Jan 610

38800

PHYSICAL CONSTANTS DATA

SUBSTANCE: HYDRATED LIME (Calcium Hydroxide)

STRUCTURAL FORMULA

Mississippi Lime Company

compiled by: Leo J. Hoog, M.L.C. — DATE: 1-25-57

A.M. Ellenburg Revised — 7-12-57

NAME		SOURCE & DATE
Formula	$Ca(OH)_2$	Ref. 1
Molecular Weight	74.10	Ref. 1
Appearance	White powder	Ref. 2
Boiling Point at 760 mm		
Boiling Point at mm		
Boiling Point at mm		
Boiling Point at mm		
Crystallizing Point		
Melting Point	Decomposes	Ref. 1
Solution Point		
Specific Gravity @ 20°C	2.2	Ref. 1
Specific Gravity @ Pounds per Gal. @ 20 °C	4	Ref. 2
Coefficient of Expansion		
Refractive Index @ n D	wD 1.574, Ed 1.545	Ref. 1
Infra Red Spectrum (Reference)		
Ultra Violet Spectrum (Reference)		
Viscosity @		
Viscosity @		
Surface Tension		
Solubility in Water	.185% @0°C, .077% @ 100°C	Ref. 1
Solubility in	Soluble in acids and NH_4Cl	Ref. 1
Solubility in		
Flash Point °F (Method)		
Fire Point °C		
Heat of Combustion		
Heat of Formation		
Thermal Stability (cal./g./min.)		
Latent Heat of Fusion		
Latent Heat of Vap.		
Specific Heat		
Critical Temperature		
Critical Pressure		
Dissociation Constant		

Other Constants

References:

1. Langes Handbook, Ed. 8, 1956
2. Information by Vendor

Toxicity (Give References)

MONS 055518

NOTE: *These data should not be released outside of Monsanto Chemical Company. Use additional sheets if necessary.*

PHYSICAL CONSTANTS DATA

SUBSTANCE	STRUCTURAL FORMULA
CHLORINE	

COMPILED BY	DATE
W. H. Demaree	7-29-56

NAME		SOURCE & DATE
Formula		
Molecular Weight	70.914	
Appearance		
Boiling Point at 760 mm	-34.05	API
Boiling Point at 100 mm	-71.82	Ref. 1
Boiling Point at 10 mm	-100.06	Ref. 1
Boiling Point at 1 mm	-120.44	Ref. 1
Crystallizing Point		
Melting Point	-100.98	Ref. 2
Solution Point		
Specific Gravity @ 0°C (gas)	2.49	Ref. 2
Specific Gravity @ 20°C	1.408	Lange
Pounds per Gal. @ °C		
Coefficient of Expansion		
Refractive Index @ 0°C n D	1.47	Ref. 2
Infra Red Spectrum (Reference)		
Ultra Violet Spectrum (Reference)		
Viscosity @		
Viscosity @		
Surface Tension		
Solubility in Water		
Solubility in		
Solubility in		
Specific gravity @ 30°C	1.377	Lange
Flash Point °F (Method)		
Fire Point °C		
Heat of Combustion		
Heat of Formation		
Thermal Stability (cal./sq./min.)		
Latent Heat of Fusion		
Latent Heat of Vap.		
Specific Heat		
Critical Temperature	144°C	Ref. 2
Critical Pressure	76.1 atmos.	Ref. 2
Dissociation Constant		

Other Constants

Ref. 1 - Calc. from det. data
Ref. 2 - Monsanto Chlorine

Toxicity (Give References)

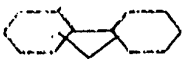
NOTE: These data should not be released outside of Monsanto Chemical Company, Use and

IN 619

PHYSICAL CONSTANTS DATA

SUBSTANCE: AROCLOR 1242

STRUCTURAL FORMULA:



COMPILED BY: A. M. Elsburg

DATE: 4-25-57

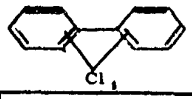
NAME		SOURCE & DATE
Formula	$C_{12}H_7Cl_3$	
Molecular Weight	257 (avg.)	
Appearance	Colorless Mobile O.	Monsanto Bull. OP-1.5, 1956
Boiling Point at 760 mm Range	325 - 360 C.	"
Boiling Point at 3 mm "	155-195 C.	
Boiling Point at mm		
Boiling Point at mm		
Crystallizing Point	Non-crystallizing	
Melting Point		
Solution Point		
Specific Gravity at 25/25 C.	1.380	"
Specific Gravity at 25/15.5 C.	1.381 - 1.392	Specification 2-14-55
Pounds per Gal. at 25 °C	11.50	M. B. OP-1.5
Coefficient of Expansion 25-65 °C.	0.00068 cc/cc/°C.	"
Refractive Index at 25 °C. n_D	1.6245 - 1.6265	Specification 2-14-55
Infra Red Spectrum (Reference)		
Ultra Violet Spectrum (Reference)		
Viscosity at 210 °F.	34-35 SUS	M. B. OP-1.5
Viscosity at 100 °F.	82-92 SUS	"
Surface Tension Dynes/cm @ 20 °C.	45.3	J. Coll. Sci. 7, 164, 1952
Solubility in Water	Insoluble	M. B. OP-1.5
Solubility in 3A Alcohol @ 29 °C.	23.1 g./100 cc	"
Solubility in Pyridine @ 30 °C.	132.5 g./100 cc	"
Flash Point °C (Method) c.o.c.	180 °C.	"
Fire Point °C c.o.c.	None	"
Heat of Combustion		
Heat of Formation		
Thermal Stability (cal./kg./min.)		
Latent Heat of Fusion		
Latent Heat of Vap. cal/gm.	61	Calculated
Specific Heat @ 25 C.	0.293	M. B. OP-1.5
Critical Temperature		
Critical Pressure		
Dissociation Constant		
Specific Heat @ 300 °C.	0.380	"
Other Constants: Pour Point	-14 °C. or lower	"
Other Constants: Thermal Conductivity, cal/cm/°C/sec.	24.0 @ 28 C.	To be published
Other Constants: Dielectric Constant, 100 °C., 60 cy.	4.7 - 4.9	M. B. OP-1.5
		MONS 055520
Toxicity (Give Reference)	Contact Medical Dept.	M. B. OP-1.5

NOTE

IN 619

PHYSICAL CONSTANTS DATA

SUBSTANCE: AROCLOR 1248

STRUCTURAL FORMULA: 

COMPILED BY: A. M. Ellenburg

DATE: 4-25-57

NAME		SOURCE & DATE
Formula	$C_{12}H_6Cl_4$	
Molecular Weight	292 (Avg.)	
Appearance	Yellow Tinted Mob. Oil	Monsanto Bull. OP-115(19
Boiling Point at 760 mm Range	345-385°C.	"
Boiling Point at 3 mm "	165-210°C.	"
Boiling Point at mm		
Boiling Point at mm		
Crystallizing Point	Non-crystallizing	"
Melting Point		
Solution Point		
Specific Gravity @ 25/25°C.	1.445	"
Specific Gravity @ 65/15.5°C.	1.405-1.415	Specifications 9/9/54
Pounds per Gal. @ 25 °C	12.04	M.B. OP-115
Coefficient of Expansion 25-65°C.	0.00070 cc/cc/°C.	
Refractive Index @ 25°C n D	1.6285-1.6305	Specification 9/9/54
Infra Red Spectrum (Reference)		
Ultra Violet Spectrum (Reference)		
Viscosity @ 130°F.	73-80 SUS	M.B. OP-115
Viscosity @		
Surface Tension Dynes/cm @20°C.	44.2	J. Coll. Sci. 7, 166. (1952)
Solubility in Water	Insoluble	M.B. OP-115
Solubility in 3A Alcohol @ 25°C.	15 g./100 cc	"
Solubility in Pyridine @ 29°C.	111.4g./100 cc	"
Flash Point °F (Method) c.o.c.	196°C.	"
Fire Point °C c.o.c.	None	"
Heat of Combustion		
Heat of Formation		
Thermal Stability (cal./kg/min.)		
Latent Heat of Fusion		
Latent Heat of Vap. cal/gm.	54	Calculated
Specific Heat @ 25°C.	0.277	M.B. OP-115
Critical Temperature		
Critical Pressure		
Dissociation Constant		
Specific Heat @ 300°C.	0.356	"
Other Constants: Pour Point	0°C. or lower	"
Other Constants: Thermal Conductivity, cal/cm/°C/sec.	23.6 @ 28°C.	To be published
Other Constants: Dielectric Constant, 100°C., 69 cy.	4.5-4.7	M.B. OP-115
		MONS 055521
Toxicity (Give Reference)	Contact Medical Dept.	M.B. OP-115

PHYSICAL CONSTANTS DATA

SUBSTANCE: AROCLOR 1254

STRUCTURAL FORMULA: 

COMPILED BY: A. M. Elierberg

DATE: 4-25-47

NAME		SOURCE & DATE
Formula	$C_{12}H_6Cl_4$	
Molecular Weight	326 (Avg.)	
Appearance	Pale Yellow viscous oil	Monsanto Bull. OP-115 (1958)
Boiling Point at 760 mm Range	365-401 °C	"
Boiling Point at 3 mm	180-220°C	"
Boiling Point at mm		
Boiling Point at mm		
Crystallizing Point	Non-crystallizing	"
Melting Point		
Solution Point		
Specific Gravity @ 25/25 °C.	1.538	"
Specific Gravity @ 65/15.5 °C.	1.495-1.505	Specifications 2/14/55
Pounds per Gal. @ 25 °C	12.82	MB OP-115
Coefficient of Expansion 25-65 °C.	0.00066 cc/cc/°C.	"
Refractive Index @ 25°C. D	1.6370-1.6390	Specification 2/14/55
Infra Red Spectrum (Reference)		
Ultra Violet Spectrum (Reference)		
Viscosity @ 210 °F	44-48 SUS	MB OP-115
Viscosity @		
Surface Tension Dynes/cm	50.3 @ 25°C. 42.0 @ 100°C	"
Solubility in Water	Insoluble	"
Solubility in SA Alcohol @ 27°C	10 g./100 cc	"
Solubility in Pyridine @ 31°C.	114 g./100 cc	"
Flash Point °F (Method) c.o.c.	None	"
Fire Point °C c.o.c.	None	"
Heat of Combustion		
Heat of Formation		
Thermal Stability (cal./kg/min.)		
Latent Heat of Fusion		
Latent Heat of Vap. cal/gm.	50	Calculated
Specific Heat @ 25 °C.	0.261	MB OP-115
Critical Temperature		
Critical Pressure		
Dissociation Constant		
Specific Heat @ 300 °C.	0.336	"
Other Constants: Pour Point	-12°C.	"
Other Constants: Thermal Conductivity, Cal/cm/°C/Sec.	22.9 @ 28°C	To be published
Other Constants: Dielectric Constant, 100°C, 60 cy.	4.15-4.35	MB-OP-115
		MONS 055522
Toxicity (Give Reference)	Contact Medical Dept.	M.B.-OP-115

NOTE: These data should not be released outside of Monsanto Chemical Company. Use additional sheets if necessary.

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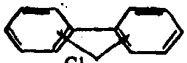
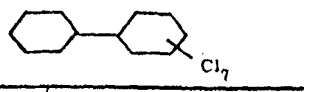
PHYSICAL CONSTANTS DATA

SUBSTANCE	STRUCTURAL FORMULA
AROCLOR 1260	
COMPILED BY: A. M. Ellenburg	DATE: 4/25/57

NAME		SOURCE & DATE
Formula	$C_{12}H_{3.75}Cl_{6.25}$	
Molecular Weight	361 (Avg.)	
Appearance	Lt. Yell. soft sticky resin	Monsanto Bull. OP-115(1956)
Boiling Point at 760 mm Range	385-420°C.	"
Boiling Point at 10 mm "	195-245°C.	"
Boiling Point at mm		
Boiling Point at mm		
Crystallizing Point	Non-Crystallizing	"
Melting Point		
Solution Point		
Specific Gravity @ 25/25/°C.	1.620	"
Specific Gravity @ 20/15.5°C.	1.555-1.568	Specification 2/14/55
Pounds per Gal. @ 25 °C	13.60	MB OP-115
Coefficient of Expansion 20-100°C.	0.00067 cc/cc/°C.	
Refractive Index @ 25°C #5	1.6455-1.6485	Specification 2/14/55
Infra Red Spectrum (Reference)		
Ultra Violet Spectrum (Reference)		
Viscosity @ 210°F.	72-78 SUS	MB OP-115
Viscosity @		
Surface Tension		
Solubility in Water	Insoluble	" "
Solubility in		
Solubility in		
Flash Point °F (Method) c.o.c.	None	"
Fire Point °C c.o.c.	None	"
Heat of Combustion		
Heat of Formation		
Thermal Mobility (cal./cc/sec.)		
Latent Heat of Fusion		
Latent Heat of Vap. cal/gm	48	Calculated'
Specific Heat @ 25°C.	0.228	MB OP-115
Critical Temperature		
Critical Pressure		
Dissociation Constant		
Specific Heat @ 300°C.	0.303	"
Other Constants: Pour Point	25-34°C.	"
Dielectric Constant, 100°C. 60 cy.	3.6-3.8	"
		MONS 055523
Toxicity (Give References)	Contact Medical Dept.	MB OP-115

NOTE: *These data should not be released outside of Monsanto Chemical Company. Use additional sheets if necessary.*

PHYSICAL CONSTANTS DATA

SUBSTANCE	STRUCTURAL FORMULA
AROCLOR 1262	
COMPILED BY: A. M. Ellenburg	DATE: 7/3/57

NAME		SOURCE & DATE
Formula	$C_{12}H_3Cl_7$	
Molecular Weight	395	
Appearance	Light yell. sticky Resin	Monsanto Bulletin OP-115 (1956)
Boiling Point at 760 mm	390-425°C	"
Boiling Point at mm		
Boiling Point at mm		
Boiling Point at mm		
Crystallizing Point		
Melting Point		
Solution Point		
Specific Gravity @ 20/15.5°C	1.577-1.587	Specs. 4/11/55
Specific Gravity @ 25/25°C	1.646	MB OP-115
Pounds per Gal. @ 25 °C	13.72	"
Coefficient of Expansion 25-65°C	0.00064 cc/cc/°C	"
Refractive Index @ 25°C n D	1.648-1.650	"
Infra Red Spectrum (Reference)		
Ultra Violet Spectrum (Reference)		
Viscosity @ 210°F	88-100 SUS	Specs. 4/11/55
Viscosity @		
Surface Tension		
Solubility in Water		
Solubility in		
Solubility in		
Flash Point °F (Method)	None	MB OP-115
Fire Point °C	None	"
Heat of Combustion		
Heat of Formation		
Thermal Stability (cal./sq/min.)		
Latent Heat of Fusion		
Latent Heat of Vap.		
Specific Heat		
Critical Temperature		
Critical Pressure		
Dissociation Constant		
Pour Point	35-38°C	
Other Constants		
		MONS 055524
Toxicity (Give Reference)	Contact Med. Dept.	MB OP-115

NOTE: *These data should not be released outside of Monsanto Chemical Company. Use additional sheets if necessary.*

Dept. 246 - Process Description

AROCLOR

APPENDIX D

UTILITIES

The utility calculations are based on design calculations for a 28.8 million pounds per year production rate.

The breakdown of utility usage by individual equipment is only on estimate. The estimates of utility usage are average values in most instances as it is difficult to measure the operating time and load for a particular piece of equipment with great accuracy.

The total usage of each utility was taken from the cost sheets. Estimates of individual operating time and percentage of the total load were made to calculate the distribution of utilities as given in the following pages of this section.

Dept. 246 - Process Description

AROCLOR

APPENDIX D

UTILITIES (Cont'd.)

1. Power Consumption

A. Electricity - 440 V., 3 phase, 60 cycle

Item No.	Equipment Motor	Motor HP	Peak Load KW	Monthly Usage KWH
101	Biphenyl transfer pump	3.00	2.6	80
103	Biphenyl head tank pump	.75	0.7	240
104	Biphenyl feed pump	7.50	6.6	1980
121	#5 Chlorinator pump	10.00	8.8	3040
122	#4 Chlorinator pump	10.00	8.8	3040
123	#3 Chlorinator pump	10.00	8.8	3040
124	#2 Chlorinator pump	10.00	8.8	3040
125	#1 Chlorinator pump	10.00	8.8	3040
127	#2 Blow tank pump	5.00	4.4	200
129	#1 Blow tank pump	5.00	4.4	1580
132	#1 still pump	5.00	4.4	1580
135	#2 still pump	7.50	6.6	2340
140	#1 Receiver pump	2.00	1.7	20
141	#2 Receiver pump	2.00	1.7	20
144	Blend tank pump	3.00	2.6	200
149	#3 Storage transfer pump	3.00	2.6	160
151	#4 storage transfer pump	3.00	2.6	240
153	#5 storage transfer pump	3.00	2.6	200
155	#8 storage transfer pump	3.00	2.6	80
157	#7 storage transfer pump	3.00	2.6	80
170	#1 city water pump	7.50	6.6	2340
171	#2 city water pump	7.50	6.6	0
180	Exhaust blower	15.00	13.0	0
	Miscellaneous Totals	135.75	119.8	26,860

Dept. 246 - Process Description

AROCLOR

APPENDIX D UTILITIES (Cont'd.)

1. Power Consumption (Cont'd.)

B. Electricity - 110 V., nne phase, 60 cycle

Equipment	Peak Load KW	Monthly Usage KWH
Lighting	15	3600
Instrumentation	2	1440
Miscellaneous	3	2150
Totals	20	7190

2. Natural Gas

Item No.	Using Equipment	Normal Use SCFH	Peak Use SCFH	Monthly Usage MSCF
131	#1 Furnace	1200	2400	430
132	#2 Furnace	1200	2400	430
	Totals	2400	4800	860

3. Compressed (plant) Air

Item No.	Using Equipment	Normal Use SCFM	Peak Use SCFM	Monthly Usage MSCF
127	#2 Blow Tank	60	200	2590
148	#3 Storage Tank	60	200	90
150	#4 Storage Tank	60	200	90
152	#5 Storage Tank	60	200	90
154	#8 Storage Tank	60	200	90
156	#7 Storage Tank	60	200	90
	Miscellaneous	10	200	330
	Totals	370	1400	3460

Dept. 246 - Process Description

AROCLOR

APPENDIX D

UTILITIES (Cont'd.)

4. Nitrogen

Item No.	Using Equipment	Normal Use SCFH	Peak Use SCFH	Monthly Usage SCF
142	#1 Blend Tank	3	4	2140
143	#2 Blend Tank	3	4	2140
146	#1 Product Tank	3	4	2140
147	#2 Product Tank	3	4	2140
148	#3 Storage Tank	3	4	2140
150	#4 Storage Tank	3	4	2140
152	#5 Storage Tank	3	4	2140
	Totals	21	28	14,980

5. Purchased Water

Item No.	Using Equipment	Normal Use GPM	Peak Use GPM	Monthly Usage M. Gal.
130	#1 Still	3	5	150
131	#2 Still	3	5	150
203	#1 Vacuum Jet	20	20	870
204	#2 Vacuum Jet	18	20	770
205	#3 Vacuum Jet	15	20	650
206	S-K Drowning Jet	25	30	120
	Miscellaneous	2	10	100
	Totals	86	110	2810

6. High Pressure Steam
200 PSIG at 388°F

Item No.	Using Equipment	Normal Use Lb./hr.	Peak Use Lb./hr.	Monthly Usage M. lb.
167	#1 Blow Tank	210	310	150
203	#1 Vacuum Jet	450	670	320
204	#2 Vacuum Jet	400	615	290
205	#3 Vacuum Jet	325	500	240
	Totals	1385	2095	1000

7. Low Pressure Steam
80 PSIG at 325°F

Item No.	Using Equipment	Normal Use Lb./hr.	Peak Use Lb./hr.	Monthly Usage M. Lb.
102	Biphenyl Storage Tank	700	900	500
138	#1 Receiver Tank	700	900	500
139	#2 Receiver Tank	700	900	500
142	#1 Blend Tank	200	300	150
143	#2 Blend Tank	200	300	150
146	#1 Finished Product Tank	200	300	150
	Totals	2700	3600	1950

Dept. 246 - Process Description

AROCLOR

APPENDIX D UTILITIES (Cont'd.)

7. Low Pressure Steam (Cont'd.)

Item No.	Using Equipment	Normal Use Lb./hr.	Peak Use Lb./hr.	Monthly Usage M. lbs.
147	#2 Finished Product Tank	200	300	150
148	#3 Storage Tank	700	900	500
150	#4 Storage Tank	700	900	500
152	#5 Storage Tank	700	900	500
154	#8 Storage Tank	700	900	500
156	#7 Storage Tank	700	900	500
	Miscellaneous	1400	2800	1000
	Totals	7800	10,500	5600

Dept. 246 - Process Description

AROCLOR

APPENDIX E PERSONNEL

Departments 246, A-246, B-246 and C-246 are closely related. Operating personnel may work in all of the departments in a given day. For this reason, the description of operating classifications and assignments for departments 246, A-246, B-246 and C-246 is given as though all four of the departments are just one department.

Operating Classifications

Job	Number of Men	
	7 day/week Schedule	10 & 4 Schedule
Premium Operator	4	3
Second Operator	4	3
Repairman	1	1
Standard Operator	2	2
Porter	½	½
Swingman	1	0
TOTAL	12½	9½

The swingman works two shifts per week (Saturday and Sunday) as a relief foreman, two shifts as a repairman, and one shift operating the premium job. There is an open shift on the second operator job that is covered by overtime. The premium operator and second operator cover three shifts each day. The repairman works the day shift, and with the swingman, there is 7 days per week repairman coverage. Standard operators work the day and middle shift 5 days per week. The porter works half time in department 246 and half time in department 243. The premium operator has lead responsibility for his shift.

The work force works all three departments Aroclor, Pyranol and Pydraul as one coordinated operation. The assignment of time is 70% to Aroclors, 15% to Pyranol and 15% to Pydraul.

Operating Assignments:

Premium Operator: Has overall responsibility and operates 5 chlorinators 2 stills and covers the necessary absences of the standard operator.

Second Operator: Operates 2 blend tanks filter, 2 finished product tanks, storage tanks, makes Pyranol and Pydraul mixes, loads trailer, and tank cars, charges chlorinators and transfers receivers and also belongs to the Fire Brigade.

Repairman: Unloads cars and trailers of Biphenyl, Trichlorobenzene and Tetra-Trichlorobenzene and finished product, makes weekly safety inspectic and department minor repair work.

Dept. 246 - Process Description

AROCLOR

APPENDIX E PERSONNEL (Cont'd)

Standard Operator: Fills, stencils and labels 5 gallon, 30 and 55 gallon drums and clean-up assignments when not drumming. The Standard Operator loads cars and trailers as does the second operator.

Porter: Cleans office, control room, repair room, wash room and smoking shelter.

Swingman: Works one day per week as premium operator, two days as repairman and two days as relief foreman. As relief foreman takes overall supervision on day shift on weekends including arranging for maintenance, night sheets and line-up of work.

AROCLOR

APPENDIX F PACKAGING & SHIPPING

Aroclor, Pyranol & Pydraul and filled about half in drums and half in tank cars or tank trucks.

A substantial amount (about 40%) of Aroclor is used to make Pyranol and Pydraul.

Sales are largely directly to the customer. The remainder is in bulk shipments to the J. F. Queeny Plant.

All electrical grade tank truck shipments are made in the customers trucks which are stainless steel. Non-electrical Aroclors are shipped in leased trucks and may be iron although other materials of construction are suitable. Pydraul is shipped in steel tank trucks.

Electrical grade Aroclor and Pyranols are shipped in solid aluminum lined tank cars or in lined tank cars either 4,000 or 8,000 gallons in capacity. The lining is either tin, zinc or aluminum spray because iron and iron oxide contamination is detrimental to the electrical properties. Electrical grade cars are either owned by Monsanto or on a long term lease. Non-electrical grade Aroclor is shipped in steel cars.

All electrical grade lots and bulk shipments of non-electrical material are sampled from the final container. That is all tank cars and tank trucks are sampled and analyzed after loading. All electrical grade drums are sampled from one of the drums.

Tank cars and tank trucks are inspected to be sure they are free of dirt and water or other foreign material before loading. Heels are drained before loading some materials. Car washing when necessary is done by the repair track. Tank cars are sealed with a numbered aluminum seal.

Lacquer lined drums are used for Aroclor and Pyranol and plain steel drums are used for Pydrauls.

A summary of products, weights and containers current use is as follows:

Product	Weights and Containers 5 Gal.	30 Gal.	55 Gal.	TT	TC
1232	-	-	600#	-	-
1242	55	-	600#	Yes	Yes
1248	60	-	600#	Yes	Yes
1254	60	-	600#	Yes	Yes
1254 Xylene	-	-	600#	-	-
1260	60	-	600#	Yes	Yes
1262	60	-	600#	-	-
MCS295	-	-	645#	-	-
Pyranol 1488	-	-	675#	-	-
Pyranol 1481	-	-	675#		

Dept. 246 - Process Description

AROCLOR

APPENDIX F

PACKAGING & SHIPPING (Cont'd.)

Product	Weights and Containers 5 Gal.	30 Gal.	55 Gal.	TT	TC
Pyranol A-13B3B	65	360#	675#	-	4000 Gal.
Inerteen PPO	60	360#	674#	-	4000 Gal. & 8000 Gal.
Pydraul A-200	59	-	645#	Yes	-
Pydraul 280	60	-	625#	-	-

Dept. 246 - Process Description

AROCLOR

APPENDIX G MATERIAL BALANCE

The material balance on Dept. 246 was made with a minimum of field measurements. Most of the estimates on the following page check fairly close with actual raw material usages that can be readily measured. The exact composition of some of the intermediate process streams is uncertain.

Dept. 246 - Process Description

AROCLOR

APPENDIX Q

SUMMARY OF MATERIAL BALANCE RESULTS

AROCLOR 1242

Raw Material & Cost ($/lb.)	Usages - Lbs/100 lbs product Theory	Material Balance	Material Balance Usages lbs/100 lbs
Biphenyl (.0662)	58	63	58 Finished Prod. 1 Filter Cake 3.5 Still Bottoms .5 Off-Gas HCl 63.0
Chlorine (.0217)	84	91.8	42 Finished Prod. 1.5 Filter Cake .05 Vacuum Jet 2.8 Still Bottoms .95 Air-HCl Mixture 44.50 Off-Gas HCl 91.80
*Ferric Chloride (.129)	0.03	.03	.03
*Attapulgus Earth (.0302)	15	.15	.15
*Air (.00055)	3	3	3.0
*Lime (.0100)	0.5	0.5	0.5

AROCLOR 1248

Biphenyl (.0662)	52	56.5	52 Finish Product 1 Filter Cake 3 Still Bottoms .5 Off-Gas HCl 56.5
Chlorine (.0217)	96	103.2	48 Finished Prod. 1.5 Filter Cake .05 Vacuum Jet 2.55 Still Bottom .95 Air-HCl Mixture 50.15 Off-Gas HCl 103.20

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*These raw materials are the same for production of all Aroclors.

Dept. 246 - Process Description

AROCLOR

APPENDIX G

SUMMARY OF MATERIAL BALANCE RESULTS (Cont'd.)

AROCLOR 1254

Raw Material & Cost ($/lb.)	Usages - Lbs/100 lbs product Theory	Material Balance	Material Balance Usages Lbs/100 Lbs
Biphenyl (.0662)	46	49.8	46 Finished Product 0.5 Filter Cake 2.8 Still Bottoms 0.5 Off-Gas HCl 49.8
Chlorine (.0217)	108	117.5	54 Finished Product 1 Filter Cake 0.05 Vacuum Jet 6.8 Still Bottoms 0.95 Air-HCl Mixture 54.7 Off-Gas HCl 117.50

AROCLOR 1260

Biphenyl (.0662)	40	43.4	40 Finished Product 0.9 Filter Cake 2.0 Still Bottoms 0.5 Off-Gas HCl 43.4
Chlorine (.0217)	120	128.8	60 Finished Product 0.5 Filter Cake 0.05 Vacuum Jet 4.8 Still Bottoms 0.95 Air-HCl Mixture 62.50 Off-Gas HCl 128.80

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Dept. 246 - Process Description

AROCLOR

APPENDIX H ATMOSPHERIC DISCHARGE - WASTE DISPOSAL

Discharge to Atmosphere	Lbs. per C lbs. of Aroclor Produced	Total Lbs/Yr based on Prod. Rate 28.6 M lbs/yr
1. HCl Fumes from blow tanks	0.01	2,000
2. HCl fumes from other tanks vented to atmosphere	0.01	2,000
3. Chlorine gas from chlorinator vented to blow tank	UNKNOWN	UNKNOWN
4. Aroclor & Biphenyl vapors of tanks vented to atmosphere	UNKNOWN	UNKNOWN
Discharge to Sewers		
1. HCl from chlorinators	2.5*	500,000*
2. Cl_2 from chlorinators	2.0*	30,000*
3. Condensibles in chlorinator off-gas	2.0*	30,000*
Discharge to Waste Disposal		
1. Montar	0.0176*	5,000*
2. Aroclor	0.33*	95,000*

*Estimated

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Dept. 246 - Process Description

AROCLOR

APPENDIX I

PROCESS CONTROL

Sampling Point	Frequency	Reason for Sample	****Normal Range	Method Number
Chlorinators	2-3 times per batch	Specific Gravity	.011	
Blend Tanks	3 times each day	Color (APHA)	50-150 Max.	10,084
		Sp.Gr. at 25/15.5°C	.011	10,114
		Acidity (mg.KOH/g.)	.014 Max.	10,087
		*Moisture (H_2O) (PPM)	35 PPM Max.	10,620
		*Refractive Index at 25°C	.0020	10,125
		*Inorganic(free)Chlorides	.05 PPM Max.	T-2092
		*Dielectric Constant	.20	11,608
		*Resistivity (500 VDC @ 100°C 0.1" GAP as ohm-cm x 10^9	500, Min.	11,607
		*Hydrolysis Stability Test (as Chlorides)	1.0 PPM Max.	T-2087
		*Monsanto Stability Test (as Chlorides)	0.5 PPM Max.	11,503
		**Sulfates	None	12,169
		**Dielectric Strength at 25°C	35 KV Min.	11,605
		**Viscosity at 100°F (SUS)	10	10,086
		***Thermal Chemical Chlorides	0.75 PPM Max.	12,722
Storage Tank Composite	Every 1-2 days	Same as blend tanks		
Tank Cars & Trailers	Every Load	Same as blend tanks		

*Tests made on electrical grade Aroclors only.
**Tests made on request only.
***Special customer test.
****Maximum range for all Aroclors including electrical and non-electrical grades.

Dept. 246 - Process Description

AROCLOR

APPENDIX J SAFETY AND TOXICITY DATA

SAFETY EQUIPMENT

The following is a list of safety equipment (personal and departmental) required in department 246.

1. Fire extinguishers:

   A. Dry Chemical (3) - Southwest corner Bldg. CR - Main Floor

   - West wall at top of stairs of second floor.

   -

   B. Carbon Dioxide Snow - Southwest corner of Bldg. CR, ground level.

2. Chlorine Gas Masks(4) - Southwest corner, second floor

   - Control room, second floor

   - East side, outside control room

   - Wall, Southwest corner of sprinkler house, main floor.

3. Scott Air Masks - West of Lean-To

4. Safety Showers (2) - Southeast corner of Bldg. CR, ground level.

   - Southeast corner of Bldg. CR, 2nd floor.

5. Davis Vapotester

6. Eye Baths

7. Sprinkler System

Safety Precautions

The following are safety precautions followed in the operation of department 246.

1. Safety Equipment of Employee

   Each employee has the following safety equipment: (1) hard hat (2) safety glasses (3) goggles (4) rubber and canvas gloves (5) rubber overshoes. Special equipment may be issued as necessary for performing a particular job in a safe manner.

Dept. 246 - Process Description

AROCLOR

APPENDIX J SAFETY & TOXICITY DATA (Cont'd.)

2. Sampling of Crude Aroclor

The samples of Aroclor taken during the chlorination reaction are hot (170°C). Precaution must be taken to avoid skin contact of samples and inhalation of hydrogen chloride, chlorine and aroclor vapors.

3. Fires

Fires may result from the ignition of leaking gas, xylene, diphenyl, rags, paper, wood, etc. Automatic fire extinguishers and sprinklers have been installed to combat fires.

4. Explosions

Explosions may be caused from accumulated pockets of natural gas or a rapid burning of Diphenyl in a closed container such as a chlorinator. Chlorinators are equipped with a 10" diameter pressure relief line with a rupture disc madeto burst at 22 psi in case diphenyl within the chlorinator ignites.

5. Toxicity

Toxicity does not present a serious problem. However, a complete daily change of clean clothes is supplied to each person and time is allotted at the end of each shift to take a bath. Instructions are also issued to avoid actual skin contact with Biphenyl and Aroclor as much as possible and to wash hands and face before eating.

6. Miscellaneous

There are many accidents that can occur that may be classified as health and safety hazards. These accidents may result from such things as broken process lines, acid leaks, steam leaks, etc.

The worst inherent hazards are as follows:

1. Free chlorine from ruptured line or major leak.
2. HCl gas from ruptured line or major leak.
3. Dropping bottoms from stills.
4. Hot aroclor and diphenyl.

Safety Record

The last lost-time injury in Department 246 was January 28, 1948. The frequency of minor injuries is low, around one per month.

Toxicity: This material is a liquid under normal conditions and has a medium toxicity range for liquid ingestion and high toxicity for vapor inhalation. The maximum allowable concentration (M.A.C.) is 1 mg/cubic meter.

Fire Hazard: There is no fire hazard under normal conditions. Aroclor mixes (Xylene, Toluene, Butyl Acetate, etc.) may burn and explode at high temperatures when exposed to flames.

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AROCLOR

APPENDIX J SAFETY & TOXICITY DATA (Cont'd.)

Other Hazards: This material can cause dermatitis, systemic poisoning from the fumes, and yellow atrophy of the liver. There are skin, mucous membranes and eye hazards encountered in handling this material.

Treatment and Antidotes: Call a physician and remove patient from fumes.

Storage and Handling: Protect the skin, lungs, and eyes by wearing approved protective clothing, respirator, and goggles. People who handle this material at elevated temperatures should have medical supervision, and the air should be sampled to insure compliance with M.A.C. There are no special storage restrictions under normal conditions except store in a ventilated area.

Shipping: There are no special shipping restrictions.

FERRIC CHLORIDE ($FeCl_3$)

Toxicity: This material is a solid under normal conditions and is non-toxic or has a rating as low.

Fire Hazard: There is no fire hazard under normal conditions, but it will emit toxic fumes at high temperatures.

Other Hazards: Some people are allergic to this material and may develop skin rash, and there is an eye hazard.

Treatment and Antidotes: Call a physician.

Storage and Handling: Protect the skin with approved protective clothing, avoid the breathing of $FeCl_3$ dust, wear approved respirator with adequate cartridge, and protect the eyes with approved goggles. There are no storage regulations.

Shipping: There are no shipping restrictions.

DIPHENYL ($C_6H_5C_6H_5$)

Toxicity: This material is a solid at normal conditions and is medium toxic. The M.A.C. of vapor is a 2 mg/cubic meter of air. If ingested, the lethal dose is 2.4 g/Kg of body weight. The fumes are not dangerous deadly, but they are poisonous over a prolonged time.

Fire Hazard: Diphenyl is very flammable and will burn when exposed to heat of flame or oxidizing materials (F.P. - 120°C).

Other Hazards: Diphenyl is not too corrosive to skin, but it will affect the eyes.

Dept. 246 - Process Description

AROCLOR

APPENDIX J SAFETY & TOXICITY DATA (Cont'd.)

DIPHENYL ($C_6H_5C_6H_5$) (Cont'd.)

Treatment and Antidotes: Wash eyes with water and get the patient to fresh air. Try to get patient to vomit, and call a physician.

Storage and Handling: This material can be stored in steel containers away from fire hazards and oxidizing agents. Wear suitable clothes and approved goggles when handling diphenyl.

Shipping: Ship in cars or other suitable containers with a red warning label of flammability.

XYLENE ($C_6H_4(CH_3)_2$

Toxicity: This material is a liquid under normal conditions and is very toxic in liquid or gaseous form, but it is less toxic than toluene. The M.A.C. is 200 ppm.

Fire Hazard: This material is very flammable and the limiting explosive concentration is 1-5.3% by volume in air. It will also react with oxidizing agents (F.P. -85°F).

Other Hazards: This material will cause necrosis if enough is inhaled, and is hazardous to eyes, mucous membranes, and the skin.

Treatment and Antidotes: Get patient to fresh air, and call a physician. If injested, get patient to vomit. Wash eyes and skin with water.

Storage and Handling: This material should be stored in a cool well-ventilated area away from fire hazards or strong oxidizing agents. The material for storage can be steel cars or tanks. Wear approved protective clothing, respirator, and goggles.

Shipping: Ship in containers of steel or appropriate material with a red label.

TRICHLOROBENZENE:

Toxicity: This material is a solid at room temperature and the vapors are quite toxic. The solid is poison if ingested. The M.A.C. is 50 ppm

Fire Hazard: This solid is flammable but is listed only as a moderate fire hazard. Will burn at 420°C or above.

Other Hazards: This material will affect the liver, eyes, and mucous membranes.

Treatment and Antidotes: Wash eyes with water, and get patient to fresh air. Call a physician.

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Dept. 246 - Process Description

AROCLOR

APPENDIX J SAFETY & TOXICITY DATA (Cont.

TRICHLOROBENZENE (Cont'd.)

Storage and Handling: Store this material in cool, well-ventilated area away from hazards and oxidizing agents. Wear protective clothing, chemical safe goggles and approved respirator.

Shipping: Ship in steel containers like cars or tanks with red label.

TETRA-TRI-CHLOROBENZENE

Toxicity: This material is a solid at normal temperatures and is medium toxic. The M.A.C. of vapor is 50-75 ppm.

Fire Hazard: This material is not a very great fire hazard, but it will burn at high temperatures and will decompose and emit chlorine.

Other Hazards: This material will affect the eyes, skin, and mucous membranes.

Treatment and Handling: Wash eyes and skin with water and get patient to fresh air. Call a physician.

Storage and Handling: Store this material in a cool place away from fire hazards and strong oxidizing agents. This material can be stored in steel cars, tanks, or etc. Wear protective clothing, approved respirator, and chemical safe goggles when handling this material.

Shipping: Ship this material in containers marked with a red label.

LIME $Ca(OH)_2$

Toxicity: Lime is not dangerously toxic, and it is regarded as more of a nuisance. This material is a solid or slurry.

Fire Hazard: This material is not flammable.

Other Hazards: Lime is very hazardous to the eyes. It will burn the skin also, and the dust will affect the mucous membranes.

Treatment and Antidotes: Flood eyes and skin with large quantities of water. If lime is ingested, get patient to vomit and call physician.

Storage and Handling: Lime can be stored in steel containers, and people should wear protective clothing, respirators, and rubber or chemical safe goggles when handling lime.

Shipping: There are no special restrictions for shipping, but the containers should have a white label, a caustic warning.

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Dept. 246 - Process Description

AROCLOR

APPENDIX J SAFETY AND TOXICITY DATA (Cont'd.)

ATTAPULGUS EARTH

Toxicity: This earth is not toxic in general.

Fire Hazard: There is no fire hazard.

Other Hazards: Attapulgus earth can create a dust hazard similar to other dusts that contain silica.

Treatment and Antidotes: Consult a physician.

Storage and Handling: Attapulgus earth presents no special storage problem and should be handling by persons wearing an approved respirator.

Shipping: There are no special restrictions on shipping.

HYDROGEN CHLORIDE (HCl)

Toxicity: This material is a gas under normal conditions and is very toxic. The M.A.C. is 5-10 ppm and a concentration of 1500-2000 ppm would be fatal to humans in a few minutes.

Fire Hazard: There is no fire hazard under normal conditions, but wet gas reacts with some metals to form hazardous hydrogen.

Other Hazards: This material is hazardous to teeth, skin, eyes, and mucous membranes.

Treatment and Antidotes: Wash profusely with water, if ingested, eat chalk, magnesium hydroxide, egg whites, and milk, and also administer oxygen. Call a physician.

Storage and Handling: This material should be stored in a cool, well ventilated area away from oxidizing agents. This material can be stored in rubber lined, glass, or tantalum vessels. People handling this material should wear suitable clothing like rubber aprons, shoes, and gloves. Also rubber goggles or chemical safe grades and approved pack or canister gas masks.

Shipping: Shipping containers must have a white warning label and a non-flammable label. Ship in appropriate containers such as rail car or carboy.

CHLORINE (Cl_2)

Toxicity: This material is a gas under normal conditions and is very toxic. The M.A.C. is .35 to 2 ppm. A concentration of 1000 ppm would be rapidly fatal. Least concentration with detectable odor is 3.5 ppm.

Dept. 246 - Process Description

AROCLOR

APPENDIX J SAFETY & TOXICITY DATA (Cont'd.)

CHLORINE (Cl_2) (Cont'd.)

Fire Hazard: There is no fire hazard under normal conditions, but there is an explosion hazard if chlorine is mixed with a strong reducing agent such as hydrogen or hydrocarbons on high temperature.

Other Hazards: This material causes eye, skin, and mucous membrane irritation.

Treatment and Antidotes: The patient should be given oxygen immediately and treated for shock. Call a physician.

Storage and Handling: This material should be stored in a ventilated and cool place away from fire hazards. When handling, wear a gas mask or approved respirator, clothing and rubber or chemical safe goggles. In strong chlorine concentrations, wear canister gas masks, Scott Air Pack, or oxygen breathing apparatus.

Shipping: The shipping containers must have a green gas label and a non-flammable label on. Ship in steel cars or cylinders.

MONS 055545

Dept. 246 - Process Description

AROCLOR

APPENDIX K BACKGROUND INFORMATION

The manufacture of Aroclors was developed quite by chance. The Indian Refining Company, in the latter part of 1926, approached the Swann Chemical Company located in Anniston, Alabama, regarding the production of Biphenyl which the Indian Refining Company wanted to use as a heat transfer medium. The Swann Chemical Company agreed to produce Biphenyl, but first a process had to be developed.

Two years later, in 1928, a pilot plant for producing Biphenyl became operative. However, in the meantime, the Indian Refining Company dropped all interest in Biphenyl. Since a process had been developed for manufacturing Biphenyl, the Swann Chemical Company started looking for other outlets for this material. The simplest outlet was in the form of Chlorinated Biphenyls which were produced in the laboratory in 1929.

The Chlorinated Biphenyls produced exhibited good electrical properties. This was reported to the General Electric Company who immediately became interested in the product which ultimately developed into large scale consumption in electrical transformers and capacitors.

The trade name "Aroclors" was adopted for the Chlorinated Biphenyl products. The properties of Aroclors vary from mobile oily liquids to fine white crystals and hard transparent resins. The excellent electrical properties, fire resistance and inertness of the Aroclors make them useful for many applications.

Plant equipment was installed to produce Aroclors at a rate of 3000 pounds per day or 1 million pounds per year. In the following years, this production rate was insufficient to meet the increases sales requirements.

The Swann Chemical Company was purchased by the Monsanto Company in 1935. This purchase gave Monsanto access to the patent rights for the production of Aroclors.

Production capacity needed to be expanded, and since Monsanto had a chlorine plant as "Plant B" (now called the W. G. Krummrich Plant), the Aroclor production was transferred from the Anniston Plant to the Monsanto, Illinois Plant, where operations at an increased productive capacity started in September, 1936.

By 1940, the Krummrich Plant production capacity was inadequate, and in 1941, a similar production unit was installed in the Anniston Plant.

AROCLOR

APPENDIX L TIME CYCLE

The design capacity of the department is 2,400,000 pounds per month or 28,800,000 pounds per year.

Figure 1 of this section illustrates the flow pattern of the Aroclor process and lists the approximate time needed to complete each process step. The time table for the Aroclor process is summarized below:

Operation		Time (hours)	Equivalent pounds of Finished Product
Charge Chlorinator		.25	
Chlorination	1242	6.00	6400
	1248	8.00	7200
	1254	10.00	8040
	1260	12.00	9100
Transfer to blow tanks		.25	
Aeration		2.00	
Distillation	1242	1.75	
	1248	1.75	
	1254	1.75	
	1260	1.75	
Blending		2.00	
Filtering		2.00	
Dropping to Storage		2.00	

The time required to make completed batches of the various Aroclors are tabulated below:

Aroclor	Batch Time (hrs.)
1242	17.25
1248	18.25
1254	20.25
1260	21.25

Process operations including filter press cleaning, sampling, etc., are independent of the batch completion time cycle because production time is not lost.

Dept. 246 - Process Description

AROCLOR

APPENDIX M QUALITY CONSIDERATIONS

The Aroclor compounds are among the most versatile chemically-made materials in industry. Aroclors are useful in many ways because of their outstanding inertness.

Aroclors are used alone for particular physical jobs such as insulating, heat transfer, sealants, and expansion media; and they are used as components or extendors in elastomers, adhesives, paints, lacquers, varnishes, pigments and waxes.

Aroclors must be highly pure, with dependably minimal traces of electrolytes for use in electrical applications. Electrical grade Aroclors must pass numerous stringent specifications. The following tests determine Aroclor quality:

Hydrolysis Stability	Measure of chemically unstable chlorine compounds.
Munch or Monsanto Stability Test	Measure of thermally unstable chlorine compounds at elevated temperatures.
Thermal Chemical Chloride	Developed by the General Electric Company to measure chemically and thermally unstable chlorine compounds.
Resistivity	Measure of insulative properties.
Power Factor	Measures power loss due to current through a capacitor.
Dielectric Constant	Measures the capacitance of a standard such as air compared to the capacitances of Aroclor.
Specific Gravity, Refractive Index	Measures of chlorination level.

The stability and electrical properties of electrical-grade Aroclors are paramount in quality considerations. The chlorination step of the process is most critical because many properties of the final product are determined by the properties of the crude Aroclor. Conditions in the chlorinator needed for a good quality product are:

1. Chlorination Temperature - The chlorination temperature must be greater than 120°C within 30 minutes from the beginning of the chlorination reaction to produce stable Aroclors. Results of research tests indicate that product stability is better as the initial chlorination temperature is increased.

APPENDIX M QUALITY CONSIDERATIONS (Cont'd.)

2. Ferric Chloride Concentration - Research has found that the ferric chloride concentration must be at least 0.03% to form stable products. Research recommends 0.05% ferric chloride. Lower catalyst ratios result in increased "addition" chlorination as opposed to "substitution" chlorination, indicated by higher chloride values and lower yields.

   The isomeric distribution of the final product is a function of the type and concentration of the catalyst used in the reaction.

   Homogeneous suspension of the catalyst is extremely important. Good catalyst contact cannot be attained without homogeneous suspension. Since ferric chloride does not mix well with biphenyl, the dry catalyst must not be poured into the chlorinator.

3. Geometry of Reacting Vessel - The shape of the reactor affects the circulation and flow pattern of the reactants. It is suspected that the chlorine gas channels through a void space in the existing catalyst basket. This problem is presently being studied.

   The reactor must be designed such that circulation of reactants is rapid and homogeneous and local over-chlorination does not occur.

4. Cleanliness - The ferric chloride settles to the bottom of the chlorinator. Areas of the packed bed become plugged with ferric chloride and channeling of reactant flow may result.

   A steam clean-out of the chlorinator may be an expedient method to remove the ferric chloride. This method was tried in the department, and evidently was successful. Further tests by the laboratory will verify the effectiveness of a steam clean-out.

5. Sparging - The sparger controls the gas distribution under the catalyst hold-up plate and the size of gas bubbles. It is not known whether the catalyst basket or sparger or both are the critical factors in achieving the proper flow of gas through the reactor. It is believed that the sparger should distribute small bubbles giving good gas distribution throughout the chlorinator. The small bubbles have a greater surface area per unit volume of gas for mass transfer and this should increase the reaction rate.

6. Raw Material Purity - The purity of raw materials can affect the quality of Aroclors. Sulfates are particularly harmful in the chlorine gas. It is suspected that sulfates poison the ferric chloride catalyst and sulfates some of the biphenyl. If the ferric chloride catalyst is poisoned, the effective catalyst concentration is reduced and thus unstable aroclors will be produced. The chemistry and mechanism of catalytic poisoning are not known for certain. Sulfonated biphenyl is carried over during distillation and is not removed by earth treating.

Dept. 246 - Process Description

AROCLOR

APPENDIX M

QUALITY CONSIDERATIONS (Cont'd.)

6. Raw Material Purity (Cont'd.)

Sulfonated biphenyl has ionic properties which lowers the resistivity of the finished product. A Brink Mist Eliminator has been installed in Dept. 246 to eliminate the chlorine impurities.

7. Earth Treatment - The factors affecting stability also influence the electrical properties of Aroclors. An absorbent will be ineffective if the Aroclor was not prepared in a manner such that a stable product was formed during the chlorination reaction.

However, research has found that absorbents are very effective for improvement of electrical properties by removing ferric chloride and tars carried over during distillation, provided the crude Aroclor has good stability.

The absorbent used in Dept. 246 (after distillation) is Attapulgus Earth, the concentration should be 0.5% for Aroclor 1242 and 0.1% for other Aroclors. The earth must be heat treated at 250°C for a minimum of 4 hours before addition to the Aroclor. Heat treatment reduces the moisture and activates the earth.

8. Lime Treatment - It is important that proper amount of lime (250 pounds per still run) be added to the still to prevent sublimation of ferric chloride.

9. The blend tanks, finished product tanks, and Aroclor 1242 and 1254 storage tanks are blanketed with nitrogen gas. Nitrogen blanketing maintains the electrical properties of the Aroclors by preventing corrosion of the equipment.

In summary, the chlorination step of the process is the most critical. A good quality Aroclor cannot be produced if a stable compound is not formed during chlorination.

Once a stable compound is formed, other techniques such as use of lime, absorbents, and nitrogen blanketing are used to maintain and improve electrical properties.

Dept. 246 - Process Description

AROCLOR

APPENDIX M QUALITY CONSIDERATIONS (Cont'd)

Absorbents - Numerous absorbents have been screened in the laboratory at various contact temperatures for their effect on resistivity of plant untreated Aroclor 1242.

The most satisfactory absorbent pound for improving the resistivity of Aroclor 1242 was LVM attasorb. Table I of this section lists the laboratory results of the different absorbents used to treat Aroclor 1242.

Degradation of Aroclors

Degradation of Aroclors, which leads to loss in electrical resistivity, is one of the short comings of using Aroclor as a dielectric, expecially since only a very minor degradation can cause a serious breakdown in electrical equipment.

The thermal degradation of fractionated Aroclor has been measured at 250°C and the amount of Hydrogen Chloride liberated was measured. The results of these tests are listed in table II of this section.

Aroclor 1242 has been degraded by ultraviolent light, and the decrease in electrical resistivity with irradiation time was measured. The plot of resistivity versus concentration is a curve for a weak electrolyte. It is possible to remove the conducting material brought about by photo-degradation, and restore the resistivity of its original value by passing the degraded material over activated alumina.

Thermal degradation of Aroclors is minor compared to photo chemical degradation. Thermal treatment causes release of a small amount of hydrogen chloride initially, but this evolution ceases after a short time. Such behavior is attributed to thermal degradation of impurities. If Aroclor is irradiated, then exposed to a thermal treatment, appreciably more HCl is liberated.

MONS 055551

TABLE I

ADSORBENT SCREENING DATA

Adsorbent	Adsorbent Pretreatment	Contact Temperature °C	Volume Resistivity at 100° ohm-cm. x 10°C
LVM Attapulgus Earth	None	60	3400
		80	2000
		100	2800
		120	2900
LVM Attapulgus Earth	Heated at 250°C 12 Hours	60	4200
		80	6400
		100	7200
		120	6100
LMV Attapulgus Earth	Heated at 350°C 12 hours	60	9300
		80	9000
		100	6300
		120	6300
LVM Attapulgus Earth	Heated at 350°C 4 hours	60	2400
		80	5600
		100	6000
		120	5700
Attasorb - LVM	None	60	9700
		80	12,100
		100	13,700
		120	17,800
Attaclay	None	80	10,200
		100	5400
		120	6000
Activated Alumina (Alcoa Grade F-3 -325 mesh)	None	60	2100
		80	2500
		100	2800
		120	3100
Voclay 325 (Western Bentonite)	None	80	5700
		100	3800
		120	9700
Panther Creek (Southern Bentonite)	None	80	6200
		100	11,300
		120	8100
Filtrol Grade 1	None	80	2600
Zeolex 7 (Zeolite)	None	80	7000
Florite 60 mesh (Activated Bauxite)	None	100	3600
Suprex L-G (Kaolin)	None	100	4500
Attasorb - LVM	Heated 350°C 12 hours	100	12,200
Attasorb - RVM	None	100	16,200

Dept. 246 - Process Description

AROCLOR

APPENDIX M

QUALITY CONSIDERATIONS (Cont'd.)

TABLE I (Cont'd.)

Adsorbent	Adsorbent Pretreatment	Contact Temperature °C	Volume Resistivity at 100°C ohm-cm. x 10°C
Linde Molecular Sieve Type 4-A	None	60	2100
Laminar Alumina	None	60	900

Note: Resisvitity of Aroclor before treatment = 1 x 10^9 ohm-cm.

QUALITY CONSIDERATIONS (Cont'd.)

TABLE II

THERMAL DEGRADATION OF AROCLORS AT 250°C

Aroclor	gm. of HCl/gm x 10^6	Heating Time
1221	3.35	1 hr.
	6.73	2 hrs.
	11.07	5 hrs.
1232	3.91	1 hr.
	6.42	2 hrs.
	9.81	5 hrs.
1242	5.96	1 hr.
	9.58	2 hrs.
	13.00	5 hrs.
1248	3.61	1 hr.
	5.44	2 hrs.
	8.48	5 hrs.
1254	3.43	1 hr.
	3.96	2 hrs.
	6.43	5 hrs.

Dept. 246 - Process Description

AROCLOR

APPENDIX N

MISCELLANEOUS

REFERENCES

1. St. Louis Report No. 2694, Job No. 171-1028, February 15, 1952.

Title: Operation of Aroclor Stills At Increased Pressure For Increased Rates

Summary: Distillation runs were made at 20 to 30 mm Hg. The rate of distillation of 1200 series Aroclors increases with pressure.

2. St. Louis Report No. 2755, Job No. 2-02-760.01 - 3948-3 March 6, 1961.

Title: Improved Aroclor 1242 Studies

Summary: Studies were carried out to determine the effect of temperature, chlorine content, and catalyst concentration in chlorinated biphenyl mixtures. 2,4-dichlorobiphenyl is the percursor of the high dielectric constant, trichlorinated components.

3. St. Louis Report No. 2072, Job No. 2-02-750.01-3428, May 4, 1958.

Title: Final Report on Aroclor Process Studies.

Summary: Purity of raw materials, catalyst concentration, reaction temperature and rate of chlorination were the variables studies with respect to their influence on the stability of the finished product.

4. St. Louis Report No. 2540, Job No. 171-616, December 28, 1958.

Title: The Effect of Prolonged Heat on the Electrical Properties of Aroclors.

Summary: Aroclors 1232, 1242, 1248 and 1254 were held at 130°C. The power factor was periodically measured.

5. St. Louis Report No. 2234, Job No. 171-451, June 14, 1956.

Title: Evaporation Loss of Aroclors.

Summary: The evaporation loss of Aroclors was determined at 100°C under static conditions.

Dept. 246 - Process Description

AROCLOR

APPENDIX N

MISCELLANEOUS (Cont'd.)

REFERENCES (Cont'd.)

6. St. Louis Report No. 2790, Job No. 171-1028, July 3, 1952.

Title: Increased Production of Aroclors by More Rapid Rate of Chlorination.

Summary: Chlorination rate was increased from 400 pounds per hour to 770 pounds per hour. Aroclors produced at increased rate was within specifications.

7. St. Louis Report No. 1842, Job No. 2-02-750.01-3368 July 12, 1957.

Title: Use of Ferric Chloride as Catalyst for Production of Aroclor 1242.

Summary: The comparison of stability chloride values revealed no difference between the product made with iron turnings as catalyst and ferric chloride as catalyst.

8. St. Louis Report No. 2096, Job No. 2-02-750.01-3202, June 6, 1958.

Title: Resistivity Improvement of Aroclor 1242.

Summary: Numerous absorbents were screened at various contact temperatures for their effect on resistivity of plant untreated Aroclor 1242. Heat activation of Attapulgus Earth was also studied.

9. E. E. Martin, OPERATING INSTRUCTIONS FOR DEPT. 246, W. G. Krummrich Plant, 1961.

10. E. E. Martin, PROCESS DESCRIPTION FOR MANUFACTURE OF AROCLORS, 1962.

11. E. Mather, PROCESS DESCRIPTION FOR MANUFACTURE OF AROCLORS, 1955.

Dept. 246 - Process Description

AROCLOR

APPENDIX N

MISCELLANEOUS

The following table shows the results of tests which measured the evaporation losses of the various Aroclors.

Aroclor	Evaporation Rate gms/cm^2/hr./100°C
Aroclor 1221	.00174
Aroclor 1232	.000874
Aroclor 1242	.000338
Aroclor 1248	.000152
Aroclor 1254	.000053
Aroclor 1260	.0000088
Aroclor 1262	.0000132

From the above results, the evaporation rate for Aroclor 1262 is greater than that of Aroclor 1260. This unexpected result may be explained by some difference in the conditions of which the two lots were prepared.

The reaction products in Biphenyl Chlorination differ with the type of catalyst used. Results of research investigations are listed below:

	Isomer Distribution of Aroclor 1232						
Catalyst	2 -	4 -	2,2' -	2,4 -	2,4' -	4,4'	tri
Fe Cl_3	15%	7%	15%	6%	38%	11%	9%
Sb Cl_3	11	0.7	20	3.6	38	18	9
Ti Cl_4	11	0	20	2.2	46	14	7
Sn Cl_4	24	1	16	2.3	38	18	1.3

Dept. 246 - Process Description

AROCLOR

APPENDIX N

MISCELLANEOUS (Cont'd.)

Some of the typical operating difficulties in department 246 and possible remedies are given below:

CHLORINATORS

Trouble	Cause	Remedy
Chlorinators operating against too much back pressure	Plugged off-gas lines	Open lines and steam them out. Dry out lines with air before resuming operation.
Chlorinator slow in picking up gravity	1. Low chlorine pressure or low chlorine gas concentration 2. Wet biphenyl	1. Call chlorine dept. for more gas 2. Check biphenyl storage tanks for moisture.

BLOW TANKS

Blow tanks stacking off	Operating chlorinators with vent open	Close chlorinator vent; possibly reduce air to blow tanks

STILLS

Not enough vacuum	1. Ejectors not pulling properly 2. Coke scrubber contains water	1. Check ejectors 2. Drain coke scrubber

36" SPARKLER FILTER

Foreign material in filtrate samples	Dirty filter or broken paper	Clean and re-paper press

MONS 055558

MONSANTO COMPANY

ORGANIC CHEMICALS DIVISION

STANDARD MANUFACTURING PROCESS FOR

AROCLORS - DEPARTMENT 246

****

Supersedes: Standard Manufacturing Process for the Manufacture of Aroclors, Department 246 Dated July 20, 1964 and all amendments.

Prepared by: D. E. Harris

Approved by:

General Superintendent

Research

Technical Production Mgr.

Date: 1966

af

COPY 4 of 15

MONS 055432

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MONSANTO COMPANY
Sauget, Illinois

December 29, 1971

Messrs: J. R. Savage - G.O.
W. R. Richard - G.O.
B. W. Corlew
D. W. Jackson
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W.G.K. Plant Records
Process Holders

Tentative Amendment "L"

TITLE

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

SUB-TITLE

Demonstrate the ability to produce electrical grade Aroclor 1254 and/or 1260 from off-gas condensate (trappings).

PRESENT PRACTICE

The condensate from the cooled off-gas is trapped, utilizing brink mist eliminators, and stored in the off-gas condensate tank. This condensate is presently used to produce non-electrical grade Aroclors by chlorinating batchwise to the desired level, usually Aroclor 1148.

PROPOSED CHANGES

It is proposed that the condensate be chlorinated batchwise to 1154 and/or 1260 and the distilled 1254 and/or 1260 be analyzed for electrical grade Aroclor.

JUSTIFICATION

The amount of condensate (100,000#/month) produced at the present rate exceeds the demands for non-electrical Aroclors. A new outlet must be developed or a yield loss on biphenyl of about 2 per cent ($40,000/year) will result.

Producing electrical grade 1254 or 1260 is preferred over the alternative of producing non-electrical 1242 batchwise. The addition of non-electrical 1242 would increase the number of products and restrict storage capacity of electrical grade Aroclor 1242.

SOURCE OF DATA

Anniston R&D Report Number 1 on Job Number 446-516, dated 6/1/70 stated electrical grade 1242 could not be produced from their trappings due to an abnormal isomer split. Electrical grade Aroclor 1254 was successfully produced from trappings in the Laboratory using simulated plant conditions. The conclusion states, "Aroclor 1254 produced from trappings can be used as electrical grade when blended with normal production".

SAFETY

Plant operating variables will not be changed and no safety hazards will be created.

QUALITY

The quality of material produced will be monitored routinely. If normal analytical tests show a deviation in quality, special disposition will be made with Marketing concurrence. If typical material is produced, it will be sold as electrical grade Aroclor.

DEMONSTRATION CRITERIA

Normal electrical grade specifications will be used to determine whether the condensate can be used for production of electrical grade Aroclors. If specifications can not be met, the practice will be discontinued and an alternate solution found.

Written By: Wayne A. Krull

sms

Approved By:

C. L. A. Process Technology

Mgr., R&D Business Group 1/15/71

Mgr., R&D Process Technology 1/22/71

PROCESS TECHNOLOGY SAFETY REVIEW COMMITTEE

1/26/71

1/27/71

1/28/71

Approved By:

Production Supervisor 1/5/71 Date

Production Gen. Superintendent 1/8/71 Date

TSD Process Gp. Superintendent 1/11/71 Date

Gen. Supt. Technical Services 1/8/71 Date

Manufacturing Manager 1/20/71 Date

MONS 055435

Monsanto

FROM (NAME & LOCATION): R. M. McCutchan, Krummrich

February 15, 1971

cc: V. Brawley
B. Engman
R. Munch
[redacted]

SUBJECT : DISPOSITION OF AROCLOR OFF-GAS CONDENSATE AND BOILDOWN

REFERENCE :

TO : B. W. Corlew

The primary purpose of this memo is to serve as an insert in the "QUALITY" section of the Aroclor Standard Manufacturing Process document. It records the data obtained in evaluating the disposition of off-gas condensate (1.0-1.5% of production) and "boildown" (2.0-3.0% of production).

Until this evaluation off-gas condensate had been used only for making Aroclor 1248 NE. "Boildown" had been used in making Pydraul A-200. Now both materials are further chlorinated to Aroclor 1254 EQ.

The data indicates that off-gas condensate presents no problems at all. Aroclor 1254 made from "boildown", however, is poorer in both thermal chemical chlorides and Monsanto Stability. This material will be used for transformer blends.

The above situation will exist until the start-up of the MCS-1016 fractionating column, at which time Aroclor 1254 will be made from column bottoms. Aroclor 1254 quality will again be reviewed at that time.

R. M. McCutchan

/gjs

LOT NO.	SPEC.	KM 648	KM 650	KA 601	KA 602	KA 603	KA 604	KA 605
Raw Mat'l.*		OGC	OGC	BiØ	BiØ & OGC	BD	BD	BiØ & BD
TCC	---	0.37	0.44	0.41	0.47	1.01	0.94	1.00
Mons. Stab.	0.50	0.48	0.37	0.38	0.40	0.52	0.56	0.52
Hyd. Stab.	1.00	0.07	0.10	0.21	0.12	0.23	0.22	0.07
West. Stab.	----	0.23	0.21	0.25	0.32	1.13	0.27	----
PF @ 60 cyc., WGK	----	0.30	0.50	0.50	0.60	0.59	2.34	0.31
Resistivity x 10^9,WGK	500	12,800	19,200	18,420	17,600	10,800	3,120	46,460
PF @ 60 cyc.So.2nd	----	0.018	0.540	----	0.108	0.047	----	----
Resistivity x 10^{12},So.2nd	----	2,659	296	----	14,894	110	----	----

*BiØ - biphenyl
OGC - off-gas condensate
BD - boildown

MONS 055437

MONSANTO COMPANY
Sauget, Illinois

November 16, 1970

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Technical Information Center (2)
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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
Wayne A. Krull

sms

Approved By:

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

Oliver DeGermo 12/2/70
Mgr., R&D Process Technology

PROCESS TECHNOLOGY SAFETY REVIEW COMMITTEE

John F. Quinn 12/3/70

M A Tarpstra 12/4/70

[illegible] 12/7/70

Approved By:

R M McCutcheon 11/18/70
Production Supervisor Date

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

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

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

J R Savage 12/4/70
Manufacturing Manager Date

MONSANTO COMPANY
Sauget, Illinois

August 26, 1970

Messrs: J. R. Savage - G.O.
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N. W. Corlew
D. W. Jackson
W. C. Engman
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Technical Information Center (2)
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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.

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
Wayne A. Krull

Approved By:

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

Research Safety Review Committee

M A Terpatra 9/15/70
Date

T Fowler 9/16/70
Date

W G 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

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

D. W. Jackson 8/31/70
T.S.D. General Superintendent Date

J R Savage 9/3/70
Manufacturing Manager Date

MONS 055442

sms

file in Aroclor SMP

MONSANTO COMPANY
Sauget, Illinois

February 19, 1971

Messrs: O. R. Savage - G.O.
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A. E. Leisy
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Status of Tentative Amendment "I" (dated 8/26/70) to the Standard Manufacturing Process for Aroclors, Department 246, dated October, 1966.

The objective of this amendment was to demonstrate reworking scrap Aroclor returned from customers to produce saleable Aroclor. This was to be accomplished in the exisiting #1 still system and would require new piping, pumps, and a storage tank.

To this date, all the equipment has not been installed, so the process has not been demonstrated fully. Some reworking has been done successfully by production on a makeshift basis. The WGK Laboratory is set up to analyze incoming material to determine suitability for reworking. Construction on the storage tank to be transferred from the old Phenol Department is to start the week of February 22 with completion of the project tentatively scheduled for July 1, 1971. Final disposition of this amendment will be made when the complete process has been demonstrated.

W. A. Krull

wms

MONSANTO COMPANY
Sauget, Illinois

February 19, 1971

Messrs: J. R. Savage - G.O.
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Process Holders

Final disposition of Tentative Amendment "J" (dated 8/26/70) to the Standard Manufacturing Process for Aroclors, Department 246, dated October, 1966.

The purpose of this amendment was to demonstrate a modified aeration procedure which would reduce PCB water pollution.

The necessary equipment consisting primarily of a Brink mist eliminator with a condensate tank and piping has been installed and operating since October 19. Water samples from the scrubber and mist samples from the mist eliminator effluent have shown the pollution level at the drowing jet have been reduced better than expected. The mist samples showed no mist after the mist eliminator. The scrubber water samples show about 0.5#/day PCB pollution compared to a previous level of up to 300#/day. Details can be found in W.G.K. T.S.D. Report No. 4 on Job 91370:4119 dated 12/15/70.

Condensate caught by the mist eliminator is being used in a manner similar to off gas condensate which is reworked to produce saleable Aroclors.

It is recommended that this procedure be incorporated as part of the Standard Manufacture Process for Aroclors.

Wayne A. Krull

sms

MONSANTO COMPANY
Sauget, Illinois

February 19, 1971

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Process Holders

Status of Tentative Amendment "K" (dated 11/16/70) to the Standard Manufacturing Process for Aroclors, Department 246, dated October, 1966.

The objective of this amendment was to demonstrate a modified chlorination procedure in an attempt to improve Aroclor 1260 after corrosion chloride stability. This was to involve a designed experiment where the catalyst level, starting chlorination temperature and finishing chlorination temperature were to be run at two levels.

The designed experiment has not been carried out. In the two production runs made on Aroclor 1260 since the Amendment was approved, the 1260 produced has met electrical grade (including after corrosion chlorides) specifications using normal conditions.

Although it appears that the amendment is not needed, it will be held open until demonstration of Aroclor 1260 using MCS-1016 fractionating column bottoms as raw material.

W. K. Krull

sms

MONS 055445

MONSANTO COMPANY
Sauget, Illinois

February 22, 1971

Messrs: J. R. Savage - G.O.
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Process Holders

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

The objective of this amendment was to demonstrate the ability to produce electrical grade Aroclors from off-gas condensate. Up to the time of the amendment, both off-gas condensate and still bottoms "boildown" material was used only for non-electrical Aroclor 1248. Since this use is going to be reduced or eliminated, and alternate use is needed for both materials.

Two lots of Aroclor 1254 E.G. were produced using only off-gas condensate as the raw material. One lot of Aroclor 1254 E.G. was produced using part byphenyl and part off-gas condensate. Two lots of Aroclor 1254 E.G. were produced from "boildowns" and one lot from part biphenyl and part "boildowns." The analytical data from these tests are attached.

The data indicates that the Aroclor made from off-gas condensate was similar to material made from biphenyl. The material made from "boildowns" made poorer quality Aroclor as evidenced by Monsanto Stability (slightly out of specification) and Thermal Chemical Chlorides (significantly higher although there is no specification).

As a result of these tests and until the start-up of the MCS-1016 fractionator, off-gas condensate will continue to be used in Aroclor 1254 E.G. for all uses. Boildown material will be used in Aroclor 1254 E.G. but the product will be used only in transformer blends where a scavenger is available.

When the fractionator is started up, Aroclor 1254 is to be made from column bottoms and a re-evaluation of quality will be made at that time.

Wayne W.Krull

MONS 055446

sms

DISPOSITION OF AROCLOR
OFF-GAS CONDENSATE AND BOILDOWN

Lot No.	Spec.	Typical	KM 648	KM 650	KA 601	KA 602	KA 603	KA604	KA 605
Raw Material*			OGC	OCG	BiØ	BiØ & OGC	BD	BD	BiØ & BD
TCC	---	---	0.37	0.44	0.41	0.47	1.01	0.94	1.00
Monsanto Stability	0.50**	0.35	0.48	0.37	0.38	0.40	0.52	0.56	0.52
Hyd. Stability	1.00**	0.10	0.07	0.10	0.21	0.12	0.23	0.22	0.07
West. Stability	---	---	0.23	0.21	0.25	0.32	1.13	0.27	---
PF @ 60 cyc., WGK	---	---	0.30	0.50	0.50	0.60	0.59	2.34	0.31
Resistivity x 10^9, WGK	500***	20,000	12,800	19,200	18,420	17,600	10,800	3,120	46,460
PF @ 60 cyc. So. 2nd	---	---	0.018	0.540	---	0.108	0.047	---	---
Resistivity x 10^{12}, So.2nd	---	---	2,659	296	---	14,894	110	---	---

*BiØ - biphenyl
OGC - off-gas condensate
BD - boildown

** Maximum
*** Minimum

MONS 055447

MONSANTO COMPANY
Sauget, Illinois

August 26, 1970

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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.

MONS 055448

SOURCE OF DATA

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 A. Krull

Approved By:

Research & Development Manager Date

Research Safety Review Committee

Date

Date

Date

Approved By:

Production Supervisor Date

Product Group Superintendent Date

TSD Group Superintendent Date

TSD General Superintendent Date

Manufacturing Manager Date

MONS 055449

sms

MONSANTO COMPANY
Sauget, Illinois

July 28, 1970

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D. W. Jackson
W. C. Engman
R. M. McCutchan
Technical Information Center (2)
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Tentative Amendment "H"

TITLE

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

PURPOSE

The purpose of this document is to describe the variances between the way the Aroclor Department at the William G. Krummrich Plant is operated and the process as described either by the "Standard Manufacturing Process" dated October, 1966 or by the "Tentative Process For The Continuous Manufacture of Aroclor 1242" dated September 16, 1968. The first section will summarize major deviations from the Standard Manufacturing Processes including amendments. The second and third sections will summarize the disposition of the amendments to the Standard Manufacturing Process and the Tentative Process respectively. A revised Standard Manufacturing Process will be circulated for approval by 1/1/71.

SUMMARY OF THE PRESENT PROCESS DEVIATIONS

The present process consists of manufacturing Aroclor 1242 continuously by the methods described in the Tentative Process and the other Aroclors batchwise as described in the Standard Manufacturing Process. Deviations from these documents as amended are described below.

The amount of catalyst used in the continuous process as measured analytically in crude samples is 0.10% in the first chlorinator of the series and 0.04% in the last of the series. Catalyst concentration in the batch chlorinators is 0.05% based on Biphenyl. The Standard Manufacturing Process states 0.05% and the Tentative Process 0.10%.

Chlorination temperatures are staggered in the continuous chlorinators. The temperature from first to fourth are: 150, 160, 180, and 190. The temperature of the batch chlorinators is 150°C. The Standard Manufacturing Process, as amended, gives the batch temperature as 195°C. The Tentative Process has the same temperatures (150, 160, 180, 190) as above for the continuous series.

SUMMARY OF THE PRESENT PROCESS DEVIATIONS (Cont'd)

The intermediate storage tank in the continuous process is held at whatever level is convenient for production with no attempt being made to control residence time. The Tentative Process quotes 24 - 48 hours as a retention time to improve quality.

Distillation of all products is over 0.1% Lime. The procedure is to charge the still, add 150 pounds of Lime and start distillation. When 150,000 pounds of product is distilled, another 150 pounds of Lime is added. Distillation is continued and another 150,000 pounds of product is distilled before the still bottoms are pumped over. A new cycle is then started. Both the Standard Manufacturing Process and Tentative Process show 0.4% Lime with 0.8% recommended.

Distilled product is no longer earth treated with rare exceptions. The distilled material is now continuously fed through an activated alumina (Porocel) packed column to improve electrical properties.

Since the Aroclors produced at W.G.K. have been of consistently good quality, the process will be operated in this manner with no changes proposed. The new Standard Manufacturing Process will include these conditions.

CANCELLATION OF AMENDMENTS TO STANDARD MANUFACTURING PROCESS

Amendment "A" pertained to producing Aroclor 1242 batchwise. This practice has been discontinued so Amendment "A" is void.

Amendment "B" was proposed to determine the effect of Bromine on Aroclor stability under altered process conditions. The material produced was shown to be of at least equal quality to normally made Aroclor. No permanent operating changes were proposed.

Amendment "C" was proposed to demonstrate improved Aroclor 1254 quality by modified process conditions. Indications of better quality were noted and a permanent change of higher temperature (195°C.) was proposed. This was followed for a period of a few months, but the temperature has been lowered to 150°C. (the original temperature) for the past two years. The quality improvement was not large enough to offset the increased Aroclor carryover in the off gas.

Amendment "D" was proposed to improve the quality of Aroclors 1248 1260, and 1262 in anticipation of high Bromine content in the chlorine raw material. The changes in chlorination temperature (195°C.) and Lime usage (0.08%) in distillation have not been done for at least two years. The catalyst level is 0.05%, the Lime usage 0.10%, and the chlorination temperature 150°C.

Amendment "E" was not approved nor published.

CANCELLATION OF AMENDMENTS TO STANDARD MANUFACTURING PROCESS (Cont'd)

Amendments "F" and "G" were proposed to demonstrate improved quality of Aroclors 1242 and 1254 by using Iodine as a co-catalyst to Ferric Chloride. These tests were inconclusive and abandoned.

Cancellation of Tentative Amendment "A" to the Tentative Process for the continuous production of Aroclor 1242.

This amendment was proposed to demonstrate Anniston Plant conditions by making changes in the process conditions and determining the effect on quality. These conditions were never demonstrated and no plans exist for demonstrating them in the future.

Originated By:

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Technical Services Department

Approved By:

Research & Development Manager — Date 9/16/70

Research Safety Review Committee

Date 9/22/70

Date 9/24/70

Date 9/24/70

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T.S.D. Group Superintendent — Date 9/25/70

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MONS 055452

bmb

MONSANTO COMPANY
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May 13, 1969

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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.

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C. W. Hamlet, Jr.

Approved by:

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Div. Resch. Group Leader Date

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MONS 055455

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File w/ Process

May 8, 1968

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Tentative Amendment No. F

TITLE

Tentative Amendment No. "F" to the Standard Manufacturing Process for the manufacture of Aroclors, Department 246, dated October, 1966.

SUB-TITLE

Demonstrate improved quality Aroclor 1242, as measured by thermal chemical chlorides, by use of modified plant conditions.

PRESENT PRACTICE

Biphenyl is chlorinated at a temperature range of 120 - 195°C. in the presence of 0.05% $FeCl_3$ catalyst. The biphenyl is preheated and dropped to the chlorinator. The catalyst is added and the chlorine is turned on. The chlorination causes the temperature to rise from 120°C. to an average chlorination temperature of 195°C. The present maximum temperature is 195°C. Chlorination is terminated by specific gravity.

From the chlorinator, the batch is moved directly to a blow tank where HCl is removed by an air purge. The blow tank is used as a feed tank for the still.

Distillation is carried out in the presence of 0.8% lime. The distilled product is earth treated and moved to storage.

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 to the biphenyl in addition to the Ferric Chloride. The Iodine would be added at the circulating line to the chlorinators immediately following the start of chlorination.

MONS 055456

JUSTIFICATION

Compared to our competition, Monsanto does not make the best Aroclor for electrical use. Ultimate loss of a profitable market will result if we do not improve quality.

JUSTIFICATION (Cont'd.)

Laboratory work has shown that the addition of iodine to the chlorination results in a definite quality improvement.

These laboratory tests need to be extended to the plant so that sufficient material can be produced to permit life testing of the product and the off gas can be adequately sampled for iodine.

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 preliminary demonstration should be processed as non-electrical Aroclor. The product made during the extended demonstration should be segregated as non-electrical product and held for life testing.

Laboratory chlorinated material using iodine as a co-catalyst meets all specification properties and exhibited excellent stability.

EXTENT OF DEMONSTRATION

The preliminary demonstration will consist of two chlorination batches. These batches will be run with iodine. One batch will be chlorinated at 150°C. and the other at 195°C. The batches will be sampled and laboratory distilled and analyzed. Samples of the HCl off gas will be sampled for iodine. The HCl will be sewered.

The results of the preliminary run will establish the conditions for a run long enough to make sufficient Aroclor 1242 for life testing. This material will also be separated from electrical quality Aroclor. The off-gas will be sewered unless data from the preliminary run indicates the absence of iodine.

CRITERIA FOR ACCEPTANCE MONS 055457

The acceptance of this amendment will be based on the results of the life testing and the economics of operation if the iodine level in the off-gas requires sewering it. Results of the life testing should be available within 6 months of the demonstration.

Written by J. A. Gloeckner
J. A. Gloeckner

C. W. Hamlet, Jr.
C. W. Hamlet

Approved by

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MONS 055458

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Tentative Amendment "D"

TITLE

Tentative Amendment No. D to the Standard Manufacturing Process to the Manufacture of Aroclors, Department 246, dated October, 1966.

OBJECTIVE

To improve department operations and to overcome the possible effects of bromine on Aroclor 1248, 1260 and 1262 quality.

JUSTIFICATION

High temperature operation for Aroclors 1242 and 1254 have demonstrated improved quality. Laboratory work on Aroclor 1242 has indicated that under normal processing conditions, bromine in the chlorine gas is detrimental to quality. High temperature operation neutralizes the bromine effect.

It is likely that in the near future, higher bromine concentrations will be present in the chlorine. Higher temperature operation will result in increased vapor losses equal to $10,000 (maximum). It would cost more than this in laboratory investigations and testing to determine the extent of the problem. Another advantage of higher temperature is to reduce quality variability in the chlorination.

"D" to Aroclor

PRESENT PRACTICE

Biphenyl is chlorinated at a temperature range of 120 - 170°C. in the presence of 0.05% $FeCl_3$ catalyst. The biphenyl is preheated and dropped to the chlorinator. The catalyst is added and the chlorine is turned on. The chlorination causes the temperature to rise from 120°C. to an average chlorination temperature of 150°C. The present maximum temperature is 170°C. Chlorination is terminated by specific gravity.

From the chlorinator, the batch is moved directly to a blow tank where HCl is removed by an air purge. The blow tank is used as a feed tank for the still.

Distillation is carried out in the presence of 0.4% lime. The distilled product is earth treated and moved to storage.

PROPOSED CHANGES

These conditions are to be applied to Aroclors 1248, 1260 and 1262. Run the process at 0.05% catalyst and 195°C. The temperature of 195°C. is to be reached no later than one hour before the end of the chlorination. Use 0.8% lime for the distillation.

SAFETY

This amendment should not result in any safety hazards. Process amendments "A", "B" and "C" have demonstrated the safety of chlorination temperatures of 195°C.

EXTENT OF DEMONSTRATION

Runs will be made on each of the products. The effects on quality and operating economics will be evaluated. Based on these results, the decision will be made on making the amendment permanent.

DISPOSAL OF PRODUCT

The product made will be distributed in the normal manner.

Prepared by J. A. Gloeckner
J. A. Gloeckner

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MONS 055460

"D" to Aroclor

APPROVED BY

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Tentative Amendment "C"

TITLE

Tentative Amendment No. "C" to the Standard Manufacturing Process to the Manufacture of Aroclors, Department 246, dated October, 1966.

OBJECTIVE

Demonstrate improved quality Aroclor 1254, as measured by thermal chemical chlorides, by use of modified plant conditions.

JUSTIFICATION

Competitive wise, Monsanto does not make the best Aroclor for electrical use. Ultimate loss of a profitable market will result if we do not improve quality.

WGK Process Research work, which is an extension of previous Organic Research work shows improved stability (thermal chemical chlorides) and no change in physical properties. The isomer distribution is narrowed slightly.

PRESENT PRACTICE

Biphenyl is chlorinated at a temperature range of 120 - 170°C. in the presence of 0.05% $FeCl_3$ catalyst. The biphenyl is preheated and dropped to the chlorinator. The catalyst is added and the chlorine is turned on. The chlorination causes the temperature to rise from 120°C. to an average chlorination temperature of 150°C. The present maximum temperature is 170°C. Chlorination is terminated by specific gravity.

From the chlorinator, the batch is moved directly to a blow tank where HCl is removed by an air purge. The blow tank is used as a feed tank for the still.

Distillation is carried out in the presence of 0.4% lime. The distilled product is earth treated and moved to storage.

Tent. Amend. "C" to Aroclor

PROPOSED CHANGES

These conditions are to be applied to Aroclor 1254. Run the process at 0.05 and 0.20% catalyst at 150°C. and 195°C. Mix the catalyst and biphenyl for 0.5 hours prior to starting the chlorination. Filter the undissolved catalyst from the batch prior to starting the chlorination when using 0.20% catalyst. Use 0.8% lime for the distillation. Aroclor 1242 has been produced under the proposed conditions and has improved (lowered) the thermal chemical chlorides.

SAFETY

This amendment should not result in any safety hazards. Process Amendments "A" and "B" have been demonstrated safely in the plant. Laboratory experience has indicated that chlorination at temperatures up to 200°C. should not cause any safety hazards.

EXTENT OF DEMONSTRATION

Four production runs will be made with combinations of the proposed condition changes. Acceptance of a set of conditions will be based on the greatest stability improvement.

DISPOSAL OF THE PRODUCT

The product made from these test batches will be used in both electrical and non-electrical sales.

Prepared by

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MONS 055463

Tent. Amend. "C" to Aroclor

Reviewed by

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Prod. General Supt. — 9/25/67 Date

Pl. Proc. Res. Group Leader — 9/26 Date

Gen. Supt. Tech. Services — 10/4/67 Date

Technical Prod. Manager — 10/9/67 Date

MONS 055464

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Tentative Amendment "B"

TITLE

Tentative Amendment No. B to the Standard Manufacturing Process for the Manufacture of Aroclors, Dept. 246, Dated October, 1966.

OBJECTIVE

Determine the effect of 500 ppm bromine in chlorine on Aroclor quality. The test will be carried out at 195°C. and 0.2% catalyst.

PRESENT PRACTICE

Biphenyl is chlorinated at a temperature of 120 - 170°C. in the presence of 0.05% $FeCl_3$ catalyst. The biphenyl is preheated and dropped to the chlorinator. The catalyst is added and the chlorine turned on. The chlorination causes the temperature to rise from 120° to an average chlorination temperature of 150°C. The present maximum temperature is 170°C. Chlorination is terminated by specific gravity.

From the chlorinator, the batch is moved directly to a blow tank where HCl is removed by an air purge. The blow tank is used as a feed tank for the still.

Distillation is carried out in the presence of 0.4% lime. The distilled product is earth treated and moved to storage.

Tentative amendment A (4/27/67) to the process permitted the use of higher temperature and catalyst level. The plant demonstration produced material that met electrical grade specification. This material is presently awaiting shipment for life testing.

MONS 055465

JUSTIFICATION

The chlorine used for the chlorination step comes in part, from DeNora chlorine-caustic cells. Some of these cells are fed with potassium chloride (KCl). Monsanto has been offered, at a considerable cost reduction, KCl with a bromide content of 500 ppm. It is believed that bromide in the salt is converted to bromine which is carried along with the chlorine.

Tent. Amend. "B" for Aroclors

JUSTIFICATION (Cont'd.)

WGK Process Research work has shown that bromine in chlorine at 500 ppm level has the effect of causing extreme variability in product stability. The rate of chlorination is also slowed.

Laboratory work has also shown that the modified conditions (high temperature, high catalyst) demonstrated in Tentative Amendment A will cancel out the effects of the bromine.

These laboratory tests needed to be extended to the plant such that sufficient material can be produced to permit life testing of the product.

PROPOSED CHANGES

Use 0.2% catalyst and a chlorination temperature of 195°C. Bromine will be metered into the main chlorine vapor line entering the department. Its level will be controlled at 500 ppm. The undissolved catalyst will be filtered out prior to the blow tank. The product will be distilled from a heel of 0.8% lime.

SAFETY

This amendment should not result in any safety hazards. The ability to control the reaction at 195°C. and the higher catalyst level has been demonstrated in the plant. Based on laboratory experience, the addition of bromine to the chlorine will not present any process safety hazards.

EXTENT OF THE DEMONSTRATION

Enough material will be produced to permit life testing. We estimate that a 24 hour demonstration will be adequate.

DISPOSAL OF THE PRODUCT

If the test material meets WGK product specifications, a trailer of the aroclor will be sent to a customer for life testing. Any remaining material will be sold as non-electrical grade Aroclor.

Prepared by J. A. Gloeckner
J. A. Gloeckner

MONS 055466

Tent. Amend. "B" for Aroclors

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Tentative Amendment "A"

TITLE

Tentative Amendment No. "A" to the Standard Manufacturing Process for the Manufacture of Aroclors, Department 246, Dated October 1966.

OBJECTIVE

Demonstrate improved quality Aroclor, as measured by thermal chemical chlorides by use of modified plant conditions.

PRESENT PRACTICE

Biphenyl is chlorinated at a temperature range of 120 - 170°C. in the presence of 0.05% $FeCl_3$ catalyst. The biphenyl is preheated and dropped to the chlorinator. The catalyst is added and the chlorine is turned on. The chlorination causes the temperature to rise from 120° to an average chlorination temperature of 150°C. The present maximum temperature is 170°C. Chlorination is terminated by specific gravity.

From the chlorinator, the batch is moved directly to a blow tank where HCl is removed by an air purge. The blow tank is used as a feed tank for the still.

Distillation is carried out in the presence of 0.4% lime. The distilled product is earth treated and moved to storage.

JUSTIFICATION

Competitive wise, Monsanto does not make the best Aroclor for electrical use. Ultimate loss of a profitable market will result if we do not improve quality.

WGK Process Research work, which is an extension of previous Organic Research work shows the following.

JUSTIFICATION (Cont'd.)

Catalyst Level	Temperature	Lime	Biphenyl	Thermal Chemical Chlorides (ppm)
Normal	Normal	Normal	Sample 2	0.23
Amended	Amended	Amended	Sample 2	0.02
Normal	Normal	Normal	Sample 3	0.32
Amended	Amended	Amended	Sample 3	0.07

PROPOSED CHANGES

Use 0.20% catalyst and a chlorination temperature of 200°C. Filter out undissolved catalyst prior to the blow tank. Distil from a heel of 0.8% lime.

These conditions are to be approached step-wise as outlined below and to be applied only to Aroclor 1242 at this time.

1. Prior to the plant demonstration, run one chlorinator on 0.2% catalyst at 150°C, 180°C, and 200°C. Check performance on temperature control, etc.

2. Operate the chlorinators temperature according to following schedule. Use 0.20% catalyst. Filter the excess catalyst from the batch prior to feeding to the still. Use 0.8% lime for the distillation.

Chlorinator #	105	106	107	108	109
1st Day	170°C.	150°C.	150°C.	150°C.	150°C.
2nd Day	180°C	170°C	170°C	170°C	170°C
3rd Day	190°C	180°C	180°C	180°C	180°C
4th Day	200°C	190°C	190°C	190°C	190°C
5th, 6th, 7th Day	200°C	200°C	200°C	200°C	200°C

SAFETY

This amendment should not result in any safety hazards. During the stepwise temperature increase, the ability to control the reactor temperature should be carefully watched. Laboratory experience has indicated that chlorination at temperatures up to 200°C. should not cause any safety hazards. The use of 0.2% catalyst will not present any safety hazards.

EXTENT OF THE DEMONSTRATION

An initial batch plus a seven day run. The last three days should be at 200°C with 0.20% catalyst and 0.8% lime.

DISPOSAL OF THE PRODUCT

These conditions will make better than normal product. It is proposed to subject this material to routine testing and normal distribution.

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Div. Research Group Leader Date

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MONS 055470

AMENDING RECORD SHEET

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MONS 055472

Dept. 246 - Process Description

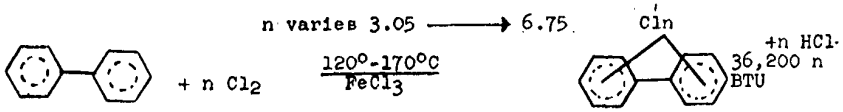
AROCLOR

SECTION I

SYNOPSIS OF PROCESS

Aroclor is a trade name used to designate chlorination products of biphenyl, biphenyl high boilers, or mixtures of the two. Liquid Aroclors are produced by chlorinating biphenyl to 21, 32, 42, 48, 54, 60, and 62% chlorine content. Chlorination above 63% yields a solid product at normal temperatures. Liquid Aroclors are identified by four digit numbers. The last two digit numbers represent the chlorine content (percentage by weight), and the first two numbers represent the Aroclor condition (crude or distilled). Crude Aroclors start with the prefix 11 whereas distilled Aroclors start with the prefix 12. For example, Aroclor 1242 is a distilled chlorinated biphenyl containing 42% chlorine.

The first process step in the manufacture of Aroclors is a chlorination reaction. Biphenyl (ϕ-ϕ) and chlorine (Cl_2) gas in the presence of a Ferric Chloride ($FeCl_3$) catalyst are reacted to form a chlorinated aromatic compound. Hydrogen chloride (HCl) gas is liberated during this reaction and piped to the muriatic acid department. The exact chemistry of biphenyl chlorination is unknown. Many isomers are formed. A schematic representation of biphenyl chlorination is as follows:



BIPHENYL	CHLORINE	AROCLOR	HYDROGEN CHLORIDE
M.W. = 154	M.W. = 71	M.W.=(254.1-395.6)	M.W.=36.5

Dept. 246 - Process Description

AROCLOR

SECTION I

SYNOPSIS OF PROCESS (Cont'd.)

The second process step is the aeration and distillation of the crude Aroclor. Dry air is blown through the crude Aroclor for a period of two hours or more. Aeration removes most of the free hydrogen chloride. Distillation of crude Aroclors is done under vacuum automatically controlled with the controller pre-set between 30-50 mm Hg. ags. to obtain the best performance. Distillation of crude Aroclor separates residue, lime, ferric chloride, and tars from the finished product.

The third process step includes blending, filtration, and storage of Aroclors. Approximately 0.1 - 0.2% by weight of Attapulgus earth is added to the distilled Aroclor. The mixture is agitated and filtered to the finished product tank. The purpose of the Attapulgus earth is to absorb moisture and chloride ion to improve the electrical properties of the Aroclor. During the filtration of distilled Aroclor, 2 - 16 oz. samples of the finished product are taken to the laboratory for control analyses. If the control analyses pass specifications, the batch is transferred to a storage tank.

This process description will describe the production of Aroclors 1242, 1248, 1254, 1260, 1254 xylene mix, and 1262.

Dept. 246 - Process Description

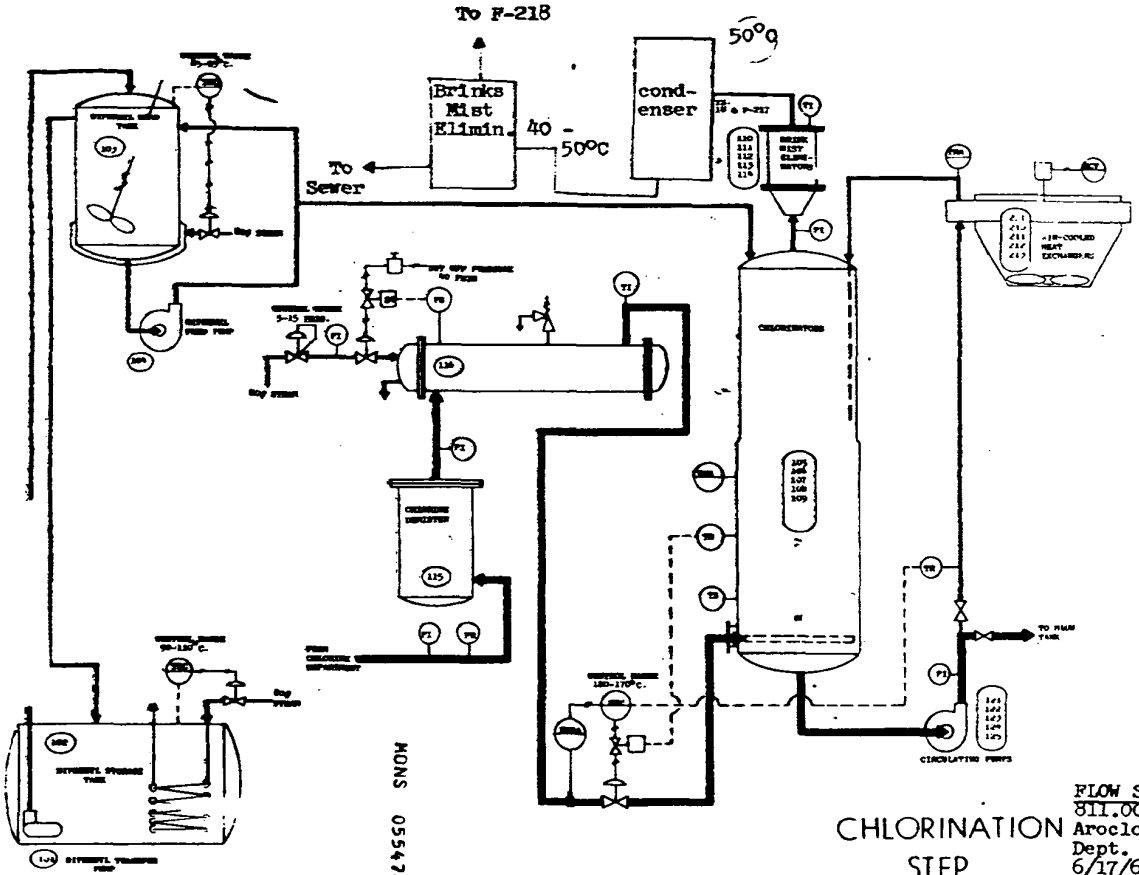
AROCLOR

SECTION II

FLOW SHEETS

This section contains the following flow sheets.

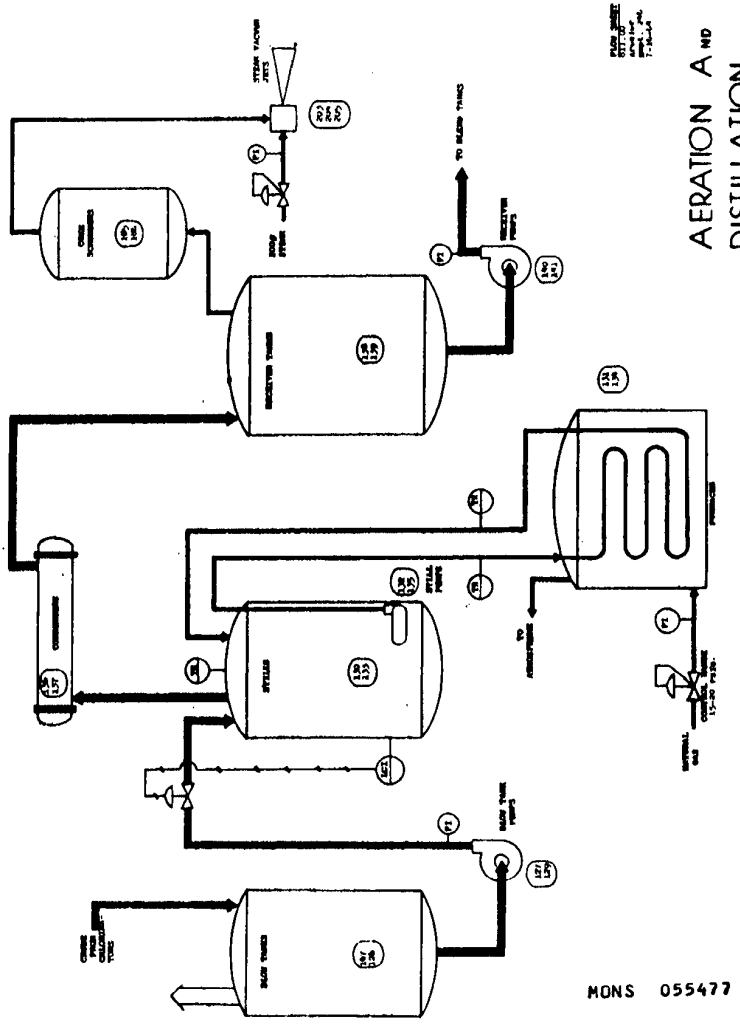
1. Complete process flow sheet.
2. Chlorination Reaction Step
3. Aeration and Distillation
4. Blending, Filtration and Storage.



MONS 055426

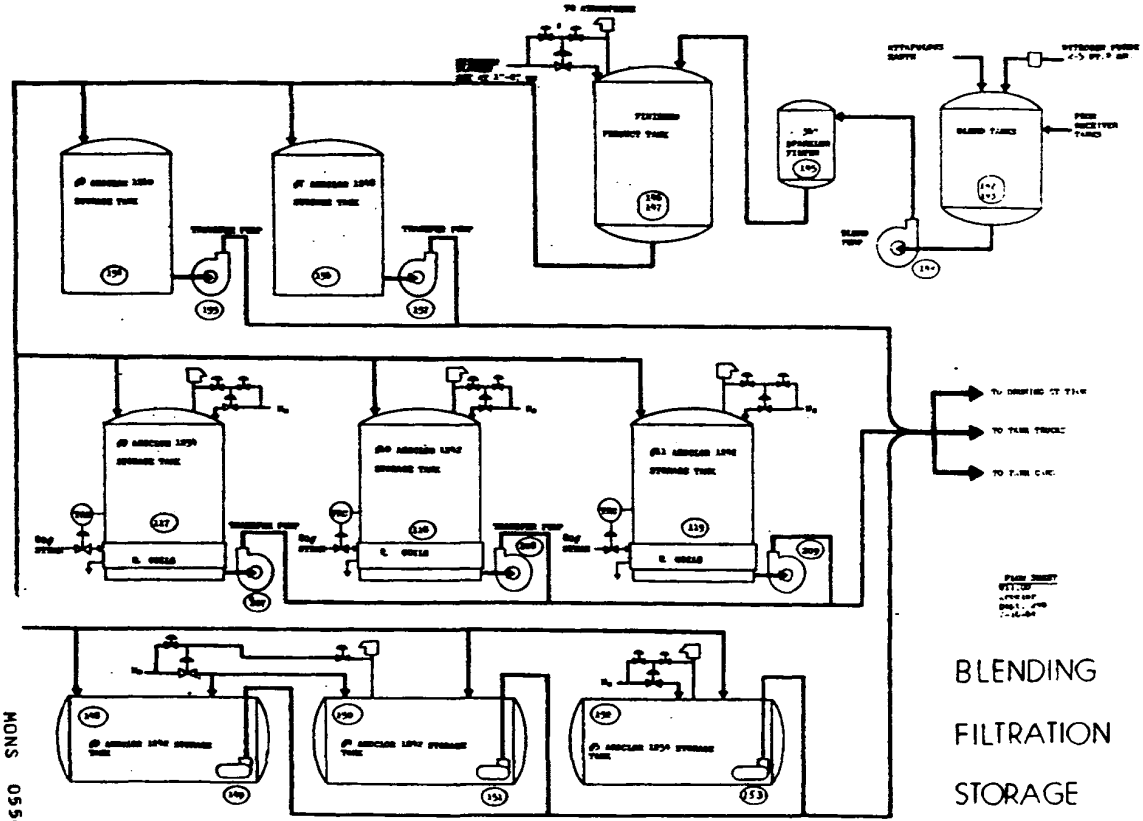
CHLORINATION STEP

FLOW SHEET
811.00
Aroclor
Dept. 246
6/17/66



AERATION AND DISTILLATION

MONS 055477



BLENDING

FILTRATION

STORAGE

3c

MONS 055478

Dept. 246 - Process Description

AROCLOR

SECTION III

PROCESS IN DETAIL

A. NOMENCLATURE AND BATCH DATA

Aroclor is a trade name used to designate chlorination products of biphenyl, biphenyl high boilers, or a mixture of the two. The physical properties vary from light free flowing liquids to crystalline and non-crystalline solids, depending upon the degree of chlorination and the composition of the raw materials. Chlorinated biphenyl yields a liquid product of increasing viscosity up to and including 63% chlorine. Chlorination above 63% yields a solid product at normal temperatures.

A numerical system of nomenclature, consisting of four digits, has been developed for identifying the various Aroclors. The first digit denotes the aromatic raw material used in the chlorination step. The figure 1 -- indicates 100% technical grade biphenyl. The second digit denotes whether or not the product is distilled. The figure -1 -- indicates undistilled product, and the figure -2 -- indicates a distilled product. The last two digits of the nomenclature system denote the approximate percentage by weight of chlorine contained in the finished product. For example, Aroclor 1242 is a distilled chlorinated biphenyl containing 42% chlorine.

Manufacture of all liquid Aroclors is essentially the same. Batch data are listed below:

Type Aroclor	1242	1248	1254	1260	1262
Biphenyl Charge	4000#	4000#	4000#	4000#	4000#
Chlorination Time	6 Hrs.	8 Hrs.	10 Hrs.	12 Hrs.	14 Hrs.
Specific Gravity of Crude	1.349-58 at 65°C	1.408-18 at 65°C	1.498-508 at 65°C	1.558-69 at 90°C	1.580-90 at 90°C
Weight of Crude Batch	6670#	7580#	8450#	9600#	10,600#
Weight of Distilled Batch	6400#	7200#	8040#	9100#	9850#
Tons of 100% by-product HCl per Batch	1.24	1.43	2.27	2.47	2.70
Theoretical Molecular Weight	257.7	292.6	326.6	369.5	395.6

Dept. 246 - Process Description

AROCLOR

SECTION III

PROCESS IN DETAIL

B. CHLORINATION REACTION STEP

Chlorination of biphenyl is the only process step where a chemical reaction takes place. All other Aroclor process operations are mechanical. The starting raw materials for Aroclor production are biphenyl and chlorine gas.

Biphenyl is received in 8,000 10,000, and 20,000 gallon tank cars from Anniston, Alabama. The biphenyl in the tank cars is a solid mass because the crystalllzing point of biphenyl is 68.7°C. Steam must be applied to the tank car coils to melt the biphenyl. It is necessary to melt a vent hole through the solid mass of biphenyl by insertion of a hairpin steam coil through the tank car dome before applying steam to the tank car coils. The vent hole avoids a pressure build-up in the bottom of the tank car and possible damage to the car. When the biphenyl is completely melted, it is sampled for identification and unloaded through the tank car standpipe by air pressure to the 25,000 gallon storage tank. Dry air is used to unload the biphenyl cars to keep the biphenyl free from moisture. The flash point of biphenyl is 112°C.

Chlorine gas is received in a 4 inch pipeline from the chlorine department. In order to facilitate operation of the chlorine liquefaction system, "snift" gas with a purity of 75-95% (the remainder being air) is transferred from the chlorine department. The normal pressure of the chlorine gas in Department 246 is 20-25 psig.

Biphenyl (4000#) is charged into each chlorinator from the measuring tank. The biphenyl charge in the measuring tank can be regulated by valves at different overflow levels. The four overflow levels on the measuring tank permit biphenyl charges of 1800, 2800, 3600, and 4000 pounds. Two pounds of anhydrous ferric chloride are charged to the chlorinators after the biphenyl is charged.

Chlorination is carried out in five chlorinators. Each chlorinator is three feet in diameter by sixteen feet high, and constructed of steel. Four of the chlorinators has a catalyst bed which is 2'3" in diameter by 8 feet high. The catalyst bed consists of 1-1/2 inch diameter by 2 inches long pieces of pipe which are similar in nature to raschig rings. The fifth chlorinator is identical to the other chlorinators except that it has no catalyst basket. The catalyst beds in four of the chlorinators will be removed as they fail mechanically.

After charging the chlorinator, circulation of the charge is started before the chlorine feed is begun to maintain an even distribution of the ferric chloride catalyst. The temperature of the biphenyl is 110°C-120°C at the start of the chlorination. The chlorinator mass reaches 120°C-130°C within 30 minutes after the biphenyl is charged.

AROCLOR

SECTION III

PROCESS IN DETAIL (Cont'd.)

B. Chlorine gas from the chlorine department passes through a Brink mist eliminator and evaporator before entering the chlorinator. The mist eliminator removes most of the impurities, and the evaporator insures that all of the chlorine is gaseous.

The purified chlorine gas is admitted to the bottom of the chlorinator through a distributor plate (sparger) and passes through the catalyst bed. A chlorinator temperature less than 170°C is maintained during the chlorination reaction to avoid sublimation and subsequent condensation of biphenyl in the off-gas system. Each chlorinator is equipped with a Brink mist eliminator. The purpose of the off-gas mist eliminators is to trap entrained particles of Aroclor and biphenyl.

The chlorination temperature in the chlorinators is controlled by automatic control of the air flow through the external air-cooled heat exchanger. The chlorination temperature must be at least 120°C 30 minutes after the start of the batch and no more than 170°C to finish off a batch. The normal batch temperature is 150°C. The louvers of the air-cooled heat exchanger located in the external circulating line of the chlorinator are controlled such that the batch temperature will remain between 120°C and 170°C. The temperature of the batch is recorded at four different points: (1) in the center of the chlorinator, (2) just above the chlorine sparger in the chlorinator, (3) at the discharge of the chlorinator pump, and (4) at the discharge of the air-cooled heat exchanger. Point 1 is alarmed for high temperatures, and point 4 is alarmed for low temperatures. As a safety device, a high temperature sensing element is positioned at point 2 to shut off the chlorine gas flow if the reaction temperature exceeds 190°C.

The batches are continuously circulated at an average flow rate of 200-220 GPM from the bottom of the chlorinator, up through the air-cooled heat exchanger, and back into the top of the chlorinator over the catalyst bed. Chlorine feed up to a maximum of 1500 pounds per hour is fed into each chlorinator through a flow recorder-integrator which is alarmed.

Progress of the chlorination reaction is checked periodically as needed after 80% chlorination as measured by the recorder-integrator.

The degree of chlorination is measured by determining the specific gravity of a sample taken from the circulating line. More frequent gravity checks are made when approaching the end of chlorination.

AROCLOR

SECTION III

PROCESS IN DETAIL

C. AERATION AND DISTILLATION

When chlorination is complete, the crude Aroclor is pumped into number two blow tank (capacity 2000 gallons). The crude Aroclor is aerated in the #2 blow tank for two hours or more with dry air. Aeration of crude Aroclor removes most of the free hydrogen chloride.

Crude aerated Aroclor is transferred from the #2 blow tank to the #1 blow tank. The #1 blow tank is used as a crude Aroclor feed tank to the stills. Crude aerated Aroclor is transferred from the #1 blow tank to vacuum stills through an automatic control valve which maintains a constant level in the stills. Under normal conditions the automatic feed to the stills is shut off after distilling bout 75,000 pounds of Aroclor. (This is equivalent to filling 7 still receivers). The still is then boiled down until a temperature difference between the still coil outlet and vapor temperature approaches 40°C. At this point distillation is discontinued and all but a small heel of the residue is drawn off to drums and discarded or sold as Montar. The still is immediately recharged with crude Aroclor and 200 pounds of lime is added directly to the still pot. Hydrated lime is received in 50 pound bags. The lime neutralizes any residual HCl in the still liquor and prevents sublimation of ferric chloride during the distillation period. Distillation of Aroclors is done under vacuum automatically controlled. The best performance is obtained at a steady vacuum which can be pre-set by a controller between 30-50 mm Hg. Abs.

Natural gas is used to heat the coil of the Aroclor still furnaces. The pressure of the gas burner (eclipse, st. 108.5, 2", #568, 600,000 BTU/hr.) is adjusted as needed for production requirements. The normal gas pressure is 3-5 psig.

D. BLENDING, FILTRATION, AND STORAGE

When the still receiver is filled, the distilled Aroclor is pumped to the blend tank (2000 gallon capacity). After two fillings of the receiver tank have been pumped to the blend tank, approximately 40 pounds of attapulgus earth is added to the distilled 1242 Aroclor. All other Aroclors are earth-treated with 20 pounds of Attapulgus earth. Regular Attapulgus earth is received in 50 pound bags. The mixture is agitated and filtered to the finished product tank (2000 gallon capacity) through a 36 inch stainless steel Sparkler Filter. The attapulgus earth is roasted at 250°C for a minimum of four hours in a Grieve-Hendry drying oven before addition to the blend tank. The purpose of earth heat treatment is to remove any moisture in the earth and activate it. The attapulgus earth absorbs water and ionic impurities. This improves the electrical-quality properties of the Aroclor.

Dept. 246 - Process Desbription

AROCLOR

SECTION III

PROCESS IN DETAIL

D. BLENDING, FILTRATION AND STORAGE (Cont'd.)

The filter press is cleaned after about 5-7 batches or as needed. During the filtration, 2-16 oz. samples are taken to the laboratory for control analyses. If the control analyses pass specifications, the batch is transferred from the product tank to a storage tank. After several batches have accumulated in the storage tank, the contents of the tank are mixed, and composite samples are taken for lot analyses.

Three underground (15,000 gallon) tanks and five above-surface (each 20,000 gallons) are available for storage of the finished products.

The blend tanks, finished product tanks, and Aroclor 1242 and 1254 storage tanks are blanketed with nitrogen. The pressure of the nitrogen gas is 10 psig. Nitrogen blanketing maintains the electrical properties of the Arocolors.

The Arocolors from the storage tanks are drummed, pumped to tank cars, pumped to tank trucks, or transferred to Department A-246 or B-246 mixing tanks for the production of Pyranols, Inerteens, or Pydraul A-200.

Batches of Aroclor 1254-mix are mixed in the #1 blend tank. This operation consists of a mix of 10% xylene and 90% Aroclor 1254. Xylene is received in 55 gallon drums. The flash point of xylene is 85°F. Mixing, sampling and drumming of 1254-mix is accomplished directly from the blend tanks. After the blending operation, the blend tank must be cleaned. The bottom outlet of the tank is opened and the tank is cleaned out with live steam and then blown with air.

E. BY-PRODUCT HYDROGEN CHLORIDE

The by-product hydrogen chloride from the chlorinators is collected in a common pipeline header and flows to the central HCl absorption unit to manufacture Muriatic Acid in Department F-218. If Department F-218 is unable to handle the off-gas, it may be sewered at Department 246 by passing through a Haveg S-K drowning jet. The removal of HCl from the off-gas concentrates the original quantity of hydrogen and air to a point well within the explosive limit. Therefore, it is essential to either dilute this gas going up the vent stack or increase its velocity past the flame propogation rate (15 ft/sec). This is accomplished by introducing a sufficient quantity of steam into the vent stack.

To remove vaporized and entrained impurities in the HCl from the chlorinators, the gas passes through a condenser and mist eliminator. The entrained liquid, which is primarily biphenyl, is sewered.

Dept. 246 - Process Description

AROCLOR

SECTION IV

COMMENTS ON PROCESS

CHLORINATION STEP

A. RAW MATERIAL YIELDS

Biphenyl and chlorine are reacted to form a chlorinated biphenyl called Aroclor. The yields on biphenyl and chlorine vary with the type of Aroclors produced. Each particular type of Aroclor has its own standard yield factors. Yields are not reported for the individual type on Aroclor each month. An average yield is reported monthly and compared with standard and theoretical yields which are calculated according to the quantities of the various Aroclors produced during the month.

Standard and theoretical conversion factors used in computing chlorine and biphenyl yields are listed below.

STANDARD CONVERSION FACTORS

AROCLOR	CHLORINE #/# Product	BIPHENYL #/# Product
1242	.9032	0.6180
1248	1.0323	0.5580
1254	1.6130	0.4978
1260	1.2903	0.4368
1262	1.3333	0.4163
1232	0.6882	0.7216
1254 Xylene	1.0452	0.4480

THEORETICAL CONVERSION FACTORS

AROCLOR	CHLORINE #/# Product	BIPHENYL #/# Product
1132-1232	0.6400	0.6891
1142-1242	0.8400	0.5919
1148-1248	0.9600	0.5357
1154-1254	1.0800	0.4754
1160-1260	1.2000	0.4147
1162-1262	1.2400	0.3976
1254-10% Xylene	0.9720	0.4279

MONS 055484

Dept. 246 - Process Description

AROCLOR

SECTION IV

COMMENTS ON PROCESS

CHLORINATION STEP

B. CAPACITY

The monthly production capacity of Department 246 is 2,400,000 pounds of Aroclors on a 7 day per week basis. The capacity of the chlorinators is a function of the following variables.

1. Batch Cooling Rate - Chlorination of biphenyl is an exothermic reaction which produces 510 BTU's per pound of chlorine gas undergoing a reaction with biphenyl. Biphenyl can be chlorinated as fast as the exothermic heat can be removed from the batch and maintain a batch temperature of 150°C.

2. Chlorine Flow Rate - The reaction time decreases as the chlorine flow rate increases. The chlorine flow rate is approximately 1000 pounds per hour per chlorinator. A maximum chlorine flow rate of 1500 pounds per hour per chlorinator can be attained if desired. The concentration of chlorine in the "snift" gas is another factor controlling the rate of chlorination.

3. Catalyst - The chlorination rate increases when ferric chloride catalyst is added to the charge. The best results are obtained when the biphenyl charge contains .05% ferric chloride catalyst.

C. QUALITY

Some of the factors which affect Aroclor quality are as follows:

1. Temperature - According to research experimental results, the chlorinator temperature must be greater than 120°C at the beginning of the chlorination reaction to produce stable Aroclors.

2. Catalyst - Good contact is necessary to produce stable Aroclors. It is suspected that agitation and circulation of the reactants improve the effectiveness of the catalyst. The catalyst is also responsible for the chlorine positioning on the biphenyl molecule Ferric chloride catalyst may be responsible for producing the desired end product. Results of research work concerning catalyst and isomeric distribution are given in Appendix N.

COMMENTS ON PROCESS

CHLORINATION STEP

C. QUALITY (Cont'd.)

3. Raw Material Purity - The purity of raw materials can affect the quality of Aroclors both directly and indirectly. In a direct manner, impurities which are ionic lessen the resistivity of Aroclors. Distillation of crude Aroclor separates most of the ionic impurities; however, minute impurities can be carried over to the receiver tanks. Attapulgus earth can remove the remaining impurities in most instances. If any ionic impurities remain after the earth treatment, the resistivity of the Aroclors will be low because such impurities will conduct electricity even in minute concentrations.

   In an indirect sense, impurities such as sulfates in the chlorine gas, will poison the ferric chloride catalyst and thus unstable Aroclors will be produced. The chemistry and mechanism of the catalyst poisoning are not known for certain.

4. Catalyst Basket - During the latter part of 1965, the catalyst basket was removed from one of the five chlorinators. The material produced in the chlorinator without the catalyst basket analyzed as normal material. This material was used by a customer with satisfactory results.

   The catalyst baskets may be removed from the other four chlorinators as they fail. The only restriction on material made without the catalyst basket is that it will not be sold to General Electric, or Westinghouse.

AERATION AND DISTILLATION

Steam is not applied to the coils of the blow tanks when aerating Aroclors 1142 and 1148. This prevents the loss of Aroclor vapors. Eighty psig steam may be applied to the coils when aerating other Aroclors. High moisture may be removed effectively by blowing the crude Aroclor with dry air.

Vacuum trouble on the stills is usually caused by flashing of product, air leaks, 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.

High color and entrainment will result from overheating (around 25°C above normal distillation temperature) Aroclor, faulty operation of the distillation step, or boiling down thestill too far. (Tars will carry over). The "tail-end" still fraction (tars) is a possible source of unstable Aroclors

Dept. 246 - Process Description

AROCLOR

SECTION IV

COMMENTS ON PROCESS

BLENDING AND FILTRATION

Attapulgus Earth is added in the blend tanks to reduce moisture and inorganic chlorides as well as improve electrical properties. If batches do not meet specification (See Appendix B), redistillation may be necessary.

The Attapulgus Earth is roasted for 4 hours at 250°C before addition to the blend tanks when earth treating Aroclor 1242.

AROCLOR

APPENDIX A

EQUIPMENT LIST

This section contains an equipment list with each piece of equipment listed by Item numbers in a consecutive numerical sequence. Miscellaneous items of Dept. 246 such as Instruments have not been assigned Item numbers. Equipment without Item numbers is not included in this equipment list. All equipment of Dept. 246 will have Item numbers assigned sometime in the future. This equipment list should be expanded as additional Item numbers are assigned.

Item No.	Equipment Name	Equipment Number	Description
101	Biphenyl Transfer Pump	19-0582 66-3930	Taber vertical submerged cent. pump, size C-3, 2½" inlet, 2" outlet. Connection bronze except shaft which is monel. Motor is 3 HP, 1800 RPM.
102	Biphenyl Storage Tank	21-2210	Tank purchased from Rogers and Wrigler. Capacity is 25,000 gallons. 10' 6" Dia. x 40'6" long. 3/8" plate shell. Design pressure is 50 psi.
103	Biphenyl Head Tank	21-0767 16-7225	Tank made by Graver. Dwg. C-799. Steel tank 4'6" ID x 5'6" str. side, dished heads, shell 3/8", top head 3/8", and bottom head 3/4" with 1/2" jacket over it and ending 9" up on tank side. Welded throughout. Test of tank is 60# and jacket is 105# hydro. pressure. Mixer is Mixco Model N33G75, gear driven propeller. Motor is 440/3/60 TEFC, 1725 RPM.
104	Biphenyl Feed	66-7224	Durco Horiz. Cent. pump. 2" inlet, 2" outlet. Cap. 100 GPM Motor is 7½ HP, 1760 RPM
105	Chlorinator #1	21-3261	Tank made by Nooter. Dwg. E-880. 3' ID x 16' long with plg. head. Shell 3/8" and head 7/16" thick, 3/16" jacket over lower half of tank.
106	Chlorinator #2	21-3245	Same as Item No. 105.

MONS 055488

AROCLOR

APPENDIX A EQUIPMENT LIST (Cont'd.)

Item No.	Equipment Name	Equipment Number	Description
107	Chlorinator #3	21-3251	Tank made by Leader Iron Works. Otherwise, same as Item No. 105.
108	Chlorinator #4	21-1283	Same as Item No. 107.
109	Chlorinator #5	21-1432	Same as Item No. 107
110	#1 Mist Eliminator	15-0581	Tank made of carbon steel. Element made of carbon steel. Design pressure is 50 psig. and design temperature is 300°F.
111	#2 Mist Eliminator	15-0582	Same as Item No. 110.
112	#3 Mist Eliminator	15-0583	Same as Item No. 110.
113	#4 Mist Eliminator	15-0584	Same as Item No. 110.
114	#5 Mist Eliminator	15-0586	Same as Item No. 110.
115	Chlorine Mist Elim.	21-4042	Tank made by Alpha. Carbon steel construction. Coded tank. Element 316 stainless steel. 15" dia., glass fiber inverted type. Design pressure is 50 psig and design temperature is 300°F.
116	Chlorine Vaporizer	38-5487	Chlorine vaporizer made by Armstrong Company. 8-5/8" OD x 11' long. Carbon steel construction. Chlorine side steel designed for 250 psig. at 400°F. Steam side designed for 100 psig at 400°F.
120	Knockout		Steel vertical 60 gal. tank.
121	Chlorinator #1 Pump	19-4305 66-8109	Durco Mark II horiz. cent. pump. Inlet is 3" and outlet is 2", ductile, iron, with Durametallic seal and Manzel lubricator. Rate is 200 GPM at 25' static head Sp. Gr. of 1.5. Motor is 10 HP, 1800 RPM.

AROCLOR

APPENDIX A EQUIPMENT LIST (Cont'd.)

Item No.	Equipment Name	Equipment Number	Description
122	Chlorinator #2 Pump	19-4306 66-8110	Same as Item No. 121
123	Chlorinator #3 Pump	19-4307 66-8111	Same as Item No. 121
124	Chlorinator #4 Pump	19-4308 66-8112	Same as Item No. 121
125	Chlorinator #5 Pump	69-3892 66-6509	Same as Item No. 121.
126	Blow Tank #2	21-2086	Tank made by Graver. Dwg. E-863. 7' x 7' str. sides, dished heads 1/2", shell 3/8", 5 turn coil of 2" pipe supported on brackets welded.
127	Blow Tank #2 Pump	66-2956 69-0577	Taber horiz. cent. pump. Type L-2. 2½" x 2". Semi-steel with monel shaft and water jacketed stuffing box. At 20' static head, rate is 80 GPM, 1.5 Sp. Gr. at 500°F. Motor is 3 HP, 1800 RPM.
128	Air Dryer	14-0104	Anders Lykens Corp. Air dehydrator. Two code welded tanks filled with 55 lbs. activated alumina. Dwg. #6456.
129	Blow Tank #1 Pump	19-0629 66-9080	Same as Item No. 127.
130	Still #1	20-0043	Vacuum still purchased from Graver. Dwg. C-809. Size 6' Dia. x 5'6" lg. on str. side, ¼" shell, dished head 5/8". 60# hydro. pressure test.
131	Furnace #1	27-0045	Steel heater furnace. Steel shell 3/16" x 3'9" dia. x 4' 10½" lg. lined with insulating fire brick. One coil 2" xHy pipe, 12 turns formed into a 2' dia. coil with spare blocks and legs. Dwg. E-886.
132	Still #1 Pump	19-0594	Taber vert. sub. cent. pump. type L-2. Casing, yoke, and impeller made of steel. 2" inlet and 2" outlet. Length 7'9". Capacity is 75 GPM, static head 15', Sp. Gr. 1.8 at 700°F. Motor is 5 HP, 1750 RPM

Dept. 246 - Process Description

AROCLOR

APPENDIX A — EQUIPMENT LIST (Cont'd.)

Item No.	Equipment Name	Equipment Number	Description
133	Still #2	20-0062	Vacuum still purchased from Nooter. Dwg. 6944. 6' ID x 11'10" str. shell internal pipes, standard dished heads, Glass wool insulation 3" with 1/2" finished coat.
134	Furnace #2	20-0066	Same as Item No. 131.
135	Still #2 Pump	66-1759 69-1277	Taber vertical sub. cent. pump. Type CL-4, 2½ x 2", size 384. Pump is dynamo steel. Capacity is 75 GPM at 25' static head, Sp. Gr. 1.8. Motor is 7½ HP, 1750 RPM.
136	Condenser #1	38-0770	Heat exchanger made by Nooter. Dwg. B-651. 12" dia. 5' long having nineteen 2" OD 11 ga. monel tubes, monel tube sheets, monel reducer, and carbon steel jacket and back up rings on flanges.
137	Condenser #2	38-1378	Same as Item No. 136.
138	Receiver Tank #1	21-0771	Vacuum receiver tank made by Nooter. Dwg. C-795. Size is 5'6" dia. x 5'6" str. side, 3/8" shell, 1/2" bottom and removable head. 2" IP, size xHy monel coil with 2" inlet and 1" outlet. 3 turns, 5' dia. along side and 3 turns spiral on bottom. 60# hydro. pressure test on tank and 300# on coil.
139	Receiver Tank #2	21-1377	Tank made by Nooter. Dwg. C-795. Same as Item No. 138.
140	Receiver Pump #1	66-9067 69-0565	Blackmer pump. Type PA-50L, bronze rotary pump, monel shaft, C.I. base. Capacity is 50 GPM, 1.65 Sp. Gr., 350 to 500°F. Motor is 2 HP, 1750 RPM.
141	Receiver Pump #2	66-5670 69-1258	Same as Item No. 140.

AROCLOR

APPENDIX A EQUIPMENT LIST (Cont'd.)

Item No.	Equipment Name	Equipment Number	Description
142	Blend Tank #1	21-0779	Tank made by Graver. Dwg. E-862. Welded steel tank, 7' dia. x 7' high dished heads ½", shell 3/8". All surfaces sprayed with .005" zinc then .003" tin. 2" xHy pipe coil and supports. Case bronze stirrer and bronze shaft. Test of tank is 60# and coil is 300# hydro. pressure.
143	Blend Tank #2	21-1399 66-0217	Same as Item No. 142.
144	Blend Tank Pump	19-1757 66-3718	Taber Horiz. Centrifugal pump. 304 s.s. 2" x 1½" capacity 60 GPM, 100' head. Motor is 10.0 HP, 1800 RPM.
145	36" Sparkler Filter	15-0238	Filter made by Sparkler Mfg. Co., 33-D-12 horizontal plate filter. Type 304 s.s. Jacket tested for pressure of 30 psi.
146	Finished Product Tank #1	21-0780	Filtrate receiver tank. Dwg. E-862. Same as Item No. 142.
147	Finished Product Tank #2	21-1400	Tank made by Nooter. Otherwise, same as Item No. 142.
148	Storage Tank #3	21-0768	Tank made by Graver. Dwg. C-609. Horizontal steel, 10' dia. x 26' long on str. side, dished heads, shell ½", head 1/16". Test of tank is 60# and coil is 300# hydro. pressure. All coils, supports, inside surface sprayed with .005" zinc and .003" tin.
149	Storage Transfer Pump #3	19-0585 66-0853	Taber Vert. Sub. Pump. Dwg. A-387. Type C-3, 2" x 2", C.I. body, length 11'6". Cap. 50 GPM, 60' static head, Sp. Gr. 1.18 at 170°F. Motor is 3 HP, 1800 RPM.
150	Storage Tank #4 Tank #4	21-0769	Same as Item No. 148
151	Storage Transfer Pump #4	19-0584 66-1501	Taber Vert. Sub. Pump Type L-2. 2½" x 2". Length 11'6". Cap 50 GPM at 40' static head. Motor is 3 HP, 1800 RPM.

Dept. 246 - Process Description

AROCLOR

APPENDIX A

EQUIPMENT LIST (Cont'd.)

Item No.	Equipment Name	Equipment Number	Description
152	Storage Tank #5	21-1310	Tank made by Leader Iron Works. C-609. 10'OD x 26' long on str. shell. Same as Item No. 148 for other characteristics.
153	Storage Transfer Pump #5	19-0929 66-0856	Same as Item No. 151, except length is 4'7".
154	Storage Tank #8	21-3526	Slpha tank 12'6" dia. x 22' high. 20,000 gllon storage capacity. Aluminum constructed Dwg. TS-D-3011.
155	Storage Transfer Pump #8	19-3172 66-2651	Durco pump, model WH2 Alloy constr. 2" x 1½", 8" impeller. Cap. 160 GPM at 55' head. Motor is 7½ HP, 1740 RPM.
156	Storage Tank #7	21-2404	Alpha tank. 13' OD x 20' high. Vertical tank, constructed of 3/8" mild steel. Capacity is 20,000 gals.
157	Storage Transfer Pump #7	19-2077 66-1691	Pump made by Blackmer. Monel shaft, 2½" x 2½". Cap. 90 GPM. 15' head. Motor is 3 HP, 1750 RPM.
158	Scales	24-0246 24-0187	Made by Toledo Scale Co. 800# capacity, dial type scale.
167	Blow Tank #1	21-0750	Tank made by Graver. Dwg. E-863. 7' dia. x 7' str. side, dished heads ¼" shell 3/8". 5 turn coil of 2" xHy pipe.
169	Surge Tank	22-0751	Cyclone collector made by Graver. Dwg. B-695. 48" dia. x 27" on str. side, 3' 6" long and tangential inlet near top of side. 3/16" steel throughout of welded construction.
170	City Water Pump #1	69-1083 69-3365	Taber Horiz. pump, Model CB5, 3" x 2½" 9" impeller. Cap. 180 GPM, 50' head. Motor is 7½ HP, 1800 RPM.
171	City Water Pump #2	69-2078 66-1796	Same as Item No. 170
172	Off-Gas Mist Eliminator	21-5150	30"OD x 13'-3" straight side, steel construction, vertical for Brink Filter Element #15-0630(#2496 carbon)
173	Off-Gas Heat Exchanger	38-5588	8'long x 16" OD, 2 pass on tube side, 5 baffles, steel construction.

APPENDIX A EQUIPMENT LIST (Cont'd.)

Item No.	Equipment Name	Equipment Number	Description
180	Exhaust Blower	11-0265	Made by American Blower Co. Type 450E. Capacity is 6408 SCFM at 1310 RPM. Dwg. E-10699. Motor is 15 HP.
185	Coke Scrubber #1	21-0756	Scrubber liquor tank made by Graver. Dwg. C-800. 4'6" Dia. x 5'6" on Str. Side. Coil 3 turns of 1½" x Hy pipe.
186	Coke Scrubber #2	21-1396	Same as Item No. 185.
200	Cyclone Separator	21-1413	Separator made by Heintz Stee. 3' ID x 6' high tangential separator with integral vapor pipe complete.
201	Air-cooled Heat Exchanger #5	38-5328	Air cooled heat exchanger made by Disler. Cooling capacity is 1,200,000 BTU/hr. Steel construction except for aluminum fins. Fan motor is 2 HP, 1150 RPM.
203	Steam Vacuum Jet #1	35-3523	#2 ½ Worthington 3-stage vacuum jet.
204	Steam Facuum Jet #2	35-1686	Same as Item No. 203.
205	Steam Vacuum Jet #3	35-3533	3-stage porcelain Kubati vacuum ejector with 10" ID porcelain condenser. Jet has a capacity of 10#/hr. air at standard conditions. Jet designed for 150# steam and 2 mm Hg absolute.
206	Off-gas Drowning Jet	35-4756	Made by Schutte-Koertig. 8" Haveg fume scrubber. Complete with standard nozzle.
207	Drying Oven	14-0138	Grieve Hendry drying oven, 440 V., 3 phase, 60 cycle, manual reset temp. controller range 0-400°C.
210	Air-cooled Heat Exchanger #1	38-5564 66-8113	Same as Item No. 201.
211	Air-cooled heat Exchanger #2	38-5565 66-8114	Same as Item No. 201.
212	Air-cooled Heat Exchanger #3	38-5566 66-8115	Same as Item No. 201.
213	Air-cooled Heat Exchanger #4	38-5567 66-8116	Same as Item No. 201.

MONS 055494

Dept. 246 - Process Description

AROCLOR

APPENDIX A EQUIPMENT LIST (Cont'd.)

Item No.	Equipment Name	Equipment Number	Description
214	Air Dryer	14-0138	
215	City Water Circulating Pump	69-4363 66-8179	Worthington 3CNFE84 with 8" impeller and Monsanto standard base.
216	Polish Filter #9 Storage	15-0633	Alsop filter model No. PAK 125-4, 316 s.s., 6,000 $in.^2$ filtration area, 840 $in.^3$ volume.
217	Polish Filter #10 Storage	15-0634	Same as Item No. 216.
218	Polish Filter #11 Storage	15-0635	Same as Item No. 216.
None	Chlorine Pressure Recorder	29-1547	Made by Taylor Instrument Co. Pressure Recorder with 2 pens. Range 0-100.
None	#5 Chlorinator Flow Recorder	29-2019	Made by Taylor Instrument Co. Flow Recorder - Controller Cat. No. 137RF135. 12" chart, 0-10 Sq. root chart.
None	Water Meter	29-2486	Made by Worthington Corporation. 3" model IH turbine type water meter.
None	#1 Still Temperature Recorder	29-3885	Made by Leeds & Northrup Co. Temperature Recorder. Range 0-400°C.
None	#1 Still Absolute Pressure Controller	29-1170	Made by Taylor Instrument Co. Absolute pressure Recorder - Controller.
None	200# Steam Flow Recorder	29-0835	Made by Bailey Meter Company Flow Recorder.
None	#2 Still Absolute Pressure Controller	29-3353	Made by Taylor Instrument Company. Absolute Pressure Recorder - Controller.
None	#2 Still Temperature Recorder	29-0244	Made by Leeds & Northrup Co. 6 point Temperature Recorder.
None	#2 Still Level Controller	29-1463	Made by Taylor Instrument Co. Liquid Level Recorder - Controller.

Dept. 246 - Process Description

AROCLOR

APPENDIX A EQUIPMENT LIST (Cont'd.)

Item No.	Equipment Name	Equipment Number	Description
None	Chlorinator Temperature Recorder	29-0288	Made by Leeds & Northrup Co. 12 point Temperature Recorder.
None	#1 Blow Tank Temperature Recorder	29-2916	Made by Taylor Instrument Co. Temperature Recorder Controller. Adjusts 200# steam to #1 Blow Tank Cat. #86 RM43185-12.
None	80# Steam Flow Recorder	29-5452	Made by Foxboro Company. Type T37, recording flow meter with integrator and indicator. Meter body 316 s.s. Integrator for 80#, 400°F. steam.
None	200# Steam Flow Recorder	29-5453	Made by Foxboro Company. Type T37 Recording Flow meter with integrator and indicator. Meter body 316 s.s. Integrator for 200#, 510°F. steam.

MONS 055496

Dept. 246 - Process Description

AROCLOR

APPENDIX B

SPECIFICATIONS

The following is a list of the raw materials used for the manufacture of Aroclors. Specification sheets are included where they exist.

Material Code	Raw Material
82601	Biphenyl
33500	Ferric Chloride
38800	Lime
19409	Attapulgus Earth
81059	Chlorine
43099	Nitrogen
64005	Xylene

The following is a list of the finished products manufactured in department 246. Specification sheets are included where they exist.

Product Code	Product
811.12	Aroclor 1254-10% Xylene
811.15	Aroclor 1232
81101(Elect & Non-Elect)	Aroclor 1242
81102 (Elect & Non-Elect)	Aroclor 1248
81103(Elect & Non-Elect)	Aroclor 1254
81105(Elect & Non-Elect)	Aroclor 1260
81107	Aroclor 1262
81101-81102 (Mix)	1242 - 1248 Mix
82868	Montars 1, 2, 3 and 4

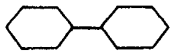
MONSANTO CHEMICAL COMPANY
ORGANIC CHEMICALS DIVISION
W.G. KRUMMRICH PLANT
RAW MATERIAL
SPECIFICATION

MATERIAL CODE: 82601
USING DEPTS.: 246
SUPPLIER: ANNISTON PLANT

Issued DEC 8 1964
W. G. Krummrich Plant
by M D Seely

MATERIAL: DIPHENYL (BIPHENYL)

CHEMICAL FORMULA



MOL WT. 154.20

SUPERSEDES SPECS OF: 4/6/51

SAMPLE FOR ANALYSIS: 2 x 16 oz. W.M.Bottles

UNRESTRICTED INFORMATION

Routine Tests	Specification	Method Number
Appearance and Color	Light Yellow Cryst. Solid	10,252
Crystallizing Point	68.7°C, min.	10,298
GENERAL INFORMATION		
Distillation Range:		
First Drop to	2.5°C, max.	10,299
Dry Point	Must include 255°C within Range	

This specification is the property of Monsanto Chemical Company and is for internal use only.

IN 86 (REV. 12/58)

Monsanto
ORGANIC CHEMICALS DIVISION
W. G. Krummrich Plant
RAW MATERIAL
SPECIFICATION

MATERIAL CODE	MATERIAL
33500	Ferric Chloride Anhydride
PLANT: WGK	USING DEPTS.: 233
DATE EFFECTIVE: JAN 7 1966	SUPPLIER: McKesson & Robbins

APPROVALS

PRODUCTION: T. W. Dalton	RESEARCH: M. A. Terpstra
PROCUREMENT: C. A. Pratte	QUALITY CONTROL (Chief Chemist): W. J. Gresham

GENERAL DESCRIPTION

CHEMICAL FORMULA

$FeCl_3$

mol wt. 162.21

SUPERSEDES SPECS OF	SAMPLE FOR ANALYSIS	ISSUED BY
11/15/62	1 x 8 oz. W.M. Bottle	J. P. Prader

UNRESTRICTED INFORMATION

CHARACTERISTIC	LIMITS	METHOD
		J.F.Q.
Appearance	Black powder or Granules	16-A
Assay	97.0%, min.	22-570
Sulfates	0.05%, max.	120-570
Ferrous Salts	Trace, max.	S-570-1
Solubility:		112-B
10:10 of Water	Complete to slightly turbid, max.	
10:10 of Formula 30 Alcohol	Complete to slightly turbid, max.	

MONS 055499

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

W&K-316

Monsanto
ORGANIC CHEMICALS DIVISION

RAW MATERIAL SPECIFICATION

MATERIAL CODE	MATERIAL
38800	Lime, Hydrated
PLANT	**USING DEPTS.**
WGK	222, 246
DATE EFFECTIVE	**SUPPLIER**
7/21/66	Mississippi Lime Co.

APPROVALS

PRODUCTION: P. E. Heisler	RESEARCH: M. E. Gibbs
PROCUREMENT: C. A. Pratte	QUALITY CONTROL (Chief Chemist): W. J. Gresham

GENERAL DESCRIPTION

CHEMICAL FORMULA

$Ca(OH)_2$

SUPERSEDES SPECS OF	SAMPLE FOR ANALYSIS	ISSUED BY
6/20/63	1 x 16 oz. W.M. Bottle	

CHARACTERISTIC	LIMITS	METHOD
Appearance	Fine white or slightly gray powder, free from lumps or gritty material	10,188
Assay ($Ca(OH)_2$)	92.00%, min.	10,191
Carbonates as ($CaCO_3$)	3.00%, max.	10,193
Magnesium	0.50%, max.	10,192
Sulfates (as SO_3)	0.30%, max.	10,189

Supplier's certificate of analysis to be sent on day of shipment to:

Chief Chemist, Monsanto Co., Monsanto, Ill.

MONS 055500

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

WGK-514

Monsanto
ORGANIC CHEMICALS DIVISION
W. G. Krummrich Plant
RAW MATERIAL
SPECIFICATION

MATERIAL CODE	MATERIAL
19409	Attapulgus Earth 200/UP
PLANT: WGK	USING DEPTS.: 246
DATE EFFECTIVE: 1-21-66	SUPPLIER: Mineral & Chemical Phillips Corp.

APPROVALS

PRODUCTION: P. E. Heisler	RESEARCH: W. D. Robinson
PROCUREMENT: C. A. Pratte	QUALITY CONTROL (Chief Chemist): W. J. Gresham

GENERAL DESCRIPTION: Clay

CHEMICAL FORMULA:

SUPERSEDES SPECS OF	SAMPLE FOR ANALYSIS	ISSUED BY
11/15/62	2 x 16 oz. W.M. Bottles	J. P. Prader

CHARACTERISTIC	LIMITS	METHOD
UNRESTRICTED INFORMATION		
(R) Volatile Matter (at 950°C.)	6 - 8%	
(R) Mesh Test:		
Through USS 325	90%, min.	

This material is not accepted without the supplier's analysis of the above properties.

MONS 055501

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

WGK-314

Monsanto
ORGANIC CHEMICALS DIVISION

RAW MATERIAL SPECIFICATION

MATERIAL CODE	MATERIAL
43099	Nitrogen Gas
PLANT: WOK	USING DEPTS.: See Below (3)
DATE EFFECTIVE: FEB 18 1965	SUPPLIER: Air Reduction Sales Co.,

APPROVALS

PRODUCTION: J.M.C., P.E.H., W.B.P., C.H.S.	RESEARCH: R.W.B., H.W.K., M.A.T., W.D.R., J.A.S., W.F.S.
PROCUREMENT: C.H.C.	QUALITY CONTROL (Other Chemist): W.J.G. C.H.R. J.S.M.

GENERAL DESCRIPTION — CHEMICAL FORMULA

Grade - C. P. Special Nitrogen

SUPERSEDES SPECS OF	SAMPLE FOR ANALYSIS	ISSUED BY
New	---	M. D. Healy

CHARACTERISTIC	LIMITS	METHOD
Assay (1)	99.9%, min.	(2)
Oxygen	0.1%, max.	
Hydrogen	0%	
DewPoint	-76°F	

Typical Analysis

Nitrogen	99.78%
Argon	0.12%
Oxygen	0.1%
Carbon Dioxide	<.00005%
Acetylene	<.00005%

(1) Nitrogen plus inert rare gases
(2) Any analyses to be obtained from supplier on request.
(3) B-215, C-216, 244, 246, 247, E-254, A-255, 256, 267, 270.

MONS 055502

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

Monsanto
ORGANIC CHEMICALS DIVISION

RAW MATERIAL SPECIFICATION

MATERIAL CODE	MATERIAL
64005	5° Xylene
PLANT WGK	**USING DEPTS.** A-255
DATE EFFECTIVE 6/21/66	**SUPPLIER** Chem Tech

APPROVALS

PRODUCTION J. E. Smith	**RESEARCH** C. Eaker (Nitro)
PROCUREMENT A. H. Smith	**QUALITY CONTROL** *(Chief Chemist)* W. J. Gresham

GENERAL DESCRIPTION — **CHEMICAL FORMULA**

$C_6H_4(CH_3)_2$

mol. wt. 106.16

SUPERSEDES SPECS OF	SAMPLE FOR ANALYSIS	ISSUED BY
7/12/63	1 x 16 oz.	J. P. Prader

CHARACTERISTIC	LIMITS	METHOD
UNRESTRICTED INFORMATION		
(R) Appearance	Clear Colorless liquid	--------
(R) Sp. Gr. @15.5/15.5°C.	0.860 - 0.870	T-2516
(R) Distillation Range		T-2518
1st Drop	137°C., min.	
Dry Point	143°C., max.	
100% over in	5°C., max.	
Acidity	No free acid	--------
Sulfur compounds	Free of H_2S and SO_2	--------

Supplier's certificate of analysis to be sent on day of shipment to:

Chief Chemist, Monsanto Company, Monsanto, Ill.

MONS 055503

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

Monsanto
ORGANIC CHEMICALS DIVISION

FINISHED PRODUCT SPECIFICATION

PRODUCT		DEPT.
CHLORINE, Liquid		232
PLANT	PRODUCT CODE	USE
WGK	81059	Sales and Internal
DATE EFFECTIVE	SALES CODE	
JUN 2 8 1966	3060-000-06-03	

APPROVALS

PRODUCTION: T. W. Dalton	RESEARCH: N. F. Mueller
SALES: W. E. Ault	QUALITY CONTROL (Chief Chemist): W. J. Gresham

GENERAL DESCRIPTION

CHEMICAL FORMULA

MOL WT. 70.914

SUPERSEDES SPECS. OF	SAMPLE FOR ANALYSIS	ISSUED BY
6/24/63	1 x 40 ml. Beaker 3/4 full	J. P. Prader

CHARACTERISTIC	LIMITS	METHOD
UNRESTRICTED INFORMATION		
(R) Appearance	Clear heavy liquid	10,748
(R) Color	Amber to greenish yellow	10,748
(R) Moisture	.015%, max.	12,793
(R) NVM	.01%, max.	12,793
Iron as:		10,688
Fe.	*Report %	
$FeCl_3.6H_2O$	Report %	

*When used in manufacture of ACl products, the specification on Iron as Fe is 20 ppm max. (H. V. Moss)

For use in Depts. 264, 258, 238, 243, 244 and 251.

MONS 055504

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

MONSANTO CHEMICAL COMPANY
ORGANIC CHEMICALS DIVISION
W. G. Krummrich Plant
FINISHED PRODUCT SPECIFICATION

PRODUCT CODE: 81115
DEPT. OR JOB: 246
USE: Internal J.F.Q.
SALES CODE:

Issued APR 7 1964
W. G. Krummrich Plant
By W. D. Daly

PRODUCT (Trade Name): Aroclor 1232
TYPE: (MCS - 236)
PRODUCT (Chemical Name): 32% Chlorinated Biphenyl
TYPE:
CHEMICAL FORMULA:

MOL WT.:

SUPERSEDES SPEC'S OF: New
SAMPLE FOR ANALYSIS: 2 x 16 oz. W. M. Bottles

Routine Tests	Specification	Method No.
Appearance	Clear Liquid	
Sp. Gr. @25/15.5°C	1.266 - 1.276	10,114
Acid Number	0.014 mg. KOH/grm. max.	10,087
Color, APHA	100, max.	10,084
H_2O	35 ppm., max.	10,620
General Tests		
Chlorine	31.5 - 32.5%	

This specification is for internal use only.

MONS 055505

IN 84 (REV. 12/60)

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

PRODUCT CODE: 81101-82612
DEPT. OR JOB: WGK-246-Ann.27
USE: Sales
SALES CODE: 1040-240-04/11/16-03/09

Issued
W. G. Krummrich Plant
By M D Seely

PRODUCT (Trade Name): Aroclor 1242
TYPE: Non-Electrical Grade
PRODUCT (Chemical Name):
TYPE:

CHEMICAL FORMULA

Mixture

MOL WT.

SUPERSEDES SPEC'S OF: 5-4-61
SAMPLE FOR ANALYSIS: 3 x 16 oz. W. M. Bottles

UNRESTRICTED INFORMATION

Routine Tests	Specification	WGK	Anniston Method No.
Condition	Clear	10084	G-1
Color, APHA	100 max.	10084	046
Sp. Gr. (25/15.5°C)	1.381 - 1.392	10114	052
Acidity (mg. KOH/g.)	0.010, max.	10087	050
Moisture (H_2O) (ppm.)	50, max.	10620	047
General Tests			
Distillation Range (ASTM D-20 Corrected)		10117	14-31-54
10% Distilled by wt.	325°C, min.		
90% " " "	360°C, max.		
Viscosity @100°F (SUS)	82-92	10086	049
Flash Point (°F)	338 - 392	10123	14-28-54
Fire Point	None	10123	14-28-54

IH 84 (REV. 10/59)

MONSANTO CHEMICAL COMPANY
ORGANIC CHEMICALS DIVISION

W.G.K. and Anniston
FINISHED PRODUCT
SPECIFICATION

PRODUCT CODE: 81102
DEPT: 946 WGK 27 Ann.
USE: Sales
SALES CODE: 1040-260-04/11/16-03/09

Issued 1/10/64
W. G. Krummrich Plant
By M. D. Dyer

PRODUCT (Trade Name) TYPE: Aroclor 1248 Electrical Grade (Pyranol 1498)
PRODUCT (Chemical Name) TYPE:

Corrected 2-16-64

CHEMICAL FORMULA

Mixture

MOL WT.

SUPERSEDES SPEC'S OF: 2-12-60
SAMPLE FOR ANALYSIS: 3 x 5 pt. Amber Bottles

UNRESTRICTED INFORMATION

Routine Tests	Specification	Method No's. WGK	Annistor
Color, APHA	50, max.	10,084	14-44-54
Condition	Clear	10,084	G-1
Sp. Gr. @65/15.5°C	1.405 - 1.415	10,114	14-49-54
Acidity (mg. KOH/gm.)	0.010, max.	10,087	14-42-54
Moisture	35 ppm., max.	10,620	14-53-54
Refractive Index @25°C	1.6285 - 1.6305	10,125	14-34-54
Inorganics (Free) Chlorides	0.05 ppm., max.	T-2092	014
Pour Point	0°C, max.	10,115	14-27-54
Dielectric Constant (1000 cycles @100°C)	4.5 - 4.7	11,608	14-36-54
Resistivity (500 VDC @100°C 0.1" GAP) as OHM-CM x 10^9	500, min.	11,607	14-35-57
Hydrolysis Stability Test (as Chlorides)	1.0 ppm., max.	T-2087	010
Monsanto Stability Test (as Chlorides)	0.5 ppm., max.	11,503	14-61-57
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.		

General Tests (made only on request)

Sulfates	None	12,169	- - -
Dielectric Strength @25°C	35 KV, min.	11,605	043
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	14-55-57
Change in wt. of Al (%)	0.0		

(over)

IN 84 (REV. 10/58)

A. C. Color, APHA	60, max.	10,084 14-44-54
A. C. Condition	Clear	10,084 C-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%

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

PRODUCT CODE: 81103 - 82613
DEPT. OR JOB: WGK-246-Ann.27
USE: Sales
SALES CODE: 1040-280-04/11/16-03/09

Issued 7/15/64
W. G. Krummrich Plant
By M D Daly

PRODUCT (Trade Name): Aroclor 1254
TYPE: Non-Electrical Grade
PRODUCT (Chemical Name):
TYPE:

CHEMICAL FORMULA

Mixture

MOL WT.

SUPERSEDES SPEC'S OF: 5-4-61
SAMPLE FOR ANALYSIS: 3 x 16 oz. W. M. Bottles

UNRESTRICTED INFORMATION

Routine Tests	Specification	WGK Method	Anniston No.
Color, APHA	100, max.	10084	046
Sp. Gr. @65/15.5°C	1.495 - 1.505	10114	052
Acidity (mg. KOH/g.)	0.010, max.	10087	050
Moisture (H_2O) (ppm.)	50, max.	10620	047
General Tests			
Flash Point	None	10123	14-28-54
Viscosity @210°F (SUS)	44-48	10086	049

MONS 055509

IM 84 (REV. 12/60)

Monsanto
ORGANIC CHEMICALS DIVISION

ANNISTON AND KRUMMRICH
FINISHED PRODUCT
SPECIFICATION

PRODUCT: Aroclor 1260 Electrical Grade			DEPT. Ann. 2 WGK - 246
PLANT: Anniston Krummrich	PRODUCT CODE: 84614 - Ann. 81105 - WGK		USE: Sales
DATE EFFECTIVE: 5/25/66	SALES CODE: 1040-290-04/11/16-03-09		

APPROVALS

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

GENERAL DESCRIPTION

CHEMICAL FORMULA

MOL WT.

SUPERSEDES SPECS. OF: 2/7/62	SAMPLE FOR ANALYSIS: 3 x 5 pt. Amber Bottles	ISSUED BY: J. P. Prader

CHARACTERISTIC	LIMITS	METHOD: WGK.	Anniston
UNRESTRICTED INFORMATION			
(R) Color (APHA)	150, max.	10084	14-44-54
(R) Condition	Clear	10084	--------
(R) Specific Gravity @ 90, 15.5°C.	1.555 - 1.566	10114	14-49-54
(R) Acidity (mg KOH/g.)	0.014, max.	10087	14-42-54
(R) Moisture (H_2O) (ppm)	35, max.	10620	14-53-54
(R) Viscosity @ 210°F. (SUS)	72 - 78	10086	14- 4-52
(R) Refractive Index @ 25°C.	1.6455 - 1.6470	10125	14-34-54
(R) Inorganic (Free) Chlorides	0.05 ppm, max	10118	14-48-57
(R) Pour Point (°C)	25 - 34	10115	14-47-54
(R) Distillation Range (ASTM D-20, Corrected)		10117	14-31-54
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	14-55-57
(R) Change in weight of Al (@)	0.0		
(R) A.C. Color (APHA)	150, max.	10084	14-44-54
(R) A.C. Condition	Clear	10084	--------
(R) A.C. Acidity (mg. KOH/g.)	0.014, max.	10087	14-42-54
(R) A.C. Inorganic (Free) Chlorides	0.05 ppm, max.	10118	14-48-57

(Over)

MONS 055510

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

UNRESTRICTED INFORMATION (Cont'd.)

Characteristic	Limits	Method	
		WGK	Anniston
Flash Point	None	10123	14-28-54
Fire Point	None	10123	14-28-54
Fixed Chlorine (%)	59.5 - 60.5	10088	14-13-54
(R) Dielectric Strength @ 50°C.	30 K.V., min.	11605	---------
(R) Resistivity (500 VDC @ 100°C, 0.1" gap as ohm-cm x 10^9)	500, min.	11607	14-35-57
(R) Dielectric Constant 1000 cycles, 100°C.	3.6 - 3.8	11607	14-36-45

RESTRICTED INFORMATION

(R) Monsanto Stability Test (As Chlorides in ppm.)	0.7, max.	11503	14-61-57

GENERAL INFORMATION

(R) Evaporation Loss after 6 hrs. @ 100°C. (%)	0.2, max.	10116	12-32-54
(R) Stability test - after 30 days at 100°C. in glass sealed in air.	No liberation of chlorine or chlorides	------	--------

Monsanto
ORGANIC CHEMICALS DIVISION

ANNISTON AND KRUMMRICH
FINISHED PRODUCT
SPECIFICATION

PRODUCT: AROCLOR DISTILLED 1262			DEPT. Ann-27 WGK-246
PLANT: ANN. & WGK	MASTER CARD: 82615-Ann. 81107-WGK		USE: Sales
DATE EFFECTIVE: MAR 02 1966	SALES CODE: 1040-300-04/11/16-03-09		

APPROVALS

PRODUCTION: P. E. Heisler	RESEARCH: W. D. Robinson
SALES: W. E. Ault	QUALITY CONTROL (Chief Chemist): 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 055512

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

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

PRODUCT CODE: 82868
DEPT. OR JOB: WOK 246 Ann. 27
USE: Sales
SALES CODE: *See Below

Issued JUL 15 1954
W. O. Krummrich Plant
By M D Daly

PRODUCT (Trade Name) TYPE
Montars 1 and 2
PRODUCT (Chemical Name) TYPE
Polychlorinated Polyphenyls
CHEMICAL FORMULA

Mixture

MOL WT.

SUPERSEDES SPEC'S OF: 6-15-61
SAMPLE FOR ANALYSIS: 2 x 16 oz. W. M. Bottles

UNRESTRICTED INFORMATION

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

General Information

Physical Properties (Typical Values)	Montar 1	Montar 2
Softening 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 055513

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 Daly

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.	WGK
Appearance	Black Solid	14-17-52	1132

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 Basi
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

Dept. 246 - Process Description

AROCLOR

APPENDIX C

PHYSICAL AND CHEMICAL DATA

Physical Constant Data sheets which are available are listed following this page.

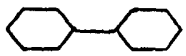
IN 619

PHYSICAL CONSTANTS DATA

SUBSTANCE

82601 DIPHENYL

STRUCTURAL FORMULA



COMPILED BY W. P. Meisner 2/12/43 Rev. DATE

6/22/43.1/11/44. Rev. A. M. Ellenburg 6/26/57

Beilstein V - 576

NAME		SOURCE & DATE
Formula	C_6H_5 C_6H_5	
Molecular Weight	154.20	Chem. Rubber Handbook
Appearance	Monoclinic	" " 1941-42
Boiling Point at 760 mm	255°C.	Int. Crit. Tables 1928
Boiling Point at 10 mm	118	*Swann file #137 1935
Boiling Point at mm		
Boiling Point at mm		
Crystallizing Point	69.0°C	*Swann Curves 1934
Melting Point	69°C.	Int. Crit Tables 1928
Solution Point		
Specific Gravity @ 77/4°C	0.9896	Int. Crit. Tables 1928
Specific Gravity @ 20/4°C	1.041	" " " "
Pounds per Gal. @ 77 °C	8.23 lbs. per gal.	Swann File #137A 1930
Coefficient of Expansion		
Refractive Index @ 77.1°C/D	D = 1.58822	Int. Crit. Tables 1928
Infra Red Spectrum (Reference)		
Ultra Violet Spectrum (Reference)		
Viscosity @ 100°C	28.8 Say. Sec.	*Swann File #137A 1930
Viscosity @ 70°C	31.2 " "	" " " "
Surface Tension 129.2°C	29.5 dyne/cm	Int. Crit. Tables 1928
Solubility in Water @ 80°C	Insoluble	Dow 1943
Solubility in abs. Alc. 19.5°C	9.98 g./100 g. solvent	Seidell 1941
Solubility in 100% Methanol 19.5°C	6.57 g./100 g. solvent	" 1941
Benzene @ 27.2°C.	137 g./100 g. solvent	" 1941
Heptane @ 26.5°C.	25.1 g./100 g. solvent	" 1941
Flash Point °F (Marked)	235°F - closed cup ~~250°F - open cup~~	Ind. & Eng. Chem. 1940 32,883
Fire Point °F (open cup)	270°F	Swann File #137 A (1943)
Heat of Combustion Kg-cal (15)	per gm. mol = 1504.4	Int. Crit. Tables 1928
Heat of Formation		
Thermal Stability (cal./sq/min.)		
Latent Heat of Fusion		
Latent Heat of Vap. @ 255°C	136.5 BTU/lb.	Swann File #137 A (1928)
Specific Heat	0.43 BTU/lb. °F.	R&E CR 964 (1956)
Critical Temperature	528°C	Rev. Sci. Instruments 563
Critical Pressure	41.4 Atm. absolute	" " " 7(193(
Dissociation Constant		
Latent Heat of Fusion	28.8 gm-cal. per gm. (53.1 BTU/lb)	Lange Handbook 1937

Other Constants

MONS 055516

*NOTE:- Files of W. P. Meisner, St. Louis

Toxicity (Give References) (1) Dr. McLester, Anniston Plant. Report copy in St. Louis physicians file 1937

(2) Percy May - Chemistry of Synthetic Drugs" 3ed p. 1

NOTE: *These data should not be released outside of Monsanto Chemical Company. Use additional sheets if necessary.*

PHYSICAL CONSTANTS DATA

SUBSTANCE: FERRIC CHLORIDE, ANHYDROUS

Penn-Salt Chem. Co.

COMPILED BY Penn-Salt Chem. Co. DATE 10-15-57

STRUCTURAL FORMULA

NAME		SOURCE & DATE
Formula	$FeCl_3$	Ref. 1
Molecular Weight	166.22	Ref. 1
Appearance	Black iridescent crystals	Ref. 1
Boiling Point at 760 mm		
Boiling Point at mm		
Boiling Point at mm		
Boiling Point at mm		
Crystallizing Point		
Melting Point	Sublimes	
Solution Point		
Specific Gravity @		
Specific Gravity @		
Pounds per Gal. @ °C		
Coefficient of Expansion		
Refractive Index @ $n_D^{\ }$		
Infra Red Spectrum (Reference)		
Ultra Violet Spectrum (Reference)		
Viscosity @		
Viscosity @		
Surface Tension		
Solubility in Water	V. Sol. (heat rise)	Ref. 1
Solubility in		
Solubility in		
Flash Point °F (Method)		
Fire Point °C		
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		
Decomposes on exposure to moist air.		

Other Constants

Reference 1. Penn-Salt Chem. Co. Tech. Data Sheet & Specs.

Toxicity (Give Reference)

MONS 055517

NOTE: *These data should not be released outside of Monsanto Chemical Company. Use additional sheets if necessary.*