorination products of Biphenyl, Terphenyls, or mixtures of the two. The physical properties vary from light free-flowing liquids to crystalline and non-crystalline solids. Depending on the degree of chlorination and the composition of the raw materials, Santowax R, and mixtures of Biphenyl and Santowax R, or Biphenyl and Santowax C, yield products of increasing viscosity up to non-crystalline resins.

A numerical system of nomenclature, consisting of four digits, has been developed for identifying the Aroclors. The thousands digit denotes the raw material used in the chlorination. The figure 1--- indicates 100% technical grade Biphenyl. The hundreds digit denotes whether or not the product is distilled. The -1-- indicates undistilled, and the figure -2-- indicates distilled. The tens and units digit denote the approximate percentage of chlorine contained in the finished product. For example, 1260 is a distilled chlorinated Biphenyl containing 60% chlorine.

There are deviations from the above nomenclature when Solid Aroclors are produced. These are listed below:

1. Aroclors 4065 and 4465

   Aroclor 4065 is the crude and 4465 is obtained by distillation. The starting raw material contains 40% Santowax R and 60% technical Biphenyl. This is chlorinated to 65%.

2. Aroclors 5060 and 5460

   Aroclor 5060 is the crude from which Aroclor 5460 is distilled. The starting raw material is 100% Santowax R which is chlorinated to 60%.

3. Aroclor 5042 and 5442

Aroclor 5042 is the crude from which Aroclor 5442 is distilled. The starting raw material is 100% Santowax R which is chlorinated to 42%.

4. Aroclor 2565

This is an undistilled product. The starting raw material consists of 25% Santowax C and 75% technical Biphenyl. This is chlorinated to 65%.

Chlorinator Area

There are four batch operated liquid chlorinators, one batch operated solid chlorinator, and one continuous operated chlorinator system. The continuous system consists of four batch chlorinators cascaded with overflow from one unit to the next. The product from the last stage is the finished crude Aroclor.

Batch operated liquid chlorinators are charged with 3,000 pounds of Biphenyl with 1-1/2 pounds of Ferric Chloride Catalyst. Charges for the solid chlorinator vary dependent upon the Aroclor to be produced. Chlorine gas added through a distributor plate reacts with the raw material to release HCl and heat. The HCl gas goes to the Muriatic Acid Department. Heat is taken away by use of external air cooled heat exchangers. The specific gravity of the crude is checked after chlorine feed has been on for four hours, again when 80% chlorinated, as indicated by alarm, and as needed thereafter.

In the continuous chlorination system, Biphenyl is fed to the first stage and chlorinated. Crude Aroclor overflows to the second stage, etc., until the final product overflows from the last stage. Each chlorinator is held at a different level of chlorination with the last stage being the final crude Aroclor desired. Normally, Aroclor 1142 is produced in this system.

Crude Aroclors from the batch chlorinators and the continuous system are transferred to a blowing tank to be air blown for one (1) hour minimum before distillation.

Still Area

Liquid Aroclors

Aerated Aroclors from a blowing tank or a feed tank are charged to a still, hydrated lime is added, a vacuum of 720 mm Hg (40 mm Hg absolute) is applied, the still furnace is fired, and the Aroclor is distilled into a receiver. The distillation is semi-continuous, since ten (10) receivers are distilled prior to drawing bottoms or residue from the still. Every two receivers (or approximately 2,000 gallons) are treated with 40 lbs. of earth for two hours and then filtered. The finished product is transferred to storage tanks prior to loading into drums or tank cars.

Solid Aroclors

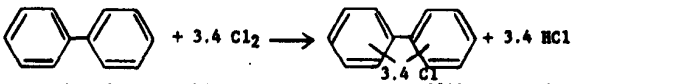
Solid Aroclors are distilled in a similar manner to Liquid Aroclors except for 1168. Aroclor 1168 is not air blown and is charged directly to the still from the chlorinator. A vacuum of 4 mm Hg absolute is applied for distillation. Solid Aroclors have one to four receivers distilled prior to drawing bottoms in the still. This is dependent upon the particular Aroclor being produced.

Solid Aroclors are not earth treated or filtered. They are drummed directly from the receiver or are flaked (Aroclors 1268 and 5460).

Chemical Equations

Liquid Aroclors

Based on the forecasted demands through 1969, the average Liquid Aroclor could be called 1244.7.



Biphenyl	Chlorine	Aroclor 1244.7	Hydrogen Chloride
154.2	70.9	271.5	36.5

Yields per CWT Aroclor	Theory	Standard
Chlorine	89.4	96.1
Biphenyl	56.5	58.2
Hydrogen Chloride	45.7	38.8

Solid Aroclors

Based on the forecasted demands through 1969, the average Solid Aroclor would contain 60.7% chlorine and 11.9% Biphenyl.

0.881 Santowax R	+ 0.119 Biphenyl	+ 10.3 Cl_2	____ Solid Aroclor	+ 10.3 HCl
230.3	154.2	70.9	586.0	36.5

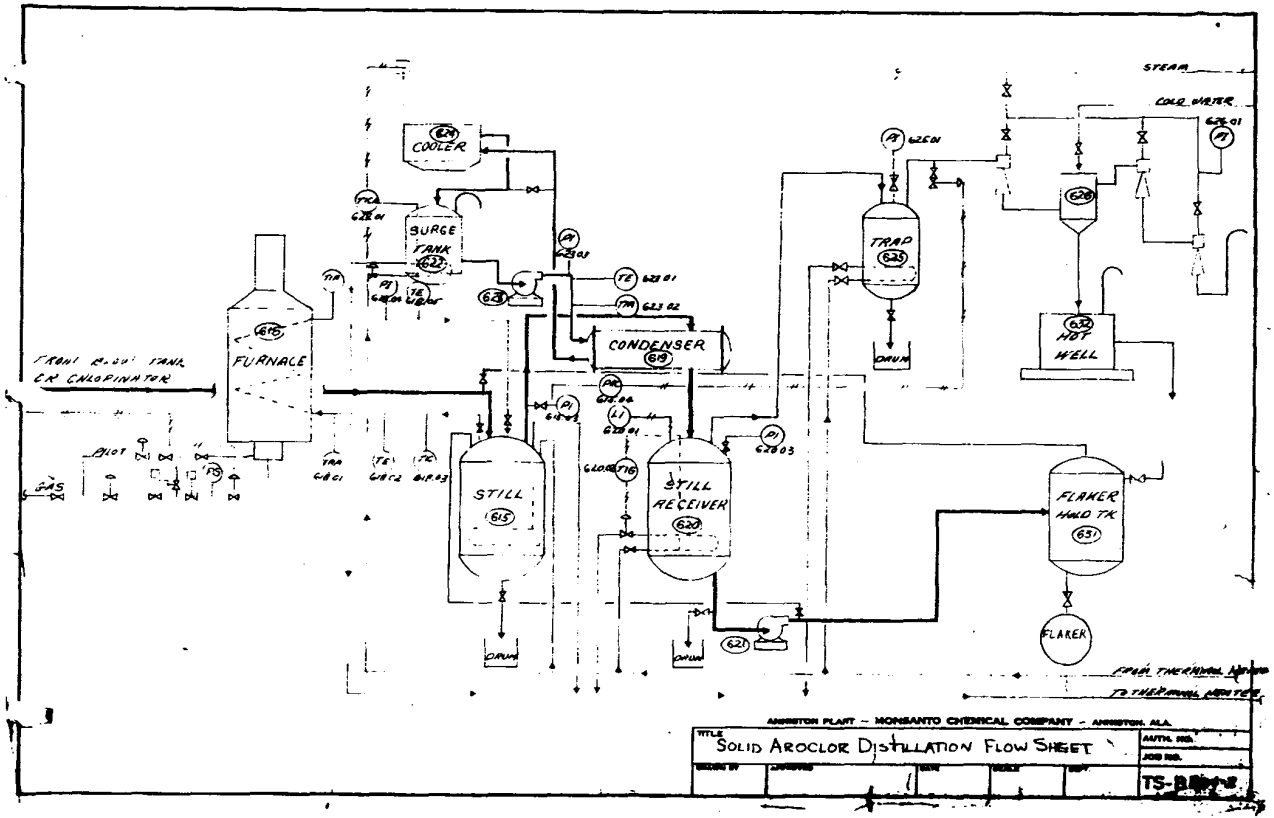
Yields per CWT Aroclor	Theory	Standard
Chlorine	121.4	146.3
Biphenyl	5.01	--
Santowax R	36.2	42.3
Hydrogen Chloride	64.1	54.5

PLAN SHEETS

MONS 049667

STANDARD MANUFACTURING PROCESS
FOR
AROCLOR

II. FLOW SHEETS



ANNISTON PLANT — MONSANTO CHEMICAL COMPANY — ANNISTON, ALA.

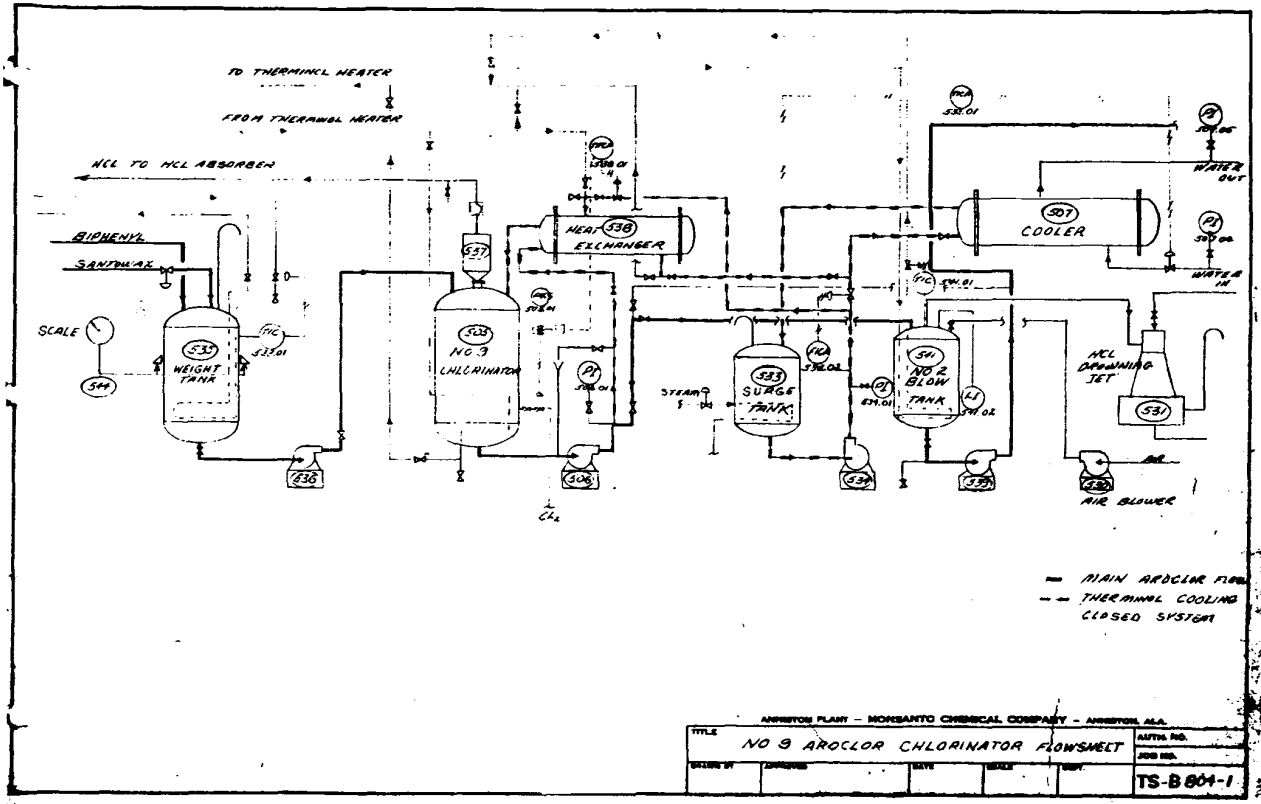
TITLE: SOLID AROCLOR DISTILLATION FLOW SHEET

AUTH. NO.

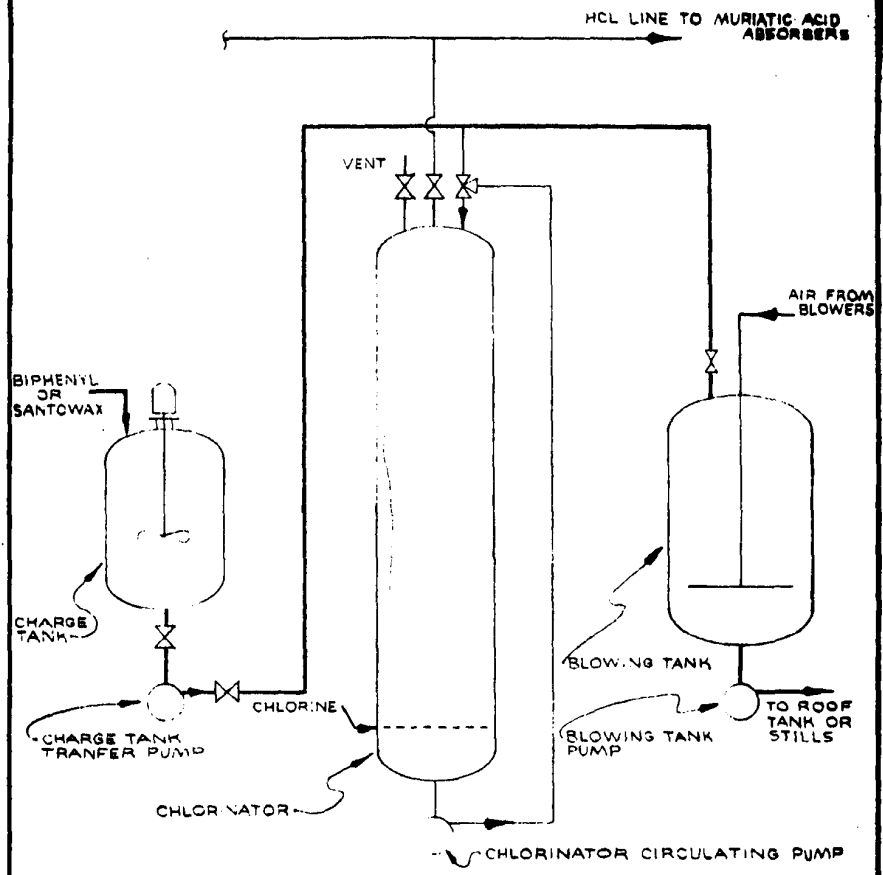
JOB NO.

TS-B[illegible]

MONS 049669


TO THERMINOL HEATER
FROM THERMINOL HEATER
HCL TO HCL ABSORBER
BIPHENYL
SANTOWAX
SCALE
WEIGHT TANK
NO 9 CHLORINATOR
HEAT EXCHANGER
SURGE TANK
NO 2 BLOW TANK
COOLER
HCL OPERATING JET
AIR BLOWER
WATER OUT
WATER IN
Steam
Cl2
MAIN AROCLOR FLOW
THERMINOL COOLING CLOSED SYSTEM
ANNISTON PLANT — MONSANTO CHEMICAL COMPANY — ANNISTON, ALA.
TITLE
NO 9 AROCLOR CHLORINATOR FLOWSHEET
TS-B 804-1

MONS 049670



BATCH CHLORINATOR OPERATION - FLOW SHEET

MONS 049671

ANNISTON PLANT — MONSANTO CHEMICAL COMPANY — ANNISTON, ALA.

TITLE					
BATCH CHLORINATOR OPERATION — FLOW SHEET					
DRAWN BY	APPROVED	DATE	SCALE	DEPT.	
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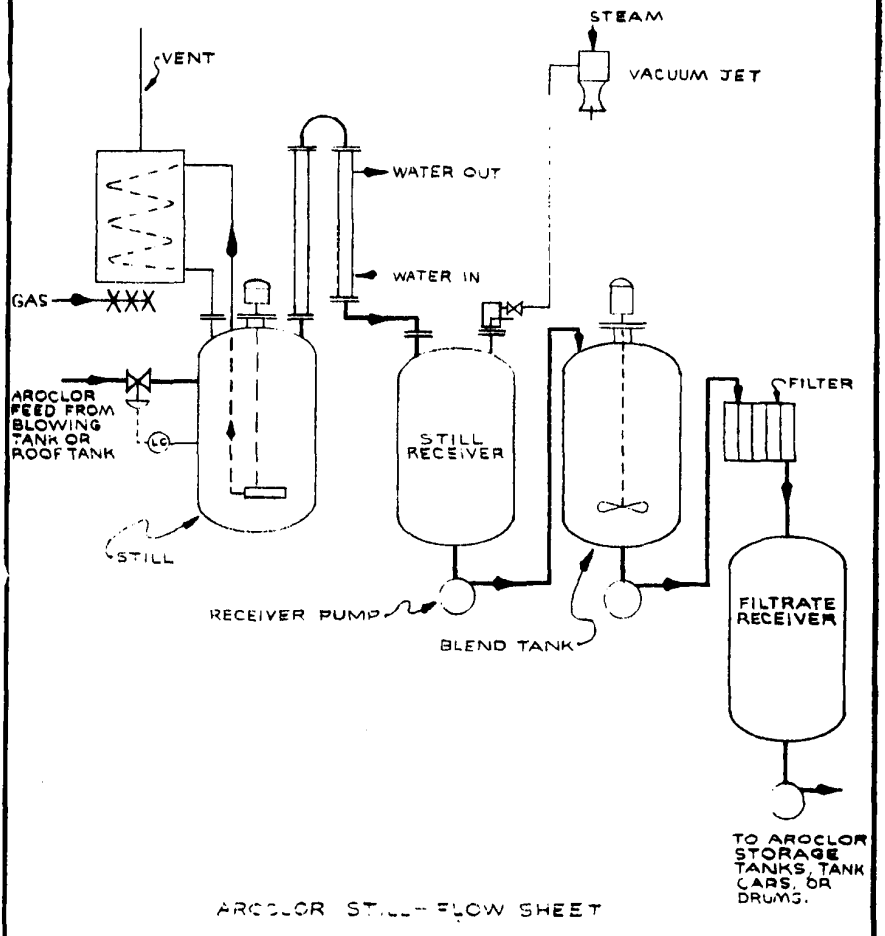


AROCLOR STILL - FLOW SHEET

MONS 049672

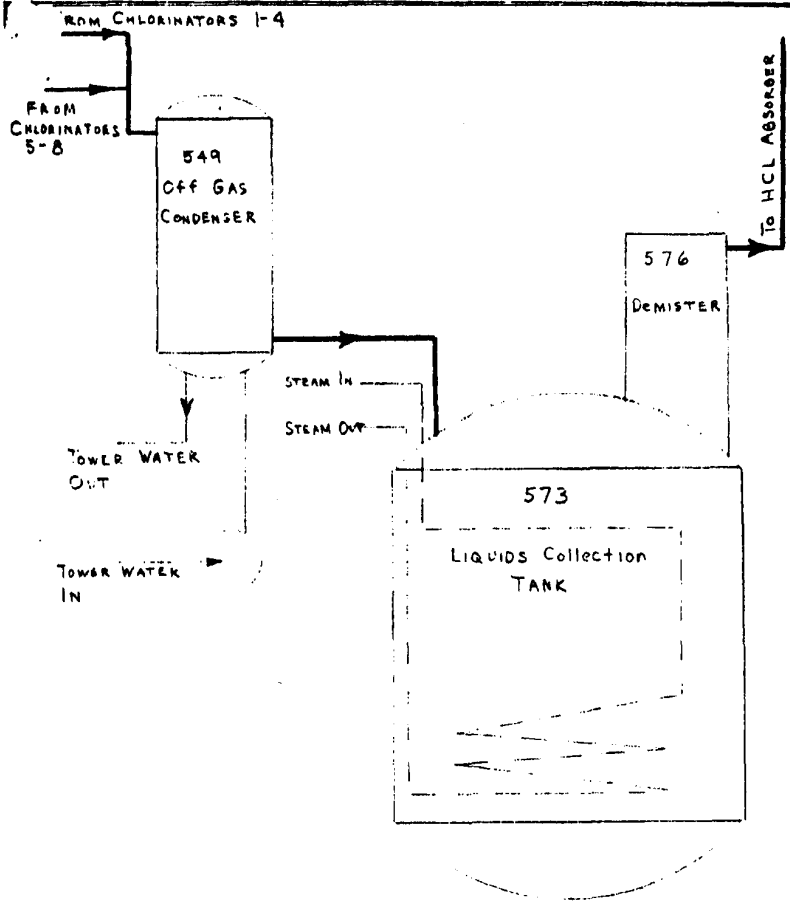
ANNISTON PLANT – MONSANTO CHEMICAL COMPANY – ANNISTON, ALA.

TITLE					
AROCLOR STILL - FLOW SHEET					
DRAWN BY	APPROVED	DATE	SCALE	DEPT.	
EAE		8-10-64	NONE	AROCLOR	TS-A-704

MONSANTO CHEMICAL COMPANY
ORGANIC CHEMICALS DIVISION
ENGINEERING DEPARTMENT
ST. LOUIS, MISSOURI

LIQUID HCL OFF GAS CLEAN UP
PLANT ANNISTON
LOCATION ANNISTON, ALA

DESIGN MANUAL SECTION NO. ____ ITEM NO. ____
ESTIMATE NO. ____ E. A. NO. ____
PREPARED BY ____ DATE ____
SHEET ____ OF ____



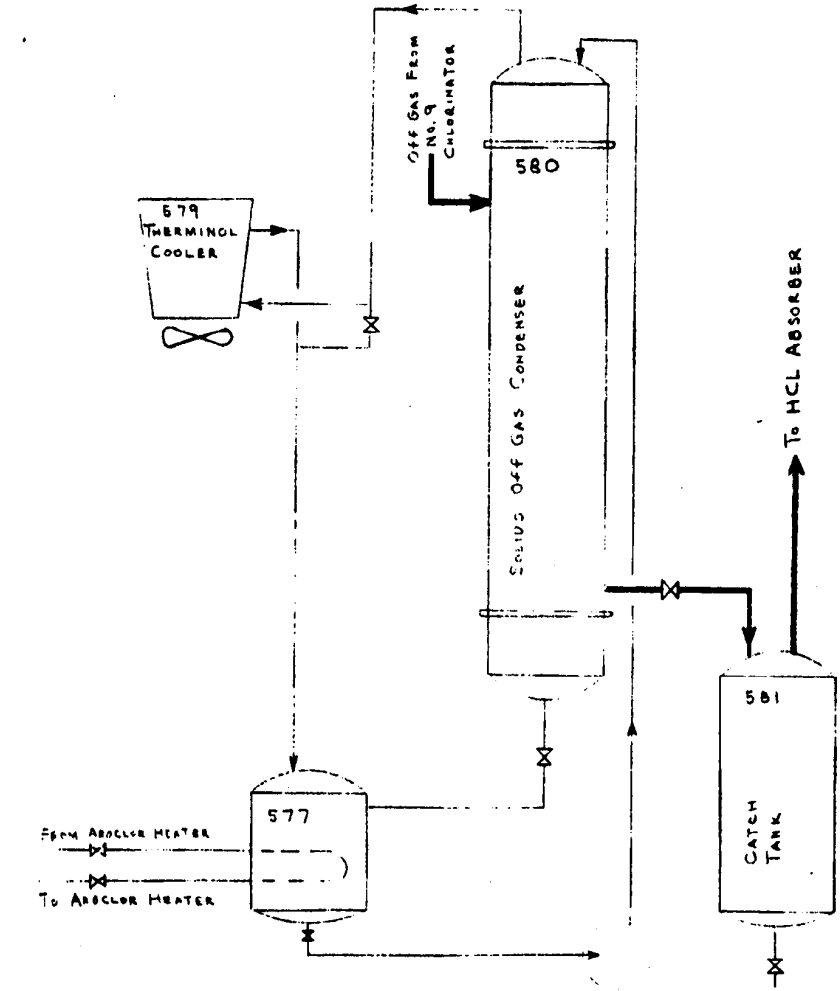
MONS 049673

REV. NO.	DATE	REVISION	BY	APPROVED BY / DATE					

MONSANTO CHEMICAL COMPANY
ORGANIC CHEMICALS DIVISION
ENGINEERING DEPARTMENT
ST. LOUIS, MISSOURI

Solid HCL Off Gas Clean Up
PLANT Anniston
LOCATION Anniston, Ala.

DESIGN MANUAL SECTION NO.
ESTIMATE NO.
PREPARED BY
SHEET OF
ITEM NO.
E. A. NO.
DATE



REV. NO.	DATE	REVISION	BY	APPROVED BY	DATE

MONS 049674

MONSANTO CHEMICAL COMPANY
ORGANIC CHEMICALS DIVISION
W. G. KRUMMRICH PLANT
RAW MATERIAL SPECIFICATION

PRODUCT CODE: 11500
METHOD IDENTITY NO.:
SUPPLIER:

ISSUED Feb. 26, 1957
STANDARDS DEPARTMENT
By: W. G. Krummrich

MATERIAL: FERRIC CHLORIDE ANHYDRIDE
CHEMICAL FORMULA: $FeCl_3$
MOL. WT.: 162.21

SUPERSEDES SPEC. DT.: New
SAMPLE FOR ANALYSIS: Ix8 ea. W. M. Battle

UNCLASSIFIED INFORMATION

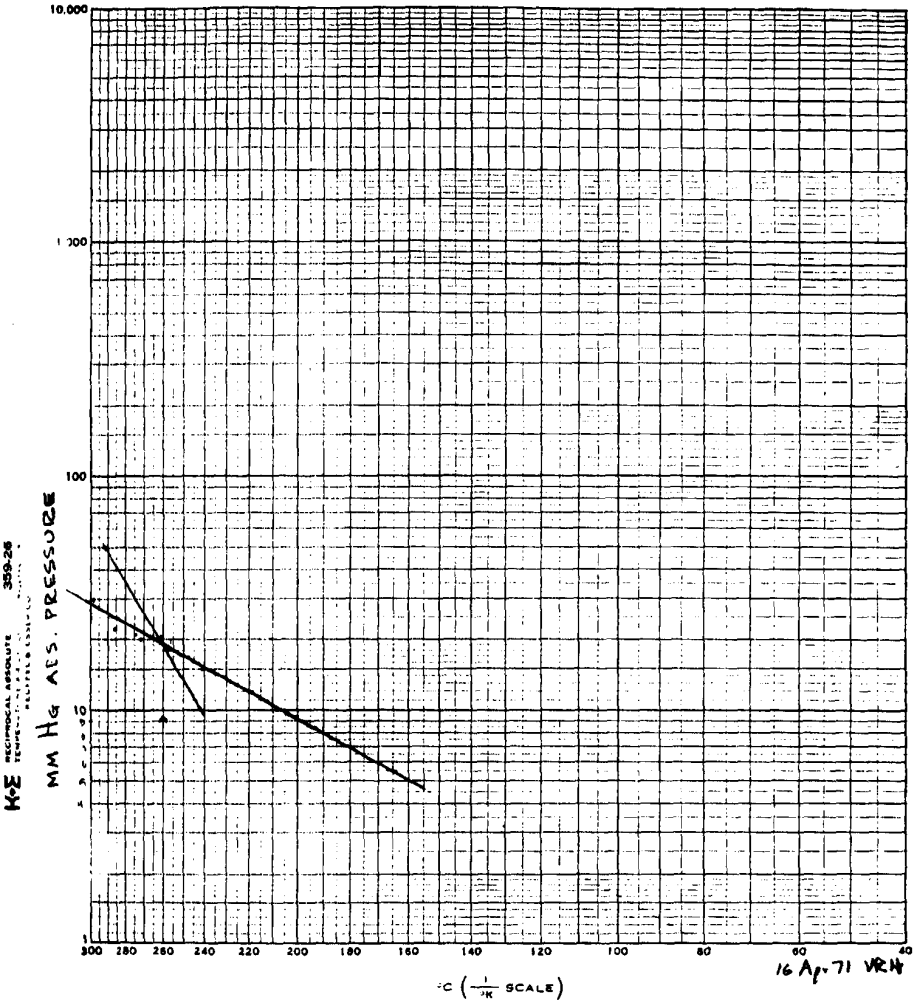
General Tests (made only on request)

Property	Specification	J.F.G. Method No.
Appearance	Black powder or granules	16-A
Assay	97.0%, Min.	22-S70
Sulfates	0.05%, Max.	120-S70
Ferrous Salts	Trace, Max.	S-S70-1
Solubility:		112-B
10:10 of water	Complete to slightly turbid, Max.	
10:10 of Formula 30 alcohol	Complete to slightly turbid, Max.	

MONS 049773

MONS 049774

VAPOR PRESS
OF A-5432



16 Ap. 71 VRH

MONS 049775

Monsanto

V. C. Haupt

FROM (NAME & LOCATION): St. Louis Organic Research - J. W. Baker

DATE: November 3, 1970

SUBJECT: AROCLORS - MARKETING REQUEST 70-102

REFERENCE:

cc M. W. Farrar - Res. 1
A. W. M. Coaker - Res. 3
J. T. Bell - Anniston
G. W. Miller - Anniston
C. E. Vogler - Res. 2
W. R. Richard/Q. E. Thompson - WR

TO: W. S. Clark
WCLAR

We have completed the work you specified in your Marketing Request 70-102 for the new Aroclors. This information was needed for a customer (3M) and will also be included in a future product bulletin.

The distillation range (225-280° C. at 9 mm.) for Aroclor 5432 was carried out by the Anniston Laboratory. A memo describing their results is attached.

The vapor pressures for Aroclor 6040, 6050, 6062, and 5432 were carried out by C. E. Vogler and the vapor pressure curves covering the temperature range of 150° C. up are attached. Extrapolation of the curves gives the following values for 100° C.:

Aroclor 6040	2.1 mm.
Aroclor 6050	1.9 mm.
Aroclor 6062	1.2 mm.
Aroclor 5432	0.014 mm.

Please let me know if you have any questions.

J. W. Baker

J. W. Baker

att.

pp

Monsanto

FROM (NAME & LOCATION): J. T. Bell - Anniston, Alabama

DEPT.
BU
REFERENCE

October 7, 1970

cc: G. L. Arnett
J. L. Brown
S. O. Kemp
C. E. Vogler - Queeny

TO : J. W. Baker
Queeny Plant

As you requested, samples of Aroclors 6040, 6050, 6062 and 5432 have been forwarded to C. E. Vogler.

The distillation conditions for Aroclor 5432 are listed below and are taken from the report (#1, Job No. 446-515) by G. L. Arnett dated 5/26/70.

Vacuum (mm)	9
First Drop:	
Pot Temp., °C	260
Head Temp., °C	225
Last Portion Retained:	
Pot Temp., °C	320
Head Temp., °C	280

May I suggest that for purposes of a Product Bulletin, distillation ranges may be more appropriate.

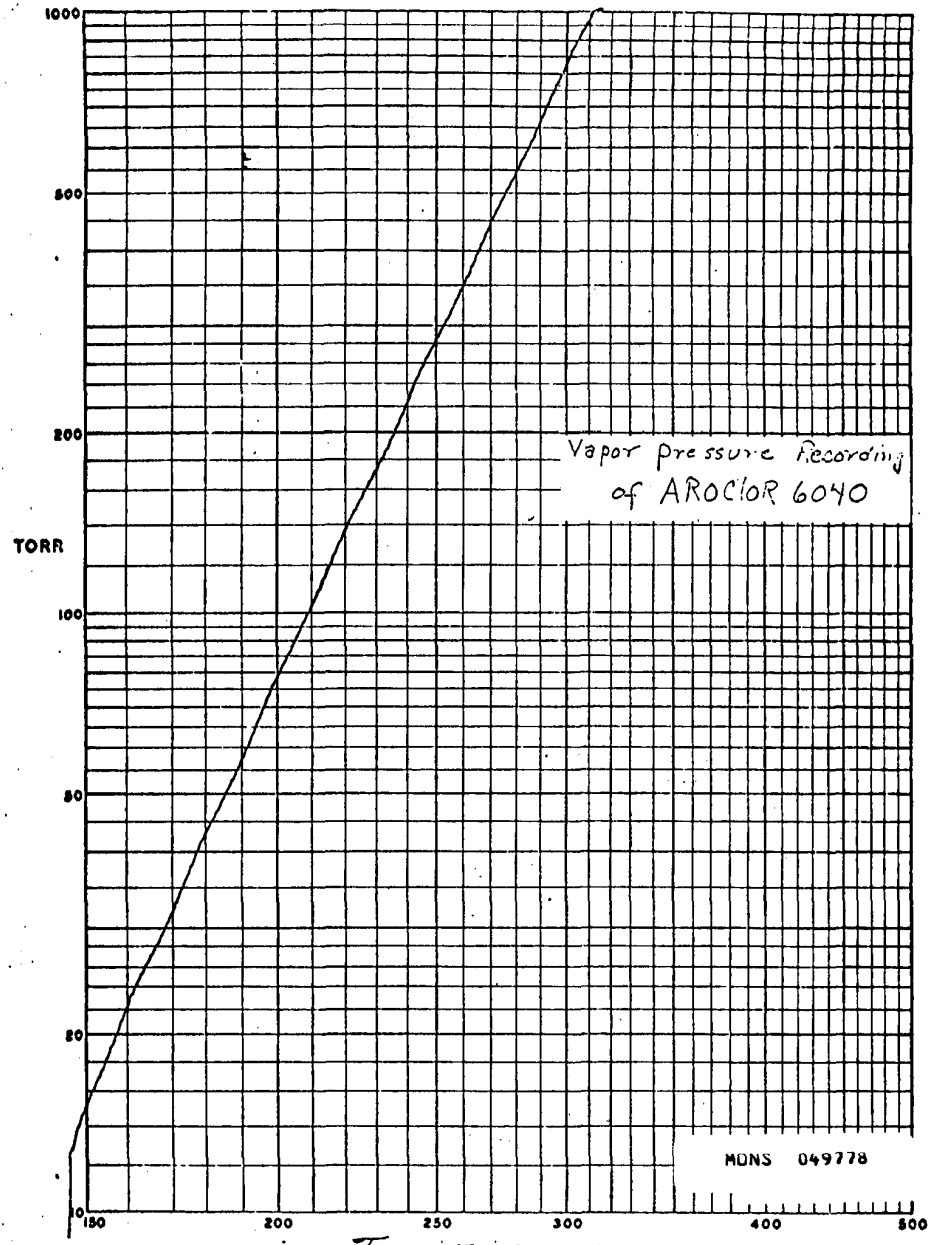
Joe, please let me know if we can be of additional assistance.

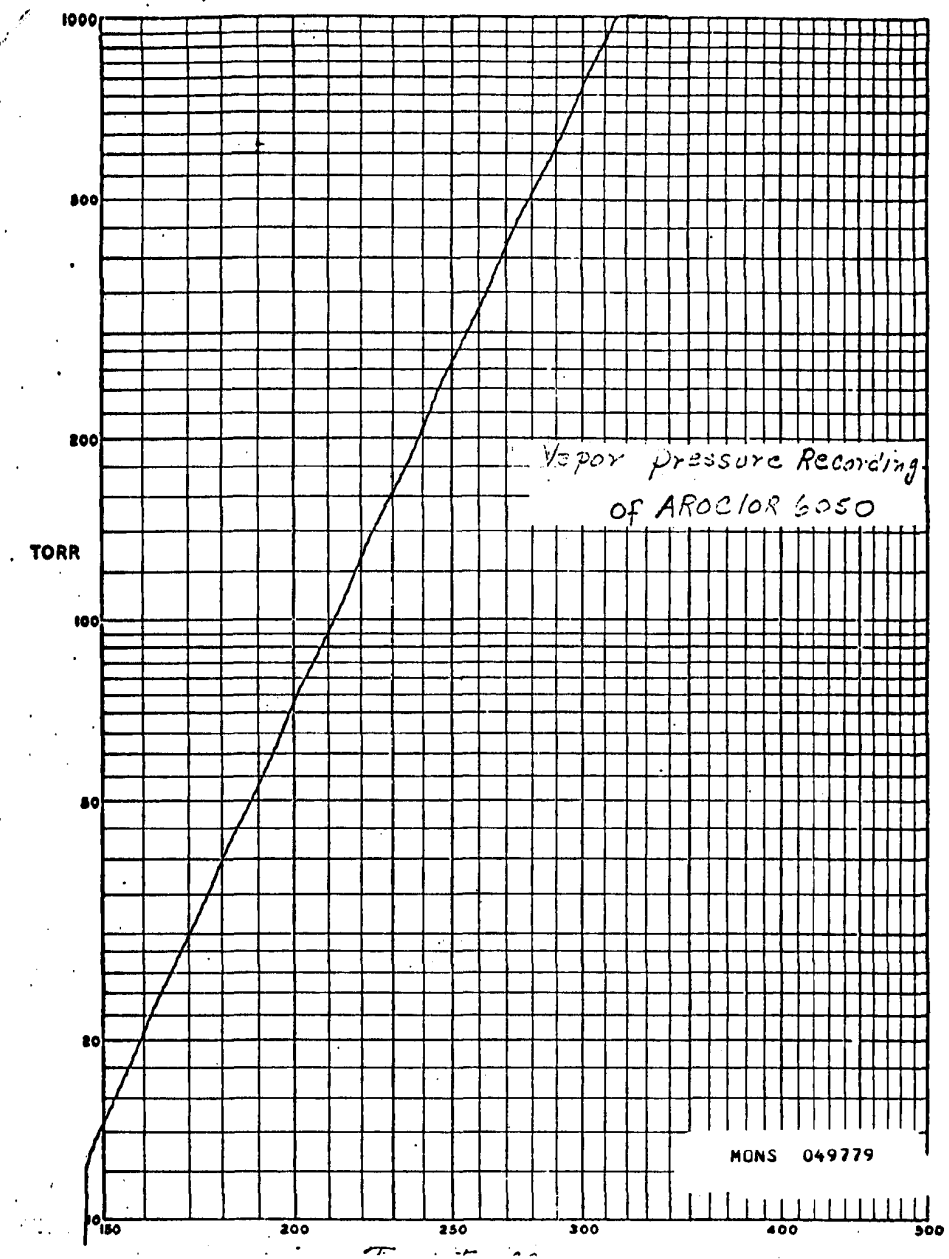
JTB
J. T. Bell

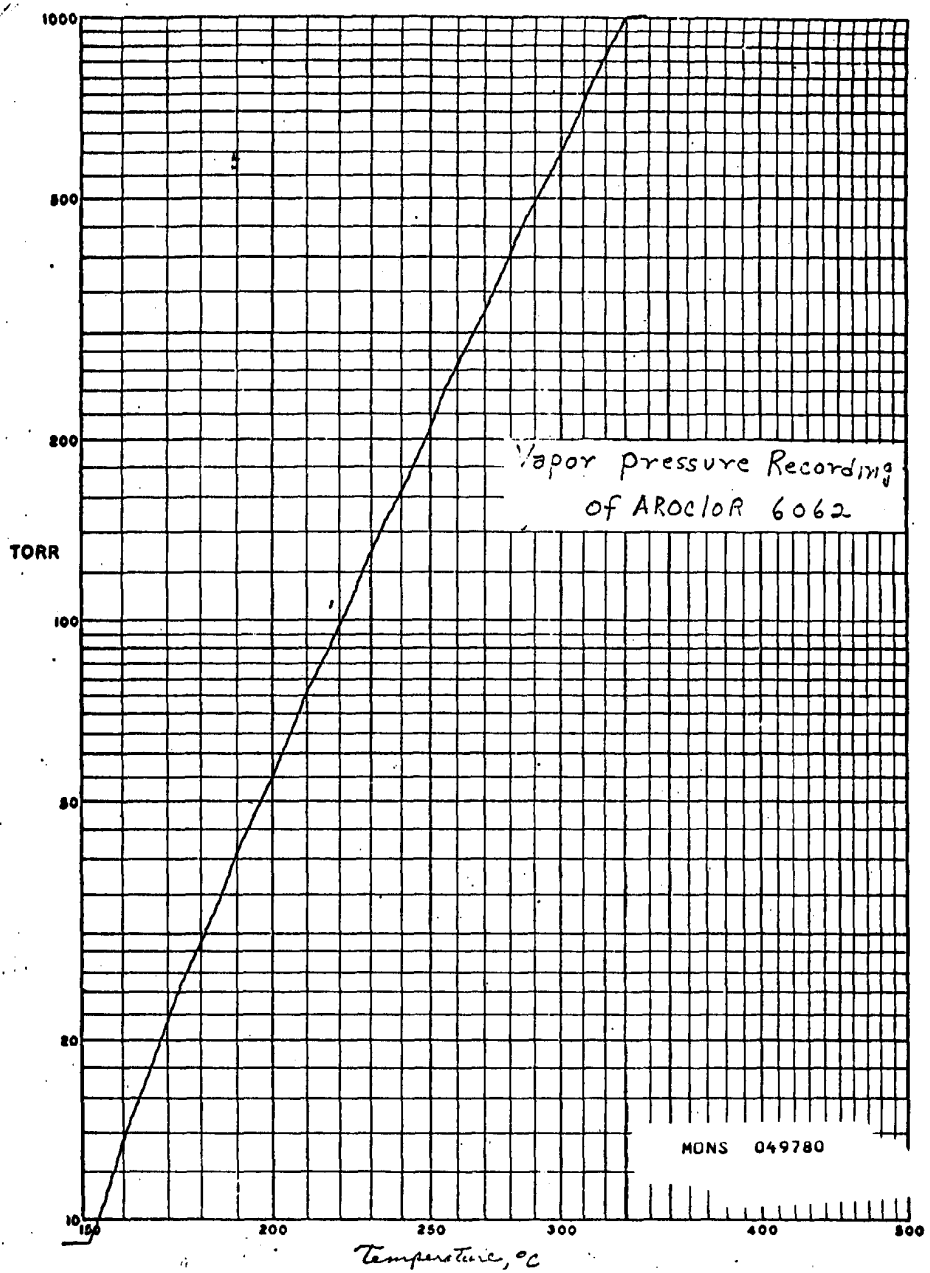
jw

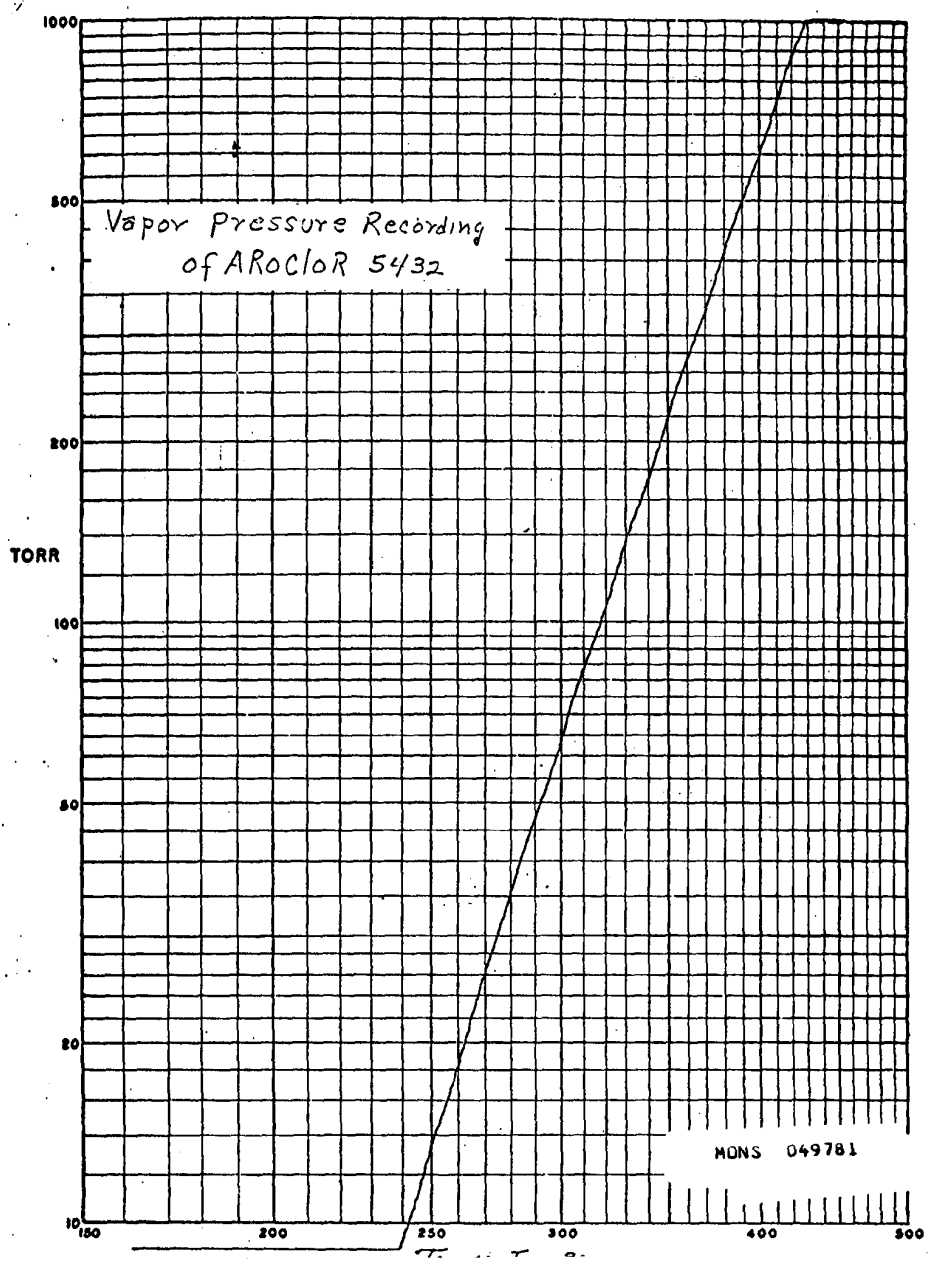
MONS 049777

IM-10 REV 11-69

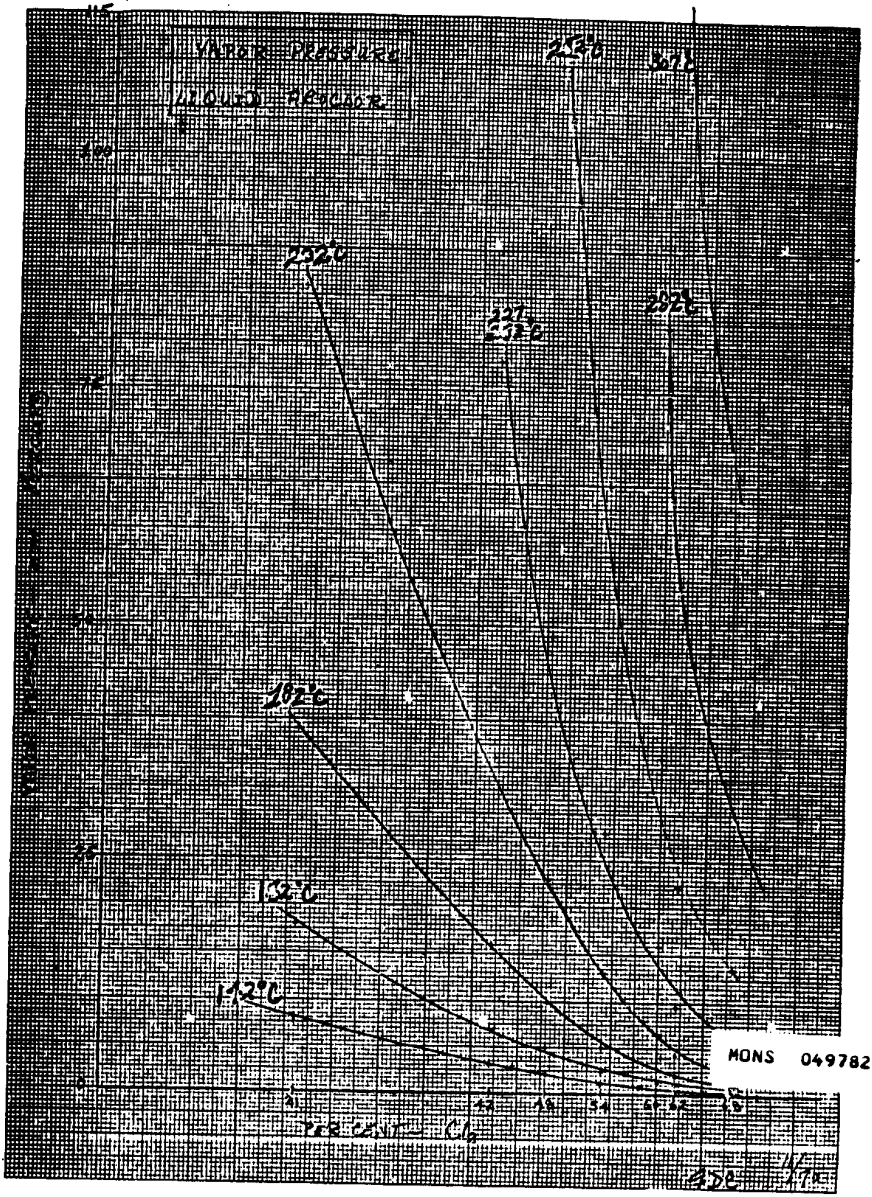

1000
500
200
TORR
100
50
20
0
150
200
250
300
400
500
Temperature, °C
Vapor pressure Recording
of AROCLOR 6040
MONS 049778


1000
800
600
TORR
100
80
60
150
200
250
300
400
500
Vapor pressure Recording
of AROCLOR 6050
MONS 049779

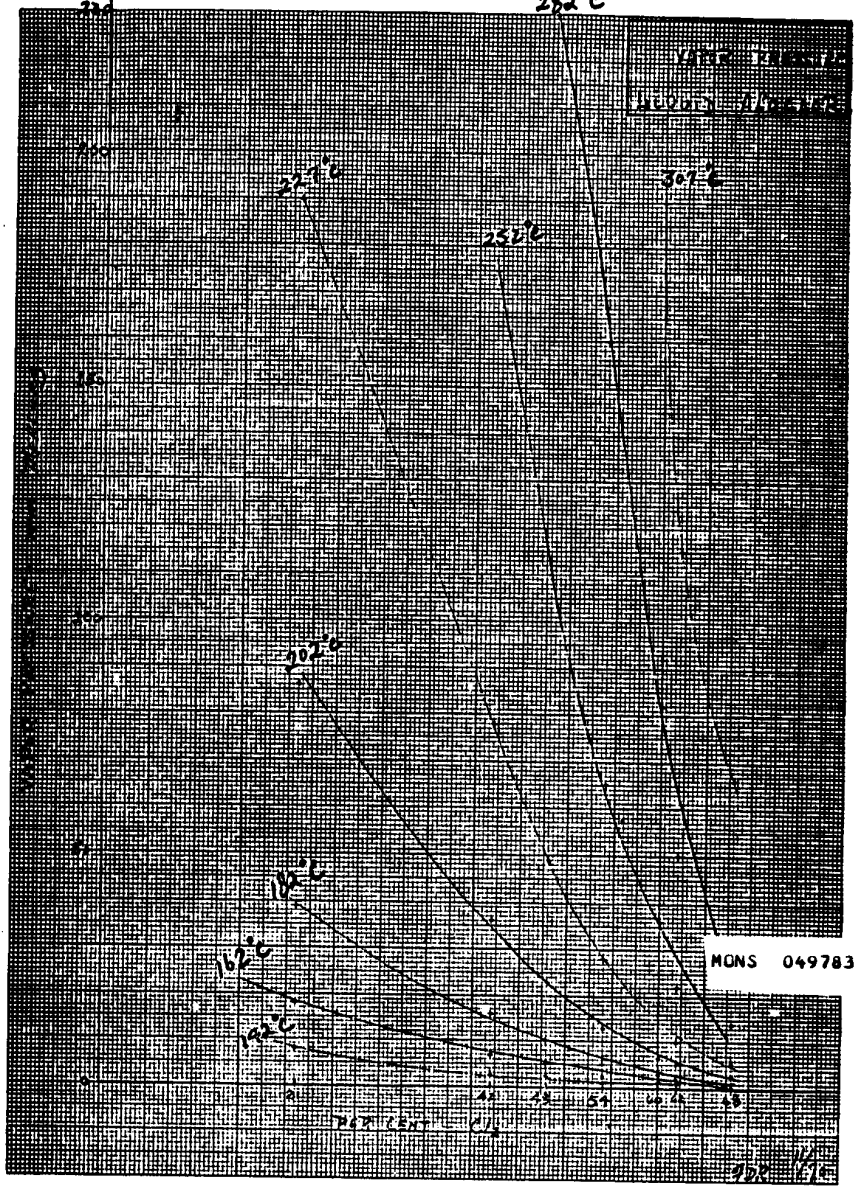

Vapor pressure Recording of AROCLOR 6062
TORR
1000
500
200
100
50
20
10
150
200
250
300
400
500
Temperature, °C
MONS 049780

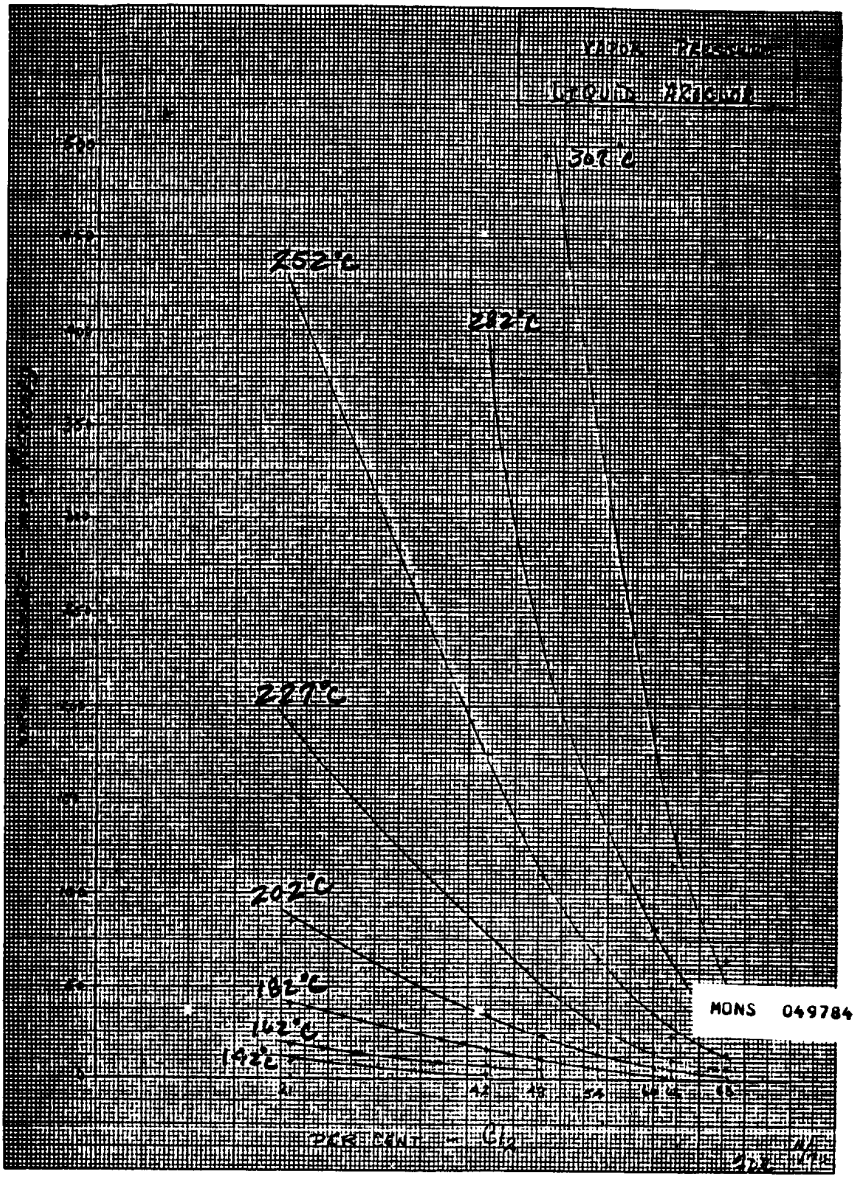

Vapor Pressure Recording
of AROCLOR 5432
TORR
1000
500
200
100
50
20
10
150
200
250
300
400
500
MONS 049781

To: VRH

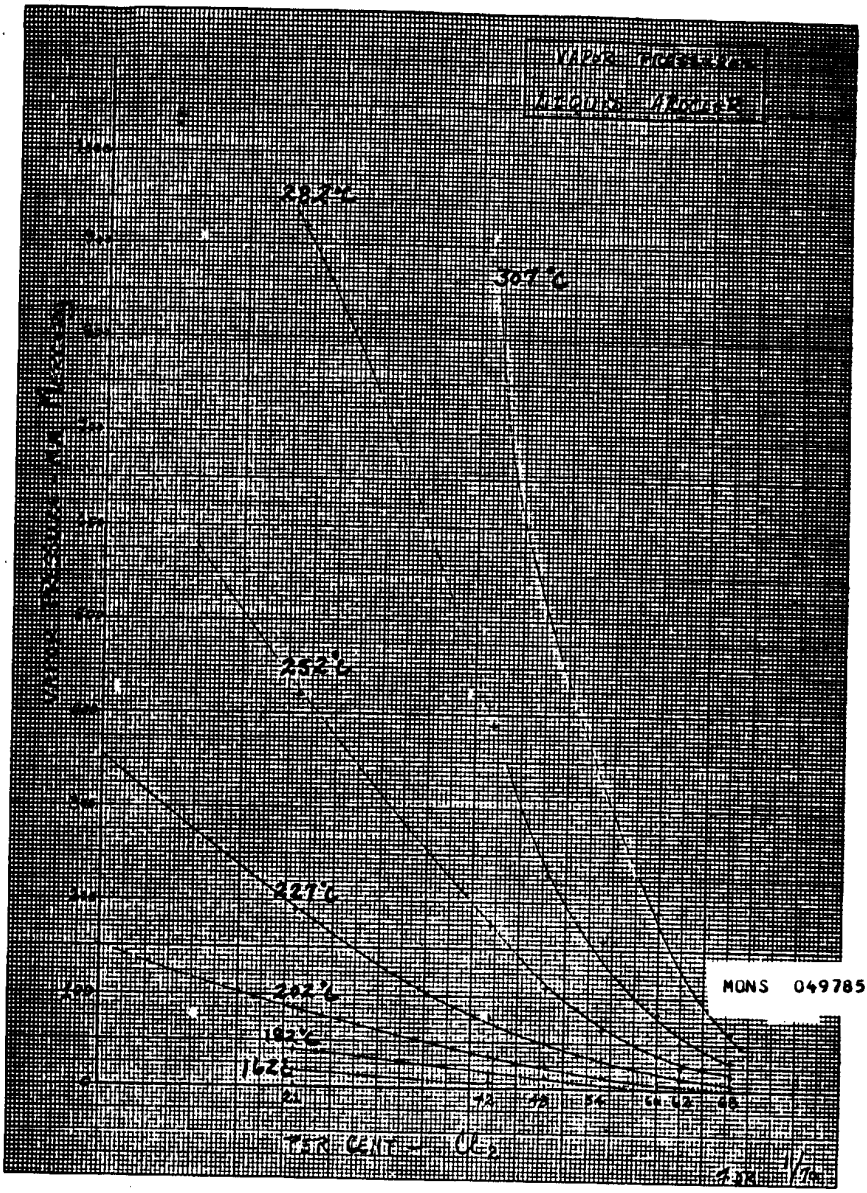


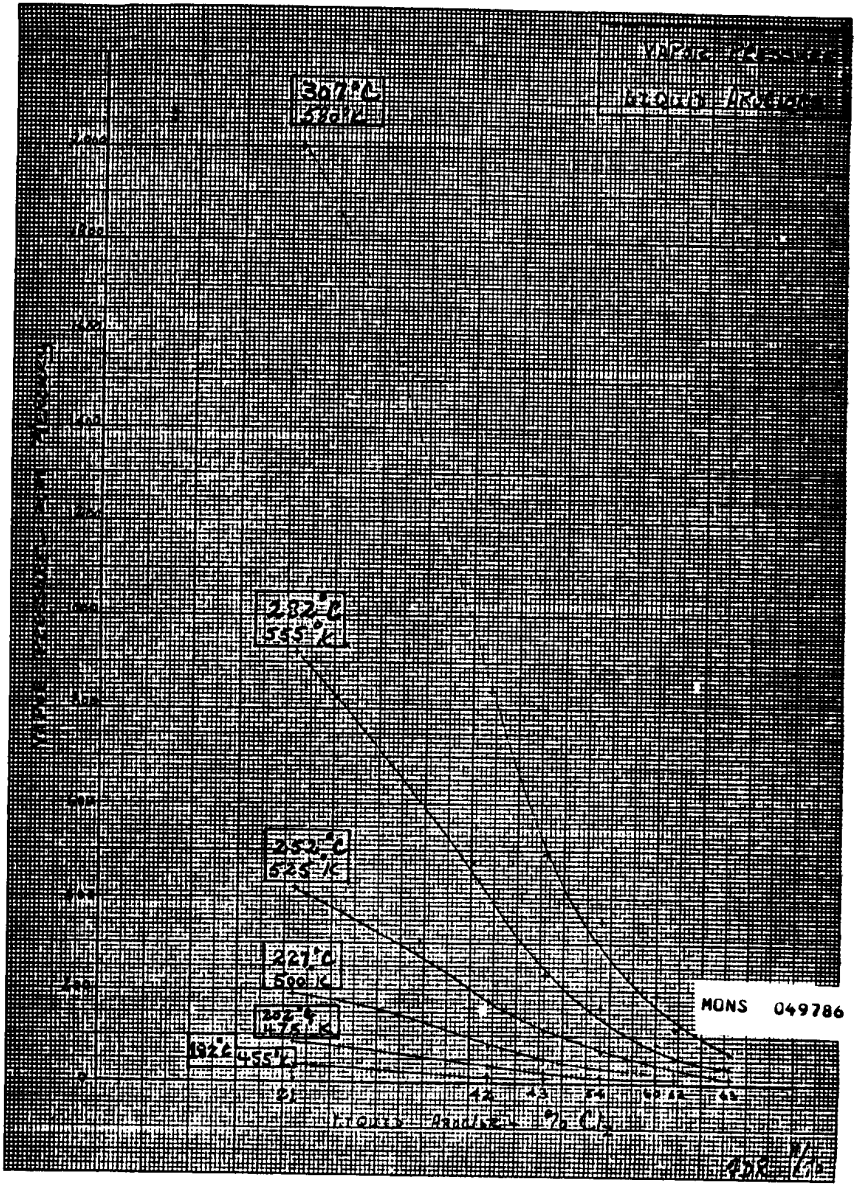
MONS 049782


282°C
301°C
252°C
202°C
182°C
162°C
142°C
MONS 049783


VAPOR
LIQUID
362°C
282°C
222°C
202°C
182°C
162°C
142°C
122°C
PER CENT

MONS 049784


VAPOR PRESSURE
282°C
307°C
252°C
227°C
202°C
182°C
162°C
MONS 049785


307°C
580 K
287°C
560 K
252.8
525.5
227.8
500 K
202.5
475.5 K
177.4
450.5
MONS 049786

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

THE AROCLOR® POLYCHLORINATED POLYPHENYLS

A series of heat-resistant, chemically inert and fire-retarding compounds ranging from mobile oily liquids through viscous resins and solids that perform unique functions in over a hundred different industrial and product applications.

TECHNICAL BULLETIN O-FF/1



MONS 049787

THE AROCLOR® POLYCHLORINATED POLYPHENYLS

A series of heat-resistant, chemically inert and fire-retarding compounds ranging from mobile oily liquids through viscous resins and solids that perform unique functions in over a hundred different industrial and product applications.

TECHNICAL BULLETIN O-FF/1

FUNCTIONAL FLUIDS Monsanto

The information contained in this bulletin is, to our best knowledge, true and accurate, but all recommendations or suggestions are made without guarantee, since the conditions of use are beyond our control. The Monsanto Company disclaims any liability incurred in connection with the use of these data or suggestions. 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.

Organic Division / 800 N. Lindbergh Blvd. / St. Louis, Missouri 63166

MONS 049788

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Ask your Man from Monsanto for additional Aroclor literature:

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

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MONS 049789

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 049790

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°-39[illegible]
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	1800-250[illegible]

*Flash indicates — "No fire point up to boiling temperature"

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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 trans-parent sticky resin	Aroclor 5460 Clear, yellow-to-amber, brittle resin	Aroclor 2565 Black, opaque, brittle resin
50 max. (APHA)	60 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
0.00067 (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)	0.00066 (25°-65°C)
1.555-1.566 (90°/15.5°C) 13.50	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
5°-420° 355-	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°—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.)	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 (266°F or 130°C)	300-400	—	—
3200-4500	600-850 (160°F or 71°C)	—	—	—	—	—
—	—	—	—	—	—	—

MONS 049792

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.

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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.

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.

The Aroclor fluids can be used in a wide variety of applications requiring a specialized dielectric. Monsanto works closely with electrical equipment makers to develop the proper dielectric with the exact physical properties required by the engineering of the equipment.

IMPREGNATING COMPOUNDS

Because of its nonflammability, high resistivity, dielectric strength and low power factor, liquid and resinous Aroclor is extremely useful as an impregnating compound. An important application of Aroclor in the electrical field is the use of Aroclor 1260, 4465, and 5460 in wire or cable coatings and as impregnants for cotton and asbestos braided insulation. Because they possess high purity and excellent electrical resistance, Aroclor 1254, 5460 and 1268 make superior dielectric sealants to close the pores of carbon resistors, and to seal electrical bushings and terminals.

To attain the lowest possible loss factor and gain resistivity, Aroclor is often treated with about 0.20% by weight of Attaupulgus clay or Fullers earth. To activate the earth it should be heated to 450°-500°F.

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 500×10^9	Greater than 35KV	<0.1%
1248	5.6	4.6	Above 500×10^9	Greater than 35KV	<0.1%
1254	5.0	4.3	Above 500×10^9	Greater than 35KV	<0.1%
1260	4.3	3.7	Above 500×10^9	Greater than 35KV	<0.1%
1268	2.5	—			
5442	3.0	4.9	Above 500×10^9		
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 049794

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.

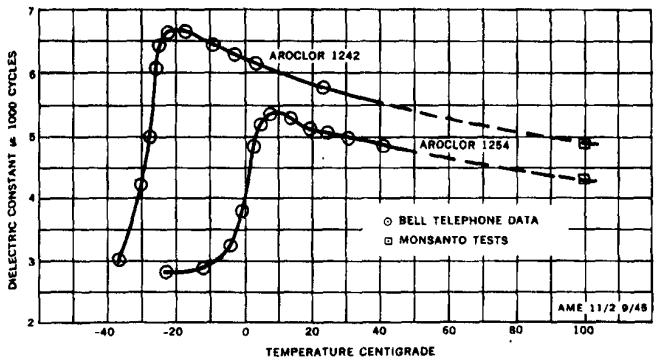
MONS 049795

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. 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.: Color, APHA 60 max. Acidity, mg. KOH/g. 0.01 max. Inorg. Chlorides, ppm 0.10 max. 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

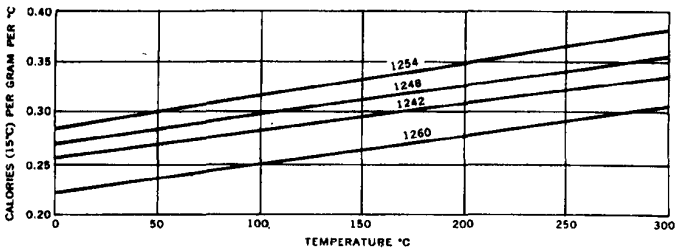


COURTESY OF THE JOURNAL OF FRANKLIN INSTITUTE AND BELL TELEPHONE LABORATORIES

Mechanical Applications of Aroclor

Because Aroclor chlorinated compounds have excellent shear resistance, heat stability, and are chemically stable . . . they can serve in dozens of mechanical applications for transferring mechanical power, heat and variable pressures. Aroclor does not attack metals even at high temperature; it resists oxidation, chemical and mechanical breakdown under a wide variety of environmental conditions. Aroclor liquids used as lubricants impart a high degree of extreme pressure lubricity.

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}

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EXPANSION MEDIUM

Because of their stability at high temperatures and ability to withstand frequent temperature cycles without gum formation, Aroclor liquid is used as the actuating medium in bellows controls, thermostats, industrial temperature control regulators and other kinds of automation equipment.

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

LIQUID SEALANT FOR FURNACE ROOFS

Because of their low vapor pressures and fire-resistance, Aroclor 1248 and 1254 make excellent liquid sealants. These non-evaporating fluids have good flow at slightly elevated temperatures and are chemically stable at elevated temperatures.

Consequently, Aroclor liquid makes excellent fluid sealants for any application where the use of oil would create a fire hazard. In the trough of annealing furnaces, for example, Aroclor makes dependable fire-safe roof seals.

VACUUM DIFFUSION PUMP OIL

Fluid Aroclor 1248 and 1254 are highly stable to air; they make good oils for vacuum pumps at a much lower cost than high priced silicone type oils. Aroclor operates efficiently in vacuum diffusion pumps used to pull high vacuum for metalizing plastics, dehydrating foods, medicinals, and for drying capacitor cones.

MONS 049798

Aroclor in Special Product Formulations

With their wide range of physical properties, their inertness, lubricity, and vapor-suppressing characteristics — Aroclor chlorinated compounds can be valuable ingredients in an extraordinary variety of formulated products. They are compatible with a variety of solvents, oils and resins. Virtually non-volatile and permanently thermoplastic, they will not react with other chemicals in the formulation. In addition, their low cost makes their use for special purposes eminently practical and economical.

SEALERS FOR GASKETS

Aroclor — particularly when hot — swells rubbers like Hycar*, Koroseal*, PerBuna N, and Neoprene. Wherever seals and gaskets of natural or synthetic rubber tend to shrink under heat and use, Aroclor 1232, 1242, or 1254 can be used as a swelling agent to tighten the shrunken seal. An example is in automotive transmission oil: a small amount of Aroclor in the oil swells the seal in place, saving the cost of tearing down the equipment to replace the seal or gasket. Aroclor can be used in gasket sealing compounds to swell the rubber after the gasket or seal is in place.

DEDUSTING AGENT

Aroclor 1254 is a low cost dedusting agent which can hold down the dusting of a variety of chemical products. Because Aroclor 1254 resists both combustion and oxidation, it can be used to control dusting of highly reactive compounds. As a typical example,(1) a few tenths of one percent will control the dusting of calcium hypochlorite.

*Hycar and Koroseal are registered trademarks of B. F. Goodrich Co.
(1) Covered by U. S. Patent No. 2,921,911, issued January 19, 1960, and assigned to Pennsalt Chemicals Corporation.

INSECTICIDES

Aroclor 5460 and 1254 act as vapor suppressants. United States Department of Agriculture scientists reported that the inclusion of from 5 to 25 parts per hundred by weight of Aroclor increased the effective kill-life of a lindane spray up to ten times. A painted or metallic surface sprayed with certain chlorinated insecticides fortified with Aroclor will remain toxic to flies, ants, roaches and silverfish up to 2 to 3 months. The Aroclor resins suppress the rapid evaporation of the volatile insecticides without adding odor or other objectionable residue. Formulation into insecticides is quite simple; the Aroclor is dissolved in a suitable solvent compatible with the insecticide formulation, and mixed in. The most pronounced effect for increasing the kill-life of the insecticide is obtained with lindane, chlordane and BHC. Aroclor is recommended for chlorinated insecticide formulations to be used for non-crop spraying. Their low cost makes this use a most practical way to lower the ultimate cost of insect control.

PRECISION CASTING WAXES

Aroclor is compatible with various natural waxes, such as carnauba and others, including those used to formulate casting wax. Aroclor helps impart to the finished casting wax a number of desirable properties: hardness without brittleness; resistance to shrinking; sharp definition; sharp melting point; and fire-resistance. Waxes formulated with Aroclor are non-tacky and highly stable. Waxes containing Aroclor are widely used in making dental castings, in the precision casting of aircraft parts, and for casting costume jewelry. Aroclor 1254, 4465 and 5460 are most frequently used . . . proportions dependent upon the properties re-

MONS 049799

quired in the finished wax. Much of the highest quality precision casting wax used in the lost wax process is formulated with Aroclor.

AROCLOR IN ABRASIVES

Aroclor 1254, 1268 and 5460 are used in the manufacture of specialized abrasives. Because of their excellent bonding characteristics, high thermal stability and resistance to oxidation and corrosion — Aroclor is used as the carrier for abrasive materials. A major use is as part of the bonding agent in specialized grinding wheels.

AROCLOR IN SPECIALIZED LUBRICANTS

For specialized lubricants requiring good extreme pressure (EP) characteristics, the Aroclor liquids make excellent additives. They impart high temperature stability, excellent lubricating qualities, and weather and corrosion resistance. As an example, Aroclor is used to formulate grease and pipe thread compounds for use in oxygen systems. Greases formulated with Aroclor have a high chemical resistance and are suitable for use in contact with corrosive chemicals. Gear oil lubricants containing Aroclor have good resistance to sheer degradation and high temperature stability. Added in small amounts to railroad car journal box oils, Aroclor imparts better extreme pressure lubricity and reduces the incidence of hot boxes.

The heat-resisting, nonflammable characteristics of the Aroclor chlorinated compounds make them attractive in themselves as lubricants under conditions of high temperature. As an example: in governor systems of central power stations, Aroclor 1248 is well suited to this lubricating application.

Straight Aroclor 1254 gives excellent results on a roller bearing test operating at 255-260°F with much less carbonization or decomposition than the usual spindle oil under the same conditions.

As an extreme pressure (EP) lubricant base added to a petroleum hydrocarbon oil in amounts up to approximately 15% by weight, Aroclor 1248 and 1254 materially increase the load-carrying properties without reducing the viscosity of the resulting composition. These two compounds represent one of the more satisfactory carriers for the element chlorine as an extreme pressure base, possessing the following advantages:

1. STABILITY. Even at higher temperatures, there will be neither separation of components nor appreciable change in physical or chemical properties during long periods of operation.
2. NON-VOLATILE. Many other types of chlorine bearing compounds are so volatile as to render them unfit for long periods of service. Aroclor is non-volatile at normal temperatures.
3. NON-OXIDIZING. Aroclor does not oxidize nor thicken up to an objectionable degree.
4. NON-CORROSIVE. Aroclor does not attack metal surfaces.
5. NON-ABRASIVE. Aroclor exerts no abrasion on the machined surfaces.
6. NON-HYDROLYSIS. Aroclor does not hydrolyze in the presence of water, thus avoiding the generation of hydrochloric acid.
7. COMPATIBILITY. Aroclor is completely miscible with mineral oils.
8. COLOR. Aroclor does not darken or change the color of lubricating oil.

MONS 049800

Where lubrication is subjected to water displacement exposure, for example in the lubrication of bridge rollers, a heavier-than-water lubricant can be prepared from mixtures of Aroclor and oil. The following are typical examples:

Mix No.	% by weight Oil*	% by weight Aroclor 1248	Pour Pt.	Gravity at 15.6°C.	Approx. Pounds/Gal.
1	50	50	0°F	1.1263	9 4
2	25	75	+5°F	1.2703	10.6

Viscosity 210°F-160 Saybolt Secs.
Color ASTM 7-8
Flash Point 545°F.
Pour Point 15°F.

*Bright Stock: Gravity API 28-31

AROCLOR IN INDUSTRIAL CUTTING OILS

Aroclor 1254 is used to formulate the finest quality straight and soluble or emulsifiable-type cutting oils. The Aroclor functions as an excellent extreme-pressure lubricant and is far superior to aliphatic chlorinated hydrocarbons because of its higher order of thermal stability. The heat resistance is most important in cutting oils for machining high grade steel. With Aroclor cutting oils there is a lower degree of hydrolysis which minimizes the staining of the metal.

MONS 049801

Appendix

Methods for Emulsifying and Making Stock Solutions of Aroclor

There are several simple methods for making Aroclor emulsions; the one used may be selected to suit the kind of Aroclor and type of formulation in which it will be used.

Emulsifying Viscous Aroclor

(Portion 1)	16 lbs. of Aroclor
	1 lb. of stearic acid
(Portion 2)	8 lbs. of water
	4 oz. Triethanolamine

Heat the Aroclor to a workable viscosity (180°F plus) and stir in the stearic acid thoroughly. Heat the water to almost boiling (207°F) and stir in the triethanolamine thoroughly. Pour the Aroclor stearic acid portion into the water portion, agitating vigorously. Then process the combined portions with a highspeed emulsifying stirrer . . . or process through a colloid mill.

Emulsifiable Concentrated Stock Solutions of Aroclor

79 parts of Aroclor
16.70 parts of toluene
3.55 parts of isopropyl alcohol
1.00 parts of Sterox® CD non-ionic emulsifier
0.75 parts of Santomerse® anionic wetting agent

The above formulation is readily emulsifiable with water. If a more resinous Aroclor is used, increase the amount of toluene (or xylene) as needed to dissolve the Aroclor resin.

MONS 049802

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

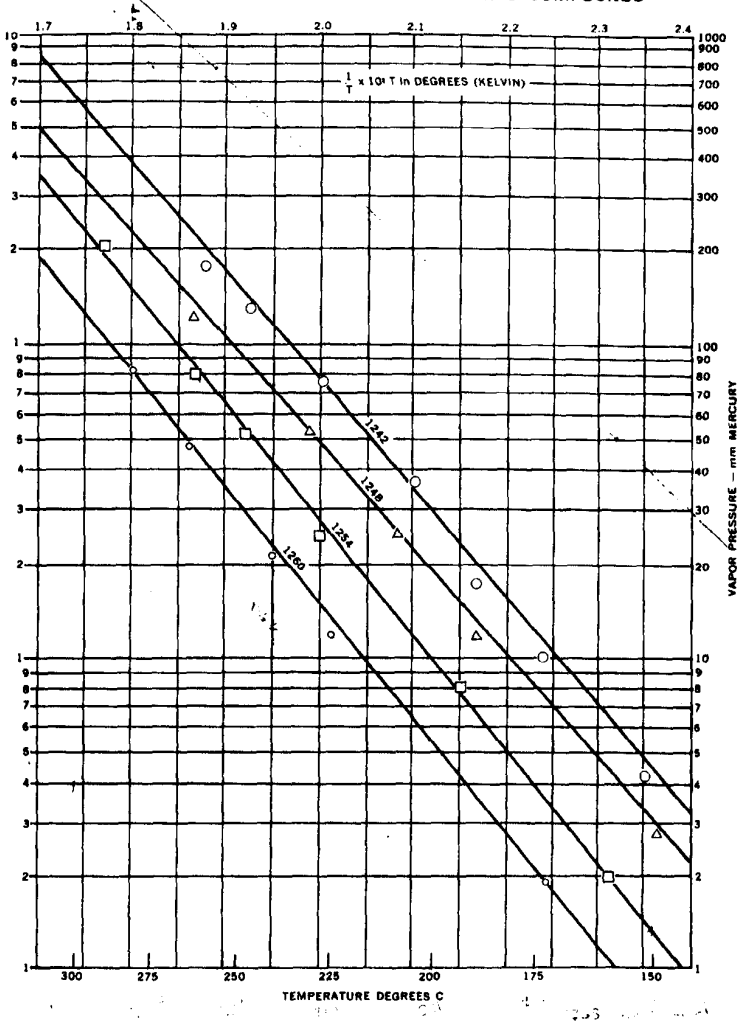
Aroclor / Type of Solvent	1242 25°C	1242 Hot	1248 25°C	1248 Hot	1254 25°C	1254 Hot	1270 Cold	1270 Hot	4465 Cold	4465 Hot	5460 25°C
Acid											
Acetic Acid	S	S	—	—	S	S	—	—	SS	S	—
Oleic Acid	S	S	—	—	S	S	—	—	S	VS	—
Benzoic Acid	10.0 31°C	—	10.0 32°C	—	—	—	—	—	—	—	—
Aldehyde											
40% Formaldehyde	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 98°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 38°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 29°C	80.0 76°C	—	—	10 27°C	28 75°C	—	—	SS	—	—
Glycerine	I	I	I	I	I	I	I	I	I	I	—
Methyl Alcohol	42.5 29°C	88.5 60°C	—	—	15 26°C	22.2 55°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 049803

VAPOR PRESSURE OF AROCLOR® CHLORINATED COMPOUNDS



MONS 049804

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 049805

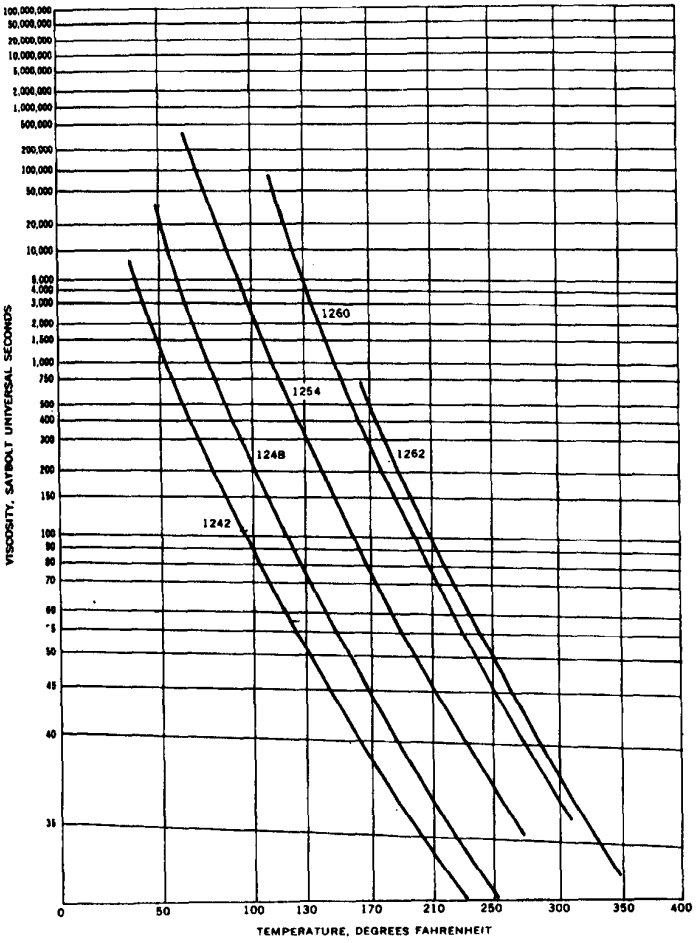
CORROSION RESISTANCE OF STRUCTURAL MATERIALS

Metals	Arcolor 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.
RR - Excellent resistance - less than 1.0×10^{-4} cm/day penetration or .00014 in/yr.
R - Good resistance - has penetration between 1.0×10^{-4} and 15×10^{-4} cm/day or between 0.00014 and 0.0014 in/yr.
D - Doubtful resistance, penetration between 15×10^{-4} cm/day and 300×10^{-4} cm/day or between 0.0014 and 0.014 in/yr.
P - Poor resistance - penetration greater than 300×10^{-4} cm/day or 0.014 in/yr.
PS - Poor resistance due to visible local action although weight change indicates greater resistance.
a - 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.

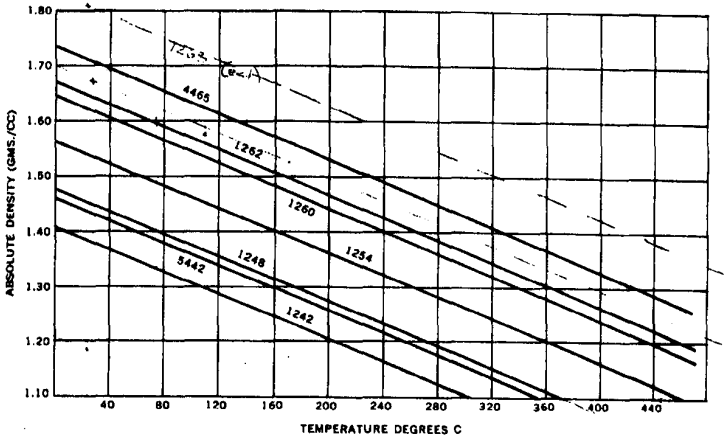
MONS 049806

VISCOSITY RANGES OF SOME OF THE AROCLOR® CHLORINATED COMPOUNDS



MONS 049807

DENSITIES OF AROCLOR® CHLORINATED COMPOUNDS AT VARIOUS TEMPERATURES



(22)

MONS 049808

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 049809

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 049810

DISTRICT SALES OFFICES
ALL DIVISIONS

ATLANTA, GEORGIA 30326
Lenox Towers West,
3390 Peachtree Rd. N.E.
Tel. (404) 231-4320

BOSTON, MASSACHUSETTS 02149
Everett Station
Tel. (617) Dunkirk 7-5010

CHICAGO, ILLINOIS
3158 Des Plaines Ave.
Des Plaines, Illinois 60018
Tel. (312) 296-6688

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

CLEVELAND, OHIO 44122
3645 Warrensville Center Rd.
Tel. (216) 991-5400

DETROIT, MICHIGAN 48235
500 Northland Towers
Tel. (313) 357-0910

HOUSTON, TEXAS 77002
1300 Main Street
Tel. (713) Capitol 3-4011

LOS ANGELES, CALIFORNIA 90022
6670 E. Flotilla St.
Tel. (213) Raymond 3-2492

MINNEAPOLIS, MINNESOTA 55402
912 Northstar Center 110 S. Seventh St.
Tel. (612) Federal 9-4651

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

PITTSBURGH, PENNSYLVANIA 15222
No. 4 Gateway Center Bldg. Room 1406
Tel. (412) 261-2156

ST. LOUIS, MISSOURI 63166
800 N. Lindbergh Blvd.
Tel. (314) Wydown 3-1000

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

SEATTLE, WASHINGTON 98104
911 Western Avenue
Tel. (206) Main 2-4203

SPRINGFIELD, MASSACHUSETTS 01101
730 Worcester Ave.
Tel. (413) 788-6911

WILMINGTON, DELAWARE 19803
2005 Concord Pike, Fairfax
Tel. (302) Olympia 8-6531

Additional District Offices are maintained by:

Agricultural Division

EL DORADO, ARKANSAS 71731
Smackover Highway
P. O. Box 231
Tel. (501) Union 3-3151

LULING, LOUISIANA 70070
P. O. Box 174
Tel. (504) 784-2911

Building Products Department

ST. LOUIS, MISSOURI 63166
800 N. Lindbergh Blvd.
Tel. (314) Wydown 3-1000

LOS ANGELES, CALIFORNIA 90066
814 San Fernando Road
Tel. (213) CA. 2-9111

Chemstrand Company Division

AKRON, OHIO 44313
3030 West Market St.
Tel. (216) Temple 8-7941

CHARLOTTE, NORTH CAROLINA 28202
Wachovia Bank Building
129 West Trade St.
Tel. (704) 376-9871

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

ENGLEWOOD CLIFFS, N. J.
661 Palisades Ave.
Englewood Cliffs, New Jersey 07631
Tel. (201) 568-7151

Hydrocarbons & Polymers Division Lion Oil

EL DORADO, ARKANSAS 71730
Lion Oil Building
Tel. (501) Union 3-3111

JACKSON, MISSISSIPPI 39209
P. O. Box 10937
Westland Station
Tel. (601) Fleetwood 2-3648

LITTLE ROCK, ARKANSAS 72203
1515 West Seventh St.
Tel. (501) Franklin 8-2437

MEMPHIS, TENNESSEE 38101
1023 Riverside Drive
P. O. Box 252
Tel. (901) Whitehall 8-4451

Organic Chemicals Division
(Rubber Industry)

AKRON, OHIO 44311
920 Brown Street
P. O. Box 2307
Tel. (216) Hemlock 4-1921

MONS 049811

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

FUNCTIONAL FLUIDS Monsanto

2-2130-0466-6 LITHO IN U.S.A.

MONS 049812

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

	5460			5060		MS	
	cp	$\sqrt{cp}$		cp	$\sqrt{cp}$	cp	$\sqrt{cp}$
180	40	3,42	+	70	4,12	2900	14.26
200	18,5	2.64	⊙	33	3.2	1400	11.2
240	5.8	1.795	△	10	2,15	405	7.4

MONS 049813

20.0^2

$$\frac{\frac{91.2}{550.7}}{+\frac{8.8}{736.5}} = \frac{0.166}{\begin{matrix}0.166\\0.012\end{matrix}} = \frac{0.166}{0.178} = 93.4 \text{ mol \%}$$

wt % S460	①		②	① + ②	① ÷ ③ mol % S460
(80)	0.145	20	0.0273	0.172	84.5
7	0.127	17	0.0409	0.168	75.6
6	0.109	14	0.0545	0.164	66.5
5	0.0908	12	0.0681	0.1589	57.2
4	0.0726	10	0.0818	0.1544	47.0
3	0.0545	7	0.0954	0.1499	36.4
2	0.0363	5	0.109	0.1453	25.0
1	0.0182	3	0.123	0.1412	12.9
90	0.1635		0.0136	0.1771	92.4

MONS 049814

Mol wt 5460

C	18.0 × 12.01	=	216
H	4.7 × 1.008	=	4.7
Cl	9.3 × 35.46	=	330
			550.7

Mol wt Φ_4 + X% Cl_2

C	24.0 × 12.01	=	288	
H	8 × 1.008	=	8	
Cl	10 × 35.46	=	354.6	= 54.5%
			650.6	

C	24 × 12.01	=	288	
H	6 × 1.008	=	6	
Cl	12 × 35.46	=	426	= 59.1%
			720	

C	24 × 12.01	=	288	
H	4 1	=	4	
Cl	14 35.46	=	496	= 63.0%
			788	

Mol wt 60% Cl Φ_4

MONS 049815

C	24 × 12.01	=	288	
H	4.5 × 1.008	=	4.5	
Cl	125 × 35.46	=	444	= 60.8%
			736.5	

5060

Temp	$\sqrt[3]{M}$	M	% 5460	mol % 5460
180 +	12.85	2120	10	12.9
	11.53	1530	20	25.0
	10.30	1100	30	36.4
	9.13	760	40	47.0
	8.02	525	50	57.2
	7.02	350	60	66.5
	6.06	224	70	75.6
	5.08	131	80	84.5
	4.12	70	91.2	93.4
	3.42	40	100	100
200°C ⊙	9.94	980	10	
	8.90	710	2	
	7.94	500	3	
	7.06	351	4	
	6.22	240	5	
	5.43	160	6	
	4.67	102	7	
	3.92	60	8	
	3.20	33	91.2	93.4
	2.64	18.5	100	
240°C △	6.68	300	10	
	5.99	215	2	
	5.34	153	3	
	4.75	107	4	
	4.18	73	5	
	3.65	49	6	
	3.15	31	7	
	2.65	18.6	8	
	2.15	10.0	91.2	93.4
	1.795	5.8	100	
180	4.22	76	90	92.4
200	3.27	35.0	90	
240	2.21	10.8	90	

MONS 049816

Monsanto

FROM (NAME & LOCATION) G. L. Arnett PR&D - Anniston

December 26, 1968

cc J. C. Landwehr
G. W. Miller
H. L. Williams
J. T. Bell

SUBJECT VISCOSITY AND SPECIFIC GRAVITY DATA RELATING TO AROCLORS 5060 AND 5460

REFERENCE

TO : V. R. Haupt

Below is a compilation of data requested by you regarding viscosity and specific gravity of Aroclors 5060 and 5460. Please advise me if you require further information.

Material	Material Soft Point °C	Temperature °C	Viscosity (Centipoise)	Specific Gravity (g/cc)
Aroclor 5060	114	170	233	
Aroclor 5460	104	140	781	
Aroclor 5460	104	150	316	
Aroclor 5460	104	170	66	
Aroclor 5460	104	200	19	
Aroclor 5460	100.5	200	18	
Aroclor 5460	104	140		1.530
Aroclor 5460	104	200		1.475
Aroclor 5460	100.5	140		1.544

G. L. Arnett

/bs

MONS 049817

IM-10 REV 11-65

STANDARD MANUFACTURING PROCESS
FOR
AROCLOR

APPENDIX C - PHYSICAL CONSTANTS OF FINISHED GOODS, INTERMEDIATES, AND MAJOR RAW MATERIALS

FINISHED GOODS	RAW MATERIALS
Aroclor 1221 - Not Available	Biphenyl
Aroclor 1232 - Not Available	Santowax - Not Available
Aroclor 1242	Santowax R-Not Available
Aroclor 1248	Chlorine
Aroclor 1254	Hydrated Lime
Aroclor 1260	Attapulgus Earth-Not Avail.
Aroclor 1262	Ferric Chloride
Aroclor 1268 - Not Available	
Aroclor 2565 - Not Available	
Aroclor 4465 - Not Available	
Aroclor 5442 - Not Available	
Aroclor 5460 - Not Available	

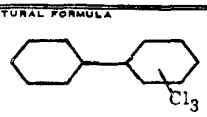
IN 619

PHYSICAL CONSTANTS DATA

SUBSTANCE

AROCLOR 1142 (Technical)

STRUCTURAL FORMULA



COMPILED BY

Rev. Ry A. M. Ellenburg

DATE 1947 7/5/57

NAME			SOURCE & DATE
Formula	$C_{12}H_7Cl_3$	Total Cl_2 41. 5 - 42.5%	Specs 12-21-54
Molecular Weight			
Appearance		Brown to black oily liquid	Specs 12-21-54
Boiling Point at 760 mm			
Boiling Point at mm			
Boiling Point at mm			
Boiling Point at mm			
Crystallizing Point			
Melting Point			
Solidus Point			
Specific Gravity	25/15.5°C	1.348-1.360	Specs 12-21-54
Specific Gravity	25/15.5°C	1.384-1.397	
Pounds per Gal. @ 25	°C	10.5	
Coefficient of Expansion			
Refractive Index @	n_D^{25}		
Infrared Spectrum (Reference)			
Ultra Violet Spectrum (Reference)			
Viscosity @			
Viscosity @			
Surface Tension			
Solubility in Water			
Solubility in			
Solubility in			
Sp. Gr. Temp Coeff. (50-105°C)		0.0009/°C	Specs 12-21-54
Flash Point °F (Method)	C. O. C.	350	Aroclor Bull. OP-115 1954
Fire Point °C		None	
Heat of Combustion			
Heat of Formation			
Thermal Stability (cal./kg/min.)			
Latent Heat of Fusion			
Latent Heat of Vap.			
Specific Heat			
Critical Temperature			
Critical Pressure			
Dissociation Constant			

Other Constants

MONS 049819

Toxicity (Give Reference)

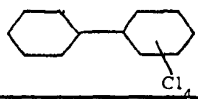
Schwartz, U. S. Pub. Health Service Bull. #229 1936
"Industrial Poisons, Hazards and Solvents" by M. B. Jacobs Vol. 1, p. 463-464 1941.

NOTE: These data should not be ... Monsanto Chemical Company. Use additional sheets if necessary.

IN 619

PHYSICAL CONSTANTS DATA

SUBSTANCE: AROCLOR 1148 (Technical)

STRUCTURAL FORMULA: 

COMPILED BY: Rev. By A. M. Ellenburg

DATE: 1947 7/5/57

NAME			SOURCE & DATE
Formula	$C_{12}H_6Cl_4$	Total Cl_2 47.5 - 48.5 %	Specs. 4/11/55
Molecular Weight			
Appearance		Brown to Black Oily Liquid	Specs 4/11/55
Boiling Point at 760 mm			
Boiling Point at mm			
Melting Point at mm			
Melting Point at mm			
Sublimation Point			
Freezing Point			
Refractive Index			
Specific Gravity 65/15.5		1.410-1.420	Specs. 4/11/55
Specific Gravity @			
Vapor Pressure @ 25 °C		12.0	
Coefficient of Expansion			
Refractive Index @ n_D			
Infra Red Spectrum (Reference)			
Ultra Violet Spectrum (Reference)			
Viscosity @			
Viscosity @			
Surface Tension			
Solubility in Water			
Solubility in			
Solubility in			
Sp. Gr. Temp. Coeff. (50-100°C)		0.0009/°C	Specs. 4/11/55
Flash Point °F (Method) C.O.C.		382	Aroclor Bulletin OP-115
Fire Point °C		None	" (1954)
Heat Capacity			
Heat of Formation			
Thermal Conductivity (cal./cm/sec./min.)			
Heat Content of Fusion			
Latent Heat of Vap.			
Specific Heat			
Critical Temperature			
Critical Pressure			
Dissociation Constant			

Other Constants

MONS 049820

Toxicity (Give Reference): Schwartz, U. S. Pub. Health Service Bull. 229, 1936. "Industrial Poisons Hazards & Solvents by M. B. Jacobs Vo. 1, p. 463-434 1941.

NOTE: *These data should not be released outside of Monsanto Chemical Company. Use additional sheets if necessary.*

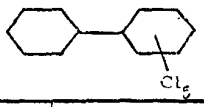
IN 618

PHYSICAL CONSTANTS DATA

SUBSTANCE

AROCLOR 1154 (Technical)

STRUCTURAL FORMULA



COMPILED BY

W. A. M. Ellenburg

DATE 1947 7/5/57

NAME		SOURCE & DATE
Formula $C_{12}H_5Cl_5$	Total Cl_2 53.5 - 54.5%	Specs. 12-21-54
Molecular Weight		
Appearance	Brown to black oily liquid	Specs. 12-21-54
Boiling Point at 760 mm		
Boiling Point at mm		
Boiling Point at mm		
Boiling Point at mm		
Crystalline Melting Point		
Melting Point		
Solidification Point		
Specific Gravity 25/15.5	1.500 - 1.510	" "
Specific Gravity		
Freezing Point °C	12.8	
Coefficient of Expansion		
Refractive Index n_D^{25}		
Ultra Red Spectrum (Reference)		
Ultra Violet Spectrum (Reference)		
Viscosity		
Viscosity		
Surface Tension		
Solubility in Water		
Solubility in		
Solubility in		
Sp. Gr. Temp. Coeff. (55-105°C)	0.00095/°C	" "
Flash Point °F (Method)	None	
Fire Point °C	None	
Point of Combustion		
Heat of Combustion		
Thermal Stability (cal./sq./min.)		
Latent Heat of Fusion		
Latent Heat of Vap.		
Specific Heat		
Critical Temperature		
Critical Pressure		
Dissociation Constant		

Other Constants

MONS 049821

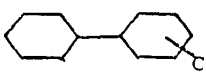
Toxicity (Give Reference)	Schwartz, U.S. Pub. Health Service, Bull. #229 1933 "Industrial Poisons, Vol. 1, -463-364 1941 Hazards and Solvents by M. B. Jacobs

NOTE: *These data should not be released outside of Monsanto Chemical Company. Use additional sheets if necessary.*

IN 619

PHYSICAL CONSTANTS DATA

SUBSTANCE: AROCLOR 1160 (Technical)

STRUCTURAL FORMULA: 

COMPILED BY: [illegible] Ellenburg

DATE: 1947 7/5/57

NAME		SOURCE & DATE
Formula $C_{12}H_{3.75}Cl_{6.25}$	Total Cl_2 59.5-60.5%	Specs. 12-21-54
Molecular Weight		
Appearance	Brown to black sticky mass	Specs 12-21-54
Boiling Point at 760 mm		
Boiling Point at mm		
Boiling Point at mm		
Boiling Point at mm		
Crystalline Point		
Melting Point		
Solidification Point		
Specific Gravity 90/15.5	1.558-1.572	Specs. 12-21-54
Specific Gravity		
Pounds per Cu. ft. 25 °C	13.5	
Coefficient of Expansion		
Refractive Index n D		
Infra Red Spectrum (Reference)		
Ultra Violet Spectrum (Reference)		
Viscosity		
Volatility		
Vapor Pressure		
Solubility in Water		
Solubility in		
Solubility in		
Sp. Gr. Temp. Coeff. (75-130°C)	0.0010/°C	Specs 12-21-54
Flash Point °F (Method)	None	
Fire Point °C	None	
Heat of Combustion		
Heat of Formation		
Thermal Stability (cal./cc/min.)		
Latent Heat of Fusion		
Latent Heat of Vap.		
Specific Heat		
Critical Temperature		
Critical Pressure		
Dissociation Constant		

Other Constants

MONS 049822

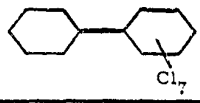
Toxicity (Give Reference)	Schwartz, U. S. Pub. Health Service Bull. #229, 1936 "Industrial Poisons, Hazards and Solvents" by M. B. Jacobs Vol. I p483-464 1941

NOTE: *These data should not be released outside of Monsanto Chemical Company. Use additional sheets if necessary.*

IN 613

PHYSICAL CONSTANTS DATA

SUBSTANCE: AROCLOR 1162 (Technical)

STRUCTURAL FORMULA: 

COMPILED BY: Rev. By A. M. Ellenburg

DATE: 1947, 7/5/47

NAME		SOURCE & DATE
Formula $C_{12}H_3Cl_7$	Total Cl_2 61.5 -62.5%	Specs 4-11-55
Molecular Weight		
Appearance	Brown to black sticky mass	Spec 4-11-55
Boiling Point at 760 mm		
Boiling Point at mm		
Boiling Point at mm		
Boiling Point at mm		
Freezing Point		
Melting Point		
Melting Point		
Specific Gravity 60/15.5	1.577 - 1.587	Spec 4-11-55
Specific Gravity		
Pounds per Gal. @ 25 °C	13.7	
Coefficient of Expansion		
Refractive Index @ °C		
Ultra Red Spectrum (Reference)		
Ultra Violet Spectrum (Reference)		
Viscosity @		
Viscosity @		
Surface Tension		
Solubility in Water		
Solubility in		
Solubility in		
Sp. Cor. TempCoeff. (85-120°C)	0.0010/°C	Spec 4-11-55
Flash Point °F (Method)	None	
Fire Point °C	None	
Heat of Combustion		
Heat of Formation		
Thermal Stability (cal./cc/min.)		
Critical Pressure		
Critical Volume		
Specific Heat		
Critical Temperature		
Critical Density		
Dielectric Constant		

Other Constants

MONS 049823

Toxicity (Give Reference): Schwartz, U.S. Pub. Health Service Bull. #229, 1936 "Industrial Poisons Hazards and Solvents" by M.B. Jacobs Vol. I, p-463-464, 1941

NOTE: *These data should not be released outside of Monsanto Chemical Company. Use additional sheets if necessary.*

ITEM	AROCLOR 1242 TECHNICAL		AROCLOR 1248 TECHNICAL		AROCLOR 1254 TECHNICAL		AROCLOR 1260 TECHNICAL		AROCLOR 1262 TECHNICAL	
	$C_{12}H_7Cl_3$	SOURCE & DATE SPECS 12-21-54	$C_{12}H_6Cl_4$	SOURCE & DATE SPECS 4-11-55	$C_{12}H_5Cl_5$	SOURCE & DATE SPECS 12-21-54	$C_{12}H_{3.75}Cl_{6.25}$	SOURCE & DATE SPECS 12-21-54	$C_{12}H_3Cl_7$	SOURCE & DATE SPECS 4-11-55
PHYSICAL STATE AT 20°C AND 1 ATM	SEMI-VISCOUS OILY LIQ.	"	BROWN-BLACK OILY LIQ.	SPECS 4-11-55	BROWN-BLACK OILY LIQ.	SPECS 12-21-54	BROWN-BLACK STICKY MASS	SPECS 12-21-54	BROWN-BLACK STICKY MASS	SPECS 4-11-55
COLOR										
BOILING POINT AT 760MM										
BOILING POINT AT MM										
BOILING POINT AT MM										
CRYSTALLIZING POINT										
MELTING POINT										
POUR POINT										
SPECIFIC GRAVITY 25/15.5°C	1.348-1.360	SPECS. 12-21-54	1.410-1.420	SPECS. 4-11-55	1.500-1.510	SPECS. 12-21-54	1.558-1.572	SPECS. 12-21-54	1.577-1.587	SPECS. 4-11-55
SPECIFIC GRAVITY 25/15.5°C	1.384-1.397									
VISCOSITY PER SAYBOLT AT 38°C	101.5		12		12.8		13.5		13.7	
COEFFICIENT OF EXPANSION										
REFRACTIVE INDEX										
INFRA RED SPECTRUM (BAIRD)										
(ABOVE 10 MU DIFFRACTION GRAT.)										
VISCOSITY										
VISCOSITY										
SURFACE TENSION										
SOLUBILITY IN WATER										
SOLUBILITY IN										
SOLUBILITY IN										
S.P. GR. TEMP COEFF. (UNITS/°C)	0.0004/°C	SPECS. 12-21-54	0.0004/°C [55-105°C]		0.00045/°C [55-105°C]	SPECS. 12-21-54	0.0010/°C [75-150°C]	SPECS. 12-21-54	0.0016/°C [85-120°C]	SPECS. 4-11-55
FLASH POINT °F (METHOD) C.O.C.	350	ARoclor Bull. CP-115 1954	360	ARoclor Bull. CP-115 1954	NONE		NONE		NONE	
FIRE POINT °C	NONE		NONE		NONE		NONE		NONE	
HEAT OF COMBUSTION										
HEAT OF FORMATION										
THERMAL STABILITY (CM²/SEC/MIN)										
LATENT HEAT OF FUSION										
LATENT HEAT OF VAP.										
SPECIFIC HEAT										
CRIT. TEMPERATURE										
CRIT. PRESSURE										
DISSOCIATION CONSTANT										
TOTAL Cl_2	41.5-42.5%	SPECS 12-21-54	47.5-48.5%	SPECS 4-11-55	53.5-54.5%	SPECS 12-21-54	59.5-60.5%	SPECS 12-21-54	61.5-62.5%	SPECS 4-11-55
TOXICITY (REFERENCE)	SCHWARTZ, U.S. PUBLIC HEALTH SERVICE BULL. 173, 1936 INDUSTRIAL POISONS, HARROW AND SWEENEY BY M.B. TYLOOS, VOL 3 p. 463-464 1941		SAME AS 1242		SAME AS 1242		SAME AS 1242		SAME AS 1242	

MONS 049824

ANNISTON PLANT – MONSANTO COMPANY – ANNISTON, ALA.

TITLE: PHYSICAL CONSTANTS DATA-CRUDE AROCLORS

AUTH. NO.

JOB NO.

DRAWN BY | CHECKED | APPROVED | DATE | SCALE

TS-B

Name	Aroclor 1242		Aroclor 1248		Aroclor 1254		Aroclor 1260		Aroclor 1262	
		Source & Date		Source & Date		Source & Date		Source & Date		Source & Date
Appearance	Colorless Viscous Oil	Monsanto Bulletin	Colorless Viscous Oil	M.B. 09-115	Pale Yellow Viscous Oil	M.B. 09-115	Pale Yellow Viscous Oil	M.B. 09-115	Colorless Viscous Oil	M.B. 09-115
Boiling Point At 760 mm	325-366 °C		345-365 °C		365-390 °C		385-420 °C		390-425 °C	
Boiling Point At 3 mm	192 °C	"	182-190 °C	"	277-323 °C	"	325-345 °C	"		
Boiling Point At mm										
Boiling Point At mm										
Crystal Form	Non-Crystallizing	"	Non-Crystallizing	"	Non-Crystallizing	"	Non-Crystallizing	"		
Melting Point										
Specific Gravity	1.38 @ 25/25 °C	"	1.445 @ 25/25 °C	"	1.538 @ 25/25 °C	"	1.620 @ 25/25 °C	"	1.646 @ 25/25 °C	"
Specific Gravity	1.380-1.392 @ 25/25 °C	Spec. 4-14-55 M.B. 09-115	1.440-1.465 @ 25/25 °C	Spec. 4-14-54 M.B. 09-115	1.495-1.505 @ 25/25 °C	Spec. 2-14-55 M.B. 09-115	1.555-1.566 @ 25/25 °C	Spec. 2-14-55 M.B. 09-115	1.627-1.637 @ 25/25 °C	Spec. 4-11-55 M.B. 09-115
Flash Point, °C	None		176		None		None		None	
Combustion Point, °C	None		340		None		None		None	
Pour Point, °C	-19		-12.04	M.B. 09-115	12.92	M.B. 09-115	13.50	M.B. 09-115	13.72	
Conductivity at Extinction	Complex @ °C at 25 °C		Complex @ °C at 25-65 °C	"	Complex @ °C at 25-65 °C	"	Complex @ °C at 25-65 °C	"	Complex @ °C at 25-65 °C	"
Resistivity, Meg. 25 °C	1.6 x 10^12 @ 25 °C	Spec. 2-14-55	1.6 x 10^12 @ 25 °C	Spec. 4-14-54	1.6 x 10^12 @ 25 °C	Spec. 2-14-55	1.6 x 10^12 @ 25 °C	Spec. 2-14-55	1.6 x 10^12 @ 25 °C	"
Index Ref. Specific Ref.										
Ultra Violet Spectrum										
Viscosity At	34-25 SUS at 210°F	M.B. 09-115	33-40 SUS at 130°F	M.B. 09-115	44-48 SUS at 210°F	M.B. 09-115	72-78 SUS at 210°F	M.B. 09-115	96-100 SUS at 210°F	Spec. 4-11-55
Viscosity At	82-92 SUS at 100°F	"								
Solubility in Water	4.5 ppm	J. Chem. Eng. Data 7:166 (1962)	4.4 ppm	T.C.A. Soc. Vol. 64 (1942)	50.3 at 25 °C	"	Insoluble	"		
Solubility in Water	Insoluble	M.B. 09-115	Insoluble	M.B. 09-115	Insoluble	"				
Solubility in 3% Alkali	23.2 g/100 cc at 20 °C		Soluble at 25 °C	"	Soluble at 27 °C	"				
Solubility in Petroleum	132.5 g/100 cc at 30 °C		Insoluble at 29 °C	"	Insoluble at 31 °C	"				
Flash Point, °C	180 °C	"	196 °C	"	None	"	None	"	None	"
Fire Point, °C	None	"	None	"	None	"	None	"	None	M.B. 09-115
Heat of Combustion										
Heat of Formation										
Thermal Stability (Volatility)										
Latent Heat of Fusion										
Latent Heat of Vaporization	61	Calculated M.B. 09-115	54	Calculated M.B. 09-115	50	Calc. M.B. 09-115	48	Calc. M.B. 09-115		
Specific Heat At 25 °C	0.213		0.277		0.261		0.228			
Critical Temperature										
Critical Pressure										
Dissociation Constant										
Other Constants: Specific Heat	0.380 at 30 °C	M.B. 09-115	0.256 at 100 °C	M.B. 09-115	0.236 at 300 °C	M.B. 09-115	0.303 at 300 °C	M.B. 09-115		
Other Constants: Boiling Point	340 °C at 760 mm	"	365-375 °C at 760 mm	To Be Published	385-420 °C at 760 mm	To Be Published	390-425 °C at 760 mm	To Be Published	35-38 °C	
Other Constants: Dielectric Constant 1000 cycles	4.7 4.4	M.B. 09-115	4.5-4.7	M.B. 09-115	4.15-4.35	M.B. 09-115	3.6-3.8	"		
Toxicity (Reference)	Contact Medical Dept.	M.B. 09-115	Contact Medical Dept.	M.B. 09-115	Contact Medical Dept.	M.B. 09-115	Contact Medical Dept.	M.B. 09-115	Contact Medical Dept.	M.B. 09-115

ANNISTON PLANT — MONSANTO COMPANY — ANNISTON, ALA.

TITLE: PHYSICAL CONSTANTS DATA - REFINED AROCLORS					AUTH. NO.
					JOB NO.
DRAWN BY	CHECKED	APPROVED	DATE	SCALE	TS-B

MONS 049825

NAME	PYRANOL 1467	PYRANOL 1470	PYRANOL 1481	PYRANOL 1488	AROCLOR 1254-40% Trichlorobenzene	AROCLOR 1260-10% Trichlorobenzene
MFR.	Source & Date	Source & Date	Source & Date	Source & Date	Source & Date	Source & Date
Appearance	Mon. Chem. Manual	Mon. Chem. Manual Spec. 4-28-55	Mon. Chem. Manual Co. Spec. 4-28-55	Mon. Chem. Manual Co. Ref. 1	Lt. Colored Viscous Liq. Spec. 3-10-55	Straw Liquid Spec. 4-11-55
Color, Max.	250-415°C	240-415°C	250-415°C	250-415°C		
Boiling Point At mm						
Boiling Point At mm						
Boiling Point At mm						
Distillation Range						
Molecular Wt.						
Color, Max.						
Specific Gravity 15/15.5°C	1.560-1.568 "	1.543-1.571 "	1.525-1.535 "	1.560-1.568 "	1.423-1.449 "	1.475-1.495 at 46/15.5°C "
Specific Gravity At 37/65°C					12 "	12.5 "
Weight Per Gal. 15.5°C	13.05 "	13.08 "	12.75 "	13.05 "		
Coefficient Of Expansion 25/100°C	0.0007 cu/cu/°C "	0.0007 cu/cu/°C "	0.0007 cu/cu/°C Ref. 2	0.0007 cu/cu/°C "		
Refractive Index 25°C	1.6137-1.6147 "	1.6075-1.6095 "	1.6205-1.6215 Spec. 4-28-55	1.6137-1.6147 "		
Index Red Spectrum (Dry)						
Ultra Violet Spectrum (Red)						
Viscosity 100°F	52-56 SUS "	41-45 SUS "	70-82 SUS "	52-56 SUS "		50.2 cs (232 SUS) WGK Lab 3-8-56
Viscosity 210°F	7.5cs at 20°C Ref. 2			7.5cs at 20°C Ref. 2		3.5 cs (39 SUS) " " "
Viscosity						
Surface Tension						
Solubility In Water						
Solubility In						
Solubility In						
Flash Point (Cleveland Open Cup)	None To Boiling Ref. 1	None To Boiling "	None To Boiling "	None To Boiling Ref. 1	390°F WGK Lab Data 8-12-57	405 °F Open Cup WGK Lab 12-5-46
Fire Point °C					390°C " "	410 " " " "
Heat Of Combustion						
Heat Of Formation						
Thermal Stability (cal/mole-hr)						
Latent Heat Of Fusion						
Latent Heat Of Vap.						
Specific Heat 25-100°C	0.26 Ref. 2			0.26 Ref. 2		
Critical Temperature						
Critical Pressure						
Dissociation Constant						
Pour Point	-32°C or Lower Ref. 1	-44°C or Lower "	-15°C or Lower "	-32°C or Lower Ref. 1	-2°F " "	
Dielectric Constant 77°C 25°C	3.7-4.0 "	3.8-4.2 "	4.1-4.8 "	3.7-4.0 "		
Thermal Expansion Coefficient	20x10⁻⁴ At 50°C Ref. 2			20x10⁻⁴ At 50°C Ref. 2		
Conversion	60% Arochlor 1260 40% Trichlorobenzene 0.65% Tetrachlorobenzene	45% Arochlor 1260 55% Trichlorobenzene Inhibitor	75% Arochlor 1254 25% Trichlorobenzene	60% Arochlor 1260 40% Trichlorobenzene	60% Arochlor 1254 40% Trichlorobenzene	90% Arochlor 1260 10% Trichlorobenzene
Reference Letter Ltr. 55 Paragraph 2-Material Safety Data Sheet						
Toxicity (Reference)	Contact Mfg. Dept.	Contact Mfg. Dept.	Contact Mfg. Dept.	Contact Mfg. Dept.	Contact Mfg. Dept.	

OTHER CONSTANTS

ANNISTON PLANT — MONSANTO COMPANY — ANNISTON, ALA.

TITLE: CHEMICAL CONSTANTS DATA - PYRANOLS

AUTH. NO.

JOB NO.

DRAWN BY	CHECKED	APPROVED	DATE	SCALE

TS-B

MONS 049826

Name	Aroclor 1262-10% Chlorine	Chlorine	Chemenyl	Ferric Chloride, Anhyd.	Hydrated Lime Calcium Hydroxide	Inerteen P.P.O.
Formula				$FeCl_3$	$Ca(OH)_2$	
Molecular Weight		70.914	546.39	166.22	74.10	
Appearance	Straw Liquid		Color, Amber	Dense Sublimation Crystal	White Powder	
Boiling Point At 760 mm		-34.05 °C	Appr. 1941-42			
Boiling Point At mm		-71.52 at 100 mm	ZIM. Cert. Tables			
Boiling Point At mm		-100.06 " "	Source File #137			
Boiling Point At mm		-137.66 " "	1935			
Crystalline Point						
Melting Point		-154.98				
Solution Point						
Specific Gravity	1.489-1.516 at 40/15.5°C	1.488 at 0°C	0.7696 at 0°C	Sublimes	Decomposes	1.560-1.568, 15.5/15.5°C
Specific Gravity			1.046 " 20°C		2.2 at 20°C	
Pounds Per Gal. 25°C	12.7		1.0 at 77°C		4 at 20°C	13.05
Coefficient Of Expansion						0.0007 cal/cc/°C (0 to 100°C)
Refractive Index		1.47 at 0°C	D=1.55822 at 77.1°C		~1.574, Eb 1.565	1.4133-1.4157 25°C
Index Red Spectrum (Ref)						
Index Red Spectrum (Abs)						
Viscosity	103.3 cs (477 SUS) 100°F		248.8 Saybolt Sec. 100°C			52-56 SUS 100°F
Viscosity	4.5 cs (41 SUS) 210°F		31.2 " 70°C			15 cs. 27°C
Surface Tension Dyne/cm			29.5 at 129.2°C			
Solubility In Water			Ext. Cert. Tables			
Solubility In Abs. Alc. 19.5°C			Less than			
Solubility In 80% Methanol 19.5°C			4.98 g/100 g Solv.			
Solubility In Benzene 25.5°C			6.67 g/100 g "			
Solubility In Heptane 26.5°C			13.7 g/100 g "			
Flash Point °F (Open)			255 Tag Open Cup			
Flash Point °F (Closed)	185 Tag Open Cup		255 Pensky Cup			
Fire Point °F	210 " "		270 Open Cup			
Heat Of Combustion			Less than 1504.6			
Heat Of Formation						
Thermal Stability (Cooling Time)						
Latent Heat Of Fusion			53.1 B'u/lb			
Latent Heat Of Vap.			126.5 B'u/lb, 255°C			
Specific Heat			0.43 B'u/lb/°F			
Critical Temperature		144.5°C	572°C			
Critical Pressure		76.1 atmos.	41.4 atm. Abs.			
Absorption Coefficient						
Pour Point	0°C					-32°C or Lower
Specific Gravity		1.377 at 25°C				
Solubility In Water				Decomposes On Exposure To Moist Air		
Dielectric Constant 100°C 60 cy.					.0779% at 100°C	3.7-4.0
Thermal Conductivity cal/cm/sec/°C					Soluble Acids And NH4Cl	20×10⁻⁴ at 50°C
Other Constants						
Toxicity (Reference					Contact Med. Dept.	

[1] Dr. McLester, Asst. Agent Report Copy in St. Louis Pensions File.

[2] Perry May "Chemistry of Synthetic Drugs" 2nd Ed., 1937

Reference 1 - Calc. From Det. Data
Reference 2 - Monsanto Chlorine
Reference 3 - Penn-Salt Chem Co. Tech Data Sheets & Specs
Reference 4 - Lange's Handbook Ed. 9, 1956
Reference 5 - Information By Vendor
Reference 6 - Specs. 6-6-65
Reference 7 - Monsanto Chemical Ltd.

ANNISTON PLANT — MONSANTO COMPANY — ANNISTON, ALA.

TITLE: PHYSICAL CONSTANTS DATA

AUTH. NO.

JOB NO.

DRAWN BY | CHECKED | APPROVED | DATE | SCALE

TS-8

MONS 049827

General Properties

The Aroclors range in form and appearance from mobile oily liquids to fine white crystals and hard transparent resins. They are non-oxidizing, permanently thermoplastic, of low volatility and non-corrosive to metals. They are not hydrolyzed by water, alkalies or acids. The viscous liquids and the resins will not support combustion when heated alone.

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

The excellent electrical properties, fire resistance and inertness of the Aroclors make them useful in many applications.

The properties imparted by the Aroclors and their usefulness for particular applications vary in regular gradients over the series so that the selection of the right Aroclor for a specific use can generally be made simply by a comparison of the physical properties of the several Aroclors.

MONS 049828

GENERAL PHYSICAL PROPERTIES

	Aroclor 1221	Aroclor 1232	Aroclor 1242	Arcolor 1248	Aroclor 125
Form	Colorless mobile oil	Practically colorless mobile oil	Practically colorless mobile oil	Yellow tinted mobile oil	Light yellow viscous oil
Color	50 Max. (APHA)	60 Max. (APHA)	100 Max. (APHA)	100 Max. (APHA)	150 Max. (APHA)
Acidity—Maximum (Mgm. KOH per Gm.)	0.015	0.015	0.015	0.015	0.015
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 25°/25°C (77°/77°F)	1.182	1.266	1.380	1.445	1.538
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°–360°	340°–375°	365°–3
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)	30–31	31–32	34–35	36–37	44–48
Sec. (ASTM—D-88) 130°F (54.4°C)	35–37	39–41	49–56	69–78	260–340
100°F (37.8°C)	40–42	47–50	80–93	185–240	1800–2500

*NONE indicates—"No fire point up to boiling temperature"

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OF SOME OF THE AROCLORS

Aroclor 1260 Light yellow soft sticky resin	Aroclor 1262 Light yellow sticky clear resin	Aroclor 1268 White opaque resin	Aroclor 4465 Yellow transparent brittle resin	Aroclor 5442 Yellow transparent sticky resin	Aroclor 5460 Yellow transparent resin	Aroclor 2565 Brown-black opaque resin
150 Max. (APHA)	150 Max. (APHA)	1.5 Max. NPA	2.0 Max. NPA	1.5 Max. NPA	2.0 Max. NPA	—
0.015	0.02	0.05	0.05	0.05	0.07	1.4
0.00067 (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)	0.00066 (25°–65°C)
1.620 13.50	1.646 13.72	1.810 15.09	1.670 13.91	1.470 12.24	1.670 13.91	1.734 14.44
120°	400°–430°	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°—3 hrs.)	0.2 to 0.3 —
None	None	None	None	247° 477°	None	None
None	None	None	None	>350° >662°	None	None
31°	37°	—	—	46°	—	—
88°	99°	—	—	115°	—	—
—	—	135° to 160° (hold pt.)	60° to 66°	50° to 61°	100° to 105.5°	66° to 72°
—	—	275° to 320° (hold pt.)	140° to 151°	113° to 122°	212° to 222°	149° to 162°
1.647–1.649	1.6501–1.6517	—	1.664–1.667	—	1.660–1.665	—
72–78	90–103	—	90–130 (266°F or 130°C)	300–400	—	—
3200–4500	600–850 (160°F or 71°C)	—	—	—	—	—
—	—	—	—	—	—	—

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TABLE II — Resistance of Structural Materials to Aroclors

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 Phenol Furfural Resin	*D	P	*R	P	D	P
Formvar Highly Plasticized	De	T	Pe	T	T	T
Formvar Low Plasticized	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
Plexiglas (Methyl Methacrylate)	*D	P	*D	P	P	P
Polystyrene (Lustron B)	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.

RR—Excellent resistance—less than 1.0×10^{-6} cm/day penetration or .00014 in/yr.

R—Good resistance—has penetration between 1.0×10^{-6} and 10×10^{-6} cm/day or between 0.00014 and 0.0014 in/yr.

D—Doubtful resistance, penetration between 10×10^{-6} cm/day and 100×10^{-6} cm/day or between 0.0014 and 0.014 in/yr.

P—Poor resistance—penetration greater than 100×10^{-6} 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.

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ADHESIVENESS

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

The softer Aroclors are indicated where a flexible non-drying, water-resistant strongly adhesive material is required.

The Aroclor adhesives are thermoplastic; are readily applied hot without solvent; do not require high temperatures for easy application, and are set immediately upon cooling.

SPECIFIC VOLUME

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

Temp. °F	Aroclor 1248 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

AVERAGE COEFFICIENTS OF EXPANSION, AROCLOR 1248

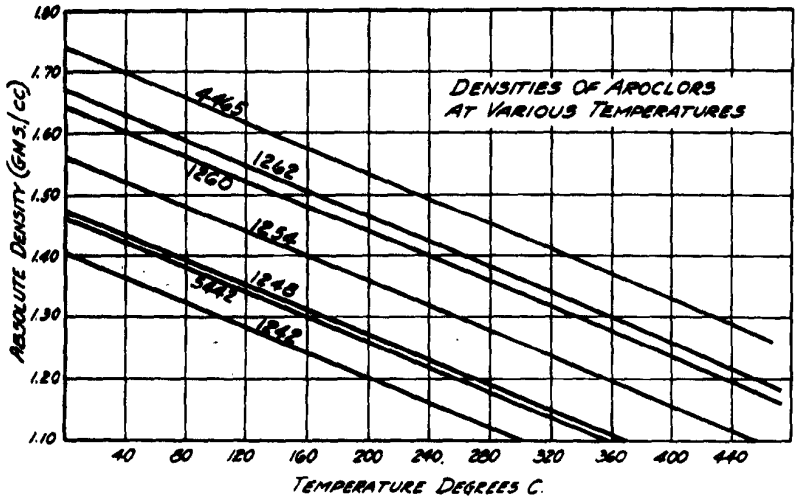
The average coefficient of expansion of Aroclor 1248 per degree F. within the various temperature ranges indicated in the table below was determined by using the simple formula $Vt = Vt^1 [1+a (t - t_1)]$. The coefficient, a, has been calculated at 100°F increments, as follows:

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

CORROSION

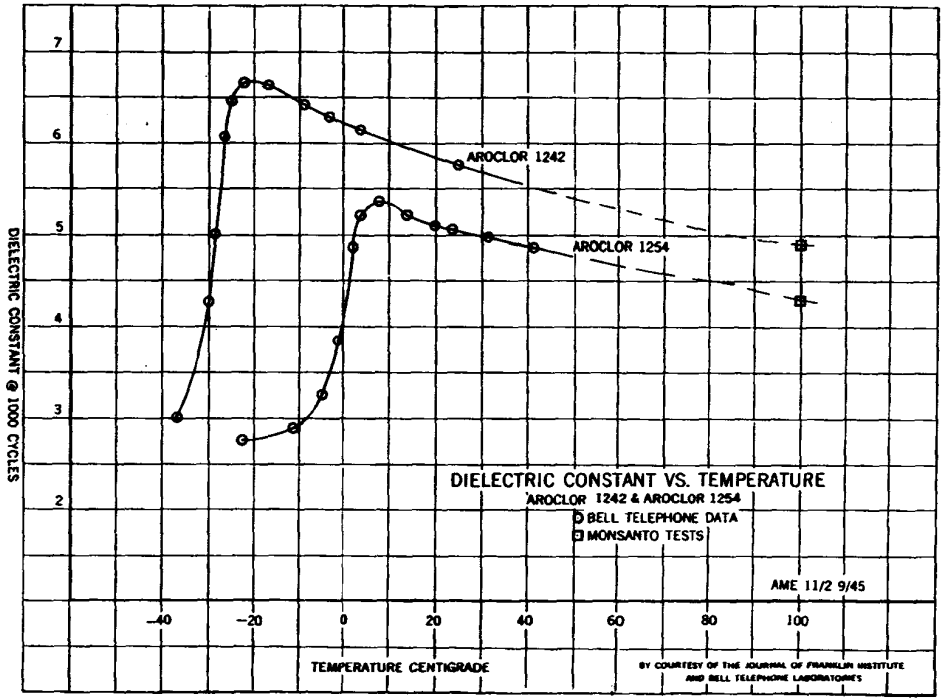
The Aroclors show practically no corrosive effect on metals within normal ranges of temperature. They do attack many plastics materials of construction as shown in Table II.

FIG. 1



MONS 049832

FIG. 2



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DENSITY

All the Aroclors are heavier than water, a valuable property for many applications. Densities are shown in Figure 1.

ELECTRICAL PROPERTIES

The Aroclors have 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.

The dielectric constants of Aroclors 1242 and 1254 at various temperatures are shown graphically in Figure 2. The electrical properties of the Aroclors are shown in Table III.

NON-DRYING PROPERTIES

The Aroclors are non-drying, and when they are exposed to the air, even in thin films, no noticeable oxidation or hardening takes place. However, when used as ingredients of lacquers, they do not retard the rate of drying of the lacquer films. Quick drying varnishes and paints may be made with Aroclor resins.

NONFLAMMABILITY

The viscous Aroclor oils and the resins do not support combustion when heated alone, even at their boiling points — temperatures above 350°C. Most of the Aroclors flux readily with resinous and pitch-like materials to give a product having a decreased fire hazard. When incorporated in nitrocellulose films and rubber foams the Aroclors retard the rate of burning.

SOLUBILITY

All Aroclors are insoluble in water. Solubilities of some of the Aroclors in the more common substances are shown in Table VI.

The Aroclor oils and resins are readily soluble in most of the common organic solvents and drying oils. The hard crystalline materials are in general less soluble than the Aroclor oils or softer resins. Compatibility data on Aroclors in nitrocellulose lacquers are shown on page 18.

SPECIFIC HEAT AND THERMAL CONDUCTIVITY

The specific heat at different temperatures of several of the Aroclors is shown in Figure 3. This, together with the thermal conductivity data given in Table IV, enable calculations involved in the use of Aroclors as high-temperature, low pressure, fluid heat-transfer media.

***TABLE III* — 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 500×10^9	Greater than 35KV	<0.1%
1248	5.6	4.6	Above 500×10^9	Greater than 35KV	<0.1%
1254	5.0	4.3	Above 500×10^9	Greater than 35KV	<0.1%
1260	4.3	3.7	Above 500×10^9	Greater than 35KV	<0.1%
1268	2.5	—			
5442	3.0	4.9	Above 500×10^9		
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

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FIG. 3

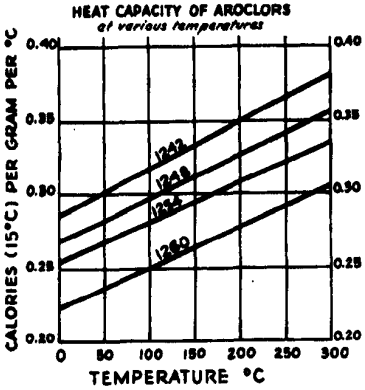

Table IV

Thermal Conductivity of Aroclor 1248

Temperature °C.	°F.	BTU./Hr./Sq. Ft./°F./Ft.	Calories, gram/Sec./Sq.Cm./°C./Cm.
30	90	0.0680	281×10^{-4}
60	140	0.0687	284×10^{-4}
100	212	0.0697	288×10^{-4}

STABILITY

Toward Alkalies

The Aroclors are remarkably resistant to the action of either hydrolysing agents or high temperature. They are not affected by boiling with sodium hydroxide solution.

Toward Acids

Experiments were made to determine whether hydrogen chloride is evolved during the treatment of Aroclors 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 solution 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 only a slight trace (too small for quantitative measurement) of hydrogen chloride in the acid layer.

Toward Heat

Because of their stability to heat, the Aroclors are useful heat-transfer media. 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 are at the same time nonflammable.

Toward Oxidation

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

SURFACE TENSION

The surface tension of Aroclor 1254 in dynes per centimeter is as follows:

Temperature	Surface Tension—dynes cm.
25°C	50.3
80°C	44.0
100°C	42.0

THERMOPLASTICITY

The Aroclors are permanently thermoplastic. They apparently undergo no condensation or hardening upon repeated melting and cooling. The clear Aroclor resins are now being produced with softening points up to 105°C. The opaque crystalline solids are produced with initial melting points up to approximately 290°C.

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TABLE VI—Solubility of Aroclors in 100 Milliliters of Various Solvents

Aroclor	1242		1248		1254		1270		4465		5460
Type of Solvent	25°C	Hot	25°C	Hot	25°C	Hot	Cold	Hot	Cold	Hot	25°C
Acid											
Acetic Acid	S	S	—	—	S	S	—	—	SS	S	—
Oleic Acid	S	S	—	—	S	S	—	—	S	VS	—
Benzoic Acid	10.0 21°C	—	10.0 20°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 20°C	440 99°C	—	—	114 21°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	—
Dichloroethylene	—	—	—	—	—	—	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 21°C	397 99°C	VS	VS	173 21°C	259 99°C	—	—	SS	—	—
Cellosolve	S	S	S	S	S	S	—	—	S	—	—
Diethylene Glycol	—	—	—	—	—	—	—	—	S	—	—
p-p' Dihydroxy Ethyl Ether	16.9 22°C	19 99°C	SS	SS	8 20°C	10 100°C	—	—	SS	—	—
Hydrocarbon											
Benzene	VS	VS	VS	VS	VS	VS	3.5	—	VS	VS	113
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 37.8°C	S	2.0 20°C	S	—	S	—	—	<3.0	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 20°C	80.0 70°C	—	—	10 21°C	28 78°C	—	—	SS	—	—
Glycerine	I	I	I	I	I	I	I	I	I	I	—
Methyl Alcohol	12.5 20°C	88.5 60°C	—	—	15 20°C	22.2 60°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.

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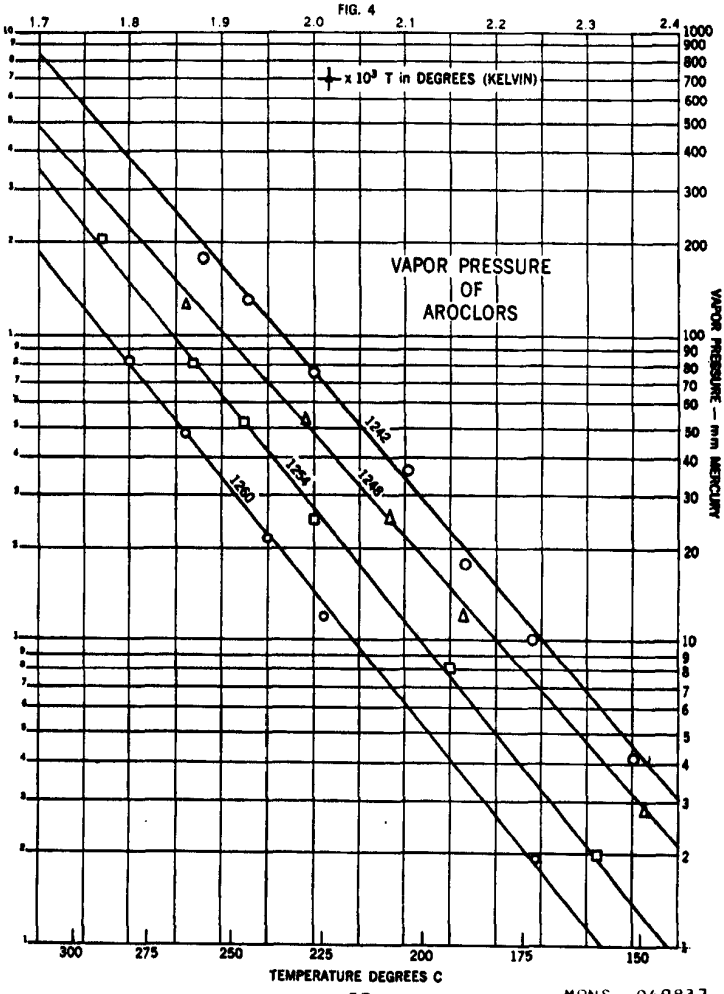
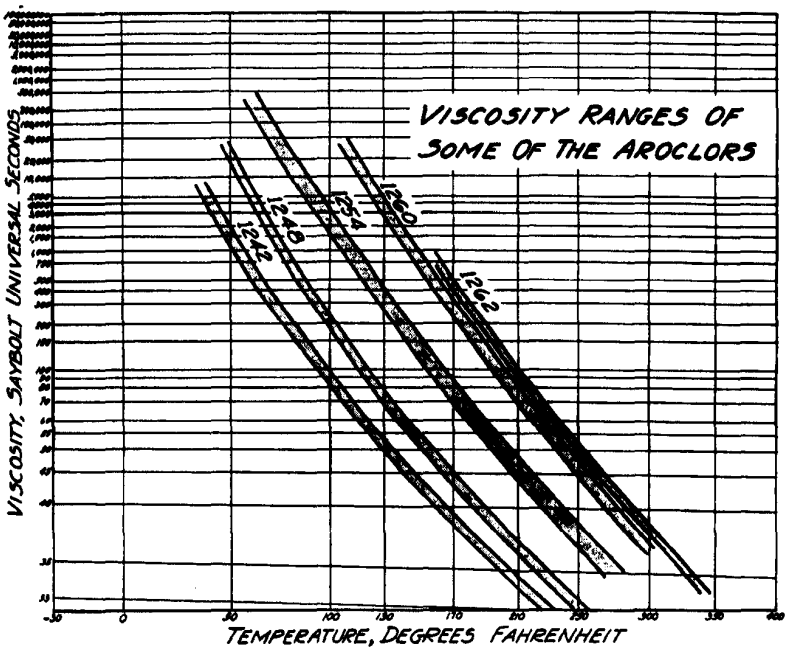
FIG. 4



MONS 049837

FIG. 5



VAPORIZATION LOSS

The low vaporisation loss of Aroclors is indicated in the following Table VII.

It is concluded that the vaporisation rates of Aroclors—especially 1254 and 1260 which are the most widely used members of the Aroclor family in the plasticizer field, compare most favorably with the similar constants of other plasticizers selected specifically for these tests because of their low vaporisation rates.

VAPOR PRESSURES

The vapor pressures of several Aroclors are indicated in Figure 4 over the temperature range, 150° to 300°C. The following estimated vapor pressures of several Aroclors at 100°F shown in Table VIII were determined by extrapolation from the values shown in Figure 4.

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TABLE VII

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
Clorafin-42-S	0.0745	48	12.28	0.000126
DOP (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

TABLE VIII

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 049839

D

MONS 049840

STANDARD MANUFACTURING PROCESS
FOR
AROCLOR

APPENDIX D - UTILITIES

The following is a list of utilities supplied to the Aroclor Department:

Steam

Steam is supplied to the department through a 6" main at 120 PSIG. Standard practice on steam is 137.5 lbs/cwt. Liquid Aroclors, 239.5 lbs/cwt. Solid Aroclors.

Recovered Water

Recovered water is supplied through a 6" main from a cooling tower. Standard practice is 625 gals/cwt. Liquid Aroclors, 1,197 gals/cwt. Solid Aroclors.

Electricity

Electrical power is supplied at 440 volts for power and 110 volts for lighting. Standard practice is 3.25 KWH/cwt. Liquid Aroclors, 7.19 KWH/cwt. Solid Aroclors.

Natural Gas

Natural gas is supplied through a 3" main at 40 psig. Standard practice is 0.1625 MCF/cwt. Liquid Aroclors, 0.5389 MCF/cwt. Solid Aroclors.

MONS 049842

STANDARD MANUFACTURING PROCESS
FOR
AROCLORS

APPENDIX E - PERSONNEL

The Aroclor operations require one Chief Operator, Classification A-2, and four Operators, Classification A-4, per shift. The chief operator is in charge of all Aroclor operations during his shift. He is also in charge of the Biphenyl group of products. A relief chief operator relieves a regular chief operator one shift per week, and an operator four shifts per week. He also works for the regular chief operator during vacations, sickness, and other absences. Each operator is assigned a specific job and is responsible for the operation of his job. There are ten (10) laborers, Classification A-8, employed in the Aroclor-Biphenyl group of departments. Each shift has a minimum of two laborers while some shifts have three laborers. Approximately 60% of all laborers' time is spent in Aroclor operations. The laborers' duties consists of filling drums, bags, crushing, screening, and milling of various products. They also clean tank cars.

The Aroclor Department is supervised by a Production Supervisor and a Production Foreman.

Attached is a Job Classification Schedule and Schedule of Hourly Wage Rates which also shows length of time required between automatic rate increases.

JOB CLASSIFICATION SCHEDULE AND SCHEDULE OF HOURLY WAGE RATES
AUTOMATIC RATE INCREASE GIVEN AT END OF:

Appendix A October 15, 1965 Department and Classification	Probationary Period Starting Rate	12 Weeks	24 Wks.	32 Wks.	40 Wks.	48 Wks.	60 Wks.	72 Wks.	108 Wks.	144 Wks.	180 Wks.	208 Wks.	Max. Day Rate	Job Shift Rate
A. Production Department														
2. Chief Operator -----Filled by upgrading --					--	--	--	--	--	3.12	3.17	3.22	3.22	Day Rate Plus 7.5%
4. Operator	--	--	--	--	--	2.84	2.89	2.94	2.99	--	--	--	2.99	
7. Operator Trainee	2.48	2.61	2.66	2.72	2.77-(1)	--	--	--	--	--	--	--	2.77	
8. Operating Labor	2.40	2.46	2.49	2.52	--	--	--	--	--	--	--	--	2.52	

(1) May be employed at any of foregoing rates when having special qualifications.

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STANDARD MANUFACTURING PROCESS
FOR
AROCLOR

APPENDIX F - PACKAGING AND SHIPPING

Solid Aroclors are packaged for shipment in 41 gallon Fibre drums, 40 gallon galvanised drums, 5 gallon galvanised cans, and in paper bags.

Liquid Aroclors are packaged in 55 gallon steel drums, and 5 gallon steel cans. These drums and cans are lined with one coat of A & W 4.A lacquer. Liquid Aroclors are loaded into tank cars and trucks. Tank cars used for electrical grade material are either aluminum or zinc and tin lined. All trucks are stainless steel. Occasionally non-electrical Aroclor is loaded into an iron car.

All tank cars and trucks are entered, cleaned, and inspected prior to loading.

APPENDIX I

AROCLOR FINISHED GOODS

CONTAINER WEIGHTS

Material	Weights Lbs.	Container
1221	50 or 520	5 Gal.-55 Gal. Steel Drum
1232	50 or 550	" " " "
1242	55 or 600	" " " "
1248	55 of 600	" " " "
1254	60 or 600	" " " "
1260	60 or 600	" " " "
1262	60 or 600	" " " "
1262 - 10% Toluene	60 or 600	" " " "
1262 - 10% Xylene	60 or 600	" " " "
1260 - 10% Toluene	60 or 600	" " " "
A13B3B	65 or 675	" " " "
5442	50 or 450	5 Gal.-40 Gal. Galv. Drum
4465	50 or 500	" " " "
2565	500	" " "
Inerteen PPO	65, 360 or 674	5 Gal.-30 Gal.-55 Gal. Drums
Inerteen 54201-KA	674	" " "
Santicizer 794	600	" " "
MCS 295	695	" " "
5060	100	Paper Bag
5460	100	Paper Bag
1268	200	41 Gal. Fibre Drums

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STANDARD MANUFACTURING PROCESS
FOR
AROCLORS

APPENDIX G - MATERIAL BALANCE

Standard and Theoratical usages of raw materials and hydrogen chlorine produced for each Aroclor is shown in Figure 3.

Figures 1 and 2 show the relationship between average number of chlorine atoms and per cent chlorine for Biphenyl and Santowax base Aroclors.

Figure 4 gives molecular weights of the various Biphenyl base Aroclors.

FIGURE No 1

CHLORINE ATOMS PER MOLECULE
CHLORINE ATOMS ON DIPHENYL MOLECULE
CHLORINATION - %
0
10
20
30
40
50
60
70
80
90
100
1221
1242
1262
1280
1298
1314
1328
1342
1356
1368
1380
1392
1404
1416
1428
1440
1452
1464
1476
1488
1500
1512
1524
1536
1548
1560
1572
1584
1596
1608
1620
1632
1644
1656
1668
1680
1692
1704
1716
1728
1740
1752
1764
1776
1788
1800
1812
1824

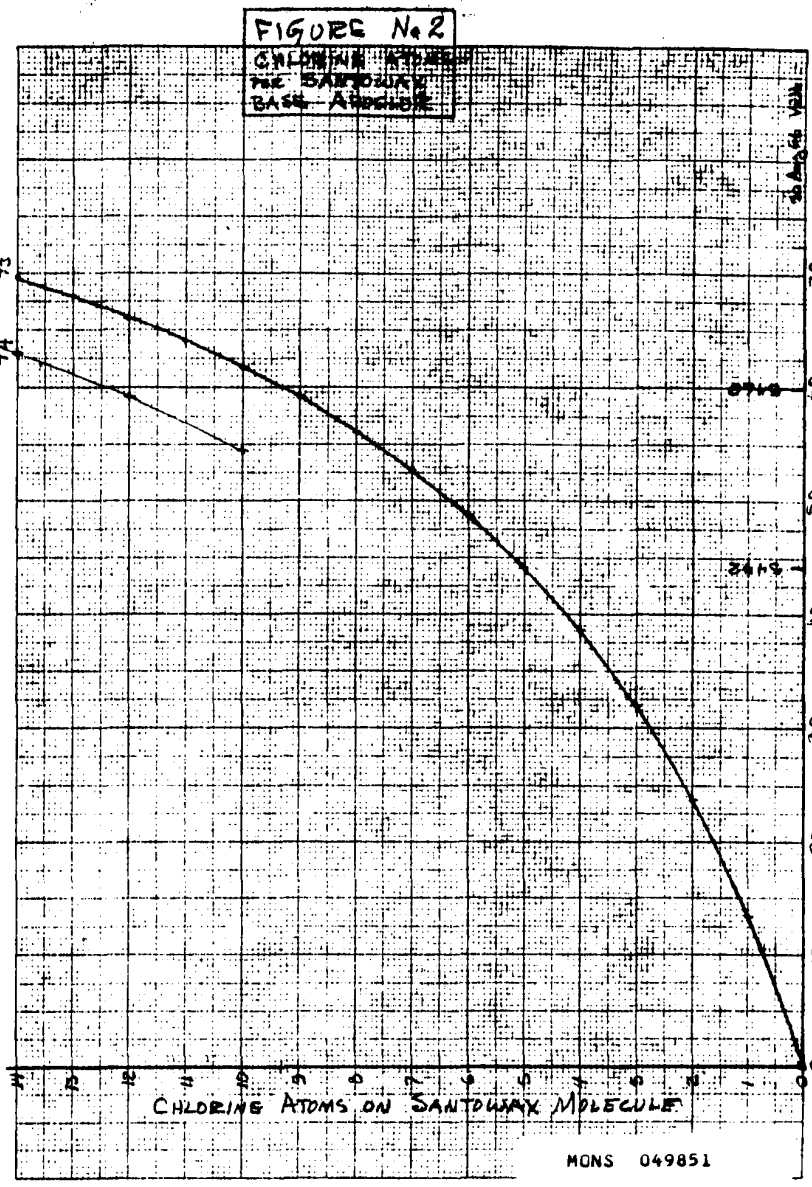
FIGURE No 2
CHLORINATION OF THE SANTOWAX BASE ARACLOR
CHLORINATION - %
CHLORINE ATOMS ON SANTOWAX MOLECULE
MONS 049851

FIGURE NO. 3
Theory and Standard Usage for Aroclors
Lbs. per CWT Aroclor

Aroclor	Biphenyl		Santowax R		Santowax C		Chlorine		Hyd. Chloride	
	Theor.	Std.	Theor.	Std.	Theor.	Std.	Theor.	Std.	Theor.	Std.
1221	79.60	82.06	--	--	--	--	42.00	45.16	21.59	~~18.33~~ 20.57
1242	59.19	61.02	--	--	--	--	84.00	90.32	~~31.90~~ 43.19	~~38.70~~ 40.17
1248	53.37	55.02	--	--	--	--	96.00	103.23	~~43.10~~ 49.36	~~41.04~~ 49.90
1254	47.53	49.00	--	--	--	--	108.00	116.13	~~49.34~~ 55.53	~~42.19~~ 51.64
1260	41.71	43.00	--	--	--	--	120.00	129.03	~~56.57~~ 61.70	~~53.43~~ 57.38
1262	39.76	40.99	--	--	--	--	124.00	133.33	~~61.60~~ 63.76	54.18 59.30
1268	33.93	39.68	--	--	--	--	136.00	163.86	~~69.00~~ 69.93	~~58.82~~ 54.54
2565	27.63	28.19	--	--	9.21	9.40	130.00	132.65	~~66.00~~ 69.63	~~56.00~~ 66.84
4465	22.10	25.86	14.74	17.24	--	--	130.00	156.63	~~66.00~~ 66.85	~~56.00~~ 52.14
5442	--	--	59.19	69.23	--	--	84.00	101.20	~~43.18~~ 43.19	~~36.71~~ 33.69
5060	--	--	41.71	42.55	--	--	120.00	122.45	~~61.60~~ 61.70	~~52.13~~ 59.23
5460	--	--	41.71	48.78	--	--	120.00	144.58	~~61.60~~ 61.60	~~52.13~~ 48.13

EUGENE DIETZGEN CO.
MADE IN U.S.A.

FIGURE No. 4



MONS 049854

STANDARD MANUFACTURING PROCESS
FOR
AROCLOR

APPENDIX B - ATMOSPHERIC & STREAM DISCHARGE & WASTE DISPOSAL

The following is an estimate of the atmospheric and stream discharge from the Aroclor operations at the maximum rate of 4,027,000 lbs/month.

	Type	Amount
Chlorine	Atmospheric	Negligible
HCL (Gas)	Atmospheric	Negligible
Monters	Plant Dump	Approximately 10% of Total Aroclor Production



MONS 049856

STANDARD MANUFACTURING PROCESS
FOR
AROCLOR

APPENDIX I - PROCESS CONTROL PROCEDURES

Control samples are taken from the chlorinator circulating line at intervals throughout the chlorination. The samples are checked, by the operator, for specific gravity, softening point or hold point dependent upon the Aroclor being produced. Temperature readings are taken every hour and recorded on data sheet.

A representative sample is taken of all distilled Aroclors and sent to the Analytical Laboratory for control tests prior to drumming, bagging, or loading into tank cars or trucks. The following control tests are performed by the Laboratory:

Test (Liquid Aroclors)	Anniston Analytical Method No.
Specific Gravity	052
Moisture	047
Resistivity	122

Test (Solid Aroclors)	Anniston Analytical Method No.
Softening Point	115
Hold Point	119
Color	128
Solubility	117

A complete analysis is run by the laboratory on all final lot samples.

MONS 049858

Kenneth Feiner

CONFIDENTIAL

MONS 049859

STANDARD MANUFACTURING PROCESS
FOR
AROCLOR

APPENDIX J - SAFETY & TOXICITY DATA AND ACCIDENT REPORTS

Safety of operations in the Aroclor Plant depends on the individual operator. Materials being handled and operations must be observed closely to guard against the following:

	Cause and Action to Prevent
1. Chlorine Gas	Chlorine gas is a very toxic corrosive gas. Leaks or high pressure can occur to liberate it.

Action to Prevent

a. Report Chlorine gas exposure immediately for treatment with Antidote. Milk may be used in mild cases to relieve throat irritation. Oxygen from the resuscitator in the Dispensary is available.

b. Keep gas mask in good condition. Keep a good canister in the mask. Use these type masks only in chlorine concentrations to 2-3% chlorine in air.

c. Use a Scott Air Pak in concentrations of chlorine gas above 3% in air. Three units are available in the Aroclor-Biphenyl Department.

d. If caught in chlorine gas without a mask, hold your breath and go cross wind until you are out of range of the gas. Place a handkerchief over your nose in small quantities of chlorine.

e. Report all chlorine leaks for repair immediately. Make temporary repairs with tape if possible.

f. In case of a major chlorine leak, the source of chlorine gas must be stopped.

Notify the Chlorine Plant immediately if the pressure on the chlorine manifold exceeds 30 psig. Cut off liquid chlorine from the car.

MONS 049860

2. Thermal Burns

Cause and Action to Prevent

Contact with hot uninsulated product lines ar the chlorinators and still areas.

Contact with uninsulated steam lines and open steam.

Contact with hot Aroclors from broken lines or leaks.

Contact with open flames at stills or from heating lines in the department.

Action to Prevent

a. Know that contact with equipment and product will cause a thermal burn due to the high temperatures. Make changes in operations with this hazard in mind.

b. Know the first aid treatment for burns. Cold Water Treatment attached.

c. Wear gloves and long sleeve shirts with the sleeves rolled down when operating. Gloves and clothing can make the difference between first and second degree burns.

d. Report uninsulated lines for repair of insulation.

e. Use only steam lines with hose and hose clamps in good condition.

f. The following operations are hazardous and should be done with care:

   (1) Catching samples at the Aroclor chlorinator circulating pumps.

   (2) Sampling the Solid Aroclor still receiver.

   (3) Drawing bottoms on the Aroclor stills.

Cause and Action to Prevent

3. Explosion

An explosion could occur in the chlorinators by slugging liquid chlorine to the distributor. Slugs of liquid chlorine could react fast enough to cause excessive pressure in the vessel. A rupture of the chlorinator could occur.

Action to Prevent

a. Observe operation of the chlorine vaporiser and do not let liquid chlorine get into the rotameters. Pipe lines will be frosted.

b. In case chlorine feed lines are frosted, close liquid chlorine feed valve to the vaporiser. Check steam addition to the vaporiser. Do not start up until source of trouble has been located.

c. Observe temperature of the chlorinator periodically and be sure it is not too hot (180°C. maximum).

4. Falls

Slipping on cement floors, stairs, Aroclor on floor, ice conditions; tripping over objects (hose, pipe, valve handles, etc.); or losing footing on ladders, etc., can cause falls.

Action to Prevent

a. The majority of minor, serious, and near-miss injuries in the Aroclor Dept. are the result of falls. Prevention is always within the ability of the operator by use of expert operating practices.

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	Cause and Action to Prevent
4. Falls (Contd.)	b. The following items should be done:
	(1) Return hose to rack after using.
	(2) Keep operating areas clean of all foreign objects.
	(3) Return ladders to racks when not in use.
	(4) Keep gloves on and hands out of pockets, especially going up stairs.
	(5) Place guards around any area that presents a hazard that should be guarded.
	c. Poor lighting due to burned out bulbs should be corrected at once. Poor lighting due to inadequate facilities should be reported.
	d. Spills must be cleaned up immediately following their occurrence. Report any spill that cannot be cleaned up within the shift to the Chief Operator. Spills are to be reported in the log book.
5. Fires	Fires can occur by:
	Biphenyl, Santowax R, or Santowax C ignition.
	Chlorine problems in the vaporiser allowing reaction with steam to release hydrogen.
	Furnace burner backfire.
	Wood, rags, or paper on hot lines.
	Sparks from welding apparatus of open flames.

Cause and Action to Prevent

5. Fires (Contd.) Action to Prevent

a. Area must be clear of trash or flammable materials. Use trash skips and cans.

b. Smoke only in areas so designated.

c. Use spark producing equipment only with a fire permit and proper inspection.

d. Use care in lighting gas torch or the still furnaces.

e. Fire fighting equipment includes:

(1) Two wheeled dry powder units.

(2) Hose house with 200 ft. of hose.

(3) Two dry powder hand extinguishers, One CO_2 hand extinguisher.

(4) Two 3/4" water hoses.

(5) Hose connection north of Santowax.

(6) Scott Air Paks.

(7) Fire truck in fire house.

f. Observe visitors in the plant and be sure they observe safety rules.

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Cause and Action to Prevent

6. The following is a list of chemicals handled in the Aroclor Plant operations and the precautions to be taken during their handling:

a. Chlorine Gas

This is a corrosive gas which is toxic. Leaks or back pressure can occur and liberate chlorine gas in the area. Operators should have their cartridge type respirators handy at all times while in the area. Use of gas masks is explained in Section 1, Chlorine Gas.

If you are caught without a gas mask, and large amounts of chlorine gas are liberated, hold your breath and go cross wind until you are out or range of the gas. Once out of the area, obtain an emergency gas mask and return to the area and correct the trouble.

A victim of chlorine gas fumes must be removed as quickly as possible from the gaseous area. Place patient on his back with head and back elevated. Milk may be used in mild cases as a relief from throat irritation. If the patient has stopped breathing, start artificial respiration immediately.

b. Biphenyl

Biphenyl is a flammable material which will burn. Burning should not be done in the presence of Biphenyl or Biphenyl vapors. The melting point is 68.7°C., and the auto ignition temperature is 258°C. Inhalation of Biphenyl fumes is not recommended, since it can cause a drugged effect on the person.

c. Santowax R

Santowax R is a flammable material which will burn. It is relatively non-toxic to human beings. However, the vapors of Santowax R are irritating to the mucous membranes and bronichial tract. Prolonged breathing of the vapors should be avoided. The melting point is 140°C.

	Cause and Action to Prevent
6. (Continued)	
d. Santowax C	Same as Santowax R, since it is the crude material prior to distillation.
e. Ferric Chloride	Ferric Chloride is a black-brown solid. It causes only slightly irritating effects on the skin or mucous membranes. When heated it will decompose and release toxic fumes of Chlorine. It will react with water to produce toxic and corrosive HCl fumes.
f. Attapulgus Earth	This material is a dried earth. No danger in handling. Wash off with water to clean.
f. Hydrated Lime	No particular hazard in handling this material. The dust is irritating to the eyes and skin, and should be washed off with water.
h. Crude Aroclors	Crude Aroclors are hot, since all are handled in steam traced or jacketed lines. They can easily cause thermal burns in contact with the skin. Prior to air blowing, the material has HCl fumes entrained in it which are irritating to the skin or mucous membranes.
i. Hydrogen Chlorine Gas	This is a corrosive gas which is toxic. It is irritating to the mucous membranes, to the eyes, and to the respiratory tract. It will react with water to form Hydrochloric Acid.
j. Still Bottoms or Residue	Fumes from still bottoms are toxic. They are extremely irritating to the mucous membranes, to the eyes, and respiratory tract.

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STANDARD MANUFACTURING PROCESS
FOR
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APPENDIX K - BACKGROUND INFORMATION

History of the Process in Monsanto

In the years 1927 - 1928, the Swann Chemical Company developed a process for making diphenyl, but as the expected demand for it did not continue, other outlets were sought for the diphenyl. Aroclors were produced in the laboratory in 1928, and as they showed good electrical properties, fire resistance, and general inertness, the General Electric Company became interested, and developed the use of Aroclors in transformers and capacitors. Biphenyl production began on February 28, 1928; Aroclor production (3,000 lbs/day) started on December 16, 1928.

In 1935 Monsanto acquired the Swann Company, so gaining access to their Aroclor patents. As the demand for Aroclors increased, additional production equipment was installed, located at the Monsanto Illinois factory (then Plant "B" and now called the Krummrich Plant). This equipment came on stream in September 1936.

The Krummrich plant site was chosen partly because of the availability of chlorine there, but when chlorine consumption overtook the production, and chlorine had to be purchased, proximity to the diphenyl production at Anniston had more weight, and additional capacity, largely designed on the plant "B" model, was installed at Anniston in 1941.

By 1946 both plants had doubled their capacity, to give a total production capacity approaching 2 million pounds a month. About 1954, chlorine cells were installed at Anniston.

The Newport plant was designed, mainly on Krummrich plant information, but to a less extent on Anniston information, under Newport Project No. 12 of the London Central Engineering Department.

Chlorination started at Newport in June 1951, Mr. Jack Clegorn from Anniston spending some time at Newport to assist in starting the diphenyl and Aroclor plants there.

The first production of Pyranol by MCC was in 1936, when Pyranol 1488 was made for the General Electric Company, the blending being done at first in rail tanks. Pyranol 1495 was made in July 1938.

Batch chlorinated Aroclors were made until November 1957 when continuous chlorinated Aroclors were first made in plant equipment.

Several test runs were made and sold to customers for evaluation. On February 14, 1961, continuous chlorinated Aroclor 1242 was made on a full time basis. Today Aroclor is made by both batch and continuous chlorination of Biphanyl and/or Santowax.

In May 1965 an Aroclor expansion was completed to bring the capacity to 58 M pounds per year which includes 10 M pounds per year of Solid Aroclors.

Aroclor Uses

Monsanto Aroclors are used "as is" or in special formulations for the liquid coolant-insulation fluids in transformers and capacitors.

In capacitors, they provide for power factor correction in electric utility transmission lines. In fixed paper capacitors, Aroclors are the dielectric substance. These capacitors are used in home appliances such as air conditioners, furnaces, washers, and driers, in electric motors, and for ballast in fluorescent fixtures.

General Electric, Westinghouse, and other producers of electric capacitors use Monsanto Aroclors in special formulations for the dielectric substance.

Other important applications of both Liquid and Solid Aroclors in the electrical field are in wire and cable coatings and as impregnants for cotton and asbestos braided insulation. In addition, they are excellent dielectric sealants and are used to close the pores of carbon resistors and to seal electrical bushings and terminals.

Aroclors are outstanding for use as the heat transfer liquids in indirect heating systems. Aroclor systems can transfer closely controllable, uniform heat to chemical process vessels, food cookers, potato chip and frito fryers, drying ovens, to heat corrugating rolls, crimping presses, and calendars in material processing, to heat treating metals such as Titanium and Vanadium, and to efficiently indirect heat distillation equipment.

It is interesting to note that as recently as 1941 only two methods of delivering process heat were known. Today non-pressurized, high temperature, fire resistant heat transfer systems based on Monsanto's Aroclor Liquids overcome practically all the deficiencies and drawbacks of Direct-Firing and Pressurized Vapor Heating.

Presently, there are numerous other uses for Liquid and Solid Aroclors and Aroclors in formulations. Only some of these uses are listed below:

As the actuating medium in bellows controls, thermostats, industrial temperature control regulators, and other kinds of automation equipment.

Liquid sealant for furnace roofs.

Vacuum diffusion pump oil-pumps used to pull high vacuum for metalizing plastics, dehydrating foods, and medicinals.

Dust entrapment-used to coat fibrous glass air filter pads, metal mesh, and other materials used for filtering air and gas streams.

As a vapor suppressant to increase the kill life of insecticides.

In waxes-waxes containing Aroclor are widely used in making dental castings, in the precision casting of aircraft parts, and for casting costume jewelry.

In specialized lubricants, adhesives, ink formulation, caulking compounds, plastics, rubbers, paints, varnishes, and lacquer formulations.

New uses for the various Aroclors are continually being developed. Continuous quality control, coupled with the unusual chemical and physical characteristics of the Aroclors, has resulted in widespread customer acceptance and a limitless expansion of uses for them.