MONSANTO COMPANY

Organic Chemicals Division

Standard Manufacturing Process For

AROCLORS

Department 246

****

Supersedes: Process description for the manufacture of Aroclors, Dated: December 17, 1962.

Prepared by: L. G. Cole
L. G. Cole, P.T.S. Engineer

Approved by: R W Bucknell 7/15/64
R. Bucknell, Research

Approved by: E E Martin
E. E. Martin, Prod.Supervisor

D. B. Hosmer 8/11/64
D. B. Hosmer, Org. Prod. Mgr.

P E Heisler
P.E. Heisler, Gen. Prod.Supt.

Issued: 7-20-64

Copy 9 of 10

MONSANTO COMPANY
Monsanto, Illinois

SAFETY REVIEW COMMITTEE

3-25-65

March 10, 1965

Messrs:

P. E. Heisler - WGK
H. C. Carder - WGK
Process Holders

R. W. Bucknell - Org. Res.
H. L. Hubbard - Org. Res.

Tentative Amendment No. "A"

Title:

Tentative Amendment No. "A" to the Standard Manufacturing Process for Aroclor (Dept. 246, WGK) dated 7/20/64.

Objective:

Alter present plant distillation system and operations for a plant test. Plant test will indicate equipment needs and ability to produce improved quality (stable) Aroclor.

Present Practice:

Two Aroclor Distillation Systems are run in parallel. The two systems are continuously fed crude Aroclor from the #2 Blow Tank. The distillation is a straight take-over operation. When a run of one type (1242, 1248, etc.) is completed (80,000-500,000#) a final boil down is conducted in No. 2 still and the bottoms are dropped.

The boil down material is combined with the previously distilled material and processed to finished product. The bottoms are drawn off and sold as Montar or discarded. Following the boil down and bottom's drop the stills are ready for the next product run.

Proposed Procedure:

Run the two stills in series. Continuously feed the No. 1 still with crude Aroclor and use this system to pre-heat the entire feed and to distill off a low-boiler fraction (up to 10% of feed). Continously feed the No. 2 still from No. 1 still pot. Collect the intermediate fraction in No. 2 receiver and process as in normal operation.

At the end of the run (4-5 days) boil down and drop bottoms. Do not combine the boil down (high-boilers) with the intermediate fraction. The low boilers from No. 1 receiver and the high boilers from the boil-down will be isolated in a storage tank, if possible.

If they pass non-electrical Aroclor specifications, they can be used as such. If the total amount has to be discarded because no storage is available, or because they are out of specification, the cost would be $3,000 based on total product costs.

Specific operating conditions for the stills will have to be determined in the field by cut and try methods.

Justification:

Foreign competition appears to be capable of producing Aroclor which is more stable than that presently made by Monsanto. An improvement of product stability is necessary to protect our market position.

Laboratory data* indicates that the distillation operation has a significant effect on product stability. These data indicate that product stability can be improved by:

1. Removing an unstable low-boil fraction
2. Preventing entrainment
3. Preventing contamination by high-boilers or boil down

This test will evaluate our ability to control the plant distillation in the three areas mentioned above, with existing equipment. Failure of the test will indicate that more drastic revisions to the existing equipment will be needed to approximate laboratory conditions.

Comments:

The production rate will be limited by maximum vapor and heat loads that can be sustained in the entrainment and condenser systems on No. 2 still. In the past 55,000#/day have been attained in these systems. The upper limit is not presently known.

Duration:

The test duration will be 4-5 days. If desired operation conditions cannot be obtained during this interval the test will be cancelled or revised.

Prepared by:

D. R. Middleton

D. R. Middleton

J. J. Luecken

J. J. Luecken

*WGK PR&D Reports J-62, 2/15/65 and J-78, 3/8/65

MONS 054762

Approvals:

P. E. Heisler

R. W. Bucknell

D. E. Harris

R. L. Hubbard

J. A. Mullendore

vmd

MONSANTO COMPANY
Monsanto, Illinois

July 12, 1965

Messrs:

P. E. Heisler - WGK
H. C. Carder - WGK
Process Holders

R. W. Bucknell - Org. Res.
H. L. Hubbard - Org. Res.

Tentative Amendment No. "B"

TITLE:

Tentative Amendment No. "B" to the Standard Manufacturing Process for Aroclor (Dept. 246, WGK) dated 7/20/64.

OBJECTIVE:

Run two plant tests using revaporized Cl_2 and dilute (25 mole %) Cl_2, as feed stock for Aroclor 1242 production.

PRESENT PRACTICE:

The Dept. 246 Chlorinators are batch charged with biphenyl (BiØ). The BiØ is then chlorinated by continuously feeding "Snift" gas to the chlorinator mass until the desired specific gravity is reached. The "Snift" Gas is a mixture of Cl_2 (from DeNora & Hooker Cells) H_2, N_2, O_2, CO_2 and trace amounts of organic impurities. The Cl_2 concentration is in the range of 75 - 95 mole % and varies with operations in the Cl_2 departments.

PROPOSED PRACTICE (Two Plant Tests, 1242 Aroclor)

1. A plant chlorination test will be run using revaporized Cl_2 from Dept. 232 as the Cl_2 feed stock. Due to limited capacity of the revaporizing facilities in Dept. 232, we will probably be able to run only two chlorinators at a time, making a total of 5 - 6 chlorinator batches and processing through the remainder of the system as normal. Necessary samples and measurements will be taken to determine effect of concentrated and impurity free Cl_2 on Aroclor stability. This material will be treated as normal production as it passes the routine plant controls.

2. A plant chlorination test will be run using revaporized Cl_2 diluted to 25 mole % with dry air as Cl_2 feed stock. This test will be limited to 2 chlorinators due to dry air capacity, making a total of 5 - 6 chlorinator batches and processing through the remainder of the system as normal. Necessary samples and measurements will be taken to determine effect of dilute and impurity free Cl_2 on Aroclor stability. This material will be segregated from normal electrical grade 1242 Aroclor. It will be used for non-electrical 1242 if it passes specification.

Tentative Amendment No. "B".

JUSTIFICATION:

Foreign competition appears to be capable of producing Aroclor which is more stable than that presently made by Monsanto. An improvement of product stability is necessary to protect our present U.S. market position and for possible expansion of foreign sales. These tests will provide information as to the effect of contaminants in chlorine, and the possibility of local overchlorination due to concentration effects.

COMMENTS:

For the revaporized Cl_2 test the production rate will be limited to about 32,000#/day for a duration of 1 - 1 1/2 days. For the dilute Cl_2 test the rate will be limited to about 11,000#/day for a duration of 3 days.

SAFETY:

No increase in safety hazards is forseen in these two test runs.

Prepared by:

D. R. Middleton

D. R. Middleton

APPROVALS:

P. E. Heisler 7/15/65

P. E. Heisler

D. E. Harris 7-16-65

D. E. Harris

J. A. Mullendore 7/19/65

J. A. Mullendore

R. W. Bucknell

R. W. Bucknell

H. L. Hubbard

H. L. Hubbard

SAFETY REVIEW COMMITTEE:

7-20-65

ODG 7-20-65

CWR 7-23-65

MONS 054765

MONSANTO COMPANY
Monsanto, Illinois

September 1, 1965

Messrs:

P. E. Heisler - WGK
H. C. Carder - WGK
Process Holders

R. W. Bucknell - Org. Res.
H. L. Hubbard - Org. Res.

Tentative Amendment No. C

TITLE:

Tentative Amendment No. C to the Standard Manufacturing Process (Dept. 246, WGK) dated 7/20/64.

OBJECTIVE:

Run plant test using chlorinator without catalyst basket.

PRESENT PRACTICE:

The Dept. 246 batch chlorinators (3' diam. x 16' high) are batch charged with biphenyl, which is chlorinated with snift gas. At the present, each chlorinator has a catalyst bed. The catalyst bed is 2'3" in diam. and 8' high and consists of 1 1/2" pipe nipples, 2" long.

PROPOSED PROCESS (1242 and 1260 Aroclor)

Remove the catalyst bed from one chlorinator and run three to five 1242 and three to five 1260 batches in that chlorinator following standard operating procedures, except without the catalyst bed. The test material will be kept separate from other production and will be used only if it is equivalent to normal production aroclor, according to routine analyses.

During the test batches the chlorinator off-gas will be sampled and analyzed for chlorine, to check chlorine utilization of the chlorinators without the bed.

The purpose of the catalyst bed is to provide iron, which is chlorinated to ferric chloride, the reaction catalyst. It is standard operating procedure to charge 0.05% by weight ferric chloride to each batch. Ferric chloride will, of course, be added to the test batches.

JUSTIFICATION:

During operation the catalyst becomes plugged with tars and ferric chloride and it is probable that only a small portion of the iron of the bed is available for utilization. Also, the plugged bed hinders chlorinator circulation and probably leads to hot spots in the chlorinator. There is a problem of cross contamination from batch to batch with the bed, which results in an excessive amount of overchlorinated products.

JUSTIFICATION: (Cont'd.)

During 1956 there were severe problems with aroclor stability. One of the problems was a lack of a consistent analytical method for checking stability. Previous to that time the catalyst bed was relied upon to supply ferric chloride and ferric chloride, per se, was not added. One of the results of the stability problem was the addition of ferric chloride to each chlorinator batch, to assure that sufficient catalyst was available. Since that time analytical methods have improved and any unstable aroclor produced would be detected immediately.

The removal of the catalyst bed, then, improves chlorinator operation by increased circulation, elimination of hot spots, and prevention of contamination. The addition of ferric chloride provides sufficient catalyst. Any unstable aroclor produced would be detected immediately by the present routine analyses.

SUPPORTING DATA:

It is reported in St. Louis Research Report Nos. 1640 and 2072 that a minimum level of 0.03% $FeCl_3$ is necessary to produce stable aroclor. No mention is made of the need for iron, and none was used in the lab chlorinators.

SAFETY:

No increase in safety hazards is anticipated.

QUALITY:

Work is in progress to improve aroclor quality (stability). It is anticipated that the removal of the basket will not harm quality but, if anything, will improve it due to improved circulation, elimination of hot spots in the chlorinators, and elimination of cross-contamination from batch to batch.

DURATION OF TEST

Three to five 1242 and three to five 1260 batches will be made without the catalyst bed. If this material is equivalent to normal production material, according to routine analyses, the chlorinator without the catalyst bed will be used for normal operations, and this amendment incorporated as a process revision. If the test material is not equivalent to normal production the bed will be replaced.

COMMENTS:

This plant test would normally involve some loss of production. The present aroclor stock position is such that it is anticipated that it will be necessary to run only three of the five chlorinators during September. Also, some repairs to be made during September will require removal of the catalyst bed from the No. 3 chlorinator. September, then, is an ideal time to run this test.

Prepared by: W. G. Krampfr
W. G. Kramper

APPROVALS:

P. E. Heisler	9/1/65 Date	R. W. Bucknell	9/3/65 Date
D. E. Harris	9-1-65 Date	H. L. Hubbard	9/3/65 Date
J. A. Mullendore	9-7-65 Date		

SAFETY REVIEW COMMITTEE

H. L. Hubbard 9-3-65
Oliver DeGarmo 9-3-65
C. W. Koch 9-7-65

emc

MONS 054768

MONSANTO COMPANY
Monsanto, Illinois

SAFETY REVIEW COMMITTEE

CWR 10-26-65
[illegible] 10-29-65
[illegible] 10-29-65

October 20, 1965

Messrs:

P. E. Heisler - WGK
H. C. Carder - WGK
Process Holders

R. W. Bucknell - Org. Res.
H. L. Hubbard - Org. Res.

Tentative Amendment No. "D"

Title:

Tentative Amendment No. "D" to the Standard Manufacturing Process for Aroclor (Dept. 246, WGK) dated 7/20/64.

Objective:

Evaluate potassium carbonate as a replacement for lime in the Aroclor distillation system.

Present Practice:

Aroclor is distilled in two parallel systems, continuously fed from the No. 2 blow tank. At the start of a run (1242, 1248, etc.) 200 lbs. of lime (calcium hydroxide) is added to each still pot. At the end of a run (250,000-500,000 lbs.) bottoms are dropped and the cycle is repeated.

Proposed Procedure:

Segregate the two distillation systems at the start of a 1242 run. To one system, add the normal amount of lime to the still pot and proceed normally throughout the run. To the second system, substitute 200 pounds of anhydrous potassium carbonate for the lime. Distill away from the potassium carbonate for a minimum of two days.

The product distilled from the potassium carbonate will be analyzed by routine tests before it is combined with normal production material. ~~If the product deviates from normal in any adverse way, it will be isolated and will not be sold as electrical grade.~~
This material will not be sold as electrical grade.
[illegible]

MONS 054769

Justification:

The presence of a base during distillation serves two known purposes: It neutralizes free acid, and it reacts with the $FeCl_3$ present. It is also thought that the base can react with some unstable Aroclors, converting them to a more stable form. Recent WGK PR&D laboratory data indicates that distillation from K_2CO_3 increases the stability of the high boiling fractions of Aroclor 1242 (low boil and mid-fractions are essentially unaffected). If this proves to be the case, it would indicate that using K_2CO_3 and making a simple low boil cut may be a practical way of making a stable Aroclor.

Safety:

No increase in safety hazard is anticipated. No unusual effect was seen in laboratory distillations using K_2CO_3.

Comments:

No production loss will be involved since WGK Dept. 246 is presently running at only 75% of demonstrated capacity.

Prepared by:

J. J. Luecken
J. J. Luecken

APPROVALS:

P. E. Heisler — 10/22/65
P. E. Heisler — Date

D. E. Harris — 10-22-65
D. E. Harris — Date

R. W. Bucknell — 10/26/65
R. W. Bucknell — Date

J. A. Mullendore — 11/1/65
J. A. Mullendore — Date

Please have this mat'l sold as non-electrical till accelerated tests by customer reveal it is satisfactory. JAM

MONSANTO COMPANY
Monsanto, Illinois

December 3, 1965

Messrs:

P. E. Heisler - WGK
H. C. Carder - WGK
Process Holders

cc.

R. W. Bucknell - Org. Res.
H. L. Hubbard -Org. Res.

Tentative Amendment No. "E"

TITLE

Tentative Amendment No. "E" to the Standard Manufacturing Process for Aroclor (Dept. 246, WGK) dated 7/20/64.

OBJECTIVE

Produce more stable Aroclor 1242 by chlorinating without a catalyst basket in the chlorinator and processing as normal.

Produce more stable Aroclor 1242 by chlorinating without a catalyst basket in the chlorinator and processing it through the still system with potassium hydroxide added in place of the normally used lime (calcium hydroxide).

Provide sufficient product, produced as above, for testing by customers.

PRESENT PRACTICE

Biphenyl (BiØ) is chlorinated in the chlorinators which contain catalyst baskets. Previously the basket furnished $FeCl_3$ catalyst for the reaction. Presently (since 1957) sufficient amount of catalyst, needed to produce stable Aroclor, is added to each chlorinator when batch charged.

At the beginning of a product (1242, 1240, etc.) run 200 pounds of lime is added to each still. The purpose of the lime is to tie up $FeCl_3$ and neutralize HCl in the crude.

PROPOSED PROCEDURE

Produce 8 - 9 batches of 1142 in No. 5 chlorinator with the catalyst basket removed. This has been done previously as per Tentative Amendment No. "C". Process half of this crude material through the remainder of the system as normal, and drum it off from the finished product tank. Process the other half through No. 1 still system, but substitute potassium hydroxide (0.06% of crude charge) for the lime in the still. Drum this material off from the finished product tank, thus producing approximately 1,000 gallons of each type of test material to be used as samples for evaluation by electrical grade customers. Any excess test material will

PROPOSED PROCEDURE (Cont'd.)

be sold as non-electrical grade 1242 providing it passes all specifications.

JUSTIFICATION

From previous plant tests, the Aroclor produced in a chlorinator without the catalyst basket was equivalent or better than normal material. By removing the baskets, hold-up and cross-contamination are reduced.

Results of PR & D Laboratory studies indicate more stable Aroclor (i.e. 0.15 ppm Cl by thermal chemical chlorides) can be made by addition of KOH to the still pot and stripping off the first 1.2% of the low boilers. Plant equipment will not permit this type of fractionation, but an improvement over normal production is expected.

SAFETY

No increase in safety hazzards is anticipated. No unusual effects were seen in the laboratory distillation using KOH. Normal precautions in handling KOH will be followed.

Prepared by: D. R. Middleton

APPROVALS:

D. R. Middleton (signed)	12/3/65	D. E. Harris (signed)	12-6-65
D. R. Middleton	Date	D. E. Harris	Date
P. E. Heisler (signed)	12/6/65	R. W. Bucknell (signed)	12/6/65
P. E. Heisler	Date	R. W. Bucknell	Date
J. A. Mullendore (signed)		[illegible signature]	12/6/65
J. A. Mullendore	Date	H. L. Hubbard	Date

SAFETY REVIEW COMMITTEE

ADG 12/6/65

[illegible signature] 12/6/65

CMR 12/6/65

Approved with following provisions:

1) Have Aroclor 1242 examined for trace quantities of phenolics.

2) Mat'l produced by this process amendment is not to be sold as electrical grade except as test mat'l at direction of Organic Marketing.

[illegible initials]

Monsanto, Illinois

May 10, 1965

AMENDMENT DISPOSITION

Tentative Amendment No. "A" to the Standard Manufacturing Process for Aroclor (Dept. 246, WGK) dated 7/20/64. Tentative Amendment No. "A" is dated 3/10/65.

TO: Messrs:

P. E. Heisler	- WGK	R. W. Bucknell	- Org. Res.
H. C. Carder	- WGK	H. L. Hubbard	- Org. Res.
D. E. Harris	- WGK	J. A. Mullendore	- Gen. Off.
J. J. Luecken	- WGK	Process Holders	- c/o P. J. Prader - WGK

This memo is to serve as a disposition of the subject tentative process amendment.

The purpose of the amendment was to alter the present plant distillation system and operations for the duration of a plant test. The purpose of the plant test was to indicate equipment needs and ability to produce improved quality (stable) Aroclor. No improvement in stability was realized and the need for fractionation was demonstrated.* The distillation system was returned to normal operation as specified in the Standard Manufacturing Process.

The subject amendment should be recorded in the Standard Manufacturing Process, but not incorporated as a process revision.

D. R. Middleton

D. R. Middleton
Technical Services Dept.

vmd

*WGK TSD Report - Aroclor: Improve Electrical Grade Quality, 91370:3198, Report No.1, dated 4/14/65.

MONS 054773

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   Manager Organic Engineering

5. Production General Superintendent/Production
   Supervisor - W.G.K.

6. Plant Technical Services

7. Extra E. E. Martin

8. Extra

9. Extra B. E. Hensler

10. Extra

MONS 054774

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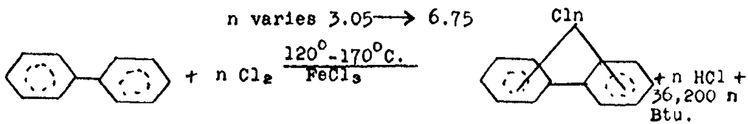
AROCLOR

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 (Ø-Ø) 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 M.W. = 154

CHLORINE M.W. = 71

AROCLOR M.W. = (257.1-395.6)

HYDROGEN CHLORIDE M.W. = 36.5

AROCLOR

SECTION I

SYNOPSIS OF PROCESS

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. abs. 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

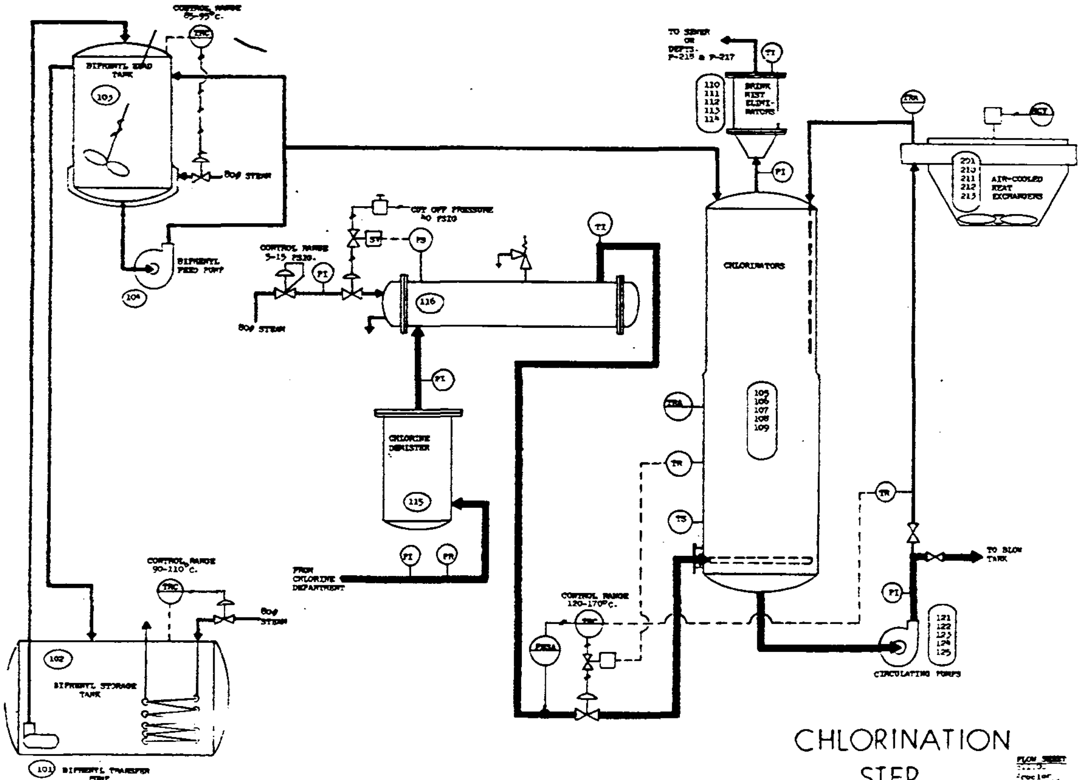
AROCLOR

SECTION II

FLOW SHEETS

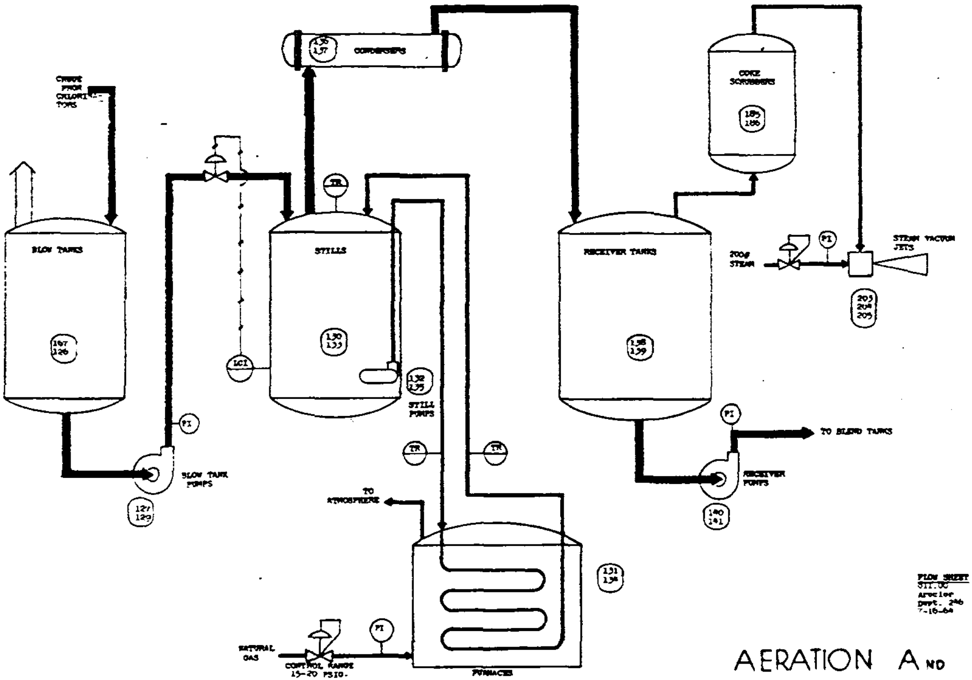
This section contains the following flow sheets.

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



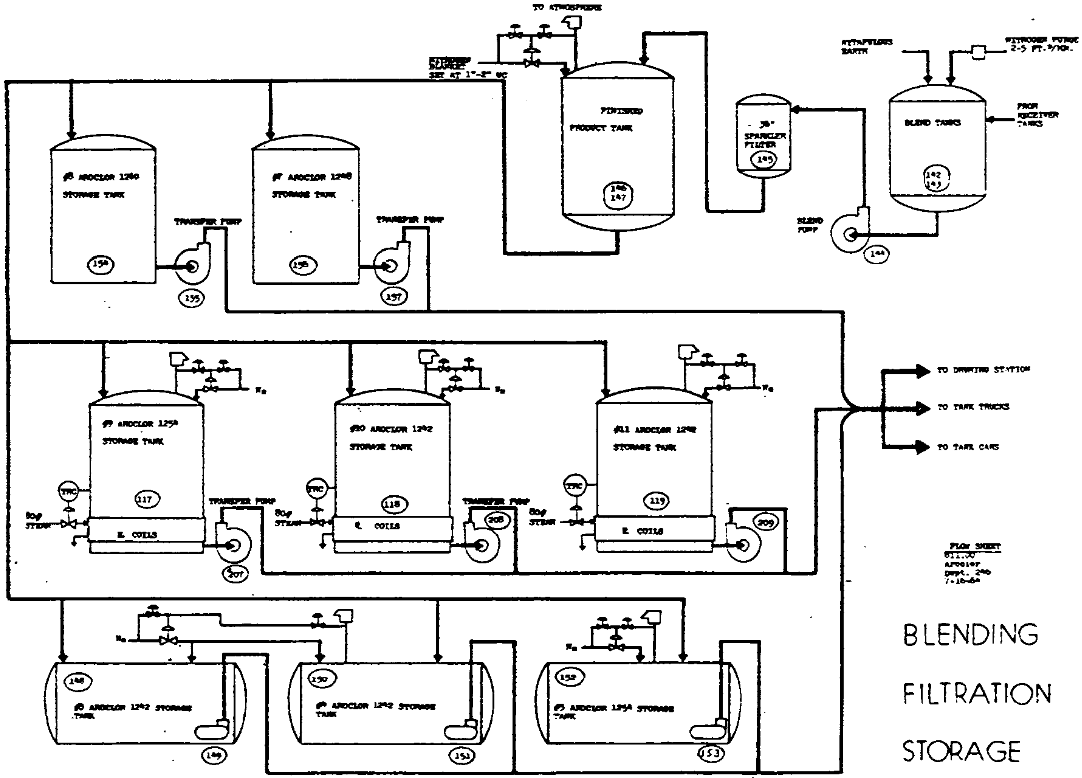
CHLORINATION STEP

MONS 054779



AERATION AND DISTILLATION

MONS 054780



BLENDING

FILTRATION

STORAGE

MONS 054781

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	10 - 12 hr.	10-12 hr.	14-17 hr.	16-20 hr.	16-22 hr.
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	6330#	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

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 and 10,000 gallon tank cars from Anniston, Alabama. The biphenyl in the tank cars is a solid mass because the crystallizing 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 crystallizing point and moisture content 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.

The measuring tank is equipped with an agitator and circulating pump. Two pounds of ferric chloride (0.05% of charge) are charged into the measuring tank for each batch. The charge from the measuring tank is pumped through the circulating line to the chlorinators.

Chlorination is carried out in five chlorinators. Each chlorinator is three feet in diameter by sixteen feet high, and constructed of steel. Each chlorinator 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 biphenyl charge is heated to 120°C. or higher before chlorination is started. 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.

AROCLOR

SECTION III

PROCESS IN DETAIL

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 vaporator 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. should be 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 chlorine gas flow regulation to hold the temperature within ± 5°C. The chlorination temperature must be at least 120°C. at the beginning 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 positioned such that the batch temperature will remain between 120°C. and 170°C. The exact batch temperature will depend on the chlorine flow rate which will fluctuate to maintain a batch temperature of 150°C. The louver adjustment is manually controlled by a hand valve located in the control room. 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. The zero return integrator measures the total amount of chlorine gas flow per batch at any given time and will shut off the gas flow when the desired pre-set pounds of chlorine has entered the reactor. The average chlorine feed rate is 1000 pounds per hour.

Progress of the chlorination reaction is checked periodically as needed after a pre-set amount of chlorine gas as measured by the recorder-integrator passes into the chlorinator.

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 about 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 inlet and outlet 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 2-3 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.

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 Aroclors.

The Aroclors 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, Interteens, 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 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.

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

AROCLOR

SECTION IV

COMMENTS ON PROCESS

CHLORINATION STEP

B. Capacity

The monthly production capacity of Department 246 is 1,700,000 pounds (2,400,000 pounds is expected by August 1, 1964) 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 BTUS 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.

AROCLOR

SECTION IV

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.

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 is 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 the still too far. (Tars will carry over). The "tail - end" still fraction (tars) is a possible source of unstable Aroclors.

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.

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, 2 1/2" 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 7 1/2 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.

Dept. 246 - Process Description

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 Eliminator	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 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.

Dept. 246 - Process Description

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' Dia. 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, ½" 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 66-4891	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, 2 1/2 X 2", size 384. Pump is dynamo steel. Capacity is 75 GPM at 25' static head, Sp. Gr. 1.8. Motor is 7 1/2 HP, 1750 RPM.
136	Condenser #1	38-0770	Heat exchanger made by Nooter. Dwg. B-651. 12" DIA 5' long having nineteen 2" O.D. 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, 1740 RPM.
141	Receiver Pump #2	66-5670 69-1258	Same as Item No. 140.

Dept. 246 - Process Description

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 9/16". 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	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

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. Dwg. 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	Alpha tank 12'6" Dia. x 22' high. 20,000 gallon 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	Slpha tank. 13' O.D. x 20' high. Vertical tank, constructed of 3/8" mild steel. Capacity is 20,000 gallons.
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 ½", 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 66-3365	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
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.

Dept. 246 - Process Description

AROCLOR

APPENDIX A EQUIPMENT LIST (Cont'd.)

Item No.	Equipment Name	Equipment Number	Description
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" xHY pipe.
186	Coke Scrubber #2	21-1396	Same as Item No. 185.
200	Cyclone Separator	21-1413	Separator made by Heintz Steel. 3' 1d 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 Vacuum 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.

AROCLOR

APPENDIX A EQUIPMENT LIST (Cont'd.)

Item No.	Equipment Name	Equipment Number	Description
None	Chlorine Pressure Recorder	29-1547	Made by Taylor Instrument Co. Pressure Recorder with 2 pens. Cat. No. X176JF235. Range 0-100
None	#5 Chlorinator Flow Recorder	29-2019	Made by Taylor Instrument Co. Flow Recorder - Controller. Cat. No. 137RF135. 12" chart, 0 to 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 Co. 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.
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.

AROCLOR

APPENDIX A EQUIPMENT LIST (Cont'd.)

Item No.	Equipment Name	Equipment Number	Description
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.

AROCLOR

APPENDIX B

SPECIFICATIONS

The folliwing is a list of the raw materials used for the manufacture of Aroclors. Specification sheets are included w.:ere they exist.

Material Code	Raw Material
82601	Biphenyl
33500	Ferric Chloride
38800	Lime
19400	Attapulgus Earth
81059	Chlorine
43099	Nitrogen

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

Product Code	Product
	MCS 295
	Aroclor 1254-10% Xylene
	Aroclor 1232
81101 (Electrical & Non-Electrical)	Aroclor 1242
81102 (Electrical & Non-Electrical)	Aroclor 1248
81103 (Electrical & Non-Electrical)	Aroclor 1254
81105 (Electrical & Non-Electrical)	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

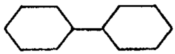
USING DEPTS.
246

SUPPLIER
ANNISTON PLANT

Issued 6/9/61
W.G.Krummrich Plant
By A. O. Martin

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

Property	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	

MONSANTO CHEMICAL COMPANY ORGANIC CHEMICALS DIVISION W. G. Krummrich Plant FINISHED PRODUCT SPECIFICATION	PRODUCT CODE 81059	DEPT. OR JOB 232
	USE Internal	
	SALES CODE	

Issued DEC 23 1963
W. G. Krummrich Plant
By W. D. Dsely

RAW MATERIAL
Date Approved DEC 23 1963
For Dept. 233, 236, 237, 246

PRODUCT (Trade Name) Chlorine (Snift Gas) TYPE

PRODUCT (Chemical Name) TYPE

CHEMICAL FORMULA

Mixture

MOL WT.

SUPERSEDES SPECS OF	SAMPLE FOR ANALYSIS
New	100 c.c. Gas Burette

UNCLASSIFIED INFORMATION

General Tests (made only on request)

Property	Typical Analyses	Method Number
Chlorine (Cl_2)	86% By Volume	- - -
Oxygen (O_2)	3% " "	- - -
Carbon Dioxide (CO_2)	1.5% " "	- - -
Carbon Monoxide (CO)	0.1% " "	- - -
Hydrogen (H_2)	1.0% " "	- - -
Inert Gases (By difference)	8.4% " "	- - -
Moisture (H_2O) @ Std. Conditions	2.4×10^{-5} lbs./ft.^{3} (Average)	

Direct pipeline transfers to using Depts.

233, 236, 237, 246

This specification is for internal use at WGK Plant only.

MONS 054802

IN 84 (REV. 12/58)

MONSANTO CHEMICAL COMPANY ORGANIC CHEMICALS DIVISION W. G. Krummrich Plant RAW MATERIAL SPECIFICATION	MATERIAL CODE 38800 USING DEPTS. 222, 246 SUPPLIER	Issued 6/20/63 W. G. Krummrich Plant By M. D. Dealy

MATERIAL
Lime, Hydrated

CHEMICAL FORMULA

$Ca(OH)_2$

MOL WT.

SUPERSEDES SPECS OF	SAMPLE FOR ANALYSIS
6/5/57	1 x 16 oz. W. M. Bottle

UNCLASSIFIED INFORMATION

General Tests (made only on request)

Property	Specification	Method Number
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

MONS 054803

W. G. Krummrich Plant
MONSANTO CHEMICAL COMPANY
ORGANIC CHEMICALS DIVISION

RAW MATERIAL SPECIFICATION

MATERIAL CODE: 33500
USING DEPTS.: 233
SUPPLIER:

Issued 11/15/62
W. G. Krummrich Plant
By J. A. Glaskus

MATERIAL: Ferric Chloride Anhydride

CHEMICAL FORMULA:

$Fe\ Cl_3$

MOL WT. 162.21

SUPERSEDES SPECS OF: 2/26/57
SAMPLE FOR ANALYSIS: 1 x 8 oz. W. M. Bottle

UNRESTRICTED INFORMATION

General Tests (made only on request)

Property	Specification	J.F.Q. Method No.
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 054804

IN 81 (REV. 12/58)

W. G. Krummrich Plant
MONSANTO CHEMICAL COMPANY
ORGANIC CHEMICALS DIVISION

RAW MATERIAL SPECIFICATION

MATERIAL CODE	19400
USING DEPTS.	246
SUPPLIER	Barada and Page, Inc.
MATERIAL	Attapulgus Earth 200/UP LVM
CHEMICAL FORMULA	Clay
MOL WT.	
SUPERSEDES SPEC OF	5/7/59
SAMPLE FOR ANALYSIS	2 x 16 oz. W. M. Bottles

Issued 11/15/62
W. G. Krummrich Plant
By D.C. Armstrong

UNRESTRICTED INFORMATION

Routine Tests

Property	Specification	Method Number
Volatile Matter (at 950°C)	6 - 8%	- -
Mesh Test:		
Through USS 325	90%, min.	- -

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

MONS 054805

IN 86 (REV. 12/58)

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

PRODUCT CODE: 81115	DEPT. OR JOB: 246	Issued APR 7 1964 W. G. Krummrich Plant By W. D. Dsely
USE: Internal J.F.Q.		
SALES CODE:		
PRODUCT (Trade Name): Aroclor 1232	TYPE: (MCS - 236)	
PRODUCT (Chemical Name): 32% Chlorinated Biphenyl	TYPE:	
CHEMICAL FORMULA:		
MOL WT.:		
SUPERSEDES SPECS 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.

MONSANTO CHEMICAL COMPANY ORGANIC CHEMICALS DIVISION ANNISTON AND KRUMMRICH FINISHED PRODUCT SPECIFICATION	PRODUCT CODE	DEPT. OR JOB 27 - Anniston 246 - WGK	Issued 1/24/62 W.G.Krummrich Plant by E.O. Martin
	USE SALES		
	SALES CODE 1040-130-04/11/16-03/09		

PRODUCT (Trade Name): AROCLOR 1142 — TYPE: CRUDE COMMERCIAL

PRODUCT (Chemical Name): — TYPE:

CHEMICAL FORMULA

MIXTURE

MOL. WT. ---

SUPERSEDES SPECS OF: 3/28/58

SAMPLE FOR ANALYSIS: 1 Qt. Bottle Anniston;2x16 oz. W.M.Bottle WGK

UNRESTRICTED INFORMATION

Routine Tests

Property	Specification	Method Number	
		Anniston	WGK
Appearance and Color	Brown to black oily liquid	- - - -	10,084
Specific Gravity 25°/15.5°C	1.384 - 1.394	14-49-54	10,114
Acid Number (mg. KOH/g.)	0.7, max.	14-46-54	11,532

RESTRICTED INFORMATION

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

MONS 054807

IN 54 (REV. 12/58)

MONSANTO CHEMICAL COMPANY ORGANIC CHEMICALS DIVISION KRUMMRICH and ANNISTON FINISHED PRODUCT SPECIFICATION	PRODUCT CODE 8I101 WGK 82612 ANN.	DEPT. OR JOB 248 WGK 27L ANN.
	USE: Sales	
	SALES CODE: 1040-240-04/11/16-03/09	

Issued 4/13/62
W.G.Krummrich Plant
By C.O. Ma...

PRODUCT (Trade Name) / TYPE: AROCLOR 1242 ELECTRICAL GRADE (PYRANOL 1499)

PRODUCT (Chemical Name) / TYPE:

CHEMICAL FORMULA

Mixture

MOL WT. ---

SUPERSEDES SPECS OF	SAMPLE FOR ANALYSIS
4/17/61	3 x 5 pt. Amber Bottles

UNRESTRICTED INFORMATION

Routine Tests

Property	Specification	Method Number WGK	Method Number ANNISTON
Color (APHA)	50, max.	10,084	14-44-54
Condition	Clear	10,084	G-1
Sp. Gr. @ 25/15.5°C	1.381-1.392	10,114	14-49-54
Acidity (mg. KOH/g.)	0.010, max.	10,087	14-42-54
Moisture (H_2O)	35 ppm., max.	10,620	14-53-54
Refractive Index @ 25°C	1.6240-1.6260	10,125	14-34-54
Inorganic (Free) Chlorides	0.05 ppm., max.	T-2092	014
Pour Point	-14°C or Lower	10,115	14-47-54
Dielectric Constant (1000 cycles @ 100°C)	4.70-4.90	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)	0.4 ppm., max.	11,503	14-61-57
Distillation Range (ASTM D-20, Corrected)		10,117	14-31-54
10% Distilled by wt.	325°C, min.		
90% Distilled by wt.	360°C, max.		

GENERAL TESTS (Made only on request)

Property	Specification	WGK	ANNISTON
Sulfates	None	12,169	---
Dielectric Strength @ 25°C	35 KV, min.	11,605	043
Flash Point (°F)	338-392	10,123	14-28-54
Fire Point	None	10,123	14-28-54
Viscosity @ 100°F (SUS)	82-92	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)

MONS 054808

IN 94 (REV. 12/58)

A.C. Color (APHA)	60, max.	10,084	14-44-54
A.C. Condition	Clear	10,084	G-1
A.C. Acidity (mg. KOH/g.)	0.010, max.	10,087	14-42-54
A.C. Inorganic (Free) Chlorides	0.05 ppm., max.	T-2092	014

GENERAL INFORMATION

Specific Heat @ 25°C	0.30
Coefficient of Expansion (25-65°C)	0.00068 cc/°C
Fixed Chlorine	42.5-43.5%

SPECIAL CUSTOMER REQUIREMENT

General Electric

Hydrolysis Stability Test (As Chlorides)	0.5 ppm., max.	T-2087	010
Thermal Chemical Chlorides	0.75 ppm., max.	12,722	

MONSANTO CHEMICAL COMPANY ORGANIC CHEMICALS DIVISION Krummrich and Anniston FINISHED PRODUCT SPECIFICATION	PRODUCT CODE 81102 - 82641 USE Sales SALES CODE 1040-260-04/11/16-03/09	DEPT. OR JOB WGK 246-Ann.27	Issued JUL 15 1964 W. G. Krummrich Plant By M D Daly

PRODUCT (Trade Name): Aroclor 1248 — TYPE: Non-Electrical Grade

PRODUCT (Chemical Name): — TYPE:

CHEMICAL FORMULA

Mixture

MOL WT.

SUPERSEDES SPECS OF: 5-4-61 — SAMPLE FOR ANALYSIS: 3 x 16 oz. W. M. Bottles

UNRESTRICTED INFORMATION

Routine Tests	Specification	WGK Method No.	Anniston Method No.
Appearance	Colorless to light yellow-green liquid	10084	G-1
Condition	Clear	10084	G-1
Color, APHA	100 max.	10084	046
Sp. Gr. @65/15.5°C	1.405 - 1.415	10114	052
Acidity (mg. KOH/g.)	0.010, max.	10087	050
Moisture (H_2O) (ppm.)	50, max.	10620	047
Viscosity @130°F (SUS)	73 - 80	10086	049
General Tests			
Flash Point (°F)	370, min.	10123	14-28-54

MONS 054810

MONSANTO CHEMICAL COMPANY ORGANIC CHEMICALS DIVISION W.G.K. and Anniston FINISHED PRODUCT SPECIFICATION	PRODUCT CODE 81102	DEPT 246 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. Dsely

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	Method No's. Anniston
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)

MONS 054811

A. C. Color, APHA	60, max.	10,084 14-44-54
A. C. Condition	Clear	10,084 0-1
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 USE Sales SALES CODE 1040-280-04/11/16-03/09	DEPT. OR JOB WGK-246-Ann.27	Issued JUL 15 1964 W. G. ~~Krummrich Plant~~ By M D D[illegible]

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

PRODUCT (Chemical Name): TYPE:

CHEMICAL FORMULA

Mixture

MOL WT.

SUPERSEDES SPECS OF: 5-4-61

SAMPLE FOR ANALYSIS: 3 x 16 oz. W. M. Bottles

UNRESTRICTED INFORMATION

Routine Tests	Specification	WGK Method No.	Anniston Method 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 054813

MONSANTO CHEMICAL COMPANY ORGANIC CHEMICALS DIVISION KRUMMRICH and ANNISTON FINISHED PRODUCT SPECIFICATION	PRODUCT CODE 81105 WGK 82615 ANN.	DEPT. OR AND 246 WGK 27 ANN.
	USE Sales	
	SALES CODE 1040-280-04/11/16-03/09	

Issued 4/13/62
W. G. Krummrich Plant
By E. O. Martin

PRODUCT (Trade Name) TYPE
AROCLOR 1254 ELECTRICAL GRADE (PYRANOL 1476)

PRODUCT (Chemical Name) TYPE

CHEMICAL FORMULA

Mixture

MOL WT. ---

SUPERSEDES SPECS OF	SAMPLE FOR ANALYSIS
10/10/61	3 x 5 pt. Amber Bottles

UNRESTRICTED INFORMATION

Routine Tests

Property	Specification	Method Number WGK	Method Number ANNISTON
Color, APHA	50, max.	10,084	14-44-54
Condition	Clear	10,084	0-1
Sp. Gr. @ 65/15.5°C	1.495-1.505	10,114	14-49-54
Acidity (mg. KOH/gm.)	0.010, max.	10,087	14-42-54
Moisture (H_2O)	35 ppm, max.	10,620	14-53-54
Refractive Index @ 25°C	1.6370-1.6390	10,125	14-34-54
Inorganic (Free) Chlorides	0.05 ppm., max.	T-2092	014
Pour Point	7-12°C	10,115	14-27-54
Dielectric Constant (1000 cycles @ 100°C)	4.15-4.35	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.	366-378°C		
50% Distilled by Wt.	371-383°C		
90% Distilled by Wt.	379-394°C		

GENERAL TESTS (Made only on request)

Property	Specification	WGK	ANNISTON
Sulfates	None	12,169	---
Dielectric Strength @ 25°C	35 KV, min.	11,605	043
Flash Point	None	10,123	14-28-54
Fire Point	None	10,123	14-28-54
Viscosity @ 210°F (SUS)	44-48	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)

A.C. Color, APHA	60, max.	10,084	14-44-54
A.C. Condition	Clear	10,084	G-1
A.C. Acidity (mg. KOH/g.)	0.010, max.	10,087	14-42-54
A.C. Inorganic (Free) Chlorides	0.05 ppm., max.	10,118	010

EXTERNAL SPECIFICATION

Cornell - Dubilier

Resistivity (500 VDC @ 100°C 0.1" GAP as OHM-CM x 10^9)	1500, min.	11,607	14-35-54

GENERAL INFORMATION

Specific Heat @ 25°C	0.27
Coefficient of Expansion (25-65°C)	0.00066 cc/°C
Fixed Chlorine	54.5-55.5%

MONSANTO CHEMICAL COMPANY
ORGANIC CHEMICALS DIVISION
ANNISTON AND KRUMMRICH
FINISHED PRODUCT
SPECIFICATION

PRODUCT CODE: B2614-Ann. B1105-WGK	DEPT. OR JOB: 27-Anniston 246-WGK	
USE: SALES		
SALES CODE: 1040-170-04/11/16-03/09		Issued 1/24/62 W.G.Krummrich Plant By [signature]
PRODUCT (Trade Name): AROCLOR 1160	TYPE: CRUDE COMMERCIAL	
PRODUCT (Chemical Name)	TYPE	
CHEMICAL FORMULA: MIXTURE		
MOL WT. - - -		
SUPERSEDES SPECS OF: 3/28/58	SAMPLE FOR ANALYSIS: 1 pt. can Anniston; 2 x 16 oz. W.M. Bottles WGK	

UNRESTRICTED INFORMATION

Routine Tests

Property	Specification	Method Number Anniston	Method Number WGK
Appearance and Color	Brown to black viscous sticky mass	--------	10,084
Specific Gravity 90°/15.5°C	1.558 - 1.569	14-49-54	10,114
Acid Number (mg. KOH/g.)	0.7, max.	14-46-54	11,532

RESTRICTED INFORMATION

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

MONS 054816

IN 84 (REV. 12/60)

MONSANTO CHEMICAL COMPANY ORGANIC CHEMICALS DIVISION Krummrich and Anniston FINISHED PRODUCT SPECIFICATION	PRODUCT CODE: 81105 - 82614 DEPT. OR JOB: WGK 246 Ann.27 USE: Sales SALES CODE: 1040-290-04/11/16-03/09	Issued JUL 15 1964 W. G. Krummrich Plant By M D Daly

PRODUCT (Trade Name): Aroclor 1260 TYPE: Non-Electric Grade

PRODUCT (Chemical Name): TYPE:

CHEMICAL FORMULA: Mixture

MOL. WT.:

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

UNRESTRICTED INFORMATION

Routine Tests	Specification	WGK Method No.	Anniston Method No.
Condition	Clear	10084	G-1
Color, APHA	150, max.	10084	046
Sp. Gr. @90/15.5°C	1.555 - 1.566	10114	052
Acidity (mg. KOH/g.)	0.014, max.	10087	050
Moisture (H_2O) (ppm.)	50, max.	10620	047
Viscosity @210°F (SUS)	72-78	10086	049
General Tests			
Flash Point	None	10123	14-28-54
Fire Point	None	10123	14-28-54

MONS 054817

MONSANTO CHEMICAL COMPANY ORGANIC CHEMICALS DIVISION Anniston and Krummrich Plants FINISHED PRODUCT SPECIFICATION	PRODUCT CODE 82614 - Ann. 81105 - WGK	DEPT. OR JOB 546 - Ann. 246 - WGK	
	USE Sales		
	SALES CODE 1040-290-04/11/16/-03/09		Issued 2/7/62 W.G.Krummrich Plant By E. O. Martin
PRODUCT (Trade Name) AROCLOR 1260	TYPE ELECTRICAL GRADE		
PRODUCT (Chemical Name)	TYPE (PYRANOL 1482)		
CHEMICAL FORMULA Mixture MOL WT. ---			
SUPERSEDES SPECS OF 3/28/58	SAMPLE FOR ANALYSIS 3 x 5 pt. Amber Bottles		

UNRESTRICTED INFORMATION

Routine Tests

Property	Specification	Method No. WGK	Method No. Anniston
Color (APHA)	150, max.	10,084	14-44-54
Condition	Clear	10,084	--------
Specific Gravity @ 90/15.5°C	1.555-1.566	10,114	14-49-54
Acidity (mg KOH/g.)	0.014, max.	10,087	14-42-54
Moisture (H_2O) (ppm.)	35, max.	10,620	14-53-54
Viscosity @ 210°F (SUS)	72-78	10,086	14- 4-52
Refractive Index @ 25°C	1.6455-1.6470	10,125	14-34-54
Inorganic (Free) Chlorides	No detectable amt.	10,118	14-48-57
Pour Point (°C)	25-34	10,115	14-47-54
Distillation Range (ASTM D-20, Corrected)		10,117	14-31-54
10% Distilled by wt.	385-398°C		
50% Distilled by wt.	390-404°C		
90% Distilled by wt.	400-420°C		
Corrosion Test (6 hrs. @ 210°C with bright aluminum foil)		10,126	14-55-57
Change in weight of Al (%)	0.0		
A.C. Color (APHA)	150, max.	10,084	14-44-54
A.C. Condition	Clear	10,084	--------
A.C. Acidity (mg.KOH/g.)	0.014, max.	10,087	14-42-54
A.C. Inorganic (Free) Chlorides	No detectable amt.	10,118	14-48-57

(Over)

UNRESTRICTED INFORMATION (cont'd)

Property	Specification	Method Number WGK	Method Number Anniston
General Tests (made only on request)			
Flash Point	None	10,123	14-28-54
Fire Point	None	10,123	14-28-54
Fixed Chlorine (%)	59.5-60.5	10,088	14-13-54
Dielectric Strength @ 50°C	30 K.V., min.	11,605	--------
Resistivity (500 VDC @ 100°C, 0.1" gap as ohm-cm. x 10^9)	500, min.	11,607	14-35-57
Dielectric Constant 1000 cycles, 100°C	3.6-3.8	11,608	14-36-45
RESTRICTED INFORMATION			
Monsanto Stability Test (As Chlorides in ppm.)	0.7, max.	11,503	14-61-57
GENERAL INFORMATION			
Evaporation Loss after 6 hrs. @ 100°C (%)	0.2, max.	10,116	14-32-54
Stability test - after 30 days at 100°C in glass sealed in air	No liberation of chlorine or chlorides	------	--------

MONSANTO CHEMICAL COMPANY
ORGANIC CHEMICALS DIVISION
ANNISTON AND KRUMMRICH FINISHED PRODUCT SPECIFICATION

PRODUCT CODE: 82615-Ann. 81107-WGK
DEPT. OR JOB: 27-Anniston 246-WGK
USE: SALES
SALES CODE: 1040-170-04/11/16-03/09

Issued 1/24/62
W.G.Krummrich Plant
by E.O. Martin

PRODUCT (Trade Name): AROCLOR 1162
TYPE: CRUDE COMMERCIAL
PRODUCT (Chemical Name):
TYPE:

CHEMICAL FORMULA

MIXTURE

MOL WT. - - -

SUPERSEDES SPECS OF: 3/28/58
SAMPLE FOR ANALYSIS: 1 pt. can, Anniston; 2 x 16 oz. W.M. Bottles WGK

UNRESTRICTED INFORMATION

Routine Tests

Property	Specification	Method Number Anniston	Method Number WGK
Appearance	Viscous liquid	- - - -	10,084
Color	Brown to black	- - - -	10,084
Specific Gravity @90/15.5°C	1.577 - 1.587	14-49-54	10,114
Acid No. (mg. KOH/g.)	0.7, max.	14-46-54	11,532

RESTRICTED INFORMATION

Acid No. of the crude which is stored in non-lacquered containers shall be 0.2 mg. KOH/g., max.

MONS 054820

MONSANTO CHEMICAL COMPANY ORGANIC CHEMICALS DIVISION ANNISTON AND KRUMMRICH FINISHED PRODUCT SPECIFICATION	PRODUCT CODE 82615-Ann 81107-WGK	DEPT. OR JOB 27-Ann 246-WGK	Issued 1/24/62 W.G.Krummrich Plant by E.O. Martin
	USE SALES		
	SALES CODE 1040-300-04/11/16-03-09		
PRODUCT (Trade Name) AROCLOR DISTILLED	TYPE 1262		
PRODUCT (Chemical Name)	TYPE		
CHEMICAL FORMULA MIXTURE MOL WT. ---			
SUPERSEDES SPECS OF 3/28/58	SAMPLE FOR ANALYSIS 2 x 16 oz. W. M. Bottles		

UNRESTRICTED INFORMATION

Routine Tests

Property	Specification	Method Number
Appearance	Viscous liquid	10,084
Color	APHA 150, max.	10,084
Specific Gravity @ 90/15.5°C	1.572 - 1.583	10,114
Acid No. (mg. KOH/g.)	0.014, max.	10,087
Viscosity @ 210°F	86 - 100 SUS	10,086

GENERAL INFORMATION

Pour Point (ASTM)	35 - 38°C
Distilling Range	390 - 425°C
Total Chlorine	61.5 - 62.5%
Specific Gravity t coeff (85 - 130°C)	0.001/°C

MONS 054821

IN 84 (REV. 12/58)

MONSANTO CHEMICAL COMPANY ORGANIC CHEMICALS DIVISION Krummrich and Anniston FINISHED PRODUCT SPECIFICATION	PRODUCT CODE 82868	DEPT. OR JOB WOK 246 Ann. 27	Issued JUL 15 1964 W. G. Krummrich Plant By MDDsaly
	USE Sales		
	SALES CODE *See Below		

PRODUCT (Trade Name) Montars 1 and 2	TYPE
PRODUCT (Chemical Name) Polychlorinated Polyphenyls	TYPE
CHEMICAL FORMULA Mixture	
MOL. WT.	
SUPERSEDED SPECS OF 6-15-61	SAMPLE FOR ANALYSIS 2 x 16 oz. W. M. Bottles

UNRESTRICTED INFORMATION

Routine Tests	Specification	Anniston Method No.	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 Basic
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 054822

IN 84 (REV. 12/59)

MONSANTO CHEMICAL COMPANY ORGANIC CHEMICALS DIVISION Krummrich and Anniston FINISHED PRODUCT SPECIFICATION	PRODUCT CODE 82868	DEPT. OR JOB WGK 246 Ann.27	Issued JUL 15 1964 W. G. Krummrich Plant By M D Deal
	USE Sales		
	SALES CODE *See Below		

PRODUCT (Trade Name): Montars 3 and 4 — TYPE:

PRODUCT (Chemical Name): Polychlorinated Polyphenyls — TYPE:

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 Method No.
Appearance	Black Solid	14-17-52	11321

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 Basic
Chlorine Content	50-52%	54-56%
CaO	5-10%	5-10%
Fe	0.3-0.6%	0.5-1.0%

RESTRICTED INFORMATION

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

*Sales Code Nos.

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

MONS 054823

IN 84 (REV. 12/60)

AROCLOR

APPENDIX C

PHYSICAL AND CHEMICAL DATA

AROCLOR

APPENDIX C

PHYSICAL CONSTANTS

GENERAL PHYSICAL PROPERTIES OF AROCLORS

		Aroclor 1242	Aroclor 1248	Aroclor 1254	Aroclor 1260	Aroclor 1262
Form..........................		Practically colorless mobile oil	Yellow tinted mobile oil	Light yellow viscous oil	Light yellow soft sticky resin	Light yellow sticky clear resin
Color..........................		100 Max. (APHA)	100 Max. (APHA)	150 Max. (APHA)	150 Max. (APHA)	150 Max. (APHA)
Acidity-Maximum (Mgm. KOH per Gm.)		0.015	0.015%	0.015	0.015	0.02
Average Coefficient of Expansion................	cc/cc°C.	0.00068 (25°-64°C)	0.00070 (25°-65°C)	0.00066 (25°-65°C)	0.00067 (20°-100°C)	0.00064 (25°-65°C)
Typical Density						
Specific Gravity 25°/25°C (77°/77°F)		1.380	1.445	1.538	1.620	1.646
Pounds per Gal. -25°C (77°F)		11.50	12.04	12.82	13.50	13.72
Distillation Range-ASTM D-20(Mod)						
°C		325°-360°	340°-375°	365°-390°	385°-420°	400°-430°
Evaporation Loss-%-ASTM D-6Mod.						
163°C	5 hrs.	3.0 to 3.6	3.0 to 4.0	1.1 to 1.3	0.5 to 0.8	0.5 to 0.6
100°C..................	6 hrs.	0.0 to 0.4	0.0 to 0.3	0.0 to 0.2	0.0 to 0.1	0.0 to 0.1
Flash Point-Cleveland Open Cup..	°C	176°-180°	193°-196°	None	None	None
	°F	348°-356°	379°-384°			
Fire Point-Cleve. Open Cup....	°C	None*	None	None	None	None
	°F					
Four Point-ASTM D-97	°C	-19°	-7°	10°	31°	37°
	°F	2°	19.4°	50°	88°	99°
Softening Point-ASTM E-28	°C	--	--	--	--	--
	°F	--	--	--	--	--

AROCLOR

APPENDIX C

PHYSICAL CONSTANTS (Cont'd.)

GENERAL PHYSICAL PROPERTIES OR AROCLORS (Cont'd.)

		Aroclor 1242	Aroclor 1248	Aroclor 1254	Aroclor 1260	Aroclor 1262
Form		Practically colorless mobile oil	Yellow tinted mobile oil	Light yellow viscous oil	Light yellow soft sticky resin	Light yellow sticky clear resin
Fefractive Index-D-line 20°C		1.627-1.629	1.630-1631	1.639-1.641	1.647-1.649	1.6501-1.6517
Viscosity-Saybolt Universal Sec. (ASTM)-D-88)	210°F (98.9°C)	34-35	36-37	44-48	72-78	90-103
	130°F (54.4°C)	49-56	69-78	260-340	3200-4500	600-103 (160°F or 71°C)
	100°F (37.8°C)	80-93	185-240	1800-2500	---	----

AROCLOR

APPENDIX C

PHYSICAL CONSTANTS (cont'd.)

PHYSICAL AND CHEMICAL DATA

Diphenyl

Specific Gravity: 0.992 at 75°C/4°C.

The Swann Chemical Company bulletin of 1930 gave thermal data on diphenyl.

Viscosity of Diphenyl (from Anniston Files)

°F.	Centipoises
160	1.439
170	1.309
180	1.208
190	1.114
200	1.034
220	0.901
250	0.752
300	0.574
350	0.459
400	0.374
450	0.313
482	0.283

Specific Heat (from Anniston Files)

°F.	B.T.U./lb.
200	0.416
300	0.470
400	0.547
500	0.616
600	0.658
700	0.679
800	0.686
900	0.690
1000	0.696

AROCLOR

APPENDIX C

PHYSICAL AND CHEMICAL DATA (cont'd.)

Diphenyl (cont'd.)

Another record gives the following values for liquid diphenyl:

$^{o}C.$	Sp. Heat cals./gram
100	0.360
150	0.380
200	0.412
250	0.460
300	0.518
350	0.575
400	0.610
450	0.625

Vapour Cp = $\frac{0.460}{250^{o}C.}$

$\frac{0.625}{450^{o}C.}$ (D. A. Roper, Design Data for Units 4 & 5)

Density of Liquid Diphenyl (from Anniston files)

$^{o}C.$	Grams./cc
75	0.9885
100	0.9695
150	0.9294
200	0.8885
250	0.8470
300	0.8010
350	0.7510
400	0.6918
450	0.6180

Heat of Vaporization:

65.4 g. cal./g. at 258.5^{o}C.

AROCLOR

APPENDIX C

PHYSICAL AND CHEMICAL DATA (Cont'd.)

Specific Gravity of Aroclors
at Various Temperatures

For	Temp. °C.	Sp. Gr.	Lbs. per Gallon (US)
1242	60	1.347	11.23
	65	1.344	11.20
	70	1.338	11.16
	75	1.335	11.13
	80	1.332	11.10
	85	1.329	11.07
	90	1.324	11.03
	95	1.319	11.00
	100	1.315	10.96
1248	60	1.413	11.78
	65	1.410	11.75
	70	1.403	11.71
	75	1.400	11.68
	80	1.397	11.65
	85	1.394	11.62
	90	1.390	11.58
	95	1.385	11.55
	100	1.381	11.51
1254 or OE 1476	60	1.505	12.55
	65	1.500	12.50
	70	1.495	12.46
	75	1.490	12.42
	80	1.485	12.38
	85	1.480	12.34
	90	1.475	12.30
	95	1.470	12.26
	100	1.465	12.21
1260 or OE 1482	60	1.584	13.21
	65	1.580	13.17
	70	1.575	13.13
	75	1.570	13.09
	80	1.565	13.05
	85	1.560	13.01
	90	1.555	12.96
	95	1.550	12.92
	100	1.545	12.88

AROCLOR

APPENDIX C

PHYSICAL AND CHEMICAL DATA (Cont'd.)

Specific Gravity of Aroclors
at Various Temperatures (Cont'd)

For	Temp. °C.	Sp. Gr.	Lbs. per Gallon (US)
1262	60	1.604	13.40
	65	1.600	13.36
	70	1.597	13.32
	75	1.593	13.28
	80	1.588	13.24
	85	1.582	13.19
	90	1.577	13.15
	95	1.572	13.11
	100	1.568	13.07

Heat Capacity of Aroclors at Various Temperatures (Cal/gm°C.)

Temperature °C. / Aroclor	0	50	100	125	150	175	200	250	300
1242	.280	.300	.320	.330	.335	.340	.350	.365	.380
1248	.270	.280	.295	.305	.315	.320	.330	.340	.355
1254	.255	.265	.275	.285	.295	.300	.310	.325	.340
1260	.220	.235	.250	.260	.265	.270	.280	.290	.305

Latent Heat of Vaporization of Aroclors

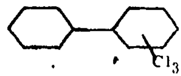
Aroclor	Temp. Range	Latent Heat of Vaporization
1242	300°-310°C.	61 Cal/gm
1248	300°-330°C.	54 Cal/gm
1254	300°-350°C.	50 Cal/gm
1260	300°-370°C.	48 Cal/gm

Sys 479
V 580

PHYSICAL CONSTANTS DATA

SUBSTANCE: AROCLOR 1142 (Technical)

STRUCTURAL FORMULA



COMPILED BY: Rev. By A. M. Ellenburg

DATE: 1947 7/5/57

NAME		SOURCE & DATE
Formula $C_{12}H_7Cl_3$	Total Cl_2 41.5 - 42.5%	Specs 12-21-54
Molecular Weight		
Appearance	Brown to black oily liquid	Specs 12-21-54
Boiling Point at 760 mm		
Boiling Point at mm		
Boiling Point at mm		
Boiling Point at mm		
Crystallizing Point		
Melting Point		
Solution Point		
Specific Gravity @ 65/15.5°C	1.348-1.360	Specs 12-21-54
Specific Gravity @ 25/15.5°C	1.384-1.397	
Pounds per Gal. @ 25 °C	10.5	
Coefficient of Expansion		
Refractive Index @ n_D		
Infra Red Spectrum *(Reference)*		
Ultra Violet Spectrum *(Reference)*		
Viscosity @		
Viscosity @		
Surface Tension		
Solubility in Water		
Solubility in		
Solubility in		
Sp. Gr. Temp. Coeff. (50-105°C)	0.0009/°C	Specs 12-21-54
Flash Point °F *(Method)* C. O. C.	350	Aroclor Bull. OP-115 1954
Fire Point °C	None	
Heat of Combustion		
Heat of Formation		
Thermal Stability (cal./kg/min.)		
Latent Heat of Fusion		
Latent Heat of Vap.		
Specific Heat		
Critical Temperature		
Critical Pressure		
Dissociation Constant		
Other Constants		
Toxicity *(Give Reference)*	Schwartz, U.S. Pub. Health Service Bull. #229 1936 "Industrial Poisons, Hazards and Solvents" by M. B. Jacobs Vol. 1, p. 463-464 1941.	

MONS 054831

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

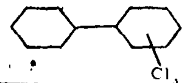
Dep 246

Syst 479
V 580

PHYSICAL CONSTANTS DATA

SUBSTANCE
AROCLOR 1148 (Technical)

STRUCTURAL FORMULA



COMPILED BY
Rev. by A. M. Ellenburg

DATE 1947
7/5/57

NAME		SOURCE & DATE
Formula $C_{12}H_6Cl_4$	Total Cl_2 47.5 - 48.5 %	Specs. 4/11/55
Molecular Weight		
Appearance	[illegible]	Specs. [illegible]
Boiling Point at 760 mm		
Boiling Point at mm		
Boiling Point at mm		
Boiling Point at mm		
Crystallizing Point		
Melting Point		
Solution Point		
Specific Gravity @ 65/15.5	1.410-1.420	Specs. 4/11/55
Specific Gravity @		
Pounds per Gal. @ 25 °C	12.0	
Coefficient of Expansion		
Refractive Index @ n_D		
Infra Red Spectrum (Reference)		
Ultra Violet Spectrum (Reference)		
Viscosity @		
Viscosity @		
Surface Tension		
Solubility in Water		
Solubility in		
Solubility in		
Sp. Gr. Temp. Coeff. (50-100°C)	0.00097°C	Specs. 4/11/55
Flash Point °F (Method) C.O.C.	382	Aroclor Bulletin OP-115
Fire Point °C	None	" (1954)
Heat of Combustion		
Heat of Formation		
Thermal Stability (cal./kg/min.)		
Latent Heat of Fusion		
Latent Heat of Vap.		
Specific Heat		
Critical Temperature		
Critical Pressure		
Dissociation Constant		
Other Constants		
Toxicity (Give Reference)	Schwartz, U.S. Pub. Health Service Bull. 229, 1936. "Industrial Poisons Hazards & Solvents by M. B. Jacobs Vo. I, p. 463-434 1941	

MONS 054832

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

DEPT 246

IN 919

Syst 977

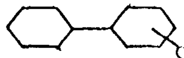
V,580

PHYSICAL CONSTANTS DATA

SUBSTANCE

AROCLOR 1160 (Technical)

STRUCTURAL FORMULA



Cl 6.25

COMPILED BY

Rev. By A. M. ..llenburg

DATE 1947
7/5/57

NAME		SOURCE & DATE
Formula $C_{12}H_{3.75}Cl_{6.25}$	Total Cl_2 59.5-60.5%	Specs. 12-21-54
Molecular Weight		
Appearance	Brown to black sticky mass	Specs 12-21-54
Boiling Point at 760 mm		
Boiling Point at mm		
Boiling Point at mm		
Boiling Point at mm		
Crystallizing Point		
Melting Point		
Solution Point		
Specific Gravity @ 90/15.5	1.558-1.572	Specs. 12-21-54
Specific Gravity @		
Pounds per Gal. @ 25 °C	13.5	
Coefficient of Expansion		
Refractive Index @ n_D		
Infra Red Spectrum *(Reference)*		
Ultra Violet Spectrum *(Reference)*		
Viscosity @		
Viscosity @		
Surface Tension		
Solubility in Water		
Solubility in		
Solubility in		
Sp. Gr. Temp. Coeff. (75-130°C)	0.0010/°C	Specs 12-21-54
Flash Point °F *(Method)*	None	
Fire Point °C	None	
Heat of Combustion		
Heat of Formation		
Thermal Stability (cal./kg/min.)		
Latent Heat of Fusion		
Latent Heat of Vap.		
Specific Heat		
Critical Temperature		
Critical Pressure		
Dissociation Constant		
Other Constants		
Toxicity *(Give Reference)*	Schwartz, U. S. Pub. Health Service Bull. #229, 1936. "Industrial Poisons, Hazards and Solvents" by M. B. Jacobs Vol. I, p463-464 1941	

MONS 054833

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

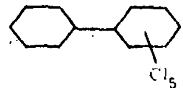
Dept 246
Min 610

Syst 479
I, 580

PHYSICAL CONSTANTS DATA

SUBSTANCE: AROCLOR 1154 (Technical)

STRUCTURAL FORMULA:



COMPILED BY: R. ... A. M. Ellenburg

DATE: 1947 7/5/57

NAME		SOURCE & DATE
Formula $C_{12}H_5Cl_5$	Total Cl_2 53.5 - 54.5%	Specs. 12-21-54
Molecular Weight		
Appearance	Brown to black oily liquid	Specs. 12-21-54
Boiling Point at 760 mm		
Boiling Point at mm		
Boiling Point at mm		
Boiling Point at mm		
Crystallizing Point		
Melting Point		
Solution Point		
Specific Gravity @ 65/15.5	1.500 - 1.510	" "
Specific Gravity @		
Pounds per Gal. @ 25 °C	12.8	
Coefficient of Expansion		
Refractive Index @ n D		
Infra Red Spectrum (Reference)		
Ultra Violet Spectrum (Reference)		
Viscosity @		
Viscosity @		
Surface Tension		
Solubility in Water		
Solubility in		
Solubility in		
Sp. Gr. Temp. Coeff. (55-105°C)	0.000957/°C	" "
Flash Point °F (Method)	None	
Fire Point °C	None	
Heat of Combustion		
Heat of Formation		
Thermal Stability (cal./kg/min.)		
Latent Heat of Fusion		
Latent Heat of Vap.		
Specific Heat		
Critical Temperature		
Critical Pressure		
Dissociation Constant		
Other Constants		
Toxicity (Give Reference)	Schwartz, U.S. Pub. Health Service, Bull. #229, 1936 "Industrial Poisons, Vol. 1, -463-364 1941 Hazards and Solvents by M. B. Jacobs	

MONS 054834

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

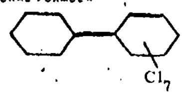
DEPT. 246

Sy 57979
I, 580

PHYSICAL CONSTANTS DATA

SUBSTANCE: AROCLOR 1162 (Technical)

STRUCTURAL FORMULA



COMPILED BY: Rev. By A. M. Ellenburg

DATE: 1947, 7/5/47

NAME		SOURCE & DATE
Formula $C_{12}H_3Cl_7$	Total Cl_2 61.5 - 62.5%	Specs. 4-11-55
Molecular Weight		
Appearance	Brown to black sticky mass	Spec 4-11-55
Boiling Point at 760 mm		
Boiling Point at mm		
Boiling Point at mm		
Boiling Point at mm		
Crystallizing Point		
Melting Point		
Solution Point		
Specific Gravity @ 90/15.5	1.577 - 1.587	Spec 4-11-55
Specific Gravity @		
Pounds per Gal. @ 25 °C	13.7	
Coefficient of Expansion		
Refractive Index @ n_D		
Infra Red Spectrum (Reference)		
Ultra Violet Spectrum (Reference)		
Viscosity @		
Viscosity @		
Surface Tension		
Solubility in Water		
Solubility in		
Solubility in		
Sp. Gr. TempCoeff. (85-120°C)	0.0010/°C	Spec 4-11-55
Flash Point °F (Method)	None	
Fire Point °C	None	
Heat of Combustion		
Heat of Formation		
Thermal Stability (cal./kg/min.)		
Latent Heat of Fusion		
Latent Heat of Vap.		
Specific Heat		
Critical Temperature		
Critical Pressure		
Dissociation Constant		
Other Constants		
Toxicity (Give Reference)	Schwartz, U.S. Pub. Health Service Bull #229, 1936; "Industrial Poisons Hazards and Solvents" by M. B. Jacobs Vol. 1, p-463-464, 1941	

MONS 054835

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

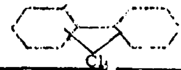
Sys 479
X, 580

Dept 246

PHYSICAL CONSTANTS DATA

SUBSTANCE: AROCLOR 1242

STRUCTURAL FORMULA



COMPILED BY: A. M. E[illegible]burg

DATE: 4-25-57

NAME		SOURCE & DATE
Formula	C12 H? Cl?	
Molecular Weight	257 (avg.)	
Appearance	Colorless Mobile Oil	M[illegible] Bull. OP-1[illegible], 95
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 25/25 C.	1.380	
Specific Gravity 25/15.5 C.	1.381 - 1.392	Specification 2-14-55
Pounds per Gal. 25 °C	11.50	M. B. OP-115
Coefficient of Expansion 25-65 C.	0.00068 cc/cc/°C.	
Refractive Index 25 C. n D	1.6245 - 1.6265	Specification 2-14-55
Infra Red Spectrum (Reference)		
Ultra Violet Spectrum (Reference)		
Viscosity 210 F.	34-35 SUS	M. B. OP-115
Viscosity 100 F.	82-92 SUS	"
Surface Tension Dynes/cm @ 20 °C.	45.3	[illegible] 1952
Solubility in Water	Insoluble	M. B. OP-115
Solubility in 3A Alcohol @ 29 °C.	23.3 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.	0.29?	M. B. OP-115
Critical Temperature		
Critical Pressure		
Dissociation Constant		
Specific Heat @ 300 °C.	0.380	"
Other Constants: Pour Point	-14 °C. or lower	"
Thermal Conductivity, cal/cm/°C/sec.	24.0 @ 28 C.	To be published
Dielectric Constant 100 °C. 60 cy.	4.? - 4.9	M. B. OP-115
Toxicity (Give Reference)	Contact Medical Dept.	M. B. OP-115

MONS 054836

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

Dept 246

Dept 246

Syst 479
X590

PHYSICAL CONSTANTS DATA

SUBSTANCE
AROCLOR 1248

STRUCTURAL FORMULA


Cl_4

COMPILED BY
A. M. Ellenburg

DATE
4-25-57

NAME		SOURCE & DATE
Formula	C12 H6 Cl4	
Molecular Weight	292 (Avg.)	
Appearance	Yellow Tinted Mob. Oil	Monsanto Bull. OP-115(1956
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 °K (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	"
Thermal Conductivity, cal/cm/°C/sec.	23.6 @ 28°C.	To be published
Dielectric Constant, 100°C., 60 cy.	4.5-4.7	M.B. OP-115
		MONS 054837
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.*

DEPT 296

SYST 479
X 580

PHYSICAL CONSTANTS DATA

SUBSTANCE: AROCLOR 1254

COMPILED BY: A. M. Ellerburg

DATE: 4-25-47

STRUCTURAL FORMULA

NAME		SOURCE & DATE
Formula	$C_{12}H_5Cl_5$	
Molecular Weight	326 (Avg.)	
Appearance	Pale Yellow viscous oil	Monsanto Bul. OP 115 1956
Boiling Point at 760 mm Range	365-400°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 2.14.52
Pounds per Gal. 25°C	12.82	MB OP 115
Coefficient of Expansion 25-65°C	0.00066 cc/cc/°C	
Refractive Index 20°C n_D	1.6370-1.6390	Specifications 2.14.52
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 3A Alcohol @ 25°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	"
Thermal Conductivity, Cal/cm/°C/Sec.	22.9 @ 28°C	To be published
Dielectric Constant, 100°C, 60 cy.	4.15-4.35	MB OP-115
Toxicity (Give Reference)	Contact Medical Dept.	MB OP 115

MONS 054838

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

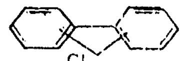
Dept 296

Syst 479

PHYSICAL CONSTANTS DATA

SUBSTANCE: AROCLOR 1260

STRUCTURAL FORMULA:



COMPILED BY: A. M. Ellenburg [illegible]

DATE: 4-15/5[illegible]

NAME			SOURCE & DATE
Formula		$C_{12}H_{3\text{-}5}Cl_{[illegible]}$	
Molecular Weight		361 (Avg.)	
Appearance		Lt. Yell. soft sticky resin	Monsanto Bul. OP-115 [illegible]
Boiling Point at 760 mm	Range	385-420°C	"
Boiling Point at 5 mm	"	[illegible]-245°C	"
Boiling Point at mm			
Boiling Point at mm			
Crystallizing Point		Non-Crystallizing	"
Melting Point			
Solution Point			
Specific Gravity	25/15.5°C	1.[illegible]20	
Specific Gravity	60/15.5°C	1.5[illegible]-1.5[illegible]	Specification [illegible]
Pounds per Gal.	25°C	1[illegible].[illegible]0	MB OP-115
Coefficient of Expansion	20-100°C	0.000[illegible] cc/cc/°C	
Refractive Index	[illegible]°C n_D	1.[illegible]-1.[illegible]40[illegible]	Specification [illegible]
Infra Red Spectrum (Reference)			
Ultra Violet Spectrum (Reference)			
Viscosity	210°F	72-[illegible] 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 Stability (cal./kg./min.)			
Latent Heat of Fusion			
Latent Heat of Vap.	cal/gm	4[illegible]	Calculated
Specific Heat	@ 25°C	0.2[illegible]	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 054839

Toxicity (Give Reference)	Contact Medical Dept.	MB OP-115

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

Dc n 246
Din 816

Sy ST979
V 580

PHYSICAL CONSTANTS DATA

SUBSTANCE: AROCLOR 1260 - 10% Toluol Mix

STRUCTURAL FORMULA: Mixture by Weight
90% - Aroclor 1260
10% - Toluol

COMPILED BY: A. M. Ellenburg

DATE: 7/3/57

NAME		SOURCE & DATE
Formula		
Molecular Weight		
Appearance	Syrupy liquid	Specs. 4/11/55
Boiling Point at 760 mm		
Boiling Point at mm		
Boiling Point at mm		
Boiling Point at mm		
Crystallizing Point		
Melting Point		
Solution Point		
Specific Gravity @ 40/15.5°C	1.475-1.495	"
Specific Gravity @		"
Pounds per Gal. @ 25 °C	12.5	
Coefficient of Expansion		
Refractive Index @ n_D		
Infra Red Spectrum (Reference)		
Ultra Violet Spectrum (Reference)		
Viscosity @ 100°F	50.2 cs. (232 SUS)	WGK Lab 3/8/56
Viscosity @ 210°F	3.5 cs. (38 SUS)	"
Surface Tension		
Solubility in Water		
Solubility in		
Solubility in		
Flash Point °F (Method) Tag open cup	105	WGK Lab 12/5/46
Fire Point °F " " "	110	"
Heat of Combustion		
Heat of Formation		
Thermal Stability (cal./kg/min.)		
Latent Heat of Fusion		
Latent Heat of Vap.		
Specific Heat		
Critical Temperature		
Critical Pressure		
Dissociation Constant		
Other Constants		
Toxicity (Give Reference)		

MONS 054840

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

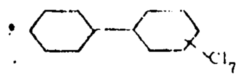
DEPT 246
[illegible]

SYST 479
V, 580

PHYSICAL CONSTANTS DATA

SUBSTANCE
AROCLOR 1262

STRUCTURAL FORMULA



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
Boiling Point at 760 mm	390-425°C	" (1956)
Boiling Point at mm		
Boiling Point at mm		
Boiling Point at mm		
Crystallizing Point		
Melting Point		
Solution Point		
Specific Gravity at 90/15.5°C	1.577-1.587	Specs. 4/11/55
Specific Gravity at 25/25°C	1.646	MB OP-115
Pounds per Gal. at 25 °C	13.72	"
Coefficient of Expansion 25-65°C	0.00064 cc/cc/°C	"
Refractive Index at 25°C n_D	1.648-1.650	"
Infra Red Spectrum *(Reference)*		
Ultra Violet Spectrum *(Reference)*		
Viscosity at 210°F	86-100 SUS	Specs. 4/11/55
Viscosity at		
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./kg/min.)		
Latent Heat of Fusion		
Latent Heat of Vap.		
Specific Heat		
Critical Temperature		
Critical Pressure		
Dissociation Constant		
Pour Point	35-38°C	
Other Constants		
Toxicity *(Give Reference)*	Contact Med. Dept.	MB OP-115

MONS 054841

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

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.

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		0.9	[illegible]
	Totals	135.75	119.8	26,860

AROCLOR

APPENDIX D UTILITIES (Cont'd.)

1. Power Consumption (Cont'd.)

B. Electricity - 110 V., one 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

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 Produt Tank	200	300	150
	Totals	2700	3600	1950

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
Standard Operator	4	3
Repairman	1	1
Packer	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 standard operator job that is covered by overtime. The premium operator and standard operator cover three shifts each day. The repairman works the day shift, and with the swingman, there is 7 days per week repairman coverage. Packers 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.

Standard 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 inspections and department minor repair work.

Dept. 246 - Process Description

AROCLOR

APPENDIX E PERSONNEL (Cont'd.)

Packer: Fills, stencils and labels 5 gallon, 30 and 55 gallon drums and clean-up assignments when not drumming.

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 and day shift on weekends including arranging for maintenance, night sheets and line-up of work.

Dept. 246 - Process Description

AROCLOR

APPENDIX F

PACKAGING & SHIPPING

Aroclor, Pyranol & Pydraul are 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 lined tank cars either 4,000 or 8,000 gallons in capacity. The lining is either tin, zinc or aluminum spray because iron 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	60	-	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#	-	-

MONS 054849

Dept. 246 - Process Description

AROCLOR

APPENDIX F

PACKAGING & SHIPPING (Cont'd.)

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

MONS 054850

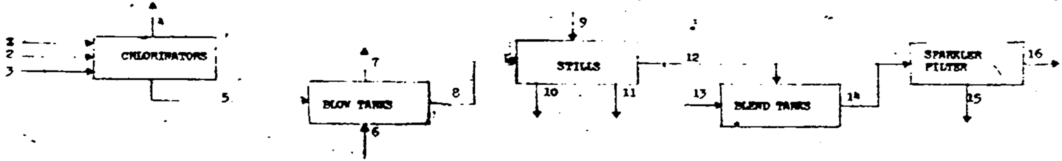
AROCLOR

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.

AROCLOR MATERIAL BALANCE

LBS. MATERIAL PER 100 LBS. AROCLOR



AROCLOR 1242

Raw Material \ Process Stream	M.W.	1 Biphenyl	2 Chlorine	3 Ferric Chloride	4 Off-Gas HCl	5 Crude Aroclor	6 Air	7 Air-HCl Mixture	8 Aerated Aroclor	9 Lime	10 Still Bottoms	11 Vacuum Jet	12 Distilled Aroclor	13 Attapulgus Earth	14 Blended Aroclor	15 Filter Cake	16 Finished Product	Total Usage
Biphenyl	154	65			.50	6[illegible]			625		35		59		59	1	58	65
Chlorine	71		918		4[illegible]5	4[illegible]5		.95	[illegible]		28	.05	435		[illegible]	.15	42	918
Ferric Chloride	162			.05		.05			.05		.05							.05
Attapulgus Earth	68													.15	.15	.15		.15
Air	29						3	3										3
Lime	74									.50	.50							[illegible]
Totals		65	918	.05	45	[illegible]	3	395	1088	.50	685	.05	[illegible]	.15	[illegible]	[illegible]65	100	[illegible]

AROCLOR 1248

Raw Material \ Process Stream	1 Biphenyl	2 Chlorine	3 Ferric Chloride	4 Off-Gas HCl	5 Crude Aroclor	6 Air	7 Air-HCl Mixture	8 Aerated Aroclor	9 Lime	10 Still Bottoms	11 Vacuum Jet	12 Distilled Aroclor	13 Attapulgus Earth	14 Blended Aroclor	15 Filter Cake	16 Finished Product	Total Usage
Biphenyl	565			.50	56			56		5		55		55	1	52	565
Chlorine		1032		50[illegible]5	5[illegible]		.95	521		255	.05	435		495	1.5	48	1032
Ferric Chloride			.05		.05			.05		.05							.05
Attapulgus Earth													.15	.15	.15		.15
Air						3	3										3
Lime									.5	.5							.5
Totals	566	[illegible]	.05	[illegible]55	1098	3	395	[illegible]	.5	[illegible]	.05	[illegible]2.5	.25	[illegible]	265	100	[illegible]

AROCLOR 1254

Raw Material \ Process Stream	M.W.	1 Biphenyl	2 Chlorine	3 Ferric Chloride	4 Off-Gas HCl	5 Crude Aroclor	6 Air	7 Air-HCl Mixture	8 Aerated Aroclor	9 Lime	10 Still Bottoms	11 Vacuum Jet	12 Distilled Aroclor	13 Attapulgus Earth	14 Blended Aroclor	15 Filter Cake	16 Finished Product	Total Usage
Biphenyl	154	498			.50	495			495		28		465		46.5	.5	46	498
Chlorine	71		1175		547	628		.95	6185		62	.05	55		55	1[illegible]	54	1175
Ferric Chloride	162			.03		.05			.05		.03							.03
Attapulgus Earth	68													.15	.15	.15		.15
Air	29						3	3										3
Lime	74									.5	.5							.5
Totals		498	1175	.05	552	1121	3	395	1118	.5	1015	.05	[illegible]	.15	[illegible]	[illegible]	100	1198

AROCLOR 1260

Raw Material \ Process Stream	1 Biphenyl	2 Chlorine	3 Ferric Chloride	4 Off-Gas HCl	5 Crude Aroclor	6 Air	7 Air-HCl Mixture	8 Aerated Aroclor	9 Lime	10 Still Bottoms	11 Vacuum Jet	12 Distilled Aroclor	13 Attapulgus Earth	14 Blended Aroclor	15 Filter Cake	16 Finished Product	Total Usage
Biphenyl	43[illegible]			.50	429			429		20		409		409	.9	40	43[illegible]
Chlorine		1288		625	663		.95	6535		38	.05	605		605	.5	60	1288
Ferric Chloride			.03		.03			.03		.03							.03
Attapulgus Earth													.15	.15	.15		.15
Air						3	3										3
Lime									.5	.5							.5
Totals	43[illegible]	1288	.03	63	1095	3	395	[illegible]	.5		.05	102[illegible]	.15	[illegible]	155	100	[illegible]

LGC 5-1-64

AROCLOR

APPENDIX G

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

Raw Material & Cost ($/lb.)	Usages - Lbs./100 lbs. product Theory	Material Balance	Material Balance Usages lbs/100 lbs.
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 Bottoms .95 Air-HCl Mixture 50.15 Off-Gas HCl 103.20

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

AROCLOR

APPENDIX O 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

Raw Material & Cost ($/lb.)	Usages - Lbs./100 lbs. product Theory	Material Balance	Material Balance Usages Lbs./100 lbs.	
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	

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 28.6Mlbs
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*
Discharge to Waste Disposal		
1. Montar	0.0176*	5,000*
2. Aroclor	0.33*	95,000*

*Estimated.

MONS 054855

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	.05PPM Max.	T-2092
		*Dielectric Constant	.20	11,608
		*Resistivity (500 VDC at 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.

AROCLOR

APPENDIX J SAFETY & 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 folliwing 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.

AROCLOR

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

Safety Precautions (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 made to 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 & Diphenyl.

Safety Record

The last lost-time injury in Dept. 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 explose at high temperatures when exposed to flames.

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 2 mg/cubic meter of air. If ingested, the lethal dose is 2.4 g/Kg of body weight. The fumes are not dangerously deadly, but they are poisonous over a prolonged time.

Fire Hazard: Diphenyl is very flammable and will burn when exposed to heat or flame or oxidizing materials.

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

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.

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.

AROCLOR

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

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 on 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.

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

ATTAPULOUS 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: Attapulsug earth presents no special storage problem and should be handled 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 injested, 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

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 at 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.

AROCLOR

APPENDIX K BACK GROUND 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 increased 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 at 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.

Monsanto Company
Monsanto, Illinois

SAFETY REVIEW COMMITTEE

Accepted by Production

WBJ

Original signed by:

CWR 2-19-64

ODG 2-20-64

HBP 2-10-61

January 17, 1964

Messrs:

P. E. Heisler - WGK
E. E. Martin - WGK
R. W. Bucknell - Org. Res.

K. L. McHugh - Org. Res.
Process Holders

TENTATIVE AMENDMENT NO. "A"

TITLE:

Aroclor Standard Manufacturing Process of Dec 17, 1962
811.01 - 811 07

OBJECTIVE:

Increase amount of Ferric Chloride Catalyst added to the Biphenyl in Dept. 246, Aroclor.

PRESENT PRACTICE:

Presently 1 lb. of ferric chloride is added to the biphenyl charge tank to 4000 lbs. of biphenyl. It is suggested that this amount be increased to 2 lbs. of ferric chloride per 4000 lbs. charge of biphenyl added to the charge tank. It has been shown in the St. Louis Research Reports Nos. 1640 and 2072 that a minimum level of $Fe\ Cl_3$ catalyst is 0.03% to produce stable Aroclors.

Aroclors manufactured at the W G. Krummrich plant do not meet specs. by as comfortable a margin as Anniston's Aroclors do. If we are to retain our customers for electrical-grade Aroclors at W.G.K., the quality must be improved. Safety will not be affected in any way. This will be a permanent procedure change.

W. B. Johnson

MONS 054865

Tentative Amendment No. "A" (Cont'd.)

APPROVAL: DATE:

Original signed by:

P. E. Heisler	2/11/64
P. E. Heisler - WGK	Date
E. E. Martin	2/11/64
E. E. Martin - WGK	Date
D. B. Hosmer	2/14/64
D. B. Hosmer - G. O.	Date
R. W. Bucknell	2/19/64
R. W. Bucknell - J. F. Q.	Date

DISTRIBUTION LIST:

1. H. L. Minckler/R. S. Wobus - Gen. Offices
2. R. E. Soden - WGK
3. T. W. Dalton - WGK
4. J. R. Kellogg - WGK
5-6. St. Louis Research
7. Vital Records Center
8. WGK Standards Department
9. WGK Technical Services
10. Vault Copy
11. England
12. England
13-14. Anniston - R. G Moody
15-16. Extra

May 9, 1963

TENTATIVE AMENDMENT NO. A

PROCESS DESCRIPTION FOR THE MANUFACTURE OF AROCLOR IN DEPT. 246 OF DECEMBER 17, 1962 - W. G. KRUMMRICH PLANT, MONSANTO, ILLINOIS

SUB-TITLE: Preparation of Aroclor 1232 by the direct chlorination process common to Aroclor 1242, 1248, 1254, 1260 and 1262.

PRESENT PROCESS: Aroclors are the reaction products formed by the chlorination of diphenyl in the presence of iron chloride catalyst. The crude Aroclor, produced in the chlorinator, is air blown, distilled over calcium oxide treated with Attapulgus earth, filtered, and transferred to storage

PROPOSED CHANGE: Amend the existing manufacturing process to include the production of Aroclor 1232, which contains high percentages of dichlorobiphenyl, to be used in the large scale preparation of MCS 177, a 700°-800°F. heat transfer fluid.

Aroclor 1232 is prepared by the direct chlorination of diphenyl to a specific gravity of 1.232 to 1.236 at 65°/15.5°C. in the presence of iron chloride catalyst. The crude Aroclor 1232 is air blown, and distilled over calcium oxide prior to transfer of the product into storage containers at 50° to 80°C. Insoluble isomers, present in this special Aroclor 1232, slowly separates out of solution upon prolonged standing at room temperatures and are very difficult to redissolve. Since this product is a starting material for the MCS 177 process, the Attapulgus treatment and final filtration are optional but not necessary.

MONS 054867

This special Aroclor 1232 cannot be back-blended if the finished product is off on its prescribed chlorine specifications The incorporation of excess monochlorobiphenyls into the product will increase the volatility of the MCS 177 and the addition of trichlorobiphenyls will drastically raise the pour point of the finished heat transfer fluid. Abnormal compositions of this Aroclor 1232 are readily detectable by gas-liquid chromatographic analyses.

Approval is requested to demonstrate this change as a source of the necessary starting material for Monsanto's candidate, in the lucrative field of high temperature heattransfer applications.

ORIGINAL SIGNED BY:

Written by J. D. Sullivan
J. D. Sullivan

Date 5/9/63

Approved By:
Original Signed by:

W. R. Richard W. R. Richard

P. E. Heisler P. E. Heisler

E. E. Martin E. E. Martin

Safety Review Committee:

1.	R. S. Wobus	8.	England
2.	C. Barbre	9.	P. G Marsh
3.	T H. Becker	10.	Plant B
4.	J. Soffranko	11.	Plant B
5.	St. L. Res. Lib.	12.	Plant B
6.	St. L. Res. Lib.	13.	H. L. Hubbard
7.	Plant B	14.	J. Mitoray

January 23, 1951

TENTATIVE AMENDMENT
AROCLOR PROCESS

Dept. 246, Plant B

This amendment provides for the addition of anhydrous $FeCl_3$, 0.3% by weight of biphenyl, to the chlorinator as fortifying catalyst for the production of Aroclor 1160

This change in process operation is a result of a complaint submitted because of the presence of green color in Aroclor 1260. Research work has indicated a trend toward improved color when anhydrous $FeCl_3$ is used either alone or in combination with plant steel catalyst. To cite an example, using 5% by weight plant steel catalyst, an untreated Aroclor 1260 was prepared in the laboratory having a color of 56% Transmission (Fisher Electrophotometer, filter 425B), whereas from a batch in which the same catalyst plus 0 3% by weight anhydrous $FeCl_3$ was employed, an Aroclor 1260 of 72% Transmission was obtained. Extensive analyses of the Aroclor 1260, which was prepared using plant steel in conjunction with 0.3% by weight anhydrous $FeCl_3$, did not indicate any abnormalities or deviations from usual quality material. A complete summary of the Research work is presented in a memorandum to Dr. R. M. Hitchens, January 24, 1951.

It is proposed to condut a plant demonstration which will comprise the production of three to four chlorination batches of Aroclor 1160 using 0.3% by weight of the biphenyl charge as anhydrous $FeCl_3$. Depending on the outcome of this plant trial, that is, if a color improvement is observed and a normal quality product is retained, a run of longer duration will be planned to study further the effect of anhydrous $FeCl_3$ catalyst on the color of Aroclor 1260. This may include variations in the amount of $FeCl_3$ charged to the chlorinator.

Original Signed by: J. P. Mitoray
J P Mitoray

ln
January 24 1951

MONS 054869

APPROVED:

Original Signed by:

H. L. Hubbard H L. Hubbard	1/25/51 Date	O. J. Weinkauff O. J. Weinkauff	1/25/51 Date
T. W. Dalton T. W Dalton	1/25/51 Date	C. Barbre C. Barbre	6/25/51 Date
D. B. Hosmer D. B. Hosmer	1/26/51 Date	Paul G. Marsh P. G. Marsh	1/26/51 Date

SAFETY REVIEW COMMITTEE
Original Signed by:
T.MP. 10-8-57
R.E.H. 10-9-57
R.H.M. 10-9-57

September 27, 1957

Distribution:

Dr. O. J. Weinkauff - Research
R. S. Wobus - Roberts Bldg.
T. M. patrick - Research
A. M. Ellenburg - Research

T. W. Dalton - WGK
J R. Kellogg - WGK
Process Holders

TENTATIVE AMENDMENT NO. B

Title:

Aroclor - Standard Manufacturing Process

Objective:

This amendment covers changes in the chlorination step of the Aroclor process; in particular, it suggests that the batch of biphenyl be circulated in the chlorinator during the entire period of chlorination, and that a temperature of 130-150°C., be maintained during the whole chlorination

Previous Practice:

In the Manufacturing Process, no definite temperature is described for the start of the Chlorination. For the biphenyl measuring tank a temperature of at least 85°C., is recommended and as a "finishing temperature" a range of 120-135°C is described for Aroclor 1242 and 1248, a "finishing temperature" of 120-150°C., for Aroclor 1254, 1260 and 1262.

The circulation of each batch in the chlorinator is started after the first four (4) hours of the chlorination (approximately half of the total chlorination time of Aroclor 1242).

Proposed Amendment:

The biphenyl charge will be heated to at least 115-120°C., in the measuring tank. After charging the chlorinator, circulation will be started before the chlorine feed is begun to allow distribution of the ferric chloride catalyst.

The temperature of the chlorinator should be brought up to 130°C., in a minimum time usually 20 to 30 minutes after the chlorine introduction The chlorination of biphenyl to all liquid Aroclors should be carried out at a reaction temperature of 130-150°C.

Proposed Amendment (Cont'd.)

NOTE: In order to mechanically reduce losses due to sublimation and entrainment, it is suggested that the circulating line introducing the charge into the top of the chlorination be extended to the surface level of the biphenyl charge. This will prevent the reaction mixture from being sprayed into the exit gas stream and should eli minate some entrainment.

Justification:

Laboratory experiments and actual plant runs have indicated that catalyst concentration and reaction temperature are imperative for the production of an end product of good quality. (Final Report No. 1640, October 22, 1956 by H Merten, Progess Report No. 5; Job No 3428 Code IND FL, of August, 1957 by H Merten and A. M. Ellsnburg.

Circulating each biphenyl batch from the beginning of the chlorination should facilitate the production of a more uniform material, since a better contact of the biphenyl charge with the catalyst at the start of each chlorination is made possible. The catalyst will be distributed more evenly and hot spots will be eliminated.

The production of inferior Aroclor caused by too low a chlorination temperature of deficient catalyst distribution would be avoided by changing the present Manufacturing Process according to this amendment.

In addition to the data obtained by laboratory experiments (described above) the following Table I illustrates the effect of temperature changes on the quality of the end product of actual plant runs (shown by stability chloride values). Table II indicates the improvement in the stability of different Aroclors produced by circulation of the batches during the whole chlorination period compared to runs carried out with batch circulation after the lapse of a four-hour chlorination period.

TABLE I

Batch No.	Temperature Low	Temperature High	Stability Chloride ppm./16 hrs.
319	94	116	0.80
320	110	129	0.74
321	133	145	0.49

TABLE II

Circulation	Aroclor No.	Lot No.	Stability Chloride ppm./16 hrs.
after 4 hours	1254	T-631	.85
after 4 hours	1254	T-632	.89
entire period	1254	T-635	.45
entire period	1254	T-636	.45
after 4 hours	1260	T-1044	.52
after 4 hours	1260	T-1045	.57
entire period	1260	T-1048	.39
entire period	1260	T-1049	.45

Precautions:

No increased toxicity or safety hazards will result from this process change

Extent of Demonstrations:

It is suggested that this amendment be incorporated in the standard Manufacturing Process as soon as possible.

Original Signed by: H. L. Merten
H. L. Merten
Research Department

ln

Approved:

Original Signed by:

J. R. Kellogg
J. R. Kellogg

A. M. Ellenburg
A. M. Ellenburg

T. W. Dalton
T. W Dalton

T. M. Patrick, Jr.
T. M. Patrick

Safety Review Committee
ORIGINAL SIGNED BY:
H. L. Hubbard 3/18/57

R. H. M. 3/18/57

R. E. Howard 3/18/57

March 13, 1957

Distribution:

Dr. O. J. Weinkauff - Research
R. S. Wobus - Roberts Bldg.
H. L. Hubbard - Research
A. M. Ellenburg - Research

T. W Dalton - WGK
J. R. Kellogg - WGK
Process Holders

Tentative Amendment No. A

Title:
Aroclor - Standard Manufacturing Process for Department 246, W. G. Krummrich - Revised 3/15/55 - G. N. Schwartz.

Objective:
This amendment covers process changes in the chlorination step of the Aroclor Process, Section V Part B, concerning the Catalyst.

Present Practice:
The biphenyl charge is dropped by gravity to the #1 2, 3, 4 or 5 chlorinators. The chlorinators are constructed of steel and are 3 feet in diameter x 16 feet in height. For catalyst, they contain an 8 foot bed of coarse steel turnings which have been burned free of oil and moisture over an open gas flame prior to their introduction into the chlorinator. Additional catalyst is added to the chlorinators as required. Normally, this is not necessary more than once a year.

Proposed Amendment:
In addition to the present catalyst source, each chlorinator batch of 3600 or 4000 pounds of biphenyl will be charged with 2 pounds of anhydrous ferric chloride before the chlorination begins.

Justification:
Experience has shown that various degrees of unstable Aroclor can result at times from the present method of supplying catalyst to the chlorination step. The use of $FeCl_3$ has been investigated and found to give a very stable product when used in the suggested purportion

The complaints from General Electric Company on Aroclor 1242 regarding the instability of certa n material produced in July and August, 1956, make it mandatory that we maintain our Aroclor quality at its maximum at all times.

Precautions:
No increased toxicity or safety hazard will result from this process change. Ferric chloride is highly hygroscopic and is acidic in nature, therefore care should be tanke to prevent contact with skin or clothing.

Extent of Demonstration:
The process change has been demonstrated at Anniston. This amendment will be a permanent change and should be incorporated in the next revision of the manufacturing process.

A. M. Ellenburg
Organic Research
Group Leader

Approved:

Original Signed by:

J. R. Kellogg
~~J. R. Kellogg~~

A. M. Ellenburg
~~A. M. Ellenburg~~

T. W. Dalton
~~T. W. Dalton~~

F. B. Zienty 3-19-57
~~T. M. Patrick~~
for T. M. Patrick

ln

Monsanto, Illinois

CC: C. M. Edelblut - Anniston
J. Clegorn - Anniston
Safety Review Committee
Original Signed by;
T.M.P. 6-12-59
R.E.H. 6-12-59
R. H. M. 6-15-59

June 8, 1959

Messrs.
T. W. Dalton
T. M. Patrick - Research
A. M. Ellenburg - Research
H. S. Scott
Process Holders

PROCESS AMENDMENT - AROCLORS
Dept. 246 - W.G.K. PLANT

Title
Modification of chlorination temperatures for Aroclor production

Purpose
To provide chlorination temperature ranges that are more compatible with plant conditions

Old Procedure
Biphenyl chlorination is performed at temperature range of 130 to 150°C.

Proposed Procedure
Initial chlorination of Biphenyl may be started at a minimum temperature of 95°C. provided that 120°C is reached within 1/2 hour. Chlorination may be continued for the next tow hours at a temperature no less than 120°C. Completion of the batch will then be controlled between 130 and 150°C.

Reason and Justification
Normal Biphenyl storage is maintained at approximately 95°C. to keep safely below the flash point. Therefore to adhere strictly to the process would require heating of the batch to 130°C. before chlorination. This results in production delays and increased Biphenyl pluggage in chlorinator off gas lines. Based on plant experience most chlorinators are recharged while still hot from the preceeding batch; this normally yeilds a starting temperature in the range of 120°C. However, occasionally delays cause charging to a cooler chlorinator where the net temperature may approach 95°C. This proposal would allow chlorination to start immediately under these conditions The batch temperature would then rise rapidly from its own heat with water being applied later to line out the temperature somewhere slightly above 120°C. A lower temperature range 120 to 130°C. is needed for the first two hours to reduce Biphenyl carry-over into the off gas lines.

MONS 054875

This proposed process ammendment has tentative approval from Research.

J. R. Kellogg

In
Original Signed by:

T. W. Dalton
T. W. Dalton

J. R. Kellogg
J. R Kellogg

A. M. Ellenburg
A. M. Ellenburg

T. M. Patrick 6-12-59
T. M Patrick

AROCLOR

APPENDIX L TIME CYCLE

The design capacity of the department is 1,700,000 (2,400,000 after August, 1964) pounds per month, or 20,400,000 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 summorized below:

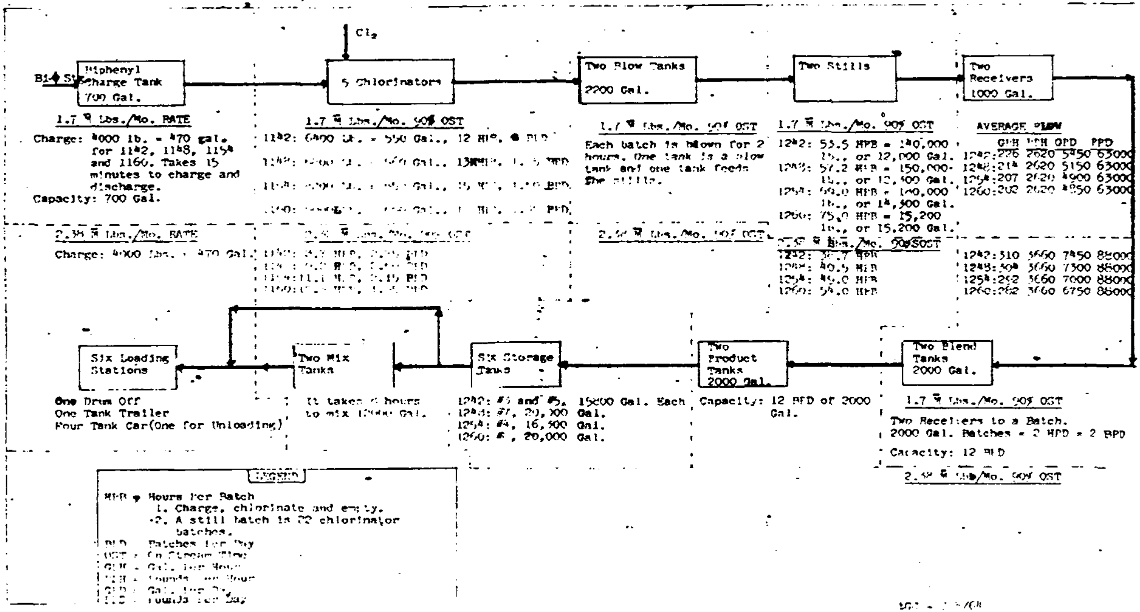
Operation		Time (hours)	Equivalent pounds of Finished Product
Charge Chlorinator		.25	
Chlorination	1242	8.70	6330
	1248	9.20	7200
	1254	11.10	8040
	1260	12.30	9100
Transfer to blow tanks		.25	
Aeration		2.00	
Distillation	1242	1.75	
	1248	1.75	
	1254	1.75	
	1260	1.75	
Blending		2.00	
Filtering		2.00	
Dropping to Storage		2.00	

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

Aroclor	Batch Time (hrs.)
1242	18.95
1248	19.45
1254	21.35
1260	22.55

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

Figure 1. AROCLOR FLOW SHEET WITH BATCH SIZE AND RATES



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 Co. 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. at 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.

Department 246 - Process Description

AROCLOR

APPENDIX M

QUALITY CONSIDERATIONS

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 can not 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 catalyst 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 give 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 Sulfonate 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

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 0.05% 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 can not 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.

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, especially 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 time of irradiation (Figure 1 of this section) resembles a conductivity versus concentration curve for a weak electrolyte. It is possible to remove the conducting material brought about by photo-degradation, and restore the resistivity to 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 irrodiated, then exposed to a thermal treatment, appreciably more HCl is liberated.

TABLE I

ADSORBENT SCREENING DATA

Adsorbent	Adsorbent Pretreatment	Contact Temperature °C.	Volume Resistivity at 100°C. ohm-cm. x 10°
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
LVM 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	6,200

TABLE I (Cont'd.)

Adsorbent	Adsorbent Pretreatment	Contact Temperature °C.	Volume Resistivity at 100°C. ohm-cm. x 10^9
Linde Molecular Sieve Type 4-A	None	60	2100
Laminar Alumina (Dayton)	None	60	900

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

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.

K+E 10 X 10 TO ½ INCH 46 1323
7 X 10 INCHES
KEUFFEL & ESSER CO.

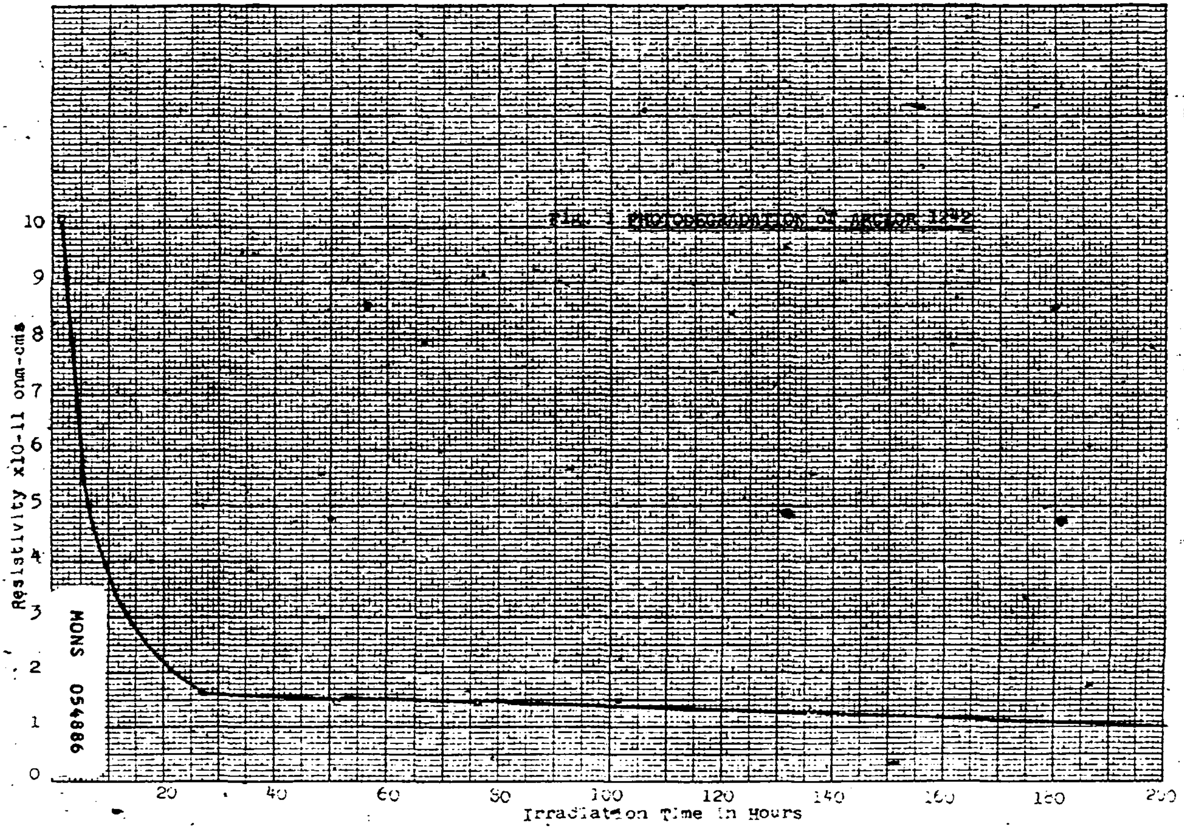


Fig. 1 PHOTODEGRADATION OF AROCLOR 1242

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 studied 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

REFERENCES

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.

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
$FeCl_3$	15%	7%	15%	6%	38%	11%	9%
$SbCl_3$	11	0.7	20	3.6	38	18	9
$TiCl_4$	11	0	20	2.2	46	14	7
$SnCl_4$	24	1	16	2.3	38	18	1.3

AROCLOR

APPENDIX N MISCELLANEOUS (Cont'd.)

Some of the typical operating diff culties 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

Trouble	Cause	Remedy
Blow tanks stacking off	Operating Chlorinators with vent open.	Close chlorinator vent; possibly reduce air to blow tanks

STILLS

Trouble	Cause	Remedy
Not enough vacuum	1. Ejectors not pulling properly 2. Coke scrubber Contains water	1. Check Ejectors 2. Drain Coke scrubber

36" SPARKLER FILTER

Trouble	Cause	Remedy
Foreign material in filtrate samples	Dirty filter or broken paper	Clean & re-paper press

PRODUCTION COST STANDARD

PLANT W.G. Krummrich

PAGE 1 OF 1

Product Aroclors		Dept. No. 246	Prod. Code 811.00
Yield on	Std #	Theory #	% Theory/Std	Capacity 1700 000	Effective Jan 1 1964
Yield on	Std #	Theory #	% Theory/Std	Cost Unit	Inv. Unit Cost —

	F OR V	ZERO PROD. BRACKET 1	INVENTORY VALUE & CAP. BRACKET 2			OTHER OPERATING BRACKETS BRACKET 3			BRACKET 4		
PRODUCTION-QUANTITY		NONE	1700 000			1200 000					
EXPENSES-AMOUNT		AMOUNT	UNIT	COST	AMOUNT	UNIT	COST	AMOUNT	UNIT	COST	AMOUNT
MATERIAL COST											
STEAM	F	216		127	2163		135	1626			
ELECTRICITY	F	94		019	323		017	209			
COMPRESSED AIR	V	9		005	85		005	63			
WATER-PURCHASED	V	39		023	385		024	286			
WATER-PLANT											
FUEL-GAS	V	49		020	337		018	218			
FUEL-OIL											
REFRIGERATION											
ICE											
LABOR-MANUFACTURING	F	4996		293	4996		285	3426			
SALARIES	B	1126		066	1126		094	1126			
PAYROLL-OVERHEAD	F	727		043	727		046	547			
FACTORY SUPPLIES	F	80		047	800		047	560			
LABORATORY	V	200		093	1600		092	1100			
CLOTHING & LAUNDRY	F	100		018	300		019	230			
PROD. DEPT. CONT. EXP.											
TECHNICAL SERVICE											
MECH. EXP.	B	6249		367	6249		521	6249			
Total Direct Conversion		13864		1116	18991		1303	15640			
DEPRECIATION	B	1822		107	1822		152	1822			
FACTORY INDIRECT EXPENSE	B	3042		179	3042		254	3042			
Total Indirect Conversion		4864		286	4864		406	4864			
Total Product Cost		18728		1402	23855		1709	20504			
Cost. Std				1411							

EXPENSE-QUANTITY	UNIT	UNIT PR	QUANTITY	QUANTITY	QUANTITY	QUANT.TY
LABOR	HOURS	XXX	1423	1423	990	
LABOR RATE	XXX	XXX	3.50	3.50	3.46	
LABOR	MEN	XXX	7.3	7.3	5.1	
STEAM	M LBS.	.640	338	3380	2540	
ELECTRICITY	C KWH	.820	115	394	255	
COMPRESSED AIR	M CF	.048	177	1776	1320	
WATER-PURCHASED	M GAL.	.147	262	2618	1945	
WATER-PLANT	M GAL.					
FUEL-GAS	M CF	.389	127	866	560	
FUEL-OIL	GAL.					
REFRIGERATION	TON					
ICE	BLKS.					
LAB.	MAN/HRS					
LABOR STANDBY BASIS	XXX			XXXX	XXXX	XXXX

DBH
10/4/63

NUMBER OF UNITS				
EQUIPMENT USED:				
DEPT. NO.	%	%	%	%
DEPT. NO. 81100 (246)	100 %	100 %	100 %	%
DEPT. NO.	%	%	%	%
OPERATING PERIOD:				
DAYS	XXX	30	22	
SHIFTS	XXX	3	3	

[signature] 10/7/63

MONS 054891

A 178 REV. 12/60

PRODUCTION COST STANDARD

PLANT	PAGE
W G Krummrich	1 OF 1

PRODUCT	Aroclors	DEPT. NO.	246	PROD. CODE	81100
% THEORY TO STD. ON	82601	95.5 %	CAPACITY 1,700,000	EFFECTIVE	Jan 1 1964
% THEORY TO STD. ON	81059	93.0 %	COST UNIT	INV. UNIT COST	

MATERIAL CODE	NAME	QUANTITY PER UNIT THEORY	QUANTITY PER UNIT STANDARD	PRICE PER LB.	UNIT COST
19400	Attapulgus Clay		.150	.03025	.005
33900	Lime Hydrated		.500	.01090	.005
33600	Ferric Chloride		.030	.12950	.004
	Aroclor 1242 · 81101				
82601	Biphenyl	59.19	61.980	.06980	4.326
81059	Chlorine	84.00	90.320	.01929	1.742
	Aroclor 1248 · 81102				
82601	Biphenyl	53.37	55.880	.06980	3.900
81059	Chlorine	96.00	103.220	.01929	1.991
	Aroclor 1254 · 81103				
82601	Biphenyl	47.54	49.780	.06980	3.475
81059	Chlorine	108.00	116.130	.01929	2.240
	Aroclor 1260 · 81105				
82601	Biphenyl	41.71	43.680	.06980	3.049
81059	Chlorine	120.00	129.030	.01929	2.489
	Aroclor 1262 · 81107				
82601	Biphenyl	39.76	41.630	.06980	2.906
81059	Chlorine	124.00	133.330	.01929	2.572
	Aroclor 1232 · 81115				
82601	Biphenyl	68.91	72.160	.06980	5.037
81059	Chlorine	64.00	68.820	.01929	1.328
	Aroclor 1254 (10% Xylene) 81117				
81103	Aroclor 1254	90.00	90.900	.07138	6.488
64005	Xylene	10.00	10.100	.05740	.580
RAW MATERIAL WAREHOUSING & HANDLING					.007
GROSS TOTAL MATERIALS					
BY-PRODUCTS					
82851 HCl Gas	Sales & Use		-	-	-
Cl_2 #/unit theory = unit Cl numbers of Aroclor Group x 2					
ϕ_2 #/unit theory = (100 - Cl_2 theory/2) + Cl_2 theory/2 x .0283					
Cl_2 #/unit actual = Cl_2 theory / .93					
ϕ_2 #/unit actual = ϕ_2 theory / .955					
HCl #/unit theory = Cl_2 theory /2 x 1.028					
TOTAL BY-PRODUCTS					
NET TOTAL MATERIALS					

PRODUCTION CONTROL DATA

CLASSIFICATION	AMOUNT	CLASSIFICATION (Cont'd.)	AMOUNT
COST OF SHUT-DOWN		COST OF STAND-BY	
COST OF START-UP		COST TO MOVE A MAN	
COST OF CHANGEOVER		STAND-BY LABOR - NO. OF MEN	

OTHER PRODUCTS PRODUCED IN CONNECTION WITH THIS PRODUCT

PRODUCTION CODE		CAPACITY
Down Days	4%	
Repairs	2	
Other	2	
On stream	92	
2560#/hr		
x 720 x 92		
1695 M#		

OTHER DATA

1964 Inventory Std. Units Per Lb.		
81101	.07491	.07881
81102	.07314	.07415
81103	.07138	.07451
81105	.06961	.07085
81107	.06901	.07029
81115	.07788	.07858
81117	.07075	.07178
81109	.08451	

Cost · Std

HONS 054892