

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 Approved by: E. E. Martin
R. Bucknell, Research 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. Spt.

Issued: 7-20-64

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TRAN 009192

MONSANTO COMPANY
Monsanto, Illinois

SAFETY REVIEW COMMITTEE

1-65
3-25-65
2-1-65

March 10, 1965

Messrs:

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

R. W. Bucknell - Org. Res.
H. LaGrubbard - 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). Continuously 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.

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March 10, 1965

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:

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D. R. Middleton
D. R. Middleton

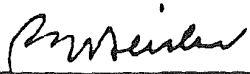
J. J. Luecken
J. J. Luecken

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

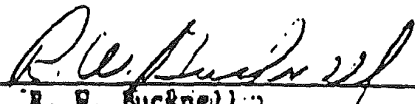
TRAN 009194

March 10, 1965

Approvals:



P. E. Heisler



R. W. Bucknell



D. E. Harris



H. L. Hubbard



P. A. Mullendore

vmd

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TRAN 009195

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 Cl₂ and dilute (25 mole %) Cl₂, 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 Cl₂ (from DeNora & Hooker Cells) H₂, N₂, O₂, CO₂ and trace amounts of organic impurities. The Cl₂ concentration is in the range of 75 - 95 mole % and varies with operations in the Cl₂ departments.

PROPOSED PRACTICE (Two Plant Tests, 1242 Aroclor)

1. A plant chlorination test will be run using revaporized Cl₂ from Dept. 232 as the Cl₂ 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 Cl₂ 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 Cl₂ diluted to 25 mole % with dry air as Cl₂ 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 Cl₂ 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.

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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 Cl₂ test the production rate will be limited to about 32,000#/day for a duration of 1 - 1 1/2 days. For the dilute Cl₂ test the rate will be limited to about 11,000#/day for a duration of 3 days.

SAFETY:

No increase in safety hazards is foreseen 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

7-20-65

7-23-65

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TRAN 009197

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.

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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.

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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. Kramp
W. G. Kramp

APPROVALS:

P. E. Heisler
P. E. Heisler

9/1/65
Date

R. W. Bucknell 9/3/65
R. W. Bucknell Date

D. E. Harris
D. E. Harris

9-1-65
Date

H. L. Hubbard 9/3/65
H. L. Hubbard Date

J. A. Mullendore
J. A. Mullendore

9-2-65
Date

SAFETY REVIEW COMMITTEE

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Ch. Ross 9-7-65

emc

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TRAN 009200

MONSANTO COMPANY
Monsanto, Illinois

SAFETY REVIEW COMMITTEE

CWR 10-26-65

PER 10-29-65

Q.C.F. 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.

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October 20, 1965

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
P. E. Heisler

10/20/65
Date

D. E. Harris
D. E. Harris

10-22-65
Date

R. W. Bucknell
R. W. Bucknell

10/29/65
Date

J. A. Mullendore
J. A. Mullendore

11/1/65
Date

Please have this mat'l sold as
non-electrical full accredited tests
by customer reveal it is satisfactory

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TRAN 009202

MONSANTO COMPANY
Monsanto, Illinois

December 3, 1965

Messrs:

cc.

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

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 FeCl₃ 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 FeCl₃ 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

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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 hazards 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
D. R. Middleton

12/3/65
Date

D. E. Harris
D. E. Harris

12-6-65
Date

P. E. Heisler
P. E. Heisler

12/6/65
Date

R. W. Bucknell
R. W. Bucknell

12/6/65
Date

J. A. Mullendore
J. A. Mullendore

Date

SAFETY REVIEW COMMITTEE

H. L. Hubbard
H. L. Hubbard

12/6/65
Date

CDG

12/6/65

12/6/65

CUR

12/6/65

Approved with following provisions:

- 1) Have reactor 1292 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.

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TRAN 009204

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.

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TRAN 009206

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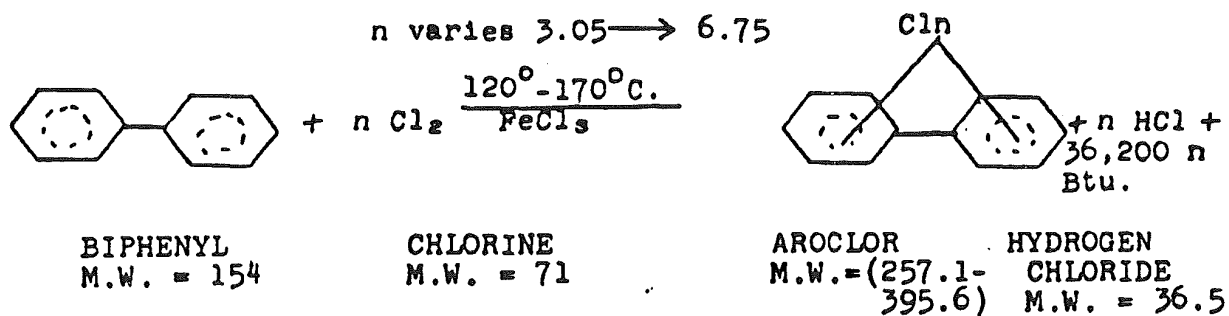
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TRAN 009207

AROCLORSECTION ISYNOPSIS OF PROCESS

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

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



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TRAN 009208

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 Attapulugus earth is added to the distilled Aroclor. The mixture is agitated and filtered to the finished product tank. The purpose of the Attapulugus 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.

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TRAN 009209

AROCLOR

SECTION II

FLOW SHEETS

This section contains the following flow sheets.

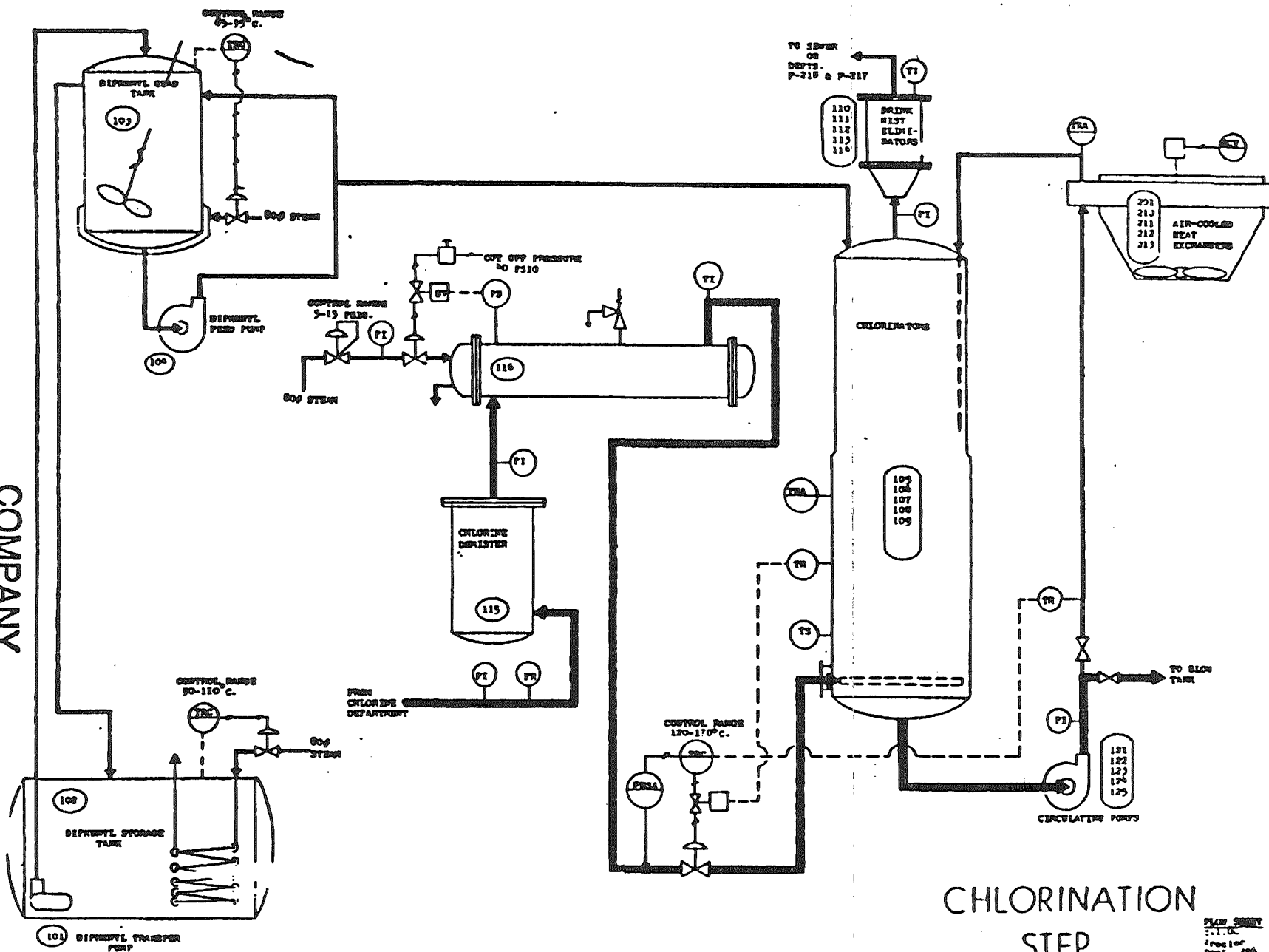
1. Complete process flow sheet.
2. Chlorination Reaction Step
3. Aeration and Distillation
4. Blending, Filtration and Storage.

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TRAN 009210

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TRAN 009211



CHLORINATION
STEP

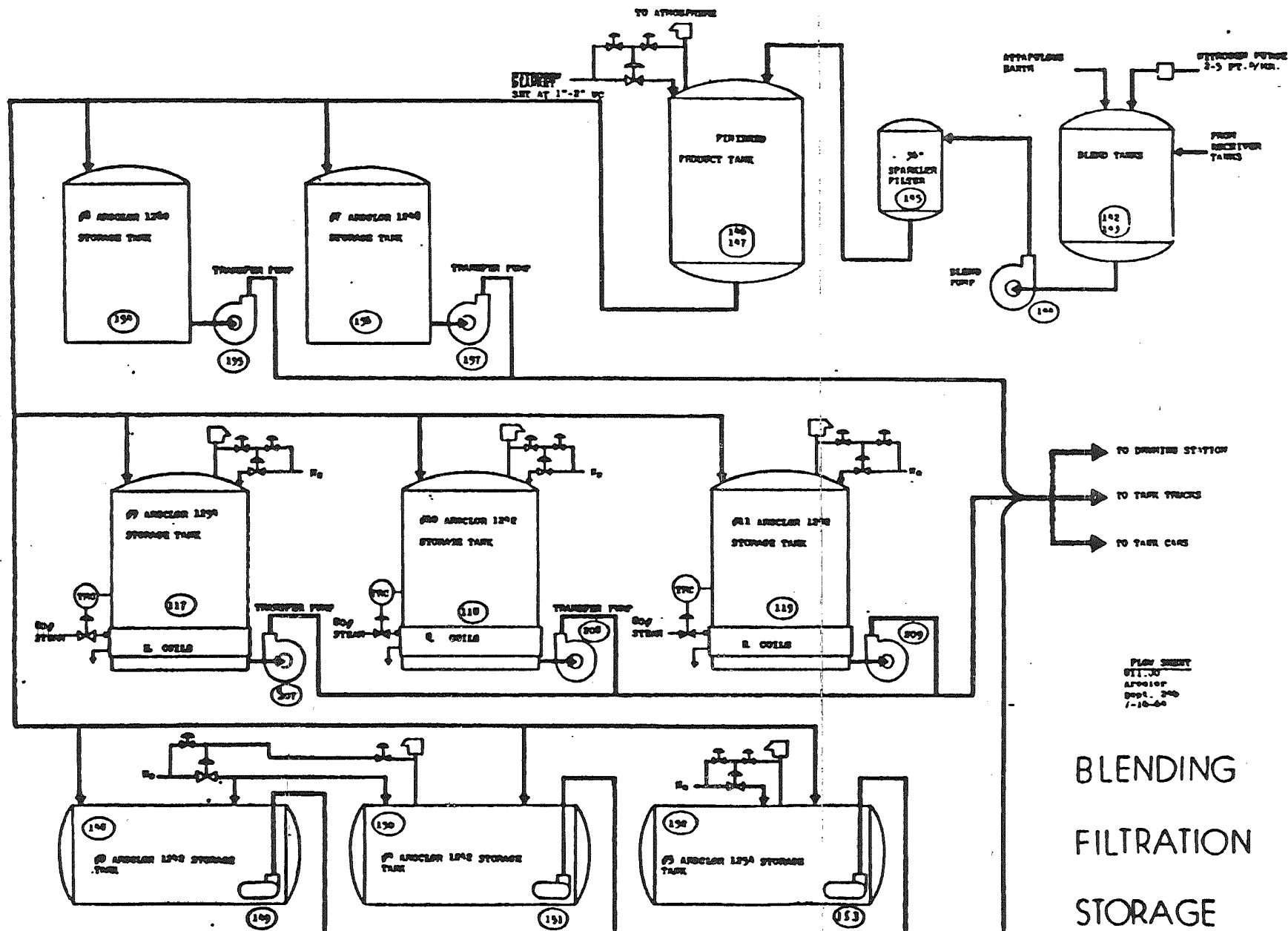
PLAN SHEET
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TRAN 009213



AROCLORSECTION IIIPROCESS IN DETAILA. 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

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TRAN 009214

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.

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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 $\pm 5^{\circ}\text{C}$. 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.

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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 attapulugus earth is added to the distilled 1242 Aroclor. All other Aroclors are earth-treated with 20 pounds of Attapulugus earth. Regular Attapulugus 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 Attapulugus 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 Attapulugus earth absorbs water and ionic impurities. This improves the electrical-quality properties of the Aroclor.

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TRAN 009217

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 Havg 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 propagation rate (15 ft./sec.). This is accomplished by introducing a sufficient quantity of steam into the vent stack.

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AROCLORSECTION IVCOMMENTS ON PROCESSCHLORINATION STEPA. 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

<u>AROCLOR</u>	<u>CHLORINE</u> <u>#/# Product</u>	<u>BIPHENYL</u> <u>#/# Product</u>
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

<u>AROCLOR</u>	<u>CHLORINE</u> <u>#/# Product</u>	<u>BIPHENYL</u> <u>#/# Product</u>
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

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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.

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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. Attapulugus 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.

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TRAN 009221

AROCLOR

SECTION IV

COMMENTS ON PROCESS

BLENDING AND FILTRATION

Attapulugus 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 Attapulugus Earth is roasted for 4 hours at 250°C, before addition to the blend tanks.

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TRAN 009222

AROCLORAPPENDIX AEQUIPMENT 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.

<u>Item No.</u>	<u>Equipment Name</u>	<u>Equipment Number</u>	<u>Description</u>
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.

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AROCLORAPPENDIX A EQUIPMENT LIST (Cont'd.)

<u>Item No.</u>	<u>Equipment Name</u>	<u>Equipment Number</u>	<u>Description</u>
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 Durametalllic seal and Manzel lubricator. Rate is 200 GPM at 25' static head Sp. Gr. of 1.5. Motor is 10 HP, 1800 RPM.

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AROCLORAPPENDIX AEQUIPMENT LIST (Cont'd.)

<u>Item No.</u>	<u>Equipment Name</u>	<u>Equipment Number</u>	<u>Description</u>
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. 2 1/2" 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 lb 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, 1/2" 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' 10 1/2" lg. lined with insulating fire brick. One coil 2" xH ₂ 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.

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TRAN 009225

Dept. 246 - Process DescriptionAROCLORAPPENDIX AEQUIPMENT LIST (Cont'd.)

<u>Item No.</u>	<u>Equipment Name</u>	<u>Equipment Number</u>	<u>Description</u>
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.

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AROCLORAPPENDIX AEQUIPMENT LIST (Cont'd.)

<u>Item No.</u>	<u>Equipment Name</u>	<u>Equipment Number</u>	<u>Description</u>
142	Blend Tank #1	21-0779	Tank made by Graver. Dwg. E-862. Welded steel tank, 7' Dia. x 7' high, dished heads $\frac{1}{2}$ ", shell $\frac{3}{8}$ ". 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 $1\frac{1}{2}$ " 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 $\frac{1}{2}$ ", head $\frac{9}{16}$ ". 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. $2\frac{1}{2}$ " x 2". Length 11'6". Cap 50 GPM at 40' static head. Motor is 3 HP, 1800 RPM

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AROCLORAPPENDIX AEQUIPMENT LIST (Cont'd.)

<u>Item No.</u>	<u>Equipment Name</u>	<u>Equipment Number</u>	<u>Description</u>
152	Storage Tank #5	21-1310	Tank made by Leader Iron Works. Dwg. C-609. 10' OD x 26' Long on str. she. Same as Item No. 148 for other characteristics.
153	Storage Transfer Pump #5	19-0929 66-0856	Same as Item No. 151, except length 14'7".
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	Silpha 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.

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AROCLORAPPENDIX AEQUIPMENT LIST (Cont'd.)

<u>Item No.</u>	<u>Equipment Name</u>	<u>Equipment Number</u>	<u>Description</u>
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' Id 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 fum 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.

COMPANY
CONFIDENTIAL

TRAN 009229

AROCLORAPPENDIX AEQUIPMENT LIST (Cont'd.)

<u>Item No.</u>	<u>Equipment Name</u>	<u>Equipment Number</u>	<u>Description</u>
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.

COMPANY
CONFIDENTIAL

TRAN 009230

AROCLORAPPENDIX AEQUIPMENT LIST (Cont'd.)

<u>Item No.</u>	<u>Equipment Name</u>	<u>Equipment Number</u>	<u>Description</u>
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. Integrato for 200#, 510°F. Steam.

COMPANY
CONFIDENTIAL

TRAN 009231

AROCLORAPPENDIX BSPECIFICATIONS

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

<u>Material Code</u>	<u>Raw Material</u>
82601	Biphenyl
33500	Ferric Chloride
38800	Lime
19400	Attapulugus Earth
81059	Chlorine
43099	Nitrogen

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

<u>Product Code</u>	<u>Product</u>
	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.

COMPANY
CONFIDENTIAL

TRAN 009232

ORGANIC CHEMICALS DIVISION
W.G. KRUMMRICH PLANT
RAW MATERIAL
SPECIFICATION

USING DEPT.

246

SUPPLIER

ANNISTON PLANT

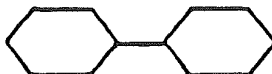
Issued 6/9/61

W.G. Krummrich Plant

By P. O. Mark

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

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

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

COMPANY
CONFIDENTIAL

TRAN 009233

☐ IN 88 (REV. 12/58)

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. Dzelg

RAW MATERIAL

Date Approved DEC 23 1963

For Dept. 233, 236, 237, 246

PRODUCT (Trade Name)

TYPE

Chlorine (Snift Gas)

PRODUCT (Chemical Name)

TYPE

CHEMICAL FORMULA

Mixture

MOL WT.

SUPERSEDES SPECS OF

New

SAMPLE FOR ANALYSIS

100 c.c. Gas Burette

UNCLASSIFIED INFORMATION

General Tests (made only on request)

<u>Property</u>	<u>Typical Analyses</u>	<u>Method Number</u>
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 ₂ O) @ Std. Conditions	2.4 x 10 ⁻⁵ lbs./ft. ³ (Average)	

Direct pipeline transfers to using Depts.

233, 236, 237, 246

This specification is for internal use at W GK Plant only.

COMPANY
CONFIDENTIAL

TRAN 009234

MONSANTO CHEMICAL COMPANY.
ORGANIC CHEMICALS DIVISION
W. G. Krummrich Plant
RAW MATERIAL
SPECIFICATION

MATERIAL CODE

38800

USING DEPT.

222. 246

SUPPLIER

Issued 6/20/63
W. G. Krummrich Plant
By M. D. Dealy

MATERIAL

Lime, Hydrated

CHEMICAL FORMULA

$\text{Ca}(\text{OH})_2$

MOL WT.

SUPERSEDES SPECS OF

6/5/57

SAMPLE FOR ANALYSIS

1 x 16 oz. W. M. Bottle

UNCLASSIFIED INFORMATION

General Tests (made only on request)

<u>Property</u>	<u>Specification</u>	<u>Method Number</u>
Appearance	Fine white or slightly gray powder, free from lumps or gritty material	10,188
Assay ($\text{Ca}(\text{OH})_2$)	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

COMPANY
CONFIDENTIAL

TRAN 009235

W. G. Krummrich Plant
Monsanto Chemical Company

ORGANIC CHEMICALS DIVISION

RAW MATERIAL
SPECIFICATION

MATERIAL CODE

33500

USING DEPTD.

233

SUPPLIER

MATERIAL

Ferric Chloride Anhydride

CHEMICAL FORMULA

Fe Cl₃

MOL WT. 162.21

SUPERSEDES SPECS OF

2/26/57

SAMPLE FOR ANALYSIS

1 x 8 oz. W. M. Bottle

Issued 11/15/62

W. G. Krummrich Plant

By *J. A. Block*

UNRESTRICTED INFORMATION

General Tests (made only on request)

<u>Property</u>	<u>Specification</u>	<u>J.F.Q. Method No.</u>
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.	

COMPANY
CONFIDENTIAL

TRAN 009236

W. G. KRUMARICH, President
MONSANTO CHEMICAL COMPANY

ORGANIC CHEMICALS DIVISION

RAW MATERIAL
SPECIFICATION

INTERNAL CODE

29400

LABORATORY

246

SUPPLIER

Barada and Page, Inc.

MATERIAL

Attapulcus Earth 200/UP LVM

CHEMICAL FORMULA

Clay

Issued 11/15/62
W. G. Krumarich
Plant
By R. C. Armstrong

MOI WT.

SUPERSEDES SPEC OF

5/7/59

SAMPLE FOR ANALYSIS

2 x 16 oz. W. M. Bottles

UNRESTRICTED INFORMATION

Routine Tests

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

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

COMPANY
CONFIDENTIAL

TRAN 009237

MONSANTO CHEMICAL COMPANY

ORGANIC CHEMICALS DIVISION

W. O. Krummrich Plant

FINISHED PRODUCT
SPECIFICATION

PRODUCT CODE

81115

DEPT. OR JOB

246

USE

Internal J.F.Q.

SALES CODE

Issued APR 7 1964

W. O. Krummrich Plant

By W. D. Dsely

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

Appearance

Sp. Gr. @25/15.5°C

Acid Number

Color, APHA

H₂OGeneral Tests

Chlorine

Specification

Clear Liquid

1.266 - 1.276

0.014 mg. KOH/grm. max.

100, max.

35 ppm., max.

31.5 - 32.5%

Method No.

10,114

10,087

10,084

10,620

This specification is for internal use only.

COMPANY
CONFIDENTIAL

TRAN 009238

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

PRODUCT CODE
DEPT OR JOB
246 - Anniston
246 - WGK
USE
SALES
SALES CODE
1040-130-04/11/16-03/09

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

PRODUCT (Trade Name)
AROCOR 1142
PRODUCT (Chemical Name)
CRUDE COMMERCIAL
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

<u>Property</u>	<u>Specification</u>	<u>Method Number</u>	
		<u>Anniston</u>	<u>WGK</u>
Appearance and Color	Brown to black oily liquid	- - - -	10,084
Specific Gravity 25°/15.5°	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.

COMPANY
CONFIDENTIAL

TRAN 009239

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

PRODUCT CODE 01101 W GK 82612 ANN.	DEPT. OR JOB 240 W GK 271 ANN.
USE Sales	
SALES CODE 1040-240-04/11/16-03/09	
PRODUCT (Trade Name) AROCOR 1242 ELECTRICAL GRADE (PYRANOL 1499)	
PRODUCT (Chemical Name) TYPE	
CHEMICAL FORMULA Mixture	

Issued 4/13/62
W.G.Krummrich Plant
By P. D. Mark

MOL. WT. ---
SUPERSEDES SPEC OF
4/17/61

SAMPLE FOR ANALYSIS
3 x 5 pt. Amber Bottles

UNRESTRICTED INFORMATION

Routine Tests

Property	Specification	Method Number	
		W GK	ANNISTON
Color (APHA)	50, max.	10,084	14-44-54
Condition	Clear	10,084	0-1
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 ₂ O)	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)

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		

COMPANY

0.0 CONFIDENTIAL

(Over)

TRAN 009240

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.	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	

COMPANY
CONFIDENTIAL

TRAN 009241

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

Appearance

Condition

Color, APHA

Sp. Gr. @65/15.5°C

Acidity (mg. KOH/g.)

Moisture (H₂O) (ppm.)

Viscosity @130°F (SUS)

General Tests

Flash Point (°F)

Specification

Colorless to light yellow-green liquid

Clear

100 max.

1.405 - 1.415

0.010, max.

50, max.

73 - 80

370, min.

| WOK | Anniston | |--------|----------| | Method | No. |

10084	G-1
10084	G-1
10084	046
10114	052
10087	050
10620	047
10086	049
10123	14-28-54

(

COMPANY
CONFIDENTIAL

TRAN 009242

MONSANTO CHEMICAL COMPANY
ORGANIC CHEMICALS DIVISION

W.Q.K. and Anniston
FINISHED PRODUCT
SPECIFICATION

PRODUCT CODE

81102

DEPT 46 WQK

27 Ann.

USE

Sales

SALES CODE

1040-260-04/11/16-03/09

PRODUCT (Type Name)

TYPE

Aroclor 1248 Electrical Grade (Pyranol 1498)

PRODUCT (Chemical Name)

TYPE

CHEMICAL FORMULA

Mixture

QDOL WT.

SUPERSEDES SPECS OF

2-12-60

SAMPLE FOR ANALYSIS

3 x 5 pt. Amber Bottles

Issued 1/10/64

W. Q. Krummrich Plant
By M. D. Dzel

Corrected 2-16-64

UNRESTRICTED INFORMATION

Routine Tests

Specification

Method No's
WQK Annisto

Color, APHA
Condition
Sp. Gr. @65/15.5°C
Acidity (mg. KOH/gm.)
Moisture
Refractive Index @25°C
Inorganics (Free) Chlorides
Pour Point
Dielectric Constant
(1000 cycles @100°C)
Resistivity
(500 VDC @100°C 0.1" GAP)
as OHM-CM x 10⁹
Hydrolysis Stability Test
(as Chlorides)
Monsanto Stability Test
(as Chlorides)
Distillation Range
(ASTM D-20, Corrected)
10% Distilled by Wt.
90% Distilled by Wt.

50, max.
Clear
1.405 - 1.415
0.010, max.
35 ppm., max.
1.6285 - 1.6305
0.05 ppm., max.
0°C, max.
4.5 - 4.7
500, min.
1.0 ppm., max.
0.5 ppm., max.
345°C, min.
385°C, max,

10,084 14-44-5
10,084 G-1
10,114 14-49-5
10,087 14-42-5
10,620 14-53-5
10,125 14-34-5
T-2092 014
10,115 14-27-5
11,608 14-36-5
11,607 14-35-5
T-2087 010
11,503 14-61-57
10,117 14-31-54

General Tests (made only on request)

Sulfates
Dielectric Strength @25°C
Fire Point
Viscosity @54.4°C (SUS)
Corrosion Test
(6 hrs. @210°C with bright
aluminum foil)
Change in wt. of Al (%)

None
35 KV, min.
None to boiling point
73 - 80
0.0

12,169 - - -
11,605 043
10,123 14-28-54
10,086 14-4-52
10,126 14-55-57

COMPANY
CONFIDENTIAL

(over)

TRAN 009243

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%

COMPANY
CONFIDENTIAL

TRAN 009244

MONSANTO CHEMICAL COMPANY

ORGANIC CHEMICALS DIVISION

Krummrich and Anniston
FINISHED PRODUCT
SPECIFICATION

PRODUCT CODE

81103 - 82613

DEPT. OR JOB

WQK-246-Ann.27

Issued JUL 15 1964

W. G. Krummrich Plant

By W.D.D. Saly

USE

Sales

SALES CODE

1040-280-04/11/16-03/09

PRODUCT (Trade Name)

Aroclor 1254

TYPE

Non-Electrical Grade

PRODUCT (Chemical Name)

TYPE

CHEMICAL FORMULA

Mixture

MOL WT.

SUPERSEDES SPEC OF

5-4-61

SAMPLE FOR ANALYSIS

3 x 16 oz. W. M. Bottles

UNRESTRICTED INFORMATION

Routine TestsSpecificationWQKAnnistonMethod 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 (H₂O) (ppm.)

50, max.

10620

047

General Tests

Flash Point

None

10123

14-28-54

Viscosity @210°F (SUS)

44-48

10086

049

COMPANY
CONFIDENTIAL

TRAN 009245

MONSANTO CHEMICAL COMPANY
ORGANIC CHEMICALS DIVISION
KRUMMIRICH and ANNISTON
FINISHED PRODUCT

SPECIFICATION

PRODUCT (Trade Name) **AROCOR 1254** TYPE **ELECTRICAL GRADE (PYRANOL 1476)**

PRODUCT (Chemical Name)

CHEMICAL FORMULA

Mixture

MDL WT. ---

SUPERSEDES SPEC OF
10/10/61

SAMPLE FOR ANALYSIS

3 x 5 pt. Amber Bottles

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

UNRESTRICTED INFORMATION

Routine Tests

Property	Specification	Method Number	
		WOK	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 ₂ O)	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
20% 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)

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 (5 hrs @ 210°C with bright aluminum foil)		10,126	14-55-57
Change in wt. of Al (%)	0.0		

(Over)

TRAN 009246

☐ IN 54 (REV. 12/70)

COMPANY
CONFIDENTIAL

WATER_PCB-SD0000019476

A.C. Color, APHA
A.C. Condition
A.C. Acidity (mg. KOH/g.)
A.C. Inorganic (Free) Chlorides

60, max.
Clear
0.010, max.
0.05 ppm., max.

10,084
10,084
10,087
10,118

14-44-54
Q-1
14-42-54
010

EXTERNAL SPECIFICATION

Cornell - Dubilier

Resistivity
(500 VDC @ 100°C 0.1" GAP
as OHM-CM x 10⁹)

1500, min.

11,607

14-35-54

GENERAL INFORMATION

Specific Heat @ 25°C
Coefficient of Expansion
(25-65°C)
Fixed Chlorine

0.27
0.00066 cc/°C
54.5-55.5%

COMPANY
CONFIDENTIAL

TRAN 009247

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

PRODUCT CODE 82614-Ann. 81105-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 P. O. Martin

PRODUCT (Trade Name) AROCOR 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

<u>Property</u>	<u>Specification</u>	<u>Method Number</u>	
		<u>Anniston</u>	<u>WGK</u>
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.

COMPANY
CONFIDENTIAL

TRAN 009248

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

PRODUCT CODE	DEPT. OR JOB
81105 - 82614	WGK 246 Ann.27
USE	
Sales	
SALES CODE	
1040-290-04/11/16-03/09	

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

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

CHEMICAL FORMULA

Mixture

MOL WT.

SUPERSEDES SPEC OF

5-4-61

SAMPLE FOR ANALYSIS

3 x 16 oz. W. M. Bottles

UNRESTRICTED INFORMATION

Routine Tests

Specification

WGK Anniston
Method No.

Condition	Clear	10084	G-1
Color, APHA	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 ₂ O) (ppm.)	50, max.	10620	047
Viscosity @210°F (SUS)	72-78	10086	049

General Tests

Flash Point	None	10123	14-28-5
Fire Point	None	10123	14-28-5

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TRAN 009249

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

SPECIFICATION

PRODUCT (Trade Name)
AROCOR 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

Issued 2/7/62
W.G. Krummrich Plant
By P. O. Martin

UNRESTRICTED INFORMATION

Routine Tests

<u>Property</u>	<u>Specification</u>	<u>Method No.</u>	
		<u>WGK</u>	<u>Anniston</u>
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 ₂ O) (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		10,117	14-31-54
(ASTM D-20, Corrected)			
10% Distilled by wt.	385-398°C		
50% Distilled by wt.	390-404°C		
90% Distilled by wt.	400-420°C		
Corrosion Test		10,126	14-55-57
(6 hrs. @ 210°C with bright aluminum foil)			
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)

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TRAN 009250

UNRESTRICTED INFORMATION (cont'd)

<u>Property</u>	<u>Specification</u>	<u>Method Number</u>	
		<u>WGK</u>	<u>Anniston</u>
<u>General Tests (made only on request)</u>			
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	-----	-----

COMPANY
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TRAN 009251

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)	TYPE
AROCLOR 1162	CRUDE COMMERCIAL
PRODUCT (Chemical Name)	TYPE
CHEMICAL FORMULA	
MIXTURE	

MOL WT. - - -

SUPERSEDES SPEC OF

3/28/58

SAMPLE FOR ANALYSIS

1 pt. can, Anniston; 2 x 16 oz. W.M. Bottles WGK

UNRESTRICTED INFORMATION

Routine Tests

<u>Property</u>	<u>Specification</u>	<u>Method Number</u>	
		<u>Anniston</u>	<u>WGK</u>
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.

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TRAN 009252

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

PRODUCT CODE
82615-ADD
81107-WGR

DEPT. OR JOB
27-Ann
246-WGR

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) TYPE
AROCOR DISTILLED 1262

PRODUCT (Chemical Name) TYPE

CHEMICAL FORMULA

MIXTURE

MOL WT. ---

SUPERSEDES SPEC OF
3/28/58

SAMPLE FOR ANALYSIS

2 x 16 oz. W. M. Bottles

UNRESTRICTED INFORMATION

Routine Tests

<u>Property</u>	<u>Specification</u>	<u>Method Number</u>
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

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TRAN 009253

MONSANTO CHEMICAL COMPANY

ORGANIC CHEMICALS DIVISION

Krummrich and Anniston
FINISHED PRODUCT
SPECIFICATION

PRODUCT CODE

82868

DEPT. OR JOB

WOK 246 Ann, 27

USE

Sales

SALES CODE

*See Below

Issued .1111. 15 1964

W. O. Krummrich Plant

By MD Dsaly

PRODUCT (Trade Name)

Montars 1 and 2

TYPE

PRODUCT (Chemical Name)

Polychlorinated Polyphenyls

TYPE

CHEMICAL FORMULA

Mixture

MOL WT.

SUPERSEDES SPECS OF

6-15-61

SAMPLE FOR ANALYSIS

2 x 16 oz. W. M. Bottles

UNRESTRICTED INFORMATION

Routine TestsSpecificationAnniston WOK
Method No.

Appearance

Black Solid

14-17-52 11321

General Information

Physical Properties (Typical Values)Montar 1Montar 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

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TRAN 009254

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

UNRESTRICTED INFORMATION

Routine Tests

Specification

Anniston WGK
Method No.

Appearance

Black Solid

14-17-52 11321

General Information

Physical Properties (Typical Values)

Montar 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

**COMPANY
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TRAN 009255

Dept. 246 - Process Description

23.

AROCLOR

APPENDIX C

PHYSICAL AND CHEMICAL DATA

**COMPANY
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TRAN 009256

AROCLORAPPENDIX CPHYSICAL CONSTANTSGENERAL 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	--	--	--	--	--

CONFIDENTIAL

COMPANY

TRAN 009257

AROCLOR

APPENDIX C

PHYSICAL CONSTANTS (Cont'd.)

GENERAL PHYSICAL PROPERTIES OF AROCLORS (Cont'd.)

Form	Aroclor 1242 Practically colorless mobile oil	Aroclor 1248 Yellow tinted mobile oil	Aroclor 1254 Light yellow viscous oil	Aroclor 1260 Light yellow soft sticky resin	Aroclor 1262 Light yellow sticky clear resin
Refractive Index-D-line 20°C	1.627-1.629	1.630-1.631	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
	100°F (37.8°C) 80-93	185-240	1800-2500	---	(160°F or 71°C) ----

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TRAN 009258

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)

<u>°F.</u>	<u>centipoises</u>
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)

<u>°F.</u>	<u>B.T.U./lb.</u>
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

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TRAN 009259

AROCLOLAPPENDIX CPHYSICAL AND CHEMICAL DATA (Cont'd.)Diphenyl (Cont'd.)

Another record gives the following values for liquid diphenyl:

<u>°C.</u>	<u>Sp. Heat cals./gram</u>
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 = 0.460
250°C.

0.625
450°C. (D. A. Roper, Design Data for Units 4 & 5)

Density of Liquid Diphenyl (from Anniston files)

<u>°C.</u>	<u>Grams./cc</u>
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°C.

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TRAN 009260

AROCLORAPPENDIX CPHYSICAL AND CHEMICAL DATA (Cont'd.)Specific Gravity of Aroclors
at Various Temperatures

<u>For</u>	<u>Temp. °C.</u>	<u>Sp. Gr.</u>	<u>Lbs. per gallon (US)</u>
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 GE 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 GE 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

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TRAN 009261

AROCLORAPPENDIX CPHYSICAL AND CHEMICAL DATA (Cont'd.)Specific Gravity of Aroclors
at Various Temperatures (Cont'd.)

<u>For</u>	<u>Temp. °C.</u>	<u>Sp. Gr.</u>	<u>Lbs. per gallon (US)</u>
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.)

<u>Temperature Aroclor °C.</u>	<u>0</u>	<u>50</u>	<u>100</u>	<u>125</u>	<u>150</u>	<u>175</u>	<u>200</u>	<u>250</u>	<u>300</u>
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

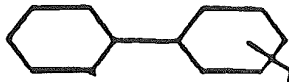
<u>Aroclor</u>	<u>Temp. Range</u>	<u>Latent Heat of vaporization</u>
1242	300°-310°C.	61 cal/gm
1248	300°-330°C.	54 cal/gm
1254	300°-350°C.	50 cal/gm
1260	300°-370°C.	48 cal/gm

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TRAN 009262

PHYSICAL CONSTANTS DATA

54579
12,580

SUBSTANCE		STRUCTURAL FORMULA	
AROCCLOR 1160 (Technical)			
REVISED BY: Rev. By A. M. Ellenburg		DATE: 1947 7/5/57	
NAME		SOURCE & DATE	
Formula $C_{12}H_7.75Cl_{6.25}$		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. #222, 1945. "Industrial Poisons, Hazards and Solvents" by M. D. Jacobs Vol. I, p463-464 1941	

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

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TRAN 009265

550

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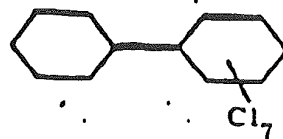
PHYSICAL CONSTANTS DATA

V, 580

SUBSTANCE

AROCLOR 1162 (Technical)

STRUCTURAL FORMULA



COMPILED BY

DATE 1947

Rev. By A. M. Ellenburg

7/5/47

NAME		SOURCE & DATE
Formula	C ₁₂ H ₉ Cl 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 at 90/15.5	1.577 - 1.587	Spec 4-11-55
Specific Gravity at		
Pounds per Gal. at 25 °C	13.7	
Coefficient of Expansion		
Refractive Index n _D		
Infra Red Spectrum (Reference)		
Ultra Violet Spectrum (Reference)		
Viscosity at		
Viscosity at		
Surface Tension		
Solubility in Water		
Solubility in		
Solubility in		
Sp. Gr. Temp Coeff. (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. E. Jacobs Vol. 1, p-463-464, 1941	

TRAN 009267

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STRUCTURAL FORMULA

FOUO

04-25-57

SOURCE & DATE

Flash Point $^{\circ}\text{C}$ (Method)	C. O. C.	180 C.	"
Fire Point $^{\circ}\text{C}$	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. F. OP. 1.5
Critical Temperature			
Critical Pressure			
Dissociation Constant			
Specific Heat @ 300 C.		0.320	"

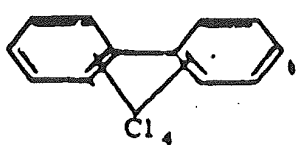
Other Constants	Pour Point	-14 C. or lower	"
	Thermal Conductivity, cal/cm ² /°C/sec.	24.0 @ 28 C.	To be published
	Dielectric Constant 100°C.	4.7 - 4.9	M. B. OP-115
	60 cy.		
			TRAN 009268
Toxicity (Give Reference)	Contact Medical Dept.	M. B. OP-115	

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PHYSICAL CONSTANTS DATA

487-9
8590

SUBSTANCE		STRUCTURAL FORMULA	
AROCLO 1248			
COMPILED BY A. M. Ellenburg		DATE 4-25-57	
NAME		SOURCE & DATE	
Formula		C ₁₂ H ₆ Cl ₄	
Molecular Weight		292 (Avg.)	
Appearance		Yellow Tinted Mob. Oil	
Boiling Point at 760 mm. Range		345-385°C.	
Boiling Point at 3 mm.		185-210°C.	
Boiling Point at 1 mm.			
Boiling Point at 0.5 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	
Pounds per Gal. @ 25°C.		12.04	
Coefficient of Expansion 25-65°C.		0.00070 cc/cc.°C.	
Refractive Index @ 25°C. D		1.6285-1.6305	
Intra Red Spectrum (Reference)			
Ultra Violet Spectrum (Reference)			
Viscosity @ 130°F.		73-80 SUS	
Viscosity @			
Surface Tension Dynes/cm @ 20°C.		44.2	
Solubility in Water		Insoluble	
Solubility in 3A Alcohol @ 25°C.		15 g./100 cc	
Solubility in Pyridine @ 29°C.		111.4 g./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	
Specific Heat @ 25°C.		0.277	
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.	
	Dielectric Constant, 100°C.	4.5-4.7	
	52. cy.		
		TRAN 009269	
Toxicity (Gus Reference)		Contact Medical Dept. M.B. OP-115	

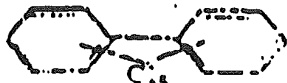
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PHYSICAL CONSTANTS DATA

SYST 4.
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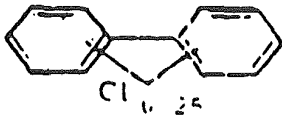
SUBSTANCE		STRUCTURAL FORMULA	
AROC'LOR 1254			
COMPILED BY A. M. Ellerburg		DATE 4-25-41	
NAME		SOURCE & DATE	
Formula		C12H5Cl10	
Molecular Weight		326 (Avg.)	
Appearance		Pale Yellow viscous oil	
Boiling Point at 760 mm Range		365-400°C	
Boiling Point at 3 mm		180-200°C	
Boiling Point at 1 mm			
Boiling Point at 0.5 mm			
Crystallizing Point		Non-crystallizable	
Melting Point			
Solution Point			
Specific Gravity at 25°C		1.438	
Specific Gravity at 65°C		1.425-1.430	
Pounds per Gal. at 25°C		12.82	
Coefficient of Expansion at 65°C		0.00066-0.00070	
Refractive Index at 20°C		1.6370-1.6390	
Infrared Spectrum (Reference)		Spec. Instr. 2-14-41	
Ultra Violet Spectrum (Reference)			
Viscosity at 210°F		44-48 S.S.	
Viscosity at 25°C		50.3 @ 25°C 42.0 @ 100°C	
Surface Tension		Insoluble	
Solubility in Water		10 g./100 cc	
Solubility in 3A Alcohol @ 2°C		114 g./100 cc	
Solubility in Pyridine @ 31°C			
Flash Point (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. cal./gm		50	
Specific Heat @ 25°C		0.261	
Critical Temperature			
Critical Pressure			
Dissociation Constant			
Specific Heat @ 300°C		0.336	
Pour Point		-12°C	
Thermal Conductivity, Cal/cm/°C/Sec.		22.9 @ 28°C	
Dielectric Constant, 100°C		4.15-4.35	
60 cc.			
Other Constants			
Toxicity (Give Reference)		Contact Medical Dept.	

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PHYSICAL CONSTANTS DATA

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SUBSTANCE		STRUCTURAL FORMULA
AROCLOH 1260		
PROPERTY BY		DATE
A. M. H. H. H. H. H.		4/13/57
NAME		SOURCE & DATE
Formula	C ₁₂ H ₁₀ Cl ₂	
Molecular Weight	306.1	
Appearance	Light yellow solid sticks	Monomerized Aroclor 1260
Boiling Point at 760 mm	Range 385-400°C	
Boiling Point at 3 mm	325-345°C	
Boiling Point at 1 mm		
Boiling Point at 0.5 mm		
Crystallizing Point	No crystallization	
Melting Point		
Solution Point		
Specific Gravity	1.20	
Specific Gravity	1.20	Specification 1.14
Pounds per Gal.	12.0	MB OP 115
Coefficient of Expansion	0.0007	
Refractive Index	1.545	Specification 1.14
Infrared Spectrum (Reference)		
Ultra Violet Spectrum (Reference)		
Viscosity	1.5 cP	MB OP 115
Viscosity		
Surface Tension		
Solubility in Water	Insoluble	
Solubility in		
Solubility in		
Flash Point OF (Method)	No	
Fire Point °C	No	
Heat of Combustion		
Heat of Formation		
Thermal Stability (cal. kg. min.)		
Latent Heat of Fusion		
Latent Heat of Vap.	40	Calculated
Specific Heat	0.22	MB OP 115
Critical Temperature		
Critical Pressure		
Disassociation Constant		
Specific Heat @ 300°C	0.303	
Boiling Point	385-400°C	
Dielectric Constant 100°C	3.638	
(0.5 cm)		
Other Constants		
Toxicity (Give Reference)	Conf. Med. Dept.	MB OP 115

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PHYSICAL CONSTANTS DATA

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SUBSTANCE		STRUCTURAL FORMULA	
AROCOR 1260 - 10% Toluol Mix		Mixture by Weight	
COMPILED BY A. M. Ellenburg		DATE 7/3/57	
NAME		SOURCE & DATE	
Formula			
Molecular Weight			
Appearance		Syrupy liquid	
Boiling Point at 760 mm		Specs. 4/11/55	
Boiling Point at mm			
Boiling Point at mm			
Boiling Point at mm			
Crystallizing Point			
Melting Point			
Solution Point			
Specific Gravity at 40/15.5°C		1.475-1.495	
Specific Gravity at 25°C		12.5	
Pounds per Gal. at 25°C			
Coefficient of Expansion			
Refractive Index at 20°C			
Infra Red Spectrum (Reference)			
Ultra Violet Spectrum (Reference)			
Viscosity at 100°F		50.2 cs. (232 SUS)	
Viscosity at 210°F		3.5 cs. (38 SUS)	
Surface Tension			
Solubility in Water			
Solubility in			
Solubility in			
Flash Point °F (Method) Tag open cup		105	
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)			

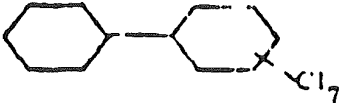
TRAN 009272

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PHYSICAL CONSTANTS DATA

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SUBSTANCE		STRUCTURAL FORMULA
AROCJ. OR 1262		
COMPILED BY A. M. Ellenburg		DATE 7/3/57
NAME	Formula	SOURCE & DATE
Formula	$C_{12}H_{10}Cl_2$	
Molecular Weight	395	
Appearance	Light yell. sticky Resin	Monsanto Bulletin OP-115 (195
Boiling Point at 760 mm	390-425°C	
Boiling Point at mm		
Boiling Point at mm		
Boiling Point at mm		
Crystallizing Point		
Melting Point		
Solution Point		
Specific Gravity 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	
Infrared 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

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

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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.

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TRAN 009274

AROCLORAPPENDIX DUTILITIES (Cont'd.)1. Power Consumption

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

<u>Item No.</u>	<u>Equipment Motor</u>	<u>Motor HP</u>	<u>Peak Load KW</u>	<u>Monthly Usage KWH</u>
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	#1 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	320
	Totals	135.75	119.8	26,860

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TRAN 009275

AROCLORAPPENDIX DUTILITIES (Cont'd.)1. Power Consumption (Cont'd.)

B. Electricity - 110 V., one phase, 60 cycle		Peak Load	Monthly Usage
<u>Equipment</u>		<u>KW</u>	<u>KWH</u>
Lighting		15	3600
Instrumentation		2	1440
Miscellaneous		<u>3</u>	<u>2150</u>
Totals		<u>20</u>	<u>7190</u>

2. Natural Gas

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

3. Compressed (plant) Air

<u>Item No.</u>	<u>Using Equipment</u>	<u>Normal Use SCFM</u>	<u>Peak Use SCFM</u>	<u>Monthly Usage MSCF</u>
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	<u>10</u>	<u>200</u>	<u>330</u>
	Totals	<u>370</u>	<u>1400</u>	<u>3460</u>

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TRAN 009276

AROCOR

APPENDIX D

UTILITIES (Cont'd.)

4. Nitrogen

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

5. Purchased Water

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

6. High Pressure Steam
200 PSIG at 388°F.

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

7. Low Pressure Steam
80 PSIG at 325°F.

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

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TRAN 009277

AROCLORAPPENDIX DUTILITIES (Cont'd.)7. Low Pressure Steam (Cont'd.)

<u>Item No.</u>	<u>Using Equipment</u>	<u>Normal Use Lb./hr.</u>	<u>Peak Use Lb./hr.</u>	<u>Monthly Usage M. Lbs.</u>
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	<u>7800</u>	<u>10,500</u>	<u>5600</u>

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TRAN 009278

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	$\frac{1}{2}$	$\frac{1}{2}$
Swingman	1	0
Total	12 $\frac{1}{2}$	9 $\frac{1}{2}$

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.

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TRAN 009279

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.

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TRAN 009280

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:

<u>Product</u>	<u>5 Gal.</u>	<u>Weights and Containers</u>		<u>TT</u>	<u>TC</u>
		<u>30 Gal.</u>	<u>55 Gal.</u>		
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#	-	-

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TRAN 009281

Dept. 246 - Process Description

AROCLOR

APPENDIX F

PACKAGING & SHIPPING (Cont'd.)

<u>Product</u>	<u>5 Gal.</u>	<u>Weights and Containers</u>		<u>TT</u>	<u>TC</u>
		<u>20 Gal.</u>	<u>55 Gal.</u>		
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#	-	-

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TRAN 009282

AROCLOR

APPENDIX G

MATERIAL BALANCE

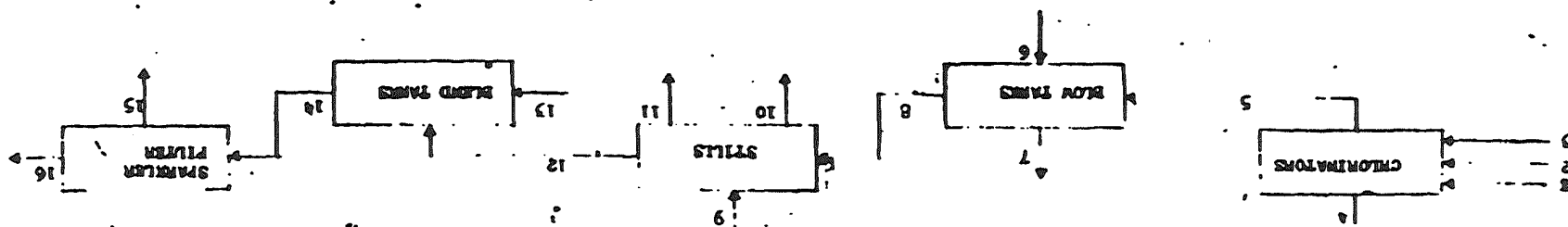
The material balance on Dept. 246 was made with a minimum of field measurements. Most of the estimates on the following page check fairly close with actual raw material usages that can be readily measured. The exact composition of some of the intermediate process streams is uncertain.

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TRAN 009283

TRAN 009284

LEADS MATERIAL PER 100 LBS. AMCLON

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LC 5-1-64

AROCLORAPPENDIX GSUMMARY OF MATERIAL BALANCE RESULTSAROCLOR 1242

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

AROCLOR 1248

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

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

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TRAN 009285

AROCLORAPPENDIX GSUMMARY OF MATERIAL BALANCE RESULTS (Cont'd.)AROCLOR 1254

<u>Raw Material & Cost (\$/lb.)</u>	<u>Usages - Theory</u>	<u>Lbs./100 lbs. product Material Balance</u>	<u>Material Balance Usages Lbs./100 lbs.</u>
Biphenyl (.0662)	46	49.8	46 Finished Product 0.5 Filter Cake 2.8 Still Bottoms 0.5 Off-Gas HCl <u>49.8</u>
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 <u>117.50</u>

AROCLOR 1260

Biphenyl (.0662)	40	43.4	40 Finished Product 0.9 Filter Cake 2.0 Still Bottoms 0.5 Off-Gas HCl <u>43.4</u>
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 <u>128.80</u>

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TRAN 009286

AROCLORAPPENDIX HATMOSPHERIC DISCHARGE - WASTE DISPOSAL

<u>Discharge to Atmosphere</u>	<u>Lbs. per C Lbs. of Aroclor Produced</u>	<u>Total Lbs./Yr. based on Prod. Rate 28.6Mlbs/yr</u>
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
<u>Discharge to Sewers</u>		
1. HCl from chlorinators	2.5*	500,000*
2. Cl ₂ from chlorinators	2.0*	30,000*
<u>Discharge to Waste Disposal</u>		
1. Montar	0.0176*	5,000*
2. Aroclor	0.33*	95,000*

*Estimated

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TRAN 009287

AROCLORAPPENDIX IPROCESS CONTROL

<u>Sampling Point</u>	<u>Frequency</u>	<u>Reason for Sample</u>	<u>****Normal Range</u>	<u>Method Number</u>
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 ₂ O) (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.	500, Min.	11,607
		0.1" GAP as ohm-cm X 10 ⁹		
		*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.

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TRAN 009288

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 Vapometer

6. Eye Baths

7. Sprinkler System

Safety Precautions

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

1. Safety Equipment of Employee

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

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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 explode at high temperatures when exposed to flames.

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AROCLOR

APPENDIX J

SAFETY & TOXICITY DATA (Cont'd.)

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

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

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

Shipping: There are no special shipping restrictions.

FERRIC CHLORIDE (FeCl₃)

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 FeCl₃ 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 (C₆H₅C₆H₅)

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.

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AROCLOR

APPENDIX J

SAFETY & TOXICITY DATA (Cont'd.)

DIPHENYL (C₆H₅C₆H₅) (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 (C₆H₄(CH₃)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 ingested, get patient to vomit. Wash eyes and skin with water.

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

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

TRICHLOROBENZENE:

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

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

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

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

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AROCLOL

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.

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AROCLOR

APPENDIX J

SAFETY & TOXICITY DATA (Cont'd.)

ATTAPULGUS EARTH:

Toxicity: This earth is not toxic in general.

Fire Hazard: There is no fire hazard.

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

Treatment and Antidotes: Consult a physician.

Storage and Handling: Attapulug 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 ingested, eat chalk, magnesium hydroxide, egg whites, and milk, and also administer oxygen. Call a physician.

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

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

CHLORINE (Cl₂)

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

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AROCLOR

APPENDIX J

SAFETY & TOXICITY DATA (Cont'd.)

CHLORINE (Cl₂) (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.

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TRAN 009295

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.

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TRAN 009296

Monsanto Company
Monsanto, Illinois

Accepted by production

WBJ

SAFETY REVIEW COMMITTEE

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 $FeCl_3$ 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

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TRAN 009297

WATER_PCB-SD0000019526

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

APPROVAL:

DATE:

Original signed by:

P. E. Heisler
P. E. Heisler - WOK

2/11/64
Date

E. E. Martin
E. E. Martin - WOK

2/11/64
Date

D. B. Hosmer
D. B. Hosmer - G. O.

2/14/64
Date

R. W. Bucknell
R. W. Bucknell - J. F. Q.

2/19/64
Date

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TRAN 009298

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 Attapulugus 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
Attapulugus treatment and final filtration are optional but not necessary.

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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 heat transfer 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:

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TRAN 009300

1. R. S. Wobus
2. C. Barbre
3. T. H. Becker
4. J. Soffranko
5. St. L. Res. Lib.
6. St. L. Res. Lib.
7. Plant B

8. England
9. P. G. Marsh
10. Plant B
11. Plant B
12. Plant B
13. H. L. Hubbard
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 conduct 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

In
January 24 1951

APPROVED:

Original Signed by:

H. L. Hubbard 1/25/51
H L Hubbard Date

T. W. Dalton 1/25/51
T. W Dalton Date

D. B. Hosmer 1/26/51
D. B. Hosmer Date

O. J. Weinkauff 1/25/51
O. J. Weinkauff Date

C. Barbre 6/25/51
C. Barbre Date

Paul G. Marsh 1/26/51
P. G. Marsh Date

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TRAN 009301

SAFETY REVIEW COMMITTEE

Original Signed by:

T.M.P. 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.

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TRAN 009302

September 27, 1957

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 eliminate 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, Progress Report No. 5; Job No. 3428 Code IND FL, of August, 1957 by H. Merten and A. M. Ellanburg.

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 or 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		Stability Chloride ppm./16 hrs.
	Low	High	
319	94	116	0.80
320	110	129	0.74
321	133	145	0.49

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September 27, 1957

TABLE II

<u>Circulation</u>	<u>Aroclor No.</u>	<u>Lot No.</u>	<u>Stability Chloride ppm./16 hrs.</u>
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

In

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

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TRAN 009304

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 - WQK
J. R. Kellogg - WQK
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 certain material produced in July and August, 1956, make it mandatory that we maintain our Aroclor quality at its maximum at all times.

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TRAN 009305

March 13 1957

-2-

Tentative Amendment No. A

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 taken 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

In

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TRAN 009306

WATER_PCB-SD0000019535

Monsanto, Illinois

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

June 8, 1959

R.F.H. 6-12-59

R. H. M. 6-15-59

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.

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This proposed process ammendment has tentative approval from Research.

J. R. Kellogg

In
Original Signed by:

T. W. Dalton
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AROCLORAPPENDIX LTIME 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 summarized below:

<u>Operation</u>		<u>Time (hours)</u>	<u>Equivalent pounds of Finished Product</u>
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:

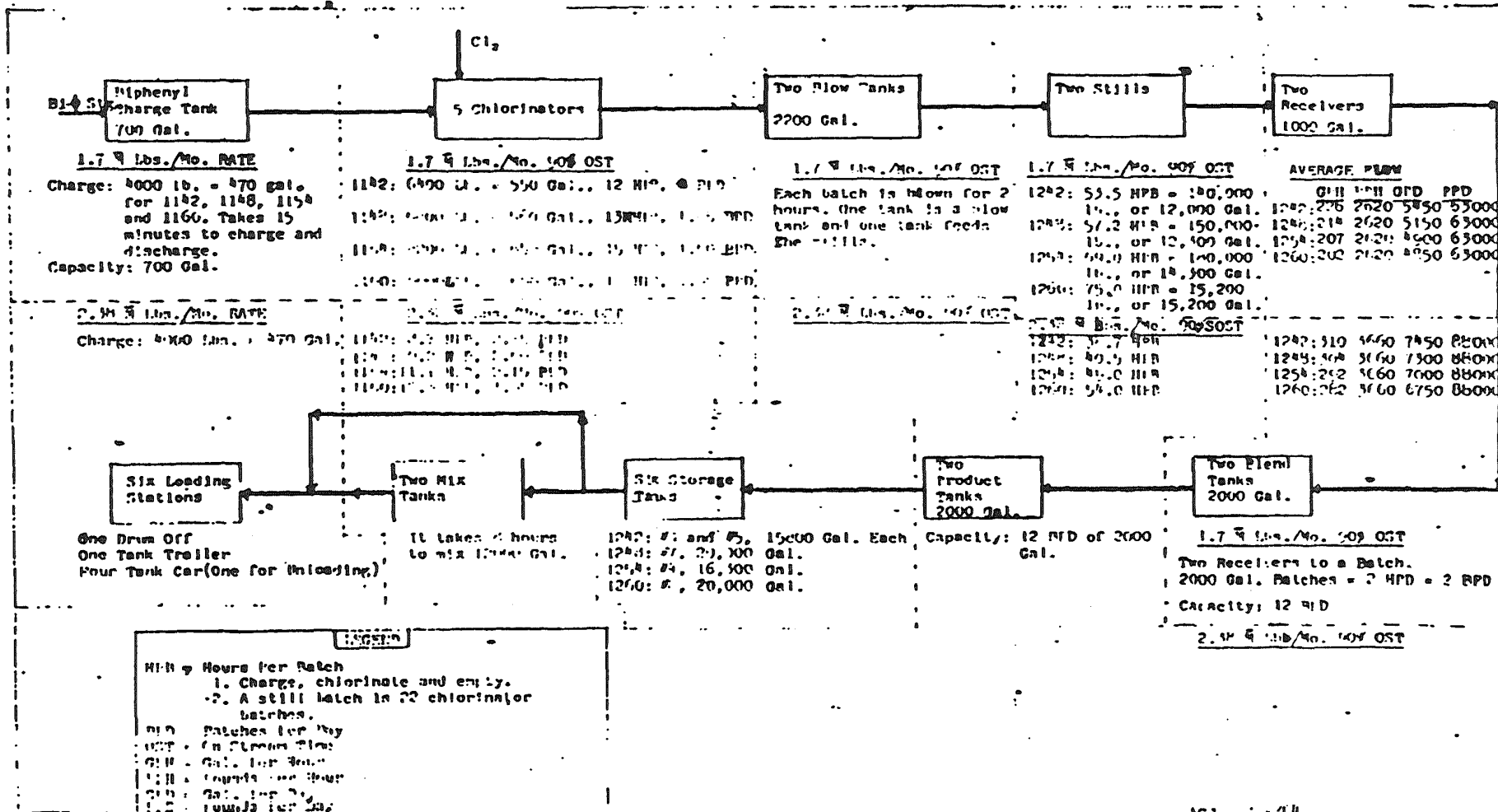
<u>Aroclor</u>	<u>Batch Time (hrs.)</u>
1242	18.95
1248	19.45
1254	21.35
1260	22.55

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

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Figure 1. AROCLOR FLOW SHEET WITH BATCH SIZE AND RATES



TRAN 009310

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WATER_PCB-SD0000019539

Dept, 246 - Process DescriptionAROCLORAPPENDIX MQUALITY 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.

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Department 246 - Process DescriptionAROCLORAPPENDIX MQUALITY 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 Sulfonates 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.

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Dept. 246 - Process DescriptionAROCLORAPPENDIX MQUALITY 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 Attapulugus 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.

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TRAN 009313

AROCLOR

APPENDIX M

QUALITY CONSIDERATIONS (Cont'd.)

Absorbents

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

The most satisfactory absorbent found 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 ultraviolet 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 irradiated, then exposed to a thermal treatment, appreciably more HCl is liberated.

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AROCLORAPPENDIX MQUALITY CONSIDERATIONS (Cont'd.)TABLE IADSORBENT SCREENING DATA

<u>Adsorbent</u>	<u>Adsorbent Pretreatment</u>	<u>Contact Temperature °C.</u>	<u>Volume Resistivity at 100°C. ohm-cm. x 10⁰</u>
LVM Attapulugus Earth	None	60	3400
		80	2000
		100	2800
		120	2900
LVM Attapulugus Earth	Heated at 250°C.- 12 hours.	60	4200
		80	6400
		100	7200
		120	6100
LVM Attapulugus Earth.	Heated at 350°C.- 12 hours.	60	9300
		80	9000
		100	6300
		120	6300
LVM Attapulugus 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

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AROCORAPPENDIX MQUALITY CONSIDERATIONS (Cont'd.)TABLE I (Cont'd.)

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

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

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TRAN 009316

AROCLORAPPENDIX MQUALITY CONSIDERATIONSTABLE IITHERMAL DEGRADATION OF AROCLORS AT 250°C.

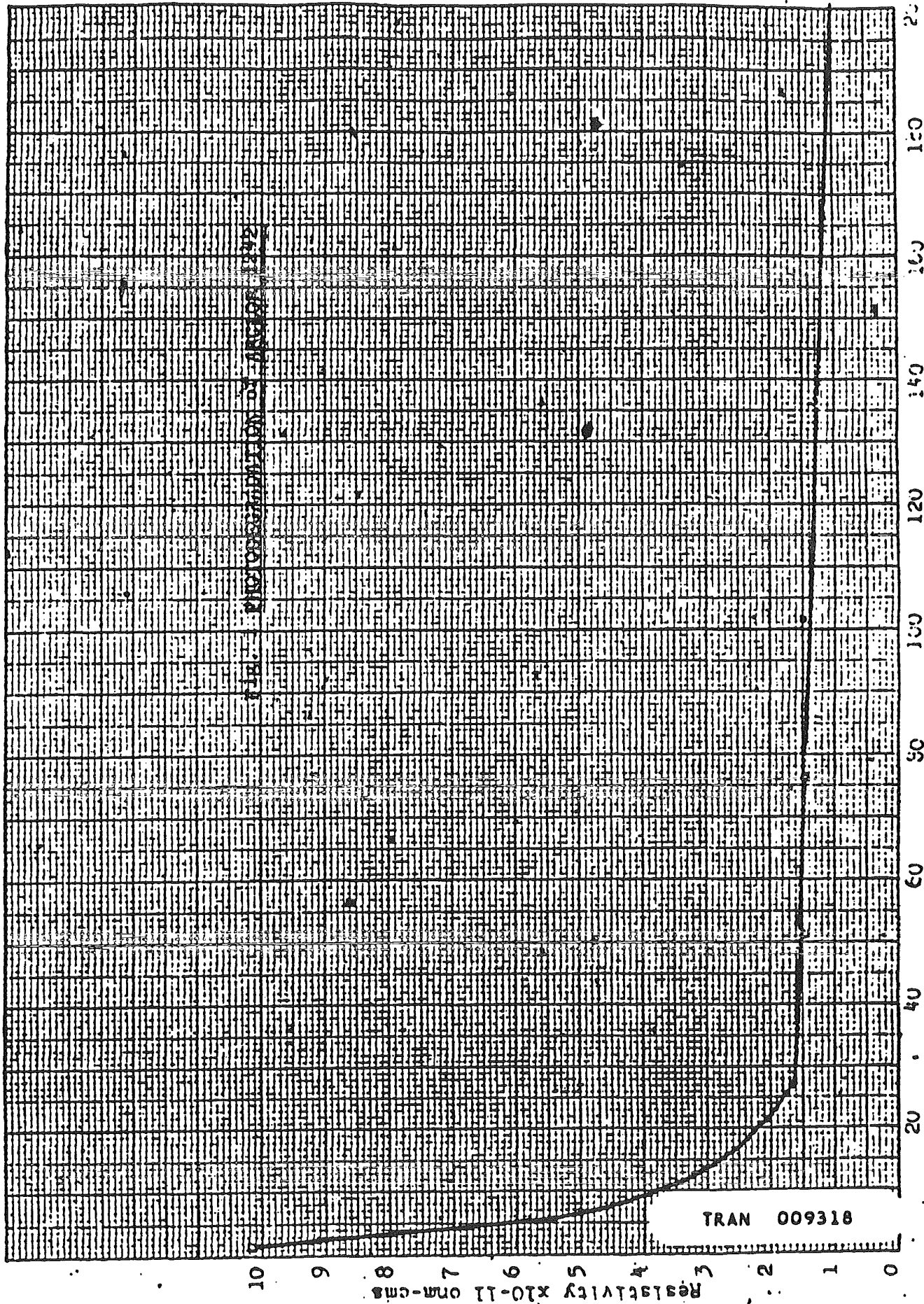
<u>Aroclor</u>	<u>gm. of HCl/gm x 10⁶</u>	<u>Heating Time</u>
1221	3.35	1 hr.
	6.73	2 hrs.
	11.07	5 hrs.
1232	3.91	1 hr.
	6.42	2 hrs.
	9.81	5 hrs.
1242	5.96	1 hr.
	9.58	2 hrs.
	13.00	5 hrs.
1248	3.61	1 hr.
	5.44	2 hrs.
	8.48	5 hrs.
1254	3.43	1 hr.
	3.96	2 hrs.
	6.43	5 hrs.

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TRAN 009317

K-E 10X10 TO 4 INCH 48 1323
7 1/2 INCHES
KENTON & BROWN CO.

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Dept. 246 - Process DescriptionAROCLORAPPENDIX NMISCELLANEOUSREFERENCES

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 precursor 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.

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Dept. 246 - Process DescriptionAROCLORAPPENDIX NMISCELLANEOUSREFERENCES

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 Attapulugus 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.

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TRAN 009320

AROCLORAPPENDIX NMISCELLANEOUS

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

<u>Aroclor</u>	<u>Evaporation Rate</u> <u>gms./cm²/hr./100° C.</u>
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:

<u>Catalyst</u>	<u>Isomer Distribution of Aroclor 1232</u>						<u>tri</u>
	<u>2 -</u>	<u>4 -</u>	<u>2,2' -</u>	<u>2,4 -</u>	<u>2,4' -</u>	<u>4,4'</u>	
Fe Cl ₃	15%	7%	15%	6%	38%	11%	9%
Sb Cl ₃	11	0.7	20	3.6	38	18	9
Ti Cl ₄	11	0	20	2.2	46	14	7
Sn Cl ₄	24	1	16	2.3	38	18	1.3

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TRAN 009321

AROCLORAPPENDIX NMISCELLANEOUS (Cont'd.)

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

CHLORINATORS

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

BLOW TANKS

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

Not enough vacuum	1. Ejectors not pulling properly 2. Coke scrubber Contains water	1. Check Ejectors 2. Drain Coke scrubber
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36" SPARKLER FILTER

Foreign material in filtrate samples	Dirty filter or broken paper	Clean & re-paper press
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PRODUCTION COST STANDARD

PLANT
W. C. Krummrich

PAGE 1 OF 1

PRODUCT	AROLAN	DEPT. NO.	246	PROD. CODE	81100
1 THEORY TO STD. ON	82601	9550	CAPACITY 1700000	EFFECTIVE	JAN 1 1964
2 THEORY TO STD. ON	81064	9300	COST UNIT	INV. UNIT COST	

MATERIAL CODE	NAME	QUANTITY PER UNIT		PRICE PER LB.	UNIT COST
		THEORY	STANDARD		
19400	ATTACHMENT CLAM		150	03025	005
32900	LIME HYDROXIDE		500	01090	005
33500	FERRIC CHLORIDE		230	12950	004
AROLAN 1242 - 81101					
82601	BIPHENYL	5919	61980	04980	4326
81064	CHLORINE	9400	90320	01925	1762
AROLAN 1248 - 81102					
82601	BIPHENYL	5937	55380	06980	3900
81064	CHLORINE	9400	103220	01925	1991
AROLAN 1254 - 81103					
82601	BIPHENYL	4764	49780	06980	3475
81064	CHLORINE	10800	116130	01925	2110
AROLAN 1260 - 81105					
82601	BIPHENYL	4171	43680	06980	3044
81064	CHLORINE	12000	129030	01925	2469
AROLAN 1262 - 81107					
82601	BIPHENYL	3976	41630	06980	2906
81064	CHLORINE	12400	133330	01925	2572
AROLAN 1272 - 81115					
82601	BIPHENYL	6891	72160	06980	5037
81064	CHLORINE	6400	69820	01925	1328
AROLAN 1284 (10% STRENGTH) 81117					
81107	AROLAN 1284	2000	20000	01135	6488
WOODS	YULEN	1000	10100	05740	580

RAW MATERIAL WAREHOUSING & HANDLING					007
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GROSS TOTAL MATERIALS

BY-PRODUCTS

82601 NET GAS SALES & USE

6 1/2% LOSS THEORY - LOSS FROM WAREHOUSE OF AROLAN GROUP X 2
 02 1/2% LOSS THEORY (WATER LOSS THEORY) X 2 = 0.0283
 6 1/2% LOSS THEORY - LOSS FROM WAREHOUSE / 0.0283
 02 1/2% LOSS THEORY - LOSS FROM WAREHOUSE / 0.0283
 6 1/2% LOSS THEORY - LOSS FROM WAREHOUSE / 2 X 1.0283

TOTAL BY-PRODUCTS

NET TOTAL MATERIALS

CLASSIFICATION	AMOUNT	CLASSIFICATION (Contd.)	AMOUNT
COST OF SHUT-DOWN		COST OF STAND-BY	
COST OF START-UP		COST TO MOVE A MAN	
COST OF CHANGE-OVER		STAND-BY LABOR - NO. OF MEN	

PRODUCTION CODE	CAPACITY	OTHER DATA
811.01	0.07491	0.0781
811.02	0.07314	0.0741
811.03	0.07138	0.0751
811.05	0.06961	0.0705
811.07	0.06901	0.0705
811.15	0.07738	0.0785
811.17	0.07075	0.0717
811.09	0.08451	

Cost - STD

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PRODUCTION
CONTROL DATA

OTHER PRODUCTS PRODUCED IN
CONNECTION WITH THIS PRODUCT

TRAN 009324